

## Chapter 1 About Science

- 1-1) In science, facts (a) are absolute (b) may change (c) mean very little (d) are more important than theories
- 1-2) The synthesis of a large collection of information that contains well tested and verified hypotheses about certain aspects of the world is known as a scientific (a) fact (b) hypothesis (c) law or principle (d) theory (e) none of these
- 1-3) In science, a theory is (a) an educated guess (b) less than a fact (c) a synthesis of a large body of well tested knowledge (d) unchangeable
- 1-4) A scientific hypothesis may turn out to be right or it may turn out to be wrong. If it is a valid hypothesis, there must be a test for proving it (a) right (b) wrong
- 1-5) Science, art, and religion do not contradict one another because (a) all three have different domains (b) if you choose the right one, you can forget the other two (c) if you choose religion and art you can forget about science (d) if you choose science you can forget about religion and art
- 1-6) Science and technology are (a) really one and the same (b) responsible for all the good in the world (c) responsible for all the bad in the world (d) fundamentally different from each other
- 1-7) Of the sciences known as physics, chemistry, and biology, the most basic is (a) physics (b) chemistry (c) biology (d) none in particular, as each may be considered fundamental
- 1-8) A scientific idea that is so well established that it cannot be questioned is (a) an hypothesis (b) a theory (c) a law (d) an impossibility
- 1-9) Early Greeks knew (to a fair approximation) (a) the size of the moon (b) the size of the earth (c) the earth-moon distance (d) all of the above (e) none of the above

## Chapter 2 Linear Motion

- 1-10) Galileo's use of inclined planes allowed him to effectively (a) slow down the acceleration of free fall (b) increase the acceleration beyond that of free fall (c) eliminate the acceleration of free fall (d) all of these (e) none of these
- 1-11) As an object freely falls, its (a) velocity increases (b) acceleration increases (c) both of these (d) none of these
- 1-12) If a freely falling object were somehow equipped with a speedometer, its speed reading would increase each second by about (a) 5 m/s (b) 10m/s (c) 15 m/s (d) a variable amount (e) depends on its initial speed
- 1-13) If a freely falling object were somehow equipped with an odometer to measure the distance it travels, then the amount of distance it travels each succeeding second would be (a) constant (b) less and less (c) greater than the second before

- 1-14) A heavy object and a light object are dropped at the same time from rest in a vacuum. The heavier object reaches the ground (a) sooner than the lighter object (b) at the same time as the lighter object (c) later than the lighter object
- 1-15) A ball tossed vertically upward rises, reaches its highest point, and then falls back to its starting point. During this time the acceleration of the ball is always (a) in the direction of motion (b) opposite its velocity (c) directed upward (d) directed downward
- 1-16) While a car travels around a circular track at constant speed its (a) acceleration is zero (b) velocity is zero (c) both of these (d) none of these
- 1-17) A ball is thrown upwards and caught when it comes back down. Neglecting air resistance, its speed when caught is (a) more than the speed it had when thrown upwards (b) less than the speed it had when thrown upwards (c) the same as the speed it had when thrown upwards
- 1-18) At one instant an object in free fall is moving upward at 50 meters per second. One second later its speed is about (a) 100 m/s (b) 60 m/s (c) 55 m/s (d) 50 m/s (e) 40 m/s
- 1-19) Starting from rest, the distance a freely falling object will fall in 10 seconds is about (a) 10 m (b) 50 m (c) 100 m (d) 500 m
- 1-20) Starting from rest, the distance a freely falling object will fall in 0.5 seconds is about (a) 0.5 m (b) 1.0m (c) 1.25 m (d) 5.0 m (e) none of these
- 1-21) An object falls freely from rest on a planet where the acceleration due to gravity is 20 meters per second squared. In the first 5 seconds it falls a distance of (a) 100 m (b) 150m (c) 250 m (d) 500 m (e) none of these
- 1-22) An apple falls from a tree and hits the ground 5 meters below. It hits the ground with a speed of about (a) 5 m/s (b) 10 m/s (c) 15 m/s (d) 20 m/s (e) not enough information given to estimate
- 1-23) It takes 6 seconds for a stone to fall to the bottom of a mineshaft. How deep is the shaft? (a) About 60 m (b) about 120 m (c) about 180 m (d) more than 200 m
- 1-24) A car accelerates at 2 meters per second per second. Assuming the car starts from rest, how far will it travel in the first 10 seconds? (a) 2 meters (b) 10 meters (c) 40 meters (d) 100 meters (e) 200 meters
- 1-25) If a projectile is fired straight up at a speed of 10 m/s, the total time to return to its starting position is about (a) 1 second (b) 2 seconds (c) 10 seconds (d) 20 seconds (e) not enough information to estimate
- 1-26) If a rocket accelerates from rest at a rate of 50 m/s/s for 10 seconds, the distance it will cover during this time is (a) 250 m (b) 500 m (c) 2500 m (d) 5000 m (e) none of these

### Chapter 3 Nonlinear Motion

1-27) A car accelerates at 2 meters per second per second. Assuming the car starts from rest, how much time does it need to accelerate to a speed of 30 m/s? (a) 2 seconds (b) 15 seconds (c) 30 seconds (d) 60 seconds (e) none of these

1-28) When a rock thrown straight upwards gets to the exact top of its path, its (a) velocity is zero and its acceleration is zero (b) velocity is zero and its acceleration is about 10 meters per second per second (c) velocity is about 10 m/s and its acceleration is zero (d) velocity is about 10 m/s and its acceleration is about 10 meters per second per second (e) none of these

1-29) A bullet is fired straight down from the top of a high cliff. Neglecting air resistance, the acceleration of the bullet in meters per second per second is (a) less than 9.8 (b) 9.8 (c) more than 9.8

1-30) The muzzle velocity of a certain gun is 100 m/s. Neglecting air resistance, at the end of one second a bullet fired straight up into the air will have traveled a distance of (a)  $(100 - 4.9)$  m (b)  $(100 + 4.9)$  m (c) 100 m (d) 4.9 m (e) none of these

1-31) Someone standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed will be (a) the one thrown upward (b) the one thrown downward (c) neither - they will both hit with the same speed

1-32) A ball is thrown upwards. Neglecting air resistance, what initial upward speed does the ball need to remain in the air for a total time of 10 seconds? (a) about 50 m/s (b) about 60 m/s (c) about 80 m/s (d) about 100 m/s (e) about 110 m/s

1-33) A pot falls from a ledge and hits the ground 45 m below. The speed with which it hits the ground is about (a) 30 m/s (b) 60 m/s (c) 120 m/s (d) more than 120 m/s

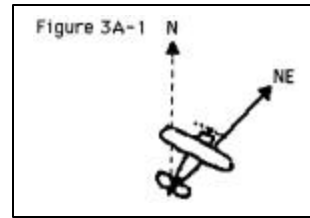
1-34) The vertical height attained by a basketball player who achieves a hang time of a full 1 s is about (a) 0.8 m (b) 1m (c) 1.2 m (d) 2.5 m (e) more than 2.5 m

1-35) A man leans over the edge of a cliff and throws a rock upward at 4.9 m/s. Neglecting air resistance, one second later the rock's speed is (a) zero (b) 4.9 m/s (c) 9.8 m/s (d) 14.7 m/s (e) none of the above

1-36) A man leans over the edge of a cliff and throws a rock upward at 4.9 m/s. Neglecting air resistance, two seconds later the rock's speed is (a) zero (b) 4.9 m/s (c) 9.8 m/s (d) 14.7 m/s (e) none of the above

1-37) A man leans over the edge of a cliff and throws a rock upward at 4.9 m/s. How far below the level from which it was thrown is the rock 2 seconds later? (a) 4.9 m (b) 9.8 m (c) 14.7 m (d) 19.6 m

1-38) An airplane that flies at 100 km/h in a 100 km/h hurricane crosswind has a ground speed of (a) 0 km/h (b) 100 km/h (c) 141 km/h (d) 200 km/h



1-39) An airplane (Fig 3A-1) travels at 141 km/h toward the northeast. What is its component of velocity due north? (a) 41 km/h (b) 100 km/h (c) 110 km/h (d) 141 km/h

1-40) A rock is thrown upward at 50 degrees with respect to the horizontal. As it rises, its horizontal component of velocity (a) increases (b) remains unchanged (c) decreases

1-41) Throw an object at an angle upward. With no gravity it will follow a straight line path. But because of gravity, at the end of 1 second, it is (a) about 5 m below the straight line (b) about 10 m below the straight line (c) about 15 m below the straight line

1-42) Roll a bowling ball off the edge of a table. As it falls, its horizontal component of velocity (a) decreases (b) remains constant (c) increases

1-43) A bullet fired from a rifle begins to fall (a) as soon as it leaves the barrel (b) after air friction reduces its speed (c) neither of these

1-44) Earth satellites are typically more than 100 km high so as to be above the earth's (a) atmosphere (b) gravitational field (c) both of these

1-45) A projectile is fired horizontally in a region of no air resistance. The projectile maintains its horizontal component of velocity because (a) it is not acted on by any forces (b) it is not acted on by any horizontal forces (c) it has no vertical component of velocity to begin with (d) the net force acting on it is zero (e) none of these

1-46) A bullet fired horizontally over level ground hits the ground in 0.5 seconds. If it had been fired with twice the speed in the same direction, it would have hit the ground in (a) less than 0.5 s (b) more than 0.5 s (c) 0.5 s

1-47) A projectile is thrown into the air at an angle of 50 degrees and lands on a target that is at the same level at which the projectile started. It will also land on the target if it is thrown at an angle of (a) 40 degrees (b) 45 degrees (c) 55 degrees (d) 60 degrees (e) none of these

1-48) A gun with a muzzle velocity of 100 m/s is fired horizontally from a tower. Neglecting air resistance, where will the bullet be 1 second later? (a) 50 m down range (b) 98 m down range (c) 100 m down range (d) 490 m down range (e) none of these

1-49) Two projectiles are fired from ground level at equal speeds but different angles. One is fired at an angle of 30 degrees and the other at 60 degrees. The projectile to hit the ground first will be the one fired at (neglect air resistance)  
(a) 30 degrees (b) 60 degrees (c) both hit at the same time

1-50) What prevents satellites such as the space shuttle from falling? (a) Gravity (b) the absence of air drag (c) nothing, they're falling continuously all around the earth

1-51) A projectile is fired vertically from the surface of the earth at 8 km/s. The projectile will (a) go into circular orbit about the earth (b) rise and fall back to the earth's surface (c) follow an uncertain path

1-52) Suppose the circumference of a bicycle wheel is 2 meters. If it rotates at 1 revolution per second when you are riding the bicycle, then your speed will be (a) 1 m/s (b) 2 m/s (c) 3 m/s (d) 3.14 m/s (e) 6.28 m/s

1-53) Without air resistance, a projectile fired horizontally at 8 km/s from atop a mountain will (a) accelerate downward at  $g$  as it moves horizontally (b) trace a curve that matches the earth's curvature (c) return later to its starting position and repeat its falling behavior (d) all of these (e) none of these

1-54) An object is thrown vertically into the air. Because of air resistance, the time for its descent will be (a) longer than the ascent time (b) shorter than the ascent time (c) equal to the ascent time (d) not enough information given to say

1-55) An airplane flies at 40 m/s at an altitude of 50 meters. The pilot drops a heavy package which falls to the ground. Where, approximately, does the package land relative to the plane's new position? (a) Beneath the plane (b) 400 m behind the plane (c) 500 m behind the plane (d) more than 500 m behind the plane (e) none of these

1-56) A bullet is fired horizontally with an initial velocity of 300 m/s from a tower 20 m high. If air resistance is negligible, the horizontal distance the bullet travels before hitting the ground is about (a) 200 m (b) 300 m (c) 400 m (d) 500 m (e) 600 m

1-57) A river 100 m wide flows due south at 1 m/s. A boat that goes 1 m/s relative to the water is pointed due east as it crosses from the west bank. The boat reaches the east bank (a) due east of where it started (b) 141 m farther south than where it started (c) 100 m farther south than where it started (d) 100 m farther north than where it started

1-58) A river 100 m wide flows due south. A boat that goes 1 m/s relative to the water is pointed due east as it crosses from the west bank. Relative to the earth, the boat travels (a) nowhere (b) 141 m (c) 100 m (d) 200 m (e) 241 m

1-59) A river 100 m wide flows due south. A boat that goes 1 m/s relative to the water is pointed due east as it crosses from the west bank. The boat crosses in (a) 50 s (b) 100 s (c) 141 s (d) 200 s

1-60) A river 100 m wide flows due south at 1 m/s. A boat that goes 1 m/s relative to the water leaves the west bank. To land at a point due east of its starting point, the boat must be pointed (a) northeast (b) east (c) southeast (d) nowhere - it can't be done

#### Chapter 4 Newton's Laws of Motion

##### a) Newton's First Law of Motion

1-61) Whirl a rock at the end of a string and it follows a circular path. If the string breaks, the tendency of the rock is to (a) continue to follow a circular path (b) follow a straight line path

1-62) Your weight is (a) actually your mass (b) the gravitational attraction between you and the earth (c) a property of mechanical equilibrium (d) all of these (e) none of these

1-63) Compared to the mass of a certain object on earth, the mass of the same object on the moon is (a) less (b) more (c) the same

1-64) Strange as it may seem, it is just as hard to accelerate a car on the moon as it is to accelerate the same car on earth. This is because (a) the mass of the car is independent of gravity (b) the weight of the car is independent of gravity (c) . Nonsense! A car is much more easily accelerated on the moon than on the earth

1-65) A package falls off a truck that is moving at 30 m/s. Neglecting air resistance, the horizontal speed of the package just before it hits the ground is (a) zero (b) less than 30 m/s but larger than zero (c) about 30 m/s (d) more than 30 m/s (e) more information needed for an estimate

1-66) The newton is a unit of (a) force (b) mass (c) density (d) inertia

1-67) A hockey puck is set in motion across a frozen pond. If ice friction and air resistance are neglected the force required to keep the puck sliding at constant velocity is (a) zero newtons (b) equal to the weight of the puck (c) the weight of the puck divided by the mass of the puck (d) the mass of the puck multiplied by 9.8 meters per second per second (e) none of these

1-68) A truck is moving at constant velocity. Inside the storage compartment, a rock is dropped from the midpoint of the ceiling and strikes the floor below. The rock hits the floor (a) exactly below the midpoint of the ceiling (b) ahead of the midpoint of the ceiling (c) behind the midpoint of the ceiling (d) more information is needed to solve this problem (e) none of these

1-69) As a bird sits on the limb of a tree, both the bird and the tree are moving about 30 km/s with respect to the sun. About 400 years ago, people philosophized that if the bird took 1 second to drop from the tree to a worm below, the worm would be 30 km downrange from the bird when it reached the ground. This was offered as evidence that the

earth does not revolve around the sun. This reasoning is best countered with Newton's (a) first law (b) second law (c) third law (d) law of gravitation (e) none of these

1-70) In which case would you have the largest mass of gold? If your chunk of gold weighed 1 N on the (a) moon (b) earth (c) planet Jupiter

1-71) An object weighs 30 N on earth. A second object weighs 30 N on the moon. Which has the greater mass? (a) the one on earth (b) the one on the moon (c) they have the same mass (d) not enough information to say

#### Chapter 4 Newton's Laws of Motion

##### b) Newton's Second Law of Motion

1-72) A force is a vector quantity because it has both (a) magnitude and direction (b) mass and acceleration (c) action and reaction counterparts

1-73) An object is propelled along a straight line path in space by a force. If the mass of the object somehow becomes twice as much, its acceleration (a) quadruples (b) doubles (c) stays the same (d) halves (e) none of these

1-74) The force of friction on a sliding object is 10 newtons. The applied force needed to maintain a constant velocity is (a) more than 10 N (b) less than 10 N (c) 10 N

1-75) A 10 N falling object encounters 10 N of air resistance. The net force on the object is (a) 0 N (b) 4N (c) 6N (d) 10 N (e) none of these

1-76) An apple weighs 1 N. When held at rest above your head, the net force on the apple is (a) 0 N (b) 0.1 N (c) 1 N (d) 9.8 N (e) none of these

1-77) An apple weighs 1 N. The net force on the apple when it is in free fall is (a) 0 N (b) 0.1N (c) 1 N (d) 9.8 N (e) none of these

1-78) Whenever the net force on an object is zero, its acceleration (a) may be zero (b) is zero

1-79) A heavy block at rest is suspended by a vertical rope. When the block is accelerated upward by the rope, the rope tension (a) increases (b) decreases (c) remains the same

1-80) If a non-rotating object has no acceleration, then we can say for certain that it is (a) at rest (b) moving at constant non-zero velocity (c) in mechanical equilibrium (d) all of these (e) none of these

1-81) Hang from a pair of gym rings and the upward support forces of the rings will always (a) each be half your weight (b) each be equal to your weight (c) add up to equal your weight

1-82) A tow truck exerts a force of 3000 N on a car, accelerating it at 2 meters per second per second. What is the mass of the car? (a) 500 kg (b) 1000 kg (c) 1500 kg (d) 3000 kg (e) none of these

1-83) A girl pulls on a 10 kg wagon with a constant horizontal force of 30 N. If there are no other horizontal forces, what is the wagon's acceleration in meters per second per second? (a) 0.3 (b) 3.0 (c) 10 (d) 30 (e) 300

1-84) A force of 1 N accelerates a mass of 1 kg at the rate of 1 m/s/s. The acceleration of a mass of 2 kg acted upon by a net force of 2 N is (a) half as much (b) twice as much (c) the same (d) none of these

1-85) The mass of a pet turtle that weighs 10 N is about (a) 1 kg (b) 10 kg (c) 100 kg (d) 1000 kg (e) none of these

1-86) The force required to maintain an object at a constant velocity in free space is equal to (a) zero (b) the mass of the object (c) the weight of the object (d) the force required to stop it (e) none of these

1-87) Neglecting friction, a large block of ice and a small block of ice start sliding down an incline together. The heavier block will get to the bottom (a) before the light block (b) after the light block (c) at the same time as the light block

1-88) A rock is thrown vertically into the air. At the top of its path, its acceleration in meters per second per second is (a) zero (b) 9.8 (c) between 0 and 9.8 (d) greater than 9.8 (e) none of these

1-89) A block is dragged without acceleration in a straight line path across a level surface by a force of 6 N. What is the force of friction between the block and the surface? (a) less than 6 N (b) more than 6 N (c) 6 N (d) need more information to say

1-90) Suppose a particle is being accelerated through space by a 10 N force. Suddenly the particle encounters a second force of 10 N in the opposite direction from the first force. The particle with both forces acting on it (a) is brought to a rapid halt (b) decelerates gradually to a halt (c) continues at the speed it had when it encountered the second force (d) theoretically tends to accelerate toward the speed of light (e) none of these

1-91) A jumbo jet has a mass of 100 000 kg. The thrust for each of its four engines is 50 000 N. What is the jet's acceleration in meters per second per second when taking off? (a) 0.25 (b) 1 (c) 2 (d) 4 (e) none of these

1-92) The brakes of a speeding truck are slammed on and it skids to a stop. If the truck were heavily loaded so that it had twice the total mass, the skidding distance would be (a) 1/2 as far (b) 1 1/2 times as far (c) 2 times as far (d) 4 times as far (e) the same

1-93) A skydiver of mass 100 kg experiences air resistance of 500 N. and an acceleration of about (a) 0.2g (b) 0.3g (c) 0.4 g (d) 0.5 g (e) more than 0.5 g

1-94) A 10 kilogram block with an initial velocity of 10 m/s slides 10 meters across a horizontal surface and comes to rest. It takes the block 2 seconds to stop. The stopping force

acting on the block is about (a) 5 N (b) 10 N (c) 25 N (d) 50 N (e) none of these

- 1-95) A 10 kilogram block is pushed across a horizontal surface with a horizontal force of 20 N against a friction force of 10 N. The acceleration of the block in meters per second per second is (a) 1 (b) 2 (c) 5 (d) 10 (e) none of these
- 1-96) If you are driving at 20 m/s and slam on your brakes and skid at 0.5 g to a full stop, the skidding time in seconds is about (a) 3 (b) 4 (c) 5 (d) 6 (e) more than 6
- 1-97) A 2000 kg car experiences a braking force of 10 000 N and skids to a stop in 6 seconds. The speed of the car just before the brakes were applied was (a) 1.2 m/s (b) 15 m/s (c) 30 m/s (d) 45 m/s (e) none of these
- 1-98) What horizontally applied force will accelerate a 400 kg crate at 1 m/s/s across a factory floor against a friction force half its weight? (a) 600 N (b) 1600 N (c) 2000 N (d) 2400 N (e) none of these
- 1-99) If an object of constant mass experiences a constant net force, it will have a constant (a) velocity (b) speed (c) acceleration (d) position (e) more than one of the above
- 1-100) If more horizontal force is applied to sliding object than is needed to maintain a constant velocity, (a) the object accelerates in the direction of the applied force (b) the object accelerates opposite the direction of the applied force (c) the friction force increases (d) two of the above (e) none of the above
- 1-101) If less horizontal force is applied to a sliding object than is needed to maintain a constant velocity, (a) the object accelerates in the direction of the applied force (b) the friction force increases (c) the object eventually slides to a stop (d) none of the above

#### Chapter 4 Newton's Laws of Motion

##### c) Falling

- 1-102) Two factors that greatly affect air resistance on falling objects are the (a) size and mass of the object (b) size and weight of the object (c) size and speed of the object
- 1-103) A light woman and a heavy man jump from an airplane at the same time and open their same size parachutes at the same time. Which person will get to a state of zero acceleration first? (a) the light woman (b) the heavy man (c) both should at the same time (d) not enough information
- 1-104) A skydiver, who weighs 500 N, reaches terminal velocity of 90 km/h. The air resistance on the diver is then (a) 90 N (b) 250 N (c) 410 N (d) 500 N (e) none of these
- 1-105) A 500 N parachutist opens his chute and experiences an air resistance force of 800 N. The net force on the parachutist is (a) 300 N downward (b) 500 N downward (c) 800 N downward (d) 300 N upward (e) 500 N upward
- 1-106) A pair of tennis balls falls through the air from a tall building. One ball is regular and the other is filled with lead

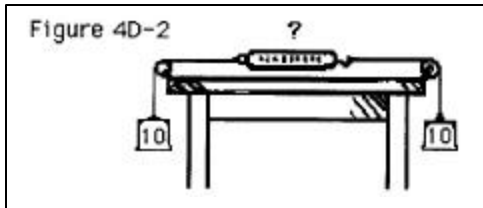
pellets. The ball to reach the ground first is the (a) regular ball (b) lead filled ball (c) same for both

- 1-107) A pair of tennis balls falls through the air from a tall building. One ball is regular and the other is filled with lead pellets. Air resistance just before they hit is greater for the (a) regular ball (b) lead filled ball (c) same for both
- 1-108) A ball thrown straight upward takes 10 seconds to go up and return to the ground. Because of air resistance, the time taken for the ball just to go up is (a) less than 5 s (b) more than 5 s (c) 5 s
- 1-109) A falling skydiver of mass 100 kg experiences 500 N air resistance. The acceleration of the skydiver is (a) 0.2 g (b) 0.3 g (c) 0.4 g (d) 0.5 g (e) more than 0.5 g
- 1-110) An astronaut on another planet drops a 1 kg rock from rest. The astronaut notices that the rock falls 2 meters straight down in one second. On this planet, how much does the rock weigh? (a) 1N (b) 4N (c) 4.9 N (d) 5N
- 1-111) A feather and a coin will have equal accelerations when falling in a vacuum because (a) their velocities are the same (b) the force of gravity is the same for each in a vacuum (c) the force of gravity does not act in a vacuum (d) the ratio of each object's weight to its mass is the same (e) none of these

#### Chapter 4 Newton's Laws of Motion

##### d) Newton's Third Law of Motion

- 1-112) An archer shoots an arrow. Consider the action force to be exerted by the bowstring against the arrow. The reaction to this force is the (a) weight of the arrow (b) air resistance against the bow (c) friction of the ground against the archer's feet (d) grip of the archer's hand on the bow (e) arrow's push against the bowstring
- 1-113) A baseball player bats a ball with a force of 1000 N. The ball exerts a reaction force against the bat of (a) less than 1000 N (b) more than 1000 N (c) 1000 N
- 1-114) As a ball falls, the action force is the pull of the earth's mass on the ball. The reaction force is the (a) air resistance acting against the ball (b) acceleration of the ball (c) pull of the ball's mass on the earth (d) non-existent in this case (e) none of these
- 1-115) A person is attracted toward the center of the earth by a 500 N gravitational force. The force of attraction of the earth toward the person is (a) very very small (b) very very large (c) 500 N
- 1-116) Arnold Strongman and Suzie Small each pull very hard on opposite ends of a rope in a tug-of-war. The greatest force on the rope is exerted by (a) Arnold, of course (b) Suzie, surprisingly (c) both the same, interestingly enough
- 1-117) A Mack truck and a Volkswagen traveling at the same speed have a head on collision. The vehicle to undergo the greatest change in velocity will be the (a) Volkswagen (b) Mack truck (c) both the same



1-118) Two 10 newton weights (Fig 4D-2) are pulling on the spring scale as shown. The reading on the scale is (a) 0 N (b) 10 N (c) 20 N

1-119) A car traveling at 100 km/hr strikes an unfortunate bug and splatters it. The force of impact is (a) greater on the bug (b) greater on the car (c) the same for both

1-120) The force exerted on the tires of a car to directly accelerate it along a road is exerted by the (a) engine (b) tires (c) air (d) road (e) none of these

1-121) A horse exerts 500 N of force on a heavy wagon. The wagon pulls back on the horse with an equal force. The wagon still accelerates because (a) these forces are not an action-reaction pair (b) nevertheless there is still an unbalanced force on the wagon (c) the horse pulls on the wagon a brief time before the wagon reacts (d) the wagon does not accelerate because these forces are equal and opposite (e) unlike the horse, it is not alive

1-122) Two people, one twice as massive as the other, attempt a tug-of-war with 12 meters of rope on frictionless ice. After a brief time, they meet. The heavier person slides a distance of (a) 3m (b) 4m (c) 5m (d) 6 m

## Chapter 5 Momentum

1-123) The difference between impulse and impact force involves the (a) distance the force acts (b) time the force acts (c) difference between acceleration and velocity (d) mass and its effect on resisting a change in momentum

1-124) Suppose a gun were made of a strong but very light material. Suppose also that the bullet is more massive than the gun itself. For such a weapon (a) the target would be safer than the shooter (b) recoil problems would be lessened (c) conservation of energy would not hold (d) conservation of momentum would not hold (e) both conservation of energy and momentum would not hold

1-125) In order to catch a ball, a baseball player extends the hand forward before impact with the ball and then lets it ride backward in the direction of the ball's motion upon impact. Doing this reduces the force of impact on the player's hand principally because the (a) force of impact is reduced (b) relative velocity is less (c) time of impact is increased (d) time of impact is decreased (e) none of these

1-126) A car traveling along the highway needs a certain amount of force exerted on it to stop it in a certain distance. More stopping force is required when the car has (a) more

mass (b) more momentum (c) less stopping distance (d) all of these (e) none of these

1-127) The force on an apple hitting the ground depends upon (a) the speed of the apple just before it hits (b) the time of impact with the ground (c) whether or not the apple bounces (d) all of these

1-128) A ball is moving at 4 m/s and has a momentum of 48 kg m/s. What is the ball's mass? (a) 4 kg (b) 12 kg (c) 48 kg (d) 192 kg (e) none of these

1-129) Recoil is noticeable if we throw a heavy ball while standing on roller skates. If instead we go through the motions of throwing the ball but hold onto it, our net recoil will be (a) zero (b) the same as before (c) small, but noticeable

1-130) A 1 N apple falls to the ground. The apple hits the ground with an impact force of about (a) 1 N (b) 2 N (c) 4 N (d) 9.8 N (e) not enough information given to say

1-131) A karate expert executes a swift blow and severs a cement block with her bare hand. The magnitude is the same for the (a) impulse on both the block and the expert's hand (b) force on both the block and the expert's hand (c) time of impact on both the block and the expert's hand (d) all of these (e) none of these

1-132) A piece of putty moving with 1 unit of momentum strikes and sticks to a heavy bowling ball that is initially at rest. After the putty sticks to the ball, both move with a combined momentum of (a) less than 1 unit (b) more than 1 unit (c) 1 unit (d) not enough information

1-133) A 1 kg chunk of putty moving at 1 m/s collides with and sticks to a 5 kg bowling ball initially at rest. The bowling ball and putty then move with a momentum of (a) 0 kg m/s (b) 1 kg m/s (c) 2 kg m/s (d) 5 kg m/s (e) more than 5 kg m/s

1-134) The force that accelerates a rocket in outer space is exerted on the rocket by the (a) rocket's engine (b) rocket's wings (c) atmospheric pressure (d) exhaust gases (e) none of these

1-135) Two billiard balls having the same mass roll toward each other, each moving at the same speed. What is the combined momentum of the two balls? (a) 0 kg m/s (b) 10 kg m/s (c) more information need to determine

1-136) A cannonball shot from a cannon with a long barrel will have a greater muzzle velocity because the cannonball receives a greater (a) force (b) impulse (c) both of these (d) neither of these

1-137) Which would be more damaging, driving into a very massive concrete wall with no "give," or having a head on collision at the same speed with an identical car moving toward you with the same speed? It would be more damaging to hit the (a) car (b) wall (c) both the same

- 1-138) A rifle of mass 2 kg is suspended by strings. The rifle fires a bullet of mass 1/100 kg at a speed of 200 m/s. The recoil velocity of the rifle is about (a) 0.001 m/s (b) 0.01 m/s (c) 0.1 m/s (d) 1 m/s (e) none of these
- 1-139) A 5 kg fish swimming at a speed of 1 m/s swallows an absent minded 1 kg fish at rest. The speed of the larger fish after lunch is (a) 1/2 m/s (b) 2/5 m/s (c) 5/6 m/s (d) 6/5 m/s (e) 1 m/s
- 1-140) A 5 kg fish swimming at a speed of 1 m/s swallows an absent minded 1 kg fish swimming toward it at 4 m/s. The speed of the larger fish after lunch is (a) 1/2 m/s (b) 1/5 m/s (c) 1/6 m/s (d) 2/3 m/s (e) 3/2
- 1-141) A 1 kg chunk of putty moving at 1 m/s collides with and sticks to a 5 kg bowling ball that is initially at rest. The bowling ball and putty are then in motion with a speed of (a) 1/4 m/s (b) 1/5 m/s (c) 1/6 m/s (d) none of these (e) not enough information given
- 1-142) Momentum is transferred to the ground when an apple falls on it. The momentum absorbed by the ground is (a) negligible compared to the momentum of the apple (b) greater than that of the apple only if the apple bounces (c) greater than that of the apple in all cases (d) none of these
- 1-143) If all people, animals, trains and trucks all over the world began to walk or run towards the east, then the (a) earth would spin a bit faster (b) earth would spin a bit slower (c) earth's spin would not be affected at
- 1-144) You're driving down the highway and a bug spatters into your windshield. Which undergoes the greater change in momentum? (a) the bug (b) your car (c) both the same
- Suppose an astronaut in outer space wishes to play a solitary "throw, bounce, and catch" game by tossing a ball against a very massive concrete wall. The ball makes a perfectly elastic collision and heads back toward the recoiling astronaut.*
- 1-145) If the ball is as massive as the astronaut, the (a) astronaut will catch one bounce only (b) astronaut will never catch the first bounce (c) astronaut's time between catches will decrease as the game progresses (d) none of these
- 1-146) A golf ball moving forward with 1 unit of momentum strikes and bounces backward off a heavy bowling ball that is initially at rest and free to move. The bowling ball is set in motion with a momentum of (a) less than 1 unit (b) more than 1 unit (c) 1 unit (d) not enough information
- 1-147) Two identical gliders slide toward each other on an air track. One moves at 1 m/s and the other at 2 m/s. They collide and stick. The combined mass moves at (a) 1/2 m/s (b) 1/3 m/s (c) 1/6 m/s (d) 3/4 m/s (e) 1.5 m/s
- 1-148) A 5000 kg freight car runs into a 10 000 kg freight car at rest. They couple upon collision and move with a speed of 2 m/s. What was the initial speed of the 5000 kg car? (a) 4 m/s (b) 5 m/s (c) 6 m/s (d) 8 m/s (e) none of these

## Chapter 6 Energy

### a) Energy

- 1-149) If you push an object with twice the work input for twice the time, your power input is (a) twice (b) four times as much (c) the same amount as for half the work in half the time
- 1-150) An object that has kinetic energy must be (a) moving (b) falling (c) at an elevated position (d) at rest (e) none of these
- 1-151) An object that has potential energy may have this energy because of its (a) speed (b) acceleration (c) momentum (d) location (e) none of these
- 1-152) A clerk can lift containers a vertical distance of 1 meter or can roll them up a 2 meter long ramp to the same elevation. With the ramp, the applied force required is about (a) half as much (b) twice as much (c) the same
- 1-153) When a car is braked to a stop, its kinetic energy is transformed to (a) stopping energy (b) potential energy (c) energy of motion (d) energy of rest (e) heat
- 1-154) A hydraulic press, like a simple lever, properly arranged is capable of multiplying energy input (a) sometimes true (b) always false (c) always true
- 1-155) The ball has maximum kinetic energy at point (a) A (b) B (c) C (d) D (e) E
- 1-156) The bead has maximum speed at point (a) A (b) B (c) C (d) D (e) F
- 1-157) No work is done by gravity on a bowling ball that rolls along a bowling alley because (a) no force acts on the ball (b) no distance is covered by the ball (c) the force on the ball is at right angles to the ball's motion (d) no potential energy is being converted to kinetic energy (e) its kinetic energy remains constant
- 1-158) It takes 40 J to push a large box 4 m across a floor. Assuming the push is in the same direction as the move, what is the magnitude of the force on the box? (a) 4 N (b) 10 N (c) 40 N (d) 160 N (e) none of these
- 1-159) A 2 kg mass has 40 J of potential energy with respect to the ground. Approximately how far is it located above the ground? (a) 1 m (b) 2m (c) 3 m (d) 4m (e) none of these
- 1-160) Using 1000 J of work, a toy elevator is raised from the ground floor to the second floor in 20seconds. What is the power rating of the elevator? (a) 20 W (b) 50 W (c) 100 W (d) 1000 W (e) 20 000 W
- 1-161) Two identical arrows, one with twice the kinetic energy of the other, are fired into a hay bale. The faster arrow will penetrate (a) the same distance as the slower arrow (b) twice as far as the slower arrow (c) four times as far as the slower arrow (d) more than four times as far as the slower arrow (e) none of these

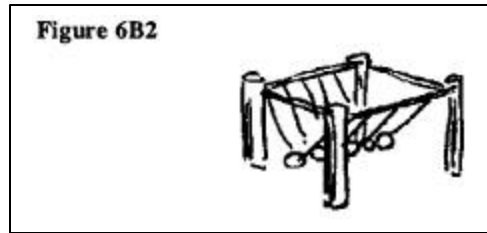
- 1-162) Strictly speaking, if any electrical device in your car is turned on (such as an air conditioner, headlights, or even a radio) more gasoline is burned by the engine. This statement is (a) totally false (b) true only if the car's engine is running (c) true only if the car's engine is stopped (d) almost always true (e) none of these
- 1-163) A machine puts out 100 Watts of power for every 1000 Watts put into it. The efficiency of the machine is (a) 10 % (b) 50 % (c) 90 % (d) 110 % (e) none of these
- 1-164) A woman lifts a box from the floor. She then moves with constant speed to the other side of the room, where she puts the box down. How much work does she do on the box while walking across the floor at constant speed? (a) zero J (b) more than zero J (c) more information needed to determine
- 1-165) A car moving at 50 km/hr skids 20 m with locked brakes. How far will the car skid with locked brakes if it is traveling at 150 km/hr? (a) 20 m (b) 60 m (c) 90 m (d) 120 m (e) 180 m
- 1-166) Which has greater kinetic energy, a car traveling at 30 km/hr or a car of half the mass traveling at 60 km/hr? (a) the 30 km/hr car (b) the 60 km/hr car (c) both have the same kinetic energy
- 1-167) A diver who weighs 500 N steps off a diving board that is 10 m above the water. The diver hits the water with kinetic energy of (a) 10 J (b) 500 J (c) 510 J (d) 5000 J (e) more than 5000 J
- 1-168) Consider a hydraulic press. When the input piston is depressed 20 cm, the output piston is observed to move 1 cm. On the same press, an input force of 1 N can raise no more than (a) 1 N (b) 10 N (c) 20 N (d) 21 N
- 1-169) A 2500 N pile driver ram falls 10 m and drives a post 0.1 m into the ground. The average impact force on the ram is (a) 2500 N (b) 25 000 N (c) 250 000 N (d) 2 500 000 N
- 1-170) Which requires the most amount of work on the brakes of a car? (a) slowing down from 100 km/h to 70 km/h (b) slowing down from 70 km/h to a stop (c) equal amounts for either
- 1-171) A car that travels twice as fast as another when braking to a stop will skid (a) twice as far (b) four times as far (c) depends on the mass of the cars
- 1-172) Two identical arrows, one with twice the speed of the other, are fired into a hay bale. The faster arrow will penetrate (a) the same distance as the slower arrow (b) twice as far as the slower arrow (c) four times as far as the slower arrow (d) more than four times as far as the slower arrow (e) none of these
- 1-173) A person on the edge of a roof throws a ball downward. It strikes the ground with 100 J of kinetic energy. The person throws another identical ball upward with the same initial speed, and this too falls to the ground. Neglecting air resistance, the second ball hits the ground with a kinetic energy of (a) 100 J (b) 200 J (c) less than 100 J (d) more than 200 J (e) none of these
- 1-174) If a power plant is 30% efficient, and the transmission system that delivers power to consumers is 60% efficient, then the overall efficiency is (a) 90% (b) 60% (c) 30% (d) 18% (e) none of these
- 1-175) How many Joules of energy are in one kilowatt-hour? (a) 1 (b) 60 (c) 60 000 (d) 3.6 million (e) none of these
- 1-176) A car's engine is 20% efficient. When cruising, the car encounters an average retarding force of 1000 N. If the energy content of gasoline is 40 megajoules per liter, how many kilometers per liter does the car get? (a) 14 (b) 12 (c) 10 (d) 8 (e) none of these
- 1-177) On a sunny day about 500 watts of solar power strikes each square meter of the earth's surface. If a solar automobile has 4 square meters of collector area and 100% efficient collectors and motor, its power output is about (a) 0.27 hp (b) 2.7 hp (c) 27 hp (d) 270 hp
- 1-178) A flower pot of mass  $m$  falls from rest to the ground below, a distance  $h$ . Which statement is correct? (a) The speed of the pot when it hits the ground is proportional to  $h$  (b) The KE of the pot when it hits the ground is proportional to  $h$  (c) The KE of the pot when it hits the ground does not depend on  $m$  (d) The speed of the pot when it hits the ground depends on  $m$  (e) none of these is correct

## Chapter 6 Energy

### b) Energy and Momentum

- 1-179) When a rifle is fired it recoils so both the bullet and rifle are set in motion. The rifle and bullet ideally acquire equal (a) but opposite amounts of momentum (b) amounts of kinetic energy (c) both of these (d) none of these
- 1-180) If an object has kinetic energy, then it also must have (a) impulse (b) momentum (c) acceleration (d) force (e) none of these
- 1-181) An open freight car rolls friction free along a horizontal track in a pouring rain that falls vertically. As water accumulates in the car, the car's speed (a) increases (b) decreases (c) doesn't change
- 1-182) A car has a head-on collision with another car with the same magnitude of momentum. An identical car driving with the same speed as the first car runs into an enormously massive wall. The greater impulse will occur on the car that is in the collision with the (a) approaching car (b) the wall (c) both impulses will be the same

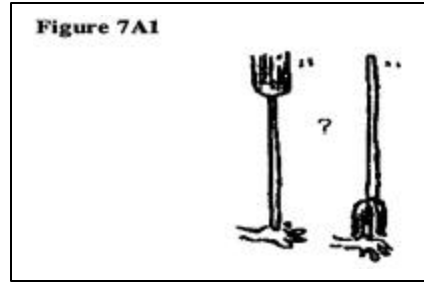
*A popular swinging-balls apparatus (Fig 6B-2) consists of an aligned row of identical elastic balls suspended by strings so that the balls barely touch each other. When two balls are lifted from one end and released, they strike the row and two balls pop out from the other end.*



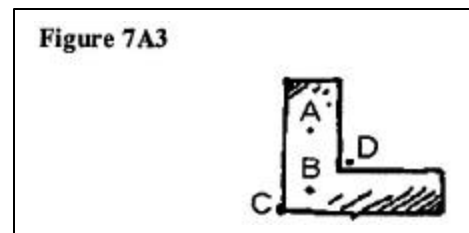
- 1-183) If instead one ball popped out with twice the velocity of the two, this would be a violation of conservation of (a) momentum (b) energy (c) both of these (d) none of these
- 1-184) If instead one ball popped out with kinetic energy equal to the combined kinetic energy of the two, this would be a violation of conservation of (a) momentum (b) energy (c) both of these (d) neither of these
- 1-185) A golf ball is thrown at and bounces backward from a massive bowling ball that is initially at rest. After the collision, compared to the golf ball, the bowling ball has more (a) momentum, but less kinetic energy (b) kinetic energy, but less momentum (c) momentum and more kinetic energy (d) but it has less momentum and less kinetic energy (e) not enough information is given to say
- 1-186) A piece of taffy slams into and sticks to another identical piece of taffy that is at rest. The momentum of the two pieces stuck together after the collision is the same as it was before the collision, but this is not true of the kinetic energy, which is partly turned into heat. What percentage of the kinetic energy is turned into heat? (a) 0 % (b) 25 % (c) 50 % (d) 75 % (e) not enough information given
- 1-187) Two 5000 kg freight cars roll without friction (one at 1 m/s, the other at 2 m/s) toward one another on a level track. They collide, couple, and roll away together with a combined momentum of (a) zero (b) 5000 kg m/s (c) 10 000 kg m/s (d) 15 000 kg m/s
- 1-188) Two 5000 kg freight cars roll without friction (one at 1 m/s, the other at 2 m/s) toward each other on a level track. Thus one car's kinetic energy is 2500 J and the other's is 10 000 J. Before they collide their total kinetic energy is (a) 1250 J (b) 2500 J (c) 7500 J (d) 10 000 J (e) 12 500 J
- 1-189) Two 5000 kg freight cars roll toward each other (one at 1 m/s, the other at 2 m/s) on a level track. Thus before they collide one car's kinetic energy is 2500 J and the other's is 10 000 J. After they collide (and couple together) their total kinetic energy is (a) 1250 J (b) 2500 J (c) 7500 J (d) 10 000 J (e) 12 500 J
- 1-190) A 1 kg ball dropped from a height of 2 m rebounds only 1.5 m after hitting the ground. The amount of energy converted to heat is about (a) 0.5J (b) 1.0 J (c) 1.5 J (d) 2.0 J (e) more than 2.0 J
- 1-191) A sandbag in outer space moves at 3 m/s and collides and sticks to a half-as-massive sandbag initially at rest. Compared to the kinetic energy of the moving bag before

collision, the kinetic energy of the coupled bags after collision is (a) one third (b) two thirds (c) three quarters (d) not enough information to say

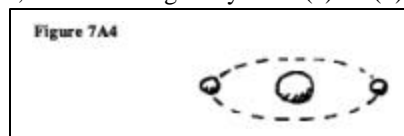
## Chapter 7 Rotational Motion

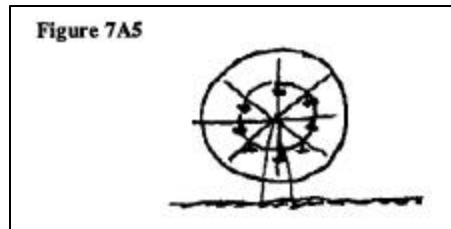


- 2-1) An upright broom (Fig 7A-1) is easier to balance when the heavier end is (a) nearest your hand (b) highest, farthest from your hand (c) same either way
- 2-2) The long, heavy tail of a spider monkey enables the monkey to easily vary its (a) weight (b) momentum (c) inertia (d) center of gravity (e) none of these
- 2-3) The famous Leaning Tower of Pisa doesn't topple over because its center of gravity is (a) above a place of support (b) relatively low for such a tall building (c) stabilized by its structure (d) displaced from its center (e) in the same place as its center of mass
- 2-4) The chef at the infamous Fattening Tower of Pizza tosses a spinning disk of uncooked pizza dough into the air. The disk's diameter increases during the flight, while its rotational speed (a) remains constant (b) increases (c) decreases
- 2-5) Centrifugal forces are an apparent reality to observers in a reference frame that is (a) moving at constant velocity (b) an inertial reference frame (c) at rest (d) rotating (e) none of these
- 2-6) Consider a rotating donut-shaped space habitat where living quarters are on the inside surface farthest from the axis. If the rotational speed of the habitat increases, the apparent weight of people inside (a) increases (b) decreases (c) stays the same



- 2-7) If a piece of sheet metal (Fig 7A-3) is cut into the shape shown, its center of gravity is at (a) A (b) B (c) C (d) D





2-8) Suppose a certain carnival has a Ferris wheel (Fig 7A-5) where the seats are located halfway between the center and outside rim. Compared to an ordinary Ferris wheel where the seats are on the outside rim, your angular speed while riding on this Ferris wheel would be (a) less and your tangential speed more (b) more and your tangential speed less (c) the same and your tangential speed less

2-9) A tightrope walker more easily balances on a tight wire if his pole (a) is held high (b) droops (c) is short but heavy

2-10) Two people are balanced on a see-saw. If one person leans toward the center of the see-saw, that person's end of the see-saw will (a) rise (b) fall (c) stay at the same level

2-11) A 1 kg rock is suspended from the tip of a meter stick at the 0 cm mark so that the meter stick balances like a see-saw when the fulcrum is at the 25 cm mark. From this information, what is the mass of the meter stick? (a) 1/4 kg (b) 1/2kg (c) 3/4 kg (d) 1 kg (e) more than 1 kg

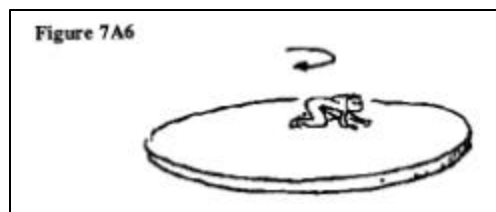
2-12) A ball rolls down a hill mainly because of (a) an unbalanced torque (b) an unbalanced force (c) its rotational inertia (d) angular momentum

2-13) A car travels in a circle with constant speed. The net force on the car is (a) directed forward, in the direction of travel (b) directed towards the center of the curve (c) zero because the car is not accelerating (d) none of these

2-14) If the earth rotated slower about its axis, your apparent weight would (a) increase (b) decrease (c) stay the same

2-15) To weigh less in the northern hemisphere, you should move to a location (a) north (b) south (c) east (d) west

2-16) A huge rotating cloud of particles in space gravitate together to form an increasingly dense ball. As it shrinks in size the cloud (a) rotates faster (b) rotates slower (c) rotates at the same speed



2-17) Suppose you are at the center of a large freely rotating horizontal turntable in a carnival funhouse (Fig 7A-6). As you crawl toward the edge, the angular momentum of you and the turntable (a) decreases (b) increases (c) remains

the same, but the RPMs decrease (d) decreases in direct proportion to your decrease in RPMs (e) none of these

2-18) Stand a meter stick on its end and let go and it rotates to the floor. If you attach a heavy weight to its upper end and repeat, falling time will be (a) more (b) less (c) the same

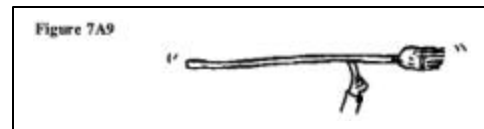
2-19) A flywheel's diameter is twice that of another of the same shape and mass. The larger flywheel's rotational inertia is (a) 4 times the other's (b) 2 times the other's (c) the same as the other's (d) half the other's

2-20) A ring and a disk, initially at rest, roll down a hill together. The one to reach the bottom first (a) is the ring (b) is the disk (c) depends on the masses (d) depends on the relative rotational inertial (e) both reach the bottom at the same time

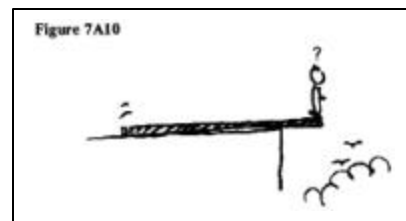
2-21) A ring, a disk, and a solid sphere begin rolling down a hill together. The one to reach the bottom first is the (a) ring (b) disk (c) sphere (d) they all reach the bottom at the same time (e) not enough information is given

2-22) Neglecting air resistance, which will roll from rest to the bottom of an incline first, an empty jar, or the same jar filled with peanut butter? (a) The filled jar (b) The empty jar (c) Both reach the bottom at the same time

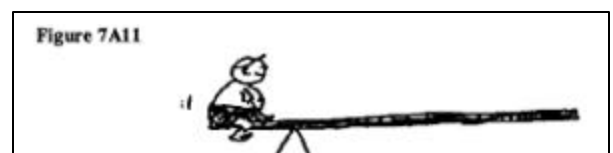
2-23) Which will roll down an incline in the shortest time, a can filled with water or the same can filled with ice? (a) Water (b) Ice (c) Both the same (d) Not enough information is given



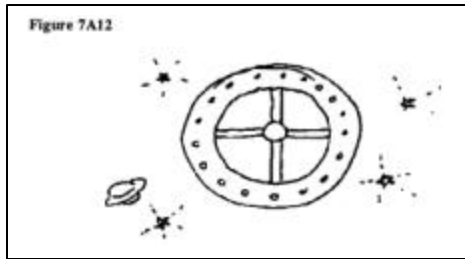
2-24) If you balance a broom horizontally on one finger (Fig 7A-9), the center of gravity of the broom will be above your finger - closer to the bristles end than the handle end. If you saw the broom in two pieces at that point and weigh the two parts on a scale, you'll find that the heavier part is the (a) bristles part (b) handle part (c) both the same weight



2-25) You know that you can safely stand on the overhanging end of a heavy plank that rests on a table (Fig 7A-10). How far out depends on your mass and the mass of the plank. Suppose you can stand on the end of a plank that overhangs the edge of the supporting table 1/4 its total length. Then how massive is the plank compared to your mass? (a) 2 your mass (b) The same as your mass (c) 12 your mass (d) Twice your mass (e) 4 times your mass



- 2-26) A careful inspection of the boy playing solitary seesaw (Fig 7A-11) indicates that the mass of the boy is (a) greater than the mass of the seesaw (b) less than the mass of the seesaw (c) equal or very nearly equal to the mass of the seesaw (d) not enough information is given by the sketch



- 2-27) Consider a bowling alley inside a rotating space torus (huge "donut", Fig 7A-12). Compared to your bowling experience on earth, you will notice that the ball (a) feels lighter when you throw it in the direction of the moving alley, and heavier when you throw it in the opposite direction (b) feels heavier when you throw it in the direction of the moving alley, and lighter when you throw it in the opposite direction (c) veers to the right when you throw it in the direction of the moving alley, and to the left when you throw it in the opposite direction (d) none of these

## Chapter 8 Gravity

### a) Gravity

- 2-71) According to Newton, doubling the distance between two interacting objects (a) divides by 2 the gravitational force between them (b) multiplies by 2 the gravitational force between them (c) divides by 4 the gravitational force between them (d) multiplies by 4 the gravitational force between them
- 2-72) The earth's gravitational field extends (a) only above and beyond the earth's surface and cancels inside the earth (b) both inside and outside the earth and throughout the entire universe (c) neither of these
- 2-73) The concept of force is not fundamental to (a) Newton's theory of gravitation (b) Einstein's theory of gravitation (c) both of these (d) neither of these
- 2-74) An asteroid exerts a 360 N gravitational force on a nearby spacecraft. If the spacecraft moves to a point 3 times as far from the center of the asteroid, the force will be (a) zero (b) 40 N (c) 120 N (d) 360 N (e) 1080 N
- 2-75) Consider two planets in space that gravitationally attract each other. If the masses of both planets are doubled, and the distance between them is also doubled, then the force between them is (a) one quarter (b) half as much (c) twice as much (d) four times as much (e) none of these
- 2-76) An object is placed exactly halfway between the earth and moon. The object will fall toward the (a) earth (b) moon (c) neither of these
- 2-77) The amount of gravitational force that acts on the space shuttle while in orbit is (a) nearly zero (b) almost as much as the shuttle's weight on the earth's surface (c) the same as the shuttle's weight on the earth's surface
- 2-78) A woman who normally weighs 400 N stands on top of a very tall ladder so she is one earth radius above the earth's surface. How much would she weigh there? (a) Zero (b) 100 N (c) 200 N (d) 400 N (e) None of these
- 2-79) A very massive object A and a less massive object B move toward each other under the influence of gravitation. Which force, if either, is greater? (a) The force on A (b) The force on B (c) Both forces are the same
- 2-80) The force of gravity acts on all apples on an apple tree. Some apples are twice as far from the ground as others. These twice-as-high apples, for the same mass, have (a) 1/4 the weight (b) 1/2 the weight (c) practically the same weight
- 2-81) The planet Jupiter is about 300 times as massive as earth, yet on its surface you would weigh only about 3 times as much. This is because (a) your mass is 100 times less on Jupiter (b) Jupiter is significantly farther from the sun (c) Jupiter's radius is 10 times the earth's radius (d) you are 100 times more weightless there (e) none of these
- 2-82) The force of gravity acting on you will increase if you (a) burrow deep inside the planet (b) stand on a planet with a radius that is shrinking (c) both of these (d) none of these
- 2-83) If you drop a stone into a hole drilled all the way to the other side of the earth (neglect the molten core), the stone will (a) come to an abrupt stop at the center of the earth (b) speed up until it gets to the center of the earth (c) speed up until it reaches the other side of the earth (d) slow down until it reaches the center
- 2-84) Half way to the center of a planet of uniform density, your weight compared to at the surface would be (a) one-quarter (b) one-half (c) three-quarters (d) the same as at the surface (e) zero
- 2-85) Half way to the center of a completely hollow planet composed of a uniform shell, your weight compared to at the outer surface would be (a) one-quarter (b) one-half (c) three-quarters (d) the same as at the surface (e) zero
- 2-86) Inside a freely-falling runaway elevator, your (a) acceleration is zero (b) apparent weight is zero (c) gravitational interaction with the earth is zero (d) all of these (e) none of these
- 2-87) Passengers in a high-flying jumbo jet feel their normal weight in flight, while passengers in the orbiting space shuttle do not. This is because passengers in the space shuttle are (a) beyond the main pull of earth's gravity (b) above the earth's atmosphere (c) without support forces (d) all of these (e) none of these

2-88) The reason the moon does not crash into the earth is that the (a) earth's gravitational field is weak at the moon (b) gravitational pull of other planets keeps the moon up (c) moon has a sufficient tangential speed (d) moon has less mass than the earth (e) none of these

2-89) The factor most directly responsible for making a black hole invisible is its (a) size (b) mass (c) color (d) surface escape velocity (e) none of these

2-90) If the sun collapsed to a black hole, the earth's gravitational attraction to it would be (a) more (b) less (c) the same

2-91) The earth is currently accelerating toward the sun (centripetal acceleration). If the sun collapsed into a black hole, this acceleration would (a) increase (b) decrease (c) stay the same (d) cease to exist

2-92) When you step on a weighing scale at noon, the earth pulls you down and the overhead sun pulls you upward. The reason the sun's pull doesn't decrease your weight at noon is because (a) the sun's pull on you is negligibly small (b) the weighing scale is calibrated only in earth weight (c) you, the scale, and the earth are freely falling around the sun (d) the sun's pull is cancelled by the gravitation of other celestial bodies (e) of tidal effects in the "solid" earth

2-93) A hollow spherical planet is inhabited by people who live inside it, where the gravitational field is zero. When a very massive space ship lands on the planet's surface, inhabitants find that the gravitational field inside the planet is (a) still zero (b) non-zero, directed toward the spaceship (c) non-zero, directed away from the spaceship

2-94) A supplier wants to make a profit by buying metal by weight at one altitude and selling it at the same price per pound at another altitude. The supplier should (a) buy at a high altitude and sell at a low altitude (b) buy at a low altitude and sell at a high altitude (c) disregard altitude because it makes no difference

2-95) Each of us weighs a tiny bit less inside the ground floor of a skyscraper than we do on the ground away from the skyscraper. The reason for this is the (a) gravitational field is shielded inside the building (b) mass of the building attracts us upward slightly (c) both of these (d) none of these

## Chapter 8 Gravity

### b) Tides

2-96) With respect to the stars, the moon (a) circles the earth (b) and the earth circle each other (c) remains stationary while the earth circles about it (d) does not rotate about its own axis as the earth does

2-97) Which is most responsible for the ocean tides? (a) the moon (b) the sun (c) both contribute equally

2-98) The main reason ocean tides exist is that the pull of the moon (a) and sun are in conjunction at high tides and in

opposition at low tides (b) is greater on oceans closer to the moon and less on oceans farther from the moon (c) is greater on the earth because the moon is closer to earth (d) and the sun on the oceans are in opposite directions (e) none of these

2-99) Tidal forces in general are the result of (a) two or more sources of gravitation (b) a combination of any kind of forces acting on a body (c) unequal forces acting on different parts of a body (d) the inverse-square law (e) unequal fluid flow

2-100) The earth is closer to the sun in January than in July, which accounts for the fact that the highest high tides in the northern hemisphere occur in (a) winter (b) spring (c) summer (d) no particular time because tides do not depend on seasons

2-101) The best time for digging clams (when the low tide is extra low) is during the time of the (a) new or full moon (b) half moon (c) quarter moon (d) none of these times in particular

2-102) Gravitation weakens as the inverse square of distance, while tidal gravity (force difference per kilogram) weakens with the inverse (a) of distance (b) square of distance (c) cube of distance

2-103) Which produces a greater tidal effect in your body, the moon or a 1 kg melon held above your head? (a) the moon (b) the melon (c) Not enough information is given to make a reasonable estimate

2-104) The origin of any micro tides in the human body is most likely the (a) sun (b) moon (c) earth

2-105) If the moon were four times as massive but twice as far from earth, high tides on earth would be (a) higher (b) lower (c) no different

## Chapter 9 Satellite Motion

2-106) The radial velocity of an earth satellite is its velocity (a) parallel to the surface of the earth (b) perpendicular to the surface of the earth (c) attributed to satellites moving in any direction (d) none of these

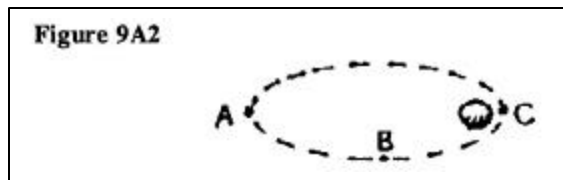
2-107) What prevents satellites such as the space shuttle from falling? (a) gravity (b) centripetal force (c) centrifugal force (d) the absence of air drag (e) nothing, they continually fall all around the earth

2-108) The circular orbit of a satellite orbiting the earth is characterized by a constant (a) speed (b) acceleration (c) radial distance (d) all of these (e) none of these

2-109) It takes Pluto a longer time to travel around the sun than the earth does because Pluto (a) has farther to go (b) goes slower (c) both of these (d) none of these

2-110) A "weightless" astronaut in an orbiting shuttle is (a) shielded from the earth's gravitational field (b) beyond the

pull of gravity (c) pulled only by gravitation to the shuttle which cancels the earth's gravitational pull (d) like the shuttle, pulled by earth's gravitation (e) none of these



- 2-111) At which position (Fig. 9A2) is the satellite's speed changing most rapidly? (a) A (b) B (c) C
- 2-112) The speeds of the planets about the sun depend on (a) their distances from the sun (b) the masses of the planets (c) both of these (d) neither of these
- 2-113) A projectile is fired vertically from the surface of the earth at 10 km/s. The projectile will (a) go into circular orbit about the earth (b) go into an elliptical orbit about the earth (c) rise and fall back to the earth's surface (d) none of these
- 2-114) A vertically-oriented rocket that is somehow able to maintain a continuous upward velocity of 8km/s will (a) escape from the earth (b) be unable to escape the earth
- 2-115) Consider a monkey wrench released at rest at the far edge of the solar system. Suppose that it drops to the earth by virtue of only earth gravity. It will strike the earth's surface with a speed of about (a) 9.8 m/s (b) 8 km/s (c) 11 km/s (d) the speed of light
- 2-116) Minimal orbital speed about the earth is about 8 km/s. Minimal orbital speed about the moon would be (a) less than 8 km/s (b) more than 8 km/s (c) about 8 km/s
- 2-117) The period of a satellite, the time it takes for a complete revolution, depends on the satellite's (a) mass (b) weight (c) radial distance (d) all of these (e) none of these
- 2-118) Communications and weather satellites always appear at the same place in the sky. This is because these satellites are (a) beyond the pull of the earth's gravitational field (b) moving at a speed just short of escape velocity (c) orbiting the earth with a 24 hour period (d) stationary in space (e) none of these
- 2-119) Pioneer 10 was able to escape the solar system by (a) having a sufficient escape velocity at launch (b) "bouncing off" approaching Jupiter like a tennis ball bounces off an approaching tennis racket (c) refueling via solar cells (d) nuclear-powered sustained thrust
- 2-120) Rockets that launch satellites into orbit need less thrust when fired from (a) Cape Canaveral (b) Edwards Air Force Base in California (c) Hawaii (d) These locations do not bear on the required rocket thrust
- 2-121) The force of gravity does work on a satellite when it is in (a) circular orbit (b) elliptical orbit (c) both of these (d) neither of these

- 2-122) Angular momentum is conserved for a satellite in (a) circular orbit (b) elliptical orbit (c) both of these (d) neither of these
- 2-123) Acceleration is greater for a satellite when it is at the (a) apogee (b) perigee (c) same at both places
- 2-124) Angular momentum is greater for a satellite when it is at the (a) apogee (b) perigee (c) same at both places
- 2-125) A rocket coasts in an elliptical orbit about the earth. To attain escape velocity using the least amount of fuel in a brief firing time, should it fire off at the apogee, or at the perigee? (Hint: let " $Fd = \text{change in KE}$ " guide your thinking.) (a) perigee, where it is closest and fastest (b) apogee where it is farthest and slowest (c) same either location

## Chapter 10 Atomic Nature of Matter

- 2-126) There are about as many atoms of air in our lungs at any moment as there are breaths of air in the atmosphere of (a) a large auditorium (b) a large city (c) the United States (d) the whole world (e) none of these
- 2-127) Atoms heavier than hydrogen were made by (a) photosynthesis (b) nuclear fusion (c) radiant energy conversion (d) radioactivity (e) none of these
- 2-128) Which of these statements is true? (a) A molecule is the smallest particle that exists (b) Chemical elements are made up of about 100 distinct molecules (c) Molecules form atoms that in turn determine chemical properties of a substance (d) Molecules are the smallest subdivision of matter that still retains chemical properties of a substance (e) None of these statements is true
- 2-129) What makes an element distinct? (a) The number of protons (b) The number of neutrons (c) The number of electrons (d) The total mass of all the particles (e) None of these
- 2-130) Which of the following is not a compound? (a) Air (b) Ammonia (c) Water (d) Salt (e) all are compounds
- 2-131) Which is the smallest particle listed below? (a) A molecule (b) An atom (c) A proton (d) A neutron (e) A quark
- 2-132) Solid matter is mostly empty space. The reason solids don't fall through one another is because (a) atoms are constantly vibrating, even at absolute zero (b) of nuclear forces (c) of gravitational forces (d) of electrical forces (e) none of these
- 2-133) Which of these forces determines the chemical properties of an atom? (a) Friction force (b) Nuclear force (c) Gravitational force (d) Electrical force (e) None of these
- 2-134) The factor that determines whether a substance is in the solid, liquid, gaseous, or plasma state is its (a) composition

(b) atomic number (c) atomic shell configuration (d) temperature (e) none of these

2-135) A plasma differs from a gas in that (a) its molecules are farther apart (b) it is hotter than a gas (c) it is electrically conducting (d) its atoms are boosted to higher atomic numbers (e) all of these

2-136) If an astronaut landed on a planet made of antimatter, there would be an explosion as both the astronaut and (a) the planet would annihilate (b) an amount of planet matter equal to that of the astronaut would annihilate (c) none of these

2-137) In our part of the universe, antimatter is (a) non-existent (b) rare (c) short-lived (d) plentiful (e) two of these

2-138) Assuming all the atoms exhaled by Julius Caesar in his last dying breath are still in the atmosphere then we probably breathe one of those atoms with each (a) single breath (b) day (c) it depends, some people still breathe a few of Caesar's atoms every day, while others wouldn't breathe one for an entire year (d) ten years (e) month

2-139) Nuclei of atoms that make up a newborn baby were made in (a) the mother's womb (b) the food the mother eats before giving birth (c) ancient stars (d) the Earth (e) none of these

2-140) Compared to the atoms that make up the body of an elderly person, the atoms that make up the body of a newborn baby are (a) newer (b) older (c) the same age

2-141) The reason a granite block is mostly empty space is that the atoms in the granite are (a) in perpetual motion (b) mostly empty space themselves (c) held together by electrical forces (d) not as close together as they could be (e) invisible

2-142) The volume of matter comes mostly from its (a) protons (b) electrons

2-143) The chemical properties of matter come mostly from its (a) protons (b) electrons

2-144) In a closed bottle are a certain number of hydrogen molecules. In an identical closed bottle at the same temperature and internal pressure are a certain number of nitrogen molecules. The bottle with the greater number of molecules is the one containing (a) hydrogen (b) nitrogen (c) both the same

2-145) A positron orbiting an antiproton would make up an atom of (a) positronium (b) unobtainium (c) anti-helium (d) anti-hydrogen (e) none of these

2-146) To change mercury into gold, a pair of protons must be (a) removed from the mercury nucleus (b) added to the mercury nucleus (c) both of these (d) neither of these

2-147) If a pair of helium nuclei are fused together, the result is (a) heavy helium (b) lithium (c) beryllium (d) all of these (e) none of these

2-148) Which of these atoms has the greatest number of electrons? (a) helium (b) carbon (c) iron (d) gold (e) uranium

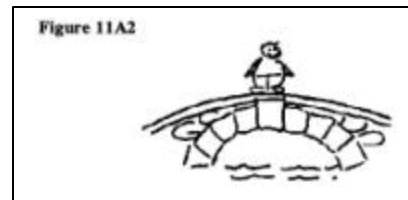
## Chapter 11 Solids

### a) Solids

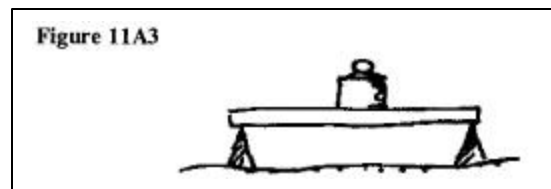
2-149) Brass and bronze are examples of (a) elements (b) mixtures (c) alloys (d) compounds (e) molecules

2-150) Which of the following is not an alloy? (a) bronze (b) copper (c) steel (d) brass (e) all are alloys

2-151) If the volume of an object were to double while its mass stays the same, its density would (a) halve (b) double (c) stay the same



2-152) When weight is applied to the top of a stone arch (Fig 11A-2), the stone blocks in the arch undergo (a) tension (b) compression



2-153) When a load is placed on the middle of a horizontal beam supported at each end (Fig 11A-3), the bottom part of the beam undergoes (a) tension (b) compression

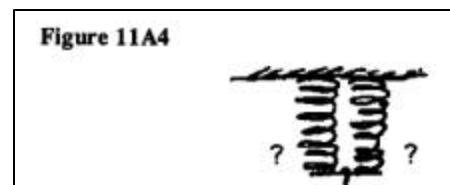
2-154) You wish to bolt a sign to a horizontal I-beam supporting a bridge. You will weaken the beam least if you drill the bolt holes through the (a) upper flange (b) lower flange (c) web (d) all these will have the same effect

2-155) A catenary refers to a (a) way of buttressing arches (b) special curved line (c) rectangular configuration of I beams (d) triangular configuration of I beams

2-156) Stone slabs are stronger under (a) tension (b) compression

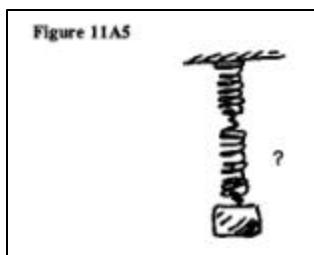
2-157) Doubling the thickness (diameter) of a rope will multiply its strength by (a) 1/2 (b) 1 (c) 2 (d) 3 (e) 4

2-158) Which will bounce higher off a hard surface? (a) a rubber ball (b) a steel ball (c) both bounce the same



amount of membrane through which to feed it is multiplied by only (a) 2 (b) 4 (c) 8 (d) more than 8

- 2-159) A spring is stretched 10 cm by a suspended 1 kg block (Fig 11A-4). If two such springs side by side are used to suspend the block, so each spring supports half the weight of the block, then each spring will stretch (a) 5 cm (b) 10 cm (c) 20 cm (d) 30 cm (e) none of these



- 2-160) A weightless spring is stretched 10 cm by a suspended 1 kg block (Fig 11A-5). If two such springs are used to suspend the block, one spring above the other, to effectively provide one double-length spring, then the total stretch of the double-length spring will be (a) 5 cm (b) 10 cm (c) 20 cm (d) 30 cm (e) none of these
- 2-161) A metal block has a density of 5000 kg per cubic meter and a volume of 2 cubic meters. What is the block's mass? (a) 1000 kg (b) 2500kg (c) 5000 kg (d) 10 000 kg (e) none of these
- 2-162) An unstretched hanging spring is 50 cm long. Suspending a 100 N weight from it makes its length 60 cm. Adding another 100 N weight will make the spring's length (a) 60 cm (b) 70 cm (c) 80 cm (d) 100 cm (e) 120 cm

## Chapter 11 Solids

### b) Scaling

- 2-163) Which potatoes when peeled produce the most peelings? (a) 10 kg of large potatoes (b) 10 kg of small potatoes (c) they both produce the same amount
- 2-164) Which has more skin compared to its body weight, an elephant or a mouse? (a) elephant (b) mouse (c) typically, both the same
- 2-165) Doubling the linear size of an object multiplies its area by (a) 2 and its volume by 4 (b) 4 and its volume by 8 (c) 8 and its volume by 16 (d) none of these
- 2-166) Tripling the linear size of an object multiplies its area by (a) 3 and its volume by 9 (b) 9 and its volume by 18 (c) 9 and its volume by 27 (d) 27 and its volume by 81 (e) none of these
- 2-167) When a living cell doubles in diameter, the amount of its material to be nourished is multiplied by eight, but the

- 2-168) An elephant eats less for its size than smaller animals because (a) its ears are bigger (b) its radiating area is small compared to its volume (c) its radiating area is large compared to its volume (d) it is taller than other animals (e) it weighs more than smaller animals

- 2-169) Compared to a 50 kg person, a 100 kg person at the beach requires (a) more than twice as much suntan lotion (b) the same amount of suntan lotion (c) less than twice as much suntan lotion

- 2-170) The effects of scaling are beneficial to small creatures (a) that get wet (b) that fall from great heights (c) who are hungry (d) all of these (e) none of these

- 2-171) If you make cupcakes and bake them as directed for a cake, you will find the cupcakes (a) overbaked (b) underbaked (c) properly baked

- 2-172) In cold weather, your hands will be warmer if you wear (a) gloves (b) mittens (c) both will be the same

- 2-173) Eight little spheres of mercury coalesce to form a single sphere. Compared to the combined surface areas of the eight little spheres, the surface area of the big sphere is (a) one eighth (b) one quarter (c) one half (d) the same (e) double

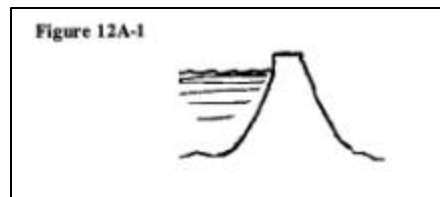
- 2-174) In cooking a turkey in a conventional oven at a given temperature, compared to a medium-sized turkey, a large turkey takes (a) more time per pound to cook (b) less time per pound to cook (c) the same time per pound to cook

- 2-175) Consider the fictional case of the incredible shrinking man. If he shrinks proportionately to 1/10 his original height, his weight will be multiplied by (a) 0.1 (b) 0.01 (c) 0.001 (d) 0.0001 (e) none of these

- 2-176) If each dimension of a steel bridge is scaled up ten times, its strength will be multiplied by about (a) ten and its weight by ten also (b) one hundred, but its weight by one thousand (c) one thousand, and its weight by one hundred (d) none of these

## Chapter 12 Liquids

### Liquids



- 3-1) A dam is thicker at the bottom (Fig 12A-1) than at the top partly because (a) water is denser at deeper levels (b) water pressure is greater with increasing depth (c) surface tension exists only on the surface of liquids (d) it looks better (e) none of these

3-2) The pressure at the bottom of a jug filled with water does NOT depend on (a) the acceleration due to gravity (b) water density (c) the height of the liquid (d) surface area of the water (e) none of these

3-3) The mass of a cubic meter of water is (a) 1 kg (b) 10kg (c) 100 kg (d) 1000 kg (e) 9800 N

3-4) The reason that buoyant force acts upward on a submerged object is that (a) it acts in a direction to oppose gravity (b) if it acted downward, nothing would float (c) the weight of fluid displaced reacts with an upward force (d) upward pressure against the bottom is greater than downward pressure against the top of the submerged object

3-5) A completely submerged object always displaces its own (a) volume of fluid (b) weight of fluid (c) density of fluid (d) all of these (e) none of these

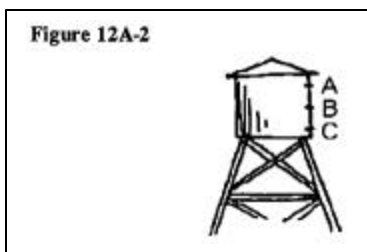
3-6) What is the buoyant force acting on a 10 ton ship floating in the ocean? (a) less than 10 tons (b) 10 tons (c) more than 10 tons (d) depends on density of sea water

3-7) When an object is partly or wholly immersed in a liquid, it is buoyed up (a) by a force equal to its own weight (b) by a force equal to the weight of liquid displaced (c) and floats because of Archimedes principle (d) but nevertheless sinks (e) none of these

3-8) The buoyant force on an object is least when the object is (a) partly submerged (b) submerged near the surface (c) submerged near the bottom (d) none of these

3-9) The buoyant force on a rock is least when the rock is submerged (a) near the surface (b) halfway to the bottom (c) near the bottom (d) all of the above

3-10) Blood pressure is normally greater in your (a) ears (b) feet (c) same in each



3-11) Three holes are drilled in a water tower (Fig 12A-2), which is filled with water, at the positions shown. Water will spurt the greatest horizontal distance from hole (a) A (b) B (c) C (d) The horizontal distance will be the same for all three holes

3-12) Lobsters live on the bottom of the ocean. The density of a lobster is (a) greater than the density of sea water (b) equal to the density of sea water (c) less than the density of sea water

3-13) A lobster crawls onto a bathroom scale submerged at the bottom of the ocean. Compared to its weight above the

surface, the lobster will have an apparent weight under water that is (a) greater (b) less (c) the same

3-14) The density of a submerged submarine is about the same as the density of (a) a crab (b) iron (c) a floating submarine (d) water (e) none of these

3-15) A rock suspended by a weighing scale weighs 5 N out of water and 3 N when submerged in water. What is the buoyant force on the rock? (a) 8 N (b) 5N (c) 3 N (d) 2 N (e) none of these

3-16) The volume of water displaced by a floating 20 ton boat is (a) 20 cubic meters (b) the volume of 20 tons of water (c) the volume of the boat (d) depends on the shape of the ship's hull (e) none of these

3-17) Compared to an empty ship, the same ship loaded with Styrofoam (a) higher in the water (b) lower in the water (c) at the same level in the water

3-18) Two equal sized buckets are filled to the top with water. One of the buckets has a piece of wood floating in it, making its total weight (a) less than the weight of the other bucket (b) equal to the weight of the other bucket (c) more than the weight of the other bucket

3-19) A block of Styrofoam floats on water while a same size block of lead lies submerged in the water. The buoyant force is greatest on the (a) lead (b) Styrofoam (c) is the same for both

3-20) Buoyant force is greatest on a submerged (a) 1 kg block of lead (b) 1 kg block of aluminum (c) is the same on each

3-21) Buoyant force is greatest on a submerged (a) 1 cubic centimeter block of lead (b) 1 cubic centimeter block of aluminum (c) is the same on each

3-22) Buoyant force is greatest on a submerged (a) 10 Newton block of lead (b) 10 Newton block of aluminum (c) is the same on each

3-23) When you float in fresh water, the buoyant force that acts on you is equal to your weight. When you float higher in the high-density water of the Dead Sea, the buoyant force that acts on you is actually (a) greater than your weight (b) less than your weight (c) also equal to your weight

3-24) Compared to the buoyant force that acts on you when you float in fresh water, the buoyant force that acts on you when you float in the dense water of the Dead Sea is actually (a) less because less of your volume is displaced (b) more because of the greater density of fluid displaced (c) the same

3-25) Two life preservers have identical volumes, but one is filled with Styrofoam while the other is filled with sand. When the two life preservers are worn by swimmers so that one swimmer floats with part of the preserver above water, and the other swimmer sinks, the buoyant force is actually greater on the life preserver filled with (a) Styrofoam (b) sand (c) same

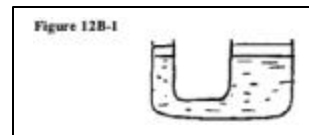
- 3-26) A heavy glass ball is placed in a pie pan that floats in a bucket. The water level at the side of the bucket is marked. Then the glass ball is removed and allowed to sink in the bucket. The water line at the side of the bucket is now (a) lower (b) the same (c) higher
- 3-27) A boat loaded with scrap iron floats in a swimming pool. When the iron is thrown overboard, the pool level will (a) rise (b) fall (c) remain unchanged
- 3-28) A boat loaded with a barrel of water floats in a swimming pool. When the water in the barrel is poured overboard, the swimming pool level will (a) rise (b) fall (c) remain unchanged
- 3-29) A boat loaded with wood floats in a swimming pool. When the wood is thrown overboard, the pool level will (a) rise (b) fall (c) remain unchanged
- 3-30) If a battleship sinks in a canal lock, the water level in the lock will (a) rise (b) fall (c) remain unchanged
- 3-31) If a weighted air-filled balloon sinks in deep water, it will (a) likely sink to an equilibrium level before reaching bottom (b) likely burst if water pressure is great enough (c) become less dense as it sinks (d) be acted on by a continuously decreasing buoyant force (e) none of these
- 3-32) When an ice cube in a glass of water melts, the water level (a) rises (b) falls (c) remains the same
- 3-33) A floating ice cube contains small pieces of iron. During melting the water level will (a) rise (b) fall (c) remain unchanged
- 3-34) An ice cube floating in a glass of water contains many air bubbles. When the ice melts, the water level will (a) rise (b) fall (c) remain unchanged
- 3-35) Three icebergs are each floating in bathtubs filled to the brim with water. Iceberg A has large air bubbles in it. Iceberg B has unfrozen water in it. Iceberg C has an iron railroad spike in it. When the ice melts, what happens? (a) the water level in C will decrease while the other two water levels will remain the same (b) only the water in C will spill over (c) the water level in A will stay the same, while the other tubs will spill over (d) all the tubs spill over (e) all stay exactly the same
- 3-36) A block of wood half as dense as water floats with half its volume above water. A piece of iron is then tied on top so the wood floats with only 1/4 its volume above the surface. If the wood and iron are turned over so that the iron is submerged beneath the wood, then the volume of wood above the water surface will be (a) more than 1/4 (b) less than 1/4 (c) the same, 1/4 (d) there's no way to say
- 3-37) A block of wood with a piece of iron tied to the top of it floats in a bucket of water. If the wood and iron are turned over so that the iron is submerged beneath the wood, the

water level at the side of the bucket (a) rises (b) falls (c) remains the same

- 3-38) There is a legend of a Dutch boy who bravely held back the Atlantic Ocean by plugging a leak near the top of a dike with his finger until help arrived. Which of the following is most likely? (a) The huge size of the Atlantic Ocean makes this impossible (b) Although the force on his finger would have been huge, the pressure would have been small enough for this to occur (c) The force on his finger would have been less than 1 N (d) Both the force and pressure on his finger would have been great, but not too great for a public spirited Dutch lad (e) None of these
- 3-39) A scale from which a rock is suspended reads 5 N when the rock is out of water and 3 N when the rock is submerged. The density of the rock is (a) the density of water (b) 1.5 times the density of water (c) 2.5 times the density of water (d) 3.5 times the density of water

## Chapter 12 Liquids Pascal's Principle and Surface Tension

*A hydraulic arrangement consists of a water filled U-tube that is wider at one end than at the other, as shown in Fig 12B-1). Pistons are fitted in both ends*



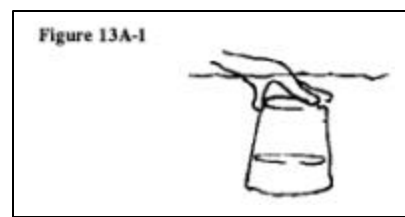
- 3-40) To multiply an input force, the input end should be the one having the (a) larger diameter piston (b) smaller diameter piston (c) relative piston sizes don't matter
- 3-41) The ratio of output force to input force will be equal to the ratio of the output and input piston (a) diameters (b) areas (c) radii (d) all of these (e) none of these
- 3-42) A hydraulic press multiplies a force by 100. This multiplication is done at the expense of (a) energy, which is divided by 100 (b) the distance through which the force acts (c) the time through which the force acts, which is multiplied by 100 (d) the mechanism providing the force (e) none of these
- 3-43) The Pascal unit equal to one (a) newton per square meter (b) kilogram per square meter (c) newton per square centimeter (d) kilogram per square centimeter (e) square meter per newton
- 3-44) Surface tension is a direct result of (a) viscosity (b) Archimedes' principle (c) Bernoulli's principle (d) adhesive forces between molecules in a liquid or solid (e) cohesive forces between molecules in a liquid
- 3-45) Surface tension of liquids (a) increases when wetting agents are added (b) decreases as the liquid temperature increases (c) is about the same for all liquids (d) results from a thin molecular membrane on the liquid surface (e) is the reason a steel ship will float

## Chapter 13 Gases and Plasmas

### Gases

- 3-46) About what percentage of the molecules that make up the atmosphere are below an aircraft that flies at an altitude of 6 kilometers? (a) 20 % (b) 30% (c) 40% (d) 50 % (e) More than 50%
- 3-47) What is the approximate mass of a 1 square-centimeter column of air that extends from sea level to the top of the atmosphere? (a) 1 gram (b) 1 kilogram (c) 10 kilograms (d) 100 kilograms
- 3-48) The weight of a 1 square meter column of air that extends from sea level to the top of the atmosphere is (a) 101 N (b) 10 100 N (c) 101 000 N (d) 101 000 000 N
- 3-49) A bubble of air released from the bottom of a lake (a) rises to the top at constant volume (b) becomes smaller as it rises (c) becomes larger as it rises (d) alternately expands and contracts as it rises (e) none of these
- 3-50) A common 5 liter metal can will float in air if it is (a) evacuated of air (b) filled with a very large amount of helium (c) thrown high enough into the air (d) nonsense! Unless the displaced air weighs more than the can and its contents, the can will not float in air
- 3-51) In drinking through a straw, we make use of (a) capillary action (b) surface tension (c) atmospheric pressure (d) Bernoulli's principle (e) none of these
- 3-52) If a TV picture tube is broken, it will (a) explode (b) implode
- 3-53) About how high can water be theoretically lifted by a vacuum pump at sea level? (a) Less than 10.3 m (b) More than 10.3 m (c) 10.3 m
- 3-54) The faster a fluid moves, the (a) greater its internal pressure (b) lesser its internal pressure
- 3-55) When water is turned on in a shower, the shower curtain moves towards the water. This has to do with (a) capillary action (b) surface tension (c) heat capacity (d) pressure of a moving fluid (e) none of these
- 3-56) On a windy day, atmospheric pressure (a) increases (b) decreases (c) remains unchanged
- 3-57) If a strong wind from the west breaks a window in the north wall of a house, most of the glass will fall (a) upward (b) inside the house (c) outside the house
- 3-58) A column that extends from sea level to the top of the atmosphere contains a certain mass of air. If the same column instead had the same mass of mercury in it, the height of the mercury column would be (a) 1/13.6 times the height of the atmosphere (b) about 3/4 meter (c) 10.3 meters (d) about 5.6 kilometers

- 3-59) As a high-altitude balloon sinks lower and lower into the atmosphere, it undergoes a decrease in (a) volume (b) density (c) weight (d) mass (e) none of these
- 3-60) A helium-filled balloon released in the atmosphere will rise until (a) the pressure inside the balloon equals atmospheric pressure (b) atmospheric pressure on the bottom of the balloon equals atmospheric pressure on the top of the balloon (c) the balloon and surrounding air have equal densities (d) all of these (e) none of these
- 3-61) Alcohol is less dense than water. If alcohol is used to make a barometer on a day when atmospheric pressure is normal, the height of the alcohol column would be (a) less than 10.3 m (b) more than 10.3 m (c) 10.3 m
- 3-62) Compared to the buoyant force of the atmosphere on a 1 liter helium-filled balloon, the buoyant force of the atmosphere on a nearby 1 liter solid iron block is (a) considerably less (b) considerably more (c) the same
- 3-63) When gas in a container is squeezed to half its volume and the temperature remains the same, the gas pressure (a) halves (b) doubles (c) quadruples (d) remains the same



- 3-64) The depth to which an inverted drinking glass (Fig 13A-1) must be pushed beneath the surface of water so that the volume of enclosed air is squeezed to half is (a) 76 cm (b) 10.3 m (c) 14.7 m (d) 20.6 m (e) 29.4 m
- 3-65) A swimmer cannot snorkel more than a meter deep because air (a) in the lungs cannot easily be expelled (b) tends to liquefy in the snorkel tube (c) is buoyed up leaving the swimmer breathless (d) at the surface will not freely enter the higher pressure region in the compressed lungs (e) all of these
- 3-66) An umbrella tends to move upwards on a windy day principally because (a) air gets trapped under the umbrella, warms, and rises (b) buoyancy increases with increasing wind speed (c) air pressure is reduced over the curved top surface (d) all of these
- 3-67) Estimate the mass of air inside an average automobile (a) 2 grams (b) 2 kilograms (c) 20 kilograms (d) 200 kilograms (e) 2000 kilograms
- 3-68) Suspend a pair of Ping-Pong balls from two strings so there is a small space between them. If you blow air between the balls, they will swing (a) toward each other (b) apart from each other (c) away from the air stream, but not necessarily toward or apart from each other

- 3-69) Suppose you are standing on a weighing scale and all of a sudden the atmosphere vanished. The reading on the scale would (a) increase (b) decrease (c) remain the same
- 3-70) Assuming no change in temperature, as a freely expanding helium-filled balloon rises in the atmosphere, the buoyant force that acts on it (a) increases (b) decreases (c) remains the same
- 3-71) The weight of air in a bathtub (about 1/3 cubic meter) is about the same as the weight of (a) a pea (b) an egg (c) a small apple (d) a pound of butter (e) a 10 pound sack of potatoes
- 3-72) A large block of wood and a smaller block of iron on weighing scales both register the same weight - 1 ton. Taking buoyancy of air into account, which has the greater mass? (a) Wood (b) Iron (c) Both have the same mass
- 3-73) If you release a ball inside a freely falling elevator, it stays in front of you instead of "falling to the floor" because you, the ball, the elevator, and the air in the elevator are all in free fall. If you similarly release a helium-filled balloon, the balloon will (a) also stay in front of you (b) press against the ceiling (c) press against the floor
- 3-74) A car with closed windows makes a left hand turn. A helium-filled balloon in the car will move to the (a) right (b) left (c) front (d) back
- 3-75) An empty jar is pushed open side downward into water so that air trapped in it cannot get out. As it is pushed deeper, the buoyant force on the jar (a) increases (b) decreases (c) remains the same
- 3-76) In a vacuum a marshmallow becomes (a) larger (b) smaller (c) no change

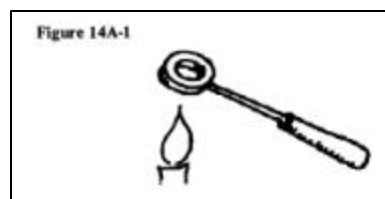
### Chapter 13 Gases and Plasmas

#### Plasmas

- 3-77) The main difference between gases and plasmas has to do with (a) the kinds of elements involved (b) interatomic spacing (c) electrical conduction (d) fluid pressure (e) the proportion of matter to antimatter in the universe
- 3-78) When a common fluorescent lamp is on, the mercury vapor inside is actually in a (a) gaseous state (b) liquid state (c) plasma state (d) solid state (e) none of these
- 3-79) Most of the matter in the universe is in the (a) solid state (b) liquid state (c) gaseous state (d) plasma state (e) none of these
- 3-80) When a gas is heated and becomes a plasma, its electric charge is usually (a) balanced (b) negative (c) positive (d) non-existent (e) none of these
- 3-81) Most of the mass of material that makes up a plasma is (a) positively charged (b) negatively charged (c) same mass for each

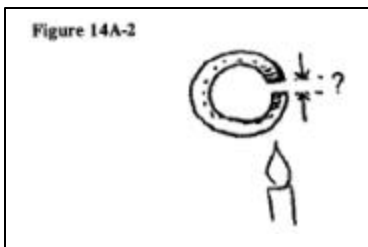
### Chapter 14 Temperature, Heat, and Expansion

- 3-82) When you touch a cold piece of ice with your finger, energy flows (a) from your finger to the ice (b) from the ice to your finger (c) both ways
- 3-83) Which of the following normally warms up fastest when heat is applied? (a) water (b) iron (c) glass (d) wood
- 3-84) Compared to a giant iceberg, a hot cup of coffee has (a) more internal energy and higher temperature (b) higher temperature, but less internal energy (c) a greater specific heat and more internal energy (d) none of these
- 3-85) Before ice can form on a lake, all the water in the lake must be cooled to (a) zero degrees C (b) 4 degrees C



- 3-86) When an iron ring is heated (Fig 14A-1), the hole becomes (a) smaller (b) larger (c) neither smaller nor larger
- 3-87) When a bimetallic bar made of copper and iron strips is heated, the bar bends toward the iron strip. The reason for this is (a) iron gets hotter before copper (b) copper gets hotter before iron (c) copper expands more than iron (d) iron expands more than copper (e) none of these
- 3-88) If glass expanded more than mercury, then the column of mercury in a mercury thermometer would rise when the temperature (a) increases (b) decreases (c) neither of these
- 3-89) Which of the following expands most when the temperature is increased? Equal volumes of (a) iron (b) wood (c) ice water (d) helium (e) all expand the same
- 3-90) Which of the following expands most when the temperature is lowered? Equal volumes of (a) iron (b) wood (c) helium (d) water at 4 degrees C (e) none expands when the temperature is lowered
- 3-91) Consider a sample of ice at 0 degrees C. If the temperature is decreased, the volume of the ice (a) increases (b) decreases (c) stays the same
- 3-92) Which of the following contracts most when the temperature is increased? Equal volumes of (a) iron (b) wood (c) ice water (d) helium (e) none of these contract when heated
- 3-93) Consider a sample of water at 0 degrees C. If the temperature is slightly increased, the volume of the water (a) increases (b) decreases (c) remains the same
- 3-94) When water at 4 degrees C is heated it expands. When water at 4 degrees C is cooled, it (a) contracts (b) expands (c) neither contracts nor expands

- 3-95) Can a sample of water possibly have the same volume after being warmed by several Celsius degrees? (a) yes (b) no
- 3-96) Room temperature on the Kelvin scale is about (a) 100 K (b) 200K (c) 300 K (d) 400 K (e) more than 400 K
- 3-97) Between 0 degrees Celsius and 8 degrees Celsius a red-dyed-water-in-glass thermometer would (a) be especially suitable (b) always be wrong (c) give ambiguous readings (d) explode (e) implode
- 3-98) The white-hot sparks that strike your skin from a 4th-of-July-type sparkler don't harm you because (a) they have a low temperature (b) the energy per molecule is very low (c) the energy per molecule is high, but little energy is transferred because of the few molecules in the spark
- 3-99) On a very hot day the pendulum on a clock swings to and fro (a) more frequently (b) less frequently
- 3-100) Place a kilogram block of iron at 40 degrees C into a kilogram of water at 20 degrees C and the final temperature of the two becomes (a) less than 30 degrees C (b) at or about 30 degrees C (c) more than 30 degrees C
- 3-101) When ice floats in water, a small part of it extends above the surface. Interestingly enough, the volume of ice that extends above the surface is equal to the volume of the (a) water the ice displaces (b) vast number of open spaces in the hexagonal ice crystals (c) both of these (d) neither of these

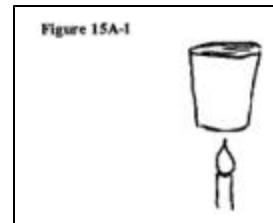


- 3-102) Consider a metal ring with a gap cut in it (Fig 14A -2). When the ring is heated, the gap (a) becomes narrower (b) becomes wider (c) retains its size

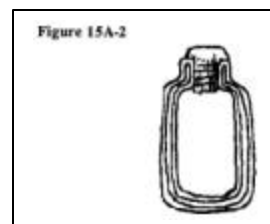
## Chapter 15 Heat Transfer

- 3-103) Metals are both good heat conductors and good electrical conductors because of the (a) similarity between thermal and electrical conductive properties (b) looseness of outer electrons in metal atoms (c) relatively high densities of metals (d) high elasticity of metals (e) ability of metals to transfer energy easily
- 3-104) At the same temperature, which move with the greater speed in the air? (a) Very light molecules (b) Heavier molecules (c) All will have equal average speeds

- 3-105) The higher the temperature of an object, the (a) longer the wavelengths it radiates (b) shorter the wavelengths it radiates
- 3-106) Objects that radiate relatively well, (a) absorb radiation relatively well (b) reflect radiation relatively well (c) both of these (d) neither of these
- 3-107) Hot water will cool to room temperature faster in a (a) black pot (b) silver pot (c) depends more on the size of the pots than their color
- 3-108) It is commonly thought that a can of beverage will cool faster in the coldest part of a refrigerator. Knowledge of Newton's law of cooling (a) supports this common knowledge (b) shows this common knowledge is false
- 3-109) Wrapping a hot potato in aluminum foil significantly reduces the rate at which it loses energy by (a) conduction (b) convection (c) radiation
- 3-110) Which body glows with electromagnetic waves? (a) The sun (b) The earth (c) Both (d) Neither
- 3-111) If you double the pressure of an ideal gas while keeping the temperature constant, the average kinetic energy of the molecules (a) is doubled (b) increases by more than twice (c) increases by less than twice (d) remains unchanged



- 3-112) A water-filled paper cup held in a flame (Fig 15A-1) will not catch fire. This is because (a) the inside of the paper is wet (b) water is an excellent conductor of heat (c) paper is a poor conductor of heat (d) the paper cup cannot become appreciably hotter than the water it contains
- 3-113) Both black and white road surfaces absorb sunlight. At the end of a sunny day the warmer road surface will be (a) the black surface (b) the white surface (c) neither -- there is no difference
- 3-114) Both black and white road surfaces radiate energy. At the end of a starry night the warmer road surface will be (a) the black surface (b) the white surface (c) neither - there is no difference
- 3-115) An object will normally be a net radiator of energy when its internal energy is (a) more than that of its surroundings (b) less than that of its surroundings (c) neither of these, because internal energy is not temperature



3-116) A Thermos bottle (Fig 15A-2) has double glass walls with silver coating on the glass surfaces that face one another. The silver coating reduces the energy that is transferred by (a) conduction (b) convection (c) radiation (d) friction (e) none of these

3-117) If a volume of air is warmed, it expands. If a volume of air expands, it (a) warms (b) cools (c) neither warms nor cools

3-118) When a volume of air is compressed, its temperature (a) increases (b) decreases (c) neither increases nor decreases

3-119) If you were caught in freezing weather with only a candle for heat, you would be warmer in (a) an igloo (b) a tent (c) a wooden house (d) a car

3-120) Double the absolute temperature of helium gas and the average speed of its molecules (a) less than doubles (b) doubles (c) more than doubles

3-121) Hydrogen and oxygen molecules in a gas sample have the same temperature. This means the hydrogen molecules, on the average, have the same (a) speed and the same kinetic energy (b) speed, but more kinetic energy (c) speed, but less kinetic energy (d) kinetic energy, but more speed (e) kinetic energy, but less speed

3-122) Suppose you are served coffee at a restaurant before you are ready to drink it. In order for it to be the hottest when you are ready for it, you should add cream (a) right away (b) at any time (c) when you are ready to drink the coffee

3-123) Suppose you want to save energy and you're going to leave your warm house for a half hour on a cold day. You should turn the thermostat (a) down (b) up (c) to room temperature

3-124) Suppose you want to save energy and you're going to leave your cool house for a half hour on a hot day. You should turn the temperature setting on the air conditioner (a) down a little (b) up a little (c) off altogether (d) to room temperature

## Chapter 16 Change of Phase

3-125) Evaporation is a cooling process because (a) heat is radiated during the process (b) of conduction and convection (c) the more energetic molecules are able to escape the liquid (d) the temperature of the remaining liquid decreases (e) none of these

3-126) To say that evaporation is a cooling process is to say that the (a) water left behind cools (b) surrounding air cools

3-127) Steam burns are more damaging than burns caused by boiling water because steam (a) gives up additional energy when it condenses (b) has more energy per kilogram than boiling water (c) both of these. (d) neither of these

3-128) We feel uncomfortably warm on a muggy day because water molecules are (a) evaporating from our moist bodies (b) condensing on our bodies (c) preventing the evaporation from our moist bodies

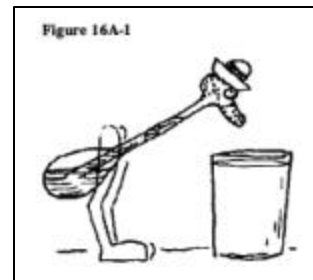
3-129) When a gas is changed to a liquid state, the gas (a) releases energy (b) absorbs energy (c) neither releases nor absorbs energy

3-130) Increased air pressure on the surface of hot water tends to (a) prevent boiling (b) promote boiling (c) neither

3-131) You can briefly touch a hot clothes iron with your bare finger if it is wet because the wetness (a) absorbs energy in vaporizing (b) provides an insulating vapor layer after it changes state (c) both of these. (d) neither of these

3-132) Hot water has a relatively high rate of cooling due to (a) evaporation (b) condensation (c) conductivity (d) radiation (e) convection

3-133) To turn 50 grams of boiling water to steam requires (a) 50 calories (b) 500 calories (c) 540 calories (d) more calories than are required to bring 50 grams of ice at absolute zero to the boiling point (e) none of these



3-134) The dunking bird (Fig 16A-1) will dunk more frequently if (a) its lower end is warmed, say by a nearby lamp (b) a breeze blows across its wet beak (c) both of these (d) neither of these

3-135) When bringing water to a boil in the mountains, the time needed to reach the boiling point is (a) less than at sea level (b) more than at sea level (c) the same as at sea level

3-136) Food in a pressure cooker is cooked faster because of the (a) higher temperature (b) greater rate of bubble formation in the water (c) increased internal energy in the water (d) all of these (e) none of these

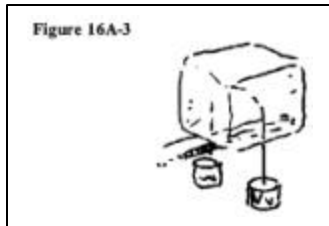
3-137) If you want to cook eggs by boiling them while in the mountains, then compared to sea-level cooking, you should (a) use a hotter flame (b) boil the eggs for a shorter time (c) boil the eggs for a longer time (d) none of these

3-138) When snow forms in clouds, the surrounding air (a) warms (b) cools (c) neither warms nor cools

3-139) When water vapor condenses on the inside of a window, the room becomes slightly (a) warmer (b) cooler (c) neither warmer nor cooler

3-140) The cooling effect inside a refrigerator is produced by (a) an electric motor that converts electrical energy into internal energy (b) compressing the refrigeration gas into a liquid (c) vaporizing the refrigeration liquid (d) proper insulation (e) none of these

3-141) On a humid day, water condenses on the outside of a glass of ice water. This phenomenon occurs mainly because of (a) the porosity of glass (b) capillary action (c) adhesion of water molecules to glass (d) the saturation of cooled air (e) evaporation



3-142) The phenomenon of regelation (Fig 16A-3) depends on the (a) freezing point of water (b) melting point of water (c) open-structured nature of ice crystals (d) high specific heat of water

3-143) An important factor in the process of regelation is (a) the conductivity of the cutting wire (b) the open structured crystals of ice (c) sufficient pressure provided by the heavy weights (d) all of these (e) none of these

3-144) Morning dew on the grass is a result of (a) evaporation of water. (b) the open-structured form of water crystals (c) air pressure on water vapor (d) slow-moving water molecules sticking to one another (e) none of these

3-145) Ice is put in a cooler in order to cool the contents. In order to speed up the cooling process, the ice can be (a) wrapped in newspaper (b) drained of ice water periodically (c) kept out of contact with the food (d) crushed (e) kept in circulating air currents provided by a small fire under one end of the cooler

3-146) Firefighters find that the temperature of burning material is best lowered when water is (a) used in small amounts (b) pointed away from the flames (c) sprayed as a fine mist (d) salted

3-147) Consider a steaming aluminum soda-pop can that contains a small amount of boiling water. When it is quickly inverted into a bath of cooler water the can is dramatically crushed by atmospheric pressure. This occurs because the pressure inside the can is rapidly reduced by (a) contact with the relatively cool water (b) sudden slowing of the air and steam molecules inside (c) condensation of steam inside (d) reduced internal energy (e) rapid conduction of heat to the relatively cool water

3-148) Which involves the larger number of calories? (a) The condensation of 1 gram of steam at 100 degrees Celsius to 100 degrees Celsius water (b) The change of state of 1 gram of 100 degree Celsius water to 1 gram of ice at absolute zero (c) Both involve the same number of calories

3-149) The minimum amount of 100 degree C steam needed to melt 1 gram of 0 degree C ice is (a) 0.125 gram (b) 0.148 gram (c) 6.75 grams (d) 8 grams (e) none of these

3-150) The mass of ice that can be melted by 1 gram of 100 degree steam is (a) 0.125 gram (b) 0.148 gram (c) 6.75 grams (d) 8 grams (e) none of these

3-151) A substance can be sprayed on crops to prevent frost formation under many conditions. If frost did not form on the fields and woods of an entire continent, cold nights would be (a) less cold (b) even colder (c) no different

## Chapter 17 Thermodynamics

3-152) It is possible to totally convert a given amount of mechanical energy into heat (a) True (b) False

3-153) The greater the difference in temperature between the input reservoir and the output reservoir for a heat engine, the (a) greater the efficiency (b) less the efficiency. (c) neither, efficiency doesn't depend on temperature difference

3-154) The first law of thermodynamics is a restatement of the (a) principle of entropy (b) law of heat addition (c) Carnot cycle (d) conservation of energy (e) none of these

3-155) Systems that are left alone, tend to move toward a state of (a) less entropy (b) more entropy (c) no entropy

3-156) Entropy measures (a) temperature at constant pressure (b) temperature at constant volume (c) temperature as pressure increases (d) temperature as volume increases (e) messiness

3-157) Entropy is closely related to the (a) 1st law of thermodynamics (b) 2nd law of thermodynamics (c) both of these (d) neither of these

3-158) When an ideal gas is subjected to an adiabatic process (a) no work is done on the gas (b) the temperature of the gas does not change (c) the internal energy of the gas does not change (d) all of these (e) none of these

3-159) During an adiabatic compression of an ideal gas, (a) the internal energy of the gas remains constant (b) the temperature of the gas does not change (c) no heat is supplied to or removed from the gas. (d) no work is done on the gas (e) none of these

3-160) A quantity of water has more entropy when it is (a) frozen ice (b) boiling

3-161) Entropy can be (a) created but not destroyed (b) neither created nor destroyed

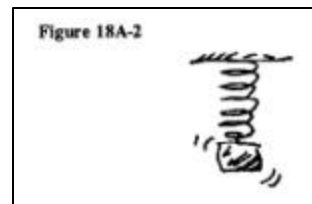
3-162) A heat engine would have 100 percent efficiency if its input reservoir were (a) 100 times hotter than the exhaust sink (b) 1000 times hotter than the exhaust sink (c) 100 times cooler than the exhaust sink (d) any finite temperature if the exhaust sink were at absolute zero (e) none of these

## Chapter 18 Vibrations and Waves

- 3-163) More efficient gasoline engines can be built if (a) engines are made to rotate faster (b) a better antifreeze is developed (c) materials are developed that can withstand lower temperatures (d) materials are developed that can withstand higher temperatures (e) none of these - they are already perfectly efficient
- 3-164) When mechanical work is done on a system, there can be an increase in its (a) internal energy (b) temperature (c) both of these (d) neither of these
- 3-165) An adiabatic process is characterized by the absence of (a) entropy (b) pressure change (c) heat exchange (d) temperature change (e) none of these
- 3-166) When a volume of air expands against the environment and no heat enters or leaves, the air temperature will (a) increase (b) decrease (c) remain unchanged
- 3-167) Two identical blocks of iron, one at 10 degrees C and the other at 20 degrees C, are put in contact. Suppose the cooler block cools to 5 degrees C and the warmer block warms to 25 degrees C. This would violate the (a) 1st law of thermodynamics (b) 2nd law of thermodynamics (c) both of these (d) neither of these
- 3-168) As a blob of air at a high elevation sinks to a lower elevation with no heat input or output, its temperature (a) increases (b) decreases (c) remains the same
- 3-169) The amount of energy ultimately converted to heat by a light bulb is about (a) 15% (b) 30% (c) 45% (d) 60% (e) 100%
- 3-170) Your refrigerator is in your kitchen. If you try to cool your kitchen on a hot day by operating your refrigerator with its door open, the kitchen temperature will (a) increase (b) decrease (c) remain unchanged
- 3-171) On a chilly 10 degree C day, your friend who likes cold weather, wishes it were twice as cold (half as hot). Taken literally, this temperature would be (a) 10 degrees C (b) 5 degrees C (c) 0 degrees C (d) -131.5 degrees C (e) -141.5 degrees C
- 3-172) The ideal efficiency for a heat engine operating between temperatures of 2700 K and 300 K is (a) 10% (b) 24% (c) 80% (d) 89% (e) none of these
- 3-173) Consider a cup of tea at room temperature, 24 degrees C. If it is heated until it has twice the internal energy, unlike a piece of metal, its temperature will be (a) 48 degrees C (b) 100 degrees C (c) 321 degrees C (d) 594 degrees C (e) none of these
- 3-174) A piece of iron and a cup of water both have the same temperature. If they are heated so the internal energy of each doubles, (a) the water will have the higher temperature (b) the iron will have the higher temperature (c) both will have the same temperature (d) not enough information given to say

- 4-1) A wiggle in time is a (a) vibration (b) wave (c) both (d) neither
- 4-2) The source of all wave motion is a (a) wave pattern (b) harmonic object (c) vibrating object (d) region of variable high and low pressure (e) none of these
- 4-3) Radio waves travel at the speed of light, 300 000 km/s. The wavelength of a radio wave received at 100 megahertz is (a) 0.3 m (b) 3.0m (c) 30 m (d) 300 m (e) none of these
- 4-4) A 60-vibration-per-second wave travels 30 meters in 1 second. Its frequency is (a) 30 hertz and it travels at 60 m/s (b) 60 hertz and it travels at 30 m/s (c) neither of these

*A weight or mass on the end of a spring as shown (Fig 18A-2) bobs up and down one complete cycle every two seconds.*



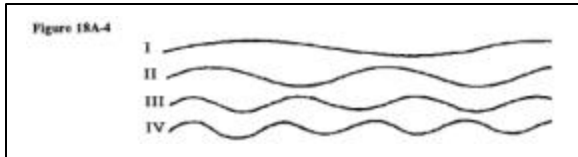
- 4-5) Its frequency is (a) 0.5 hertz (b) 1 hertz (c) 2 hertz (d) none of these
- 4-6) Its period is (a) 0.5 second (b) 1 second (c) 2 seconds (d) none of these
- 4-7) To say that one wave is out of phase with another is to say that the waves are (a) of different amplitudes (b) of different frequencies (c) of different wavelengths (d) out of step (e) all of these
- 4-8) A standing wave occurs when (a) two waves overlap (b) a wave reflects upon itself (c) the speed of the wave is zero or near zero (d) the amplitude of a wave exceeds its wavelength
- 4-9) The Doppler effect is characteristic of (a) water waves (b) sound waves (c) light waves (d) all of these (e) none of these
- 4-10) A Doppler effect occurs when a source of sound moves (a) towards you (b) away from you (c) both of these (d) none of these
- 4-11) A wave barrier is produced when a wave source moves (a) nearly as fast as the waves it produces (b) as fast as the waves it produces (c) faster than the waves it produces
- 4-12) A bow wave is produced when a wave source moves (a) nearly as fast as the waves it produces (b) as fast as the waves it produces (c) faster than the waves it produces
- 4-13) An observer on the ground hears a sonic boom which is created by an airplane flying at a speed (a) just below the

speed of sound (b) equal to the speed of sound (c) greater than the speed of sound (d) all of these (e) none of these

4-14) The source of a sonic boom (a) must itself be an emitter of sound (b) may or may not be an emitter of sound (c) is not itself an emitter of sound

4-15) A fishing-boat captain returns to port saying, "It's rough out there - the waves are 4 meters high." He probably means that the amplitude of the waves is (a) 4 m (b) 3 m (c) 2 m (d) 1 m

Below (Fig 18A-4) are "snapshots" of water waves going by.



4-16) If the waves are going by at the same speed, which wave has the greatest period of oscillation? (a) I (b) II (c) III (d) IV

4-17) If the waves are going by at the same frequency, which wave has the greatest speed? (a) I (b) II (c) III (d) IV (e) All would have the same speed

4-18) A floating leaf oscillates up and down two complete cycles in one second as a water wave passes by. The wave's wavelength is 10 meters. What is the wave's speed? (a) 2 m/s (b) 10 m/s (c) 20 m/s (d) 40 m/s (e) more than 40 m/s

4-19) A wave travels an average distance of 1 meter in 1 second with a frequency of 1 hertz. Its amplitude is (a) less than 1 meter (b) 1 meter (c) more than 1 meter (d) not enough information to say

4-20) The frequency of the second hand on a clock is (a) 1 hertz (b) 1/60 hertz (c) 60 hertz

4-21) For light, a red shift indicates that the light source is moving (a) toward you (b) away from you (c) at right angles to you (d) all of these (e) none of these

4-22) Some of a wave's energy dissipates as heat. In time, this will reduce the wave's (a) speed (b) wavelength (c) amplitude (d) frequency (e) period

4-23) When a pendulum clock at sea level is taken to the top of a high mountain, it will (a) gain time (b) lose time (c) neither gain nor lose time

4-24) A floating object oscillates up and down 2 complete cycles in 1 second as a water wave of wavelength 5 meters passes by. The speed of the wave is (a) 2 m/s (b) 5 m/s (c) 10 m/s (d) 15 m/s (e) none of these

4-25) A wave oscillates up and down two complete cycles each second. If the wave travels an average distance of 6 meters in one second, its wavelength is (a) 0.5 m (b) 1 m (c) 2 m (d) 3 m (e) 6 m

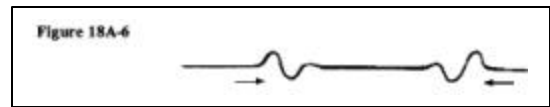
4-26) A child swings to and fro on a playground swing. If the child stands rather than sits, the time for a to-and-fro swing is (a) lengthened (b) shortened (c) unchanged

4-27) Suppose a simple pendulum is suspended in an elevator. When the elevator is accelerating upward, the frequency of the pendulum (a) increases (b) decreases (c) doesn't change

4-28) A tuning fork of frequency 200 hertz will resonate if a sound wave incident on it has a frequency of (a) 100 hertz (b) 400 hertz (c) either of these (d) none of these

4-29) If at a concert, a wind blows directly from the orchestra toward you, the frequency of the sound you hear will be (a) decreased (b) increased (c) neither decreased nor increased

4-30) If at a concert, a wind blows directly from the orchestra toward you, the speed of the sound you hear will be (a) decreased (b) increased (c) neither decreased nor increased



4-31) Two waves are generated at either end of a long rope and travel toward each other as shown (Fig 18A-6). Will there be an instant in which the rope's amplitude is zero everywhere? (a) yes (b) no

## Chapter 19 Sound

4-32) The source of every sound is something that is (a) vibrating (b) moving (c) accelerating (d) undergoing simple harmonic motion (e) a net emitter of energy

4-33) Double the frequency of a sound and you halve its (a) wavelength (b) speed (c) amplitude (d) all of these (e) none of these

4-34) Double the frequency of sound and you also double its (a) wavelength (b) speed (c) amplitude (d) all of these (e) none of these

4-35) A sound wave is a (a) longitudinal wave (b) transverse wave (c) standing wave (d) shock wave (e) none of these

4-36) Compressions and rarefactions normally travel in (a) the same direction in a wave (b) opposite directions in a wave

4-37) The speed of a sound wave in air depends on (a) its frequency (b) its wavelength (c) the air temperature (d) all of these (e) none of these

4-38) Reverberation is actually a case of (a) sound interference (b) forced vibrations (c) re-echoed sound (d) resonance (e) none of these

4-39) The explanation for refraction must involve a change in (a) frequency (b) wavelength (c) speed (d) all of these (e) none of these

4-40) When the speed of sound near the ground is greater than higher in the air, sound tends to be bent (a) upward (b) downward

4-41) Refraction of sound can occur in (a) air (b) water (c) both (d) neither

4-42) The energy of sound in air eventually becomes (a) increased internal energy of the air (b) weaker and weaker until it disappears (c) cancelled by destructive interference (d) cancelled by both destructive and constructive interference

4-43) The frequencies of sound that carry farther in air are relatively (a) low (b) high (c) no difference

4-44) The natural frequency of an object depends on its (a) elasticity (b) size and shape (c) both of these (d) neither of these

4-45) Caruso is said to have made a crystal chandelier shatter with his voice. This is a demonstration of (a) an echo (b) sound refraction (c) beats (d) resonance (e) interference

4-46) In designing a music hall, an acoustical engineer deals mainly with (a) modulation (b) forced vibrations (c) resonance (d) beats (e) wave interference

4-47) Sound waves can interfere with one another so that no sound results (a) True (b) False

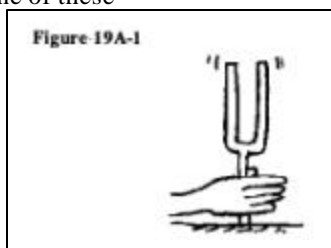
4-48) The phenomenon of beats results from sound (a) refraction (b) reflection (c) interference (d) all of these (e) none of these

4-49) When you tune a radio to a certain station, you match the frequency of the internal electrical circuit to the frequency of the wanted radio station. In so doing you are employing the principle of (a) forced vibrations (b) resonance (c) beats (d) reverberation (e) wave interference

4-50) In the case of radio, which has the higher frequency? (a) Carrier wave (b) Sound wave (c) Both may be the same

4-51) On some days, air nearest the ground is colder than air that is higher up. On one of these days, sound waves (a) tend to be refracted upward (b) tend to be refracted downward (c) travel without refraction

4-52) A 340 hertz sound wave travels at 340 m/s in air with a wavelength of (a) 1 m (b) 10m (c) 100 m (d) 1000 m (e) none of these



4-53) When the handle of a tuning fork is held solidly against a table (Fig 19A -1), the sound becomes louder and the time

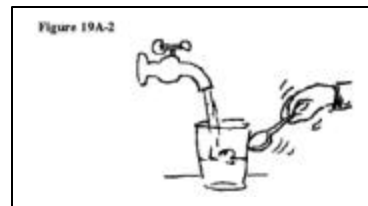
the fork keeps vibrating (a) becomes longer (b) becomes shorter (c) remains the same

4-54) In which one of these does sound travel the fastest? (a) water vapor (b) water (c) ice (d) steam (e) ...sound travels the same speed in each of these

4-55) A 1056 hertz tuning fork is sounded at the same time a piano note is struck. You hear three beats per second. What is the frequency of the piano string? (a) 1053 hertz (b) 1056 hertz (c) 1059 hertz (d) 2112 hertz (e) not enough information given to determine

4-56) Suppose you sound a 1056 hertz tuning fork at the same time you strike a note on the piano and hear 2 beats/second. You tighten the piano string very slightly and now hear 3 beats/second. What is the frequency of the piano string? (a) 1053 hertz (b) 1054 hertz (c) 1056 hertz (d) 1058 hertz (e) 1059 hertz

4-57) Which type of radio wave produces the least static in a radio receiver? (a) AM (b) FM (c) both have equal amounts of static



4-58) Repeatedly tap the side of a drinking glass with a spoon while filling it with water (Fig 19A-2) and you will notice that the pitch of the sound (a) increases (b) decreases (c) remains relatively constant

4-59) Two tuning forks produce sounds of wavelengths 3.4 meters and 3.3 meters. Approximately what beat frequency is produced? (a) 0.1 hertz (b) 1.0 hertz (c) 2.0 hertz (d) 3.0 hertz (e) 4.0 hertz

## Chapter 20 Musical Sounds

4-60) As we grow older, we hear less far into the (a) low frequencies (b) high frequencies

4-61) The loudness of a musical sound is a measure of the sound wave's (a) wavelength (b) frequency (c) speed (d) amplitude (e) all of these

4-62) The quality of a musical note has to do with its (a) loudness (b) frequency (c) harmonics (d) amplitude (e) all of these

4-63) The fundamental frequency of a violin string is 440 hertz. The frequency of its second harmonic is (a) 220 hertz (b) 440 hertz (c) 880 hertz (d) none of these

4-64) What is the threshold of hearing? (a) 10 decibel (b) 1 decibel (c) 0.1 decibel (d) 0.01 decibel (e) none of these

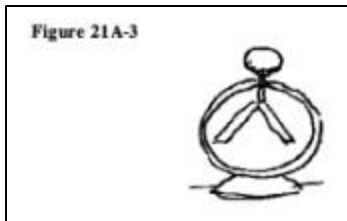
- 4-65) If a guitar has no sounding board, a note played on the guitar will sound for (a) a shorter time (b) the same length of time (c) a longer time
- 4-66) Compared to a sound of 40 decibels, a sound of 50 decibels is (a) 10 times as intense (b) 100 times as intense (c) 1000 times as intense (d) 10 000 times as intense (e) more than 10 000 times as intense
- 4-67) Compared to a sound of 30 decibels, a sound of 60 decibels is (a) twice as intense (b) 10 times as intense (c) 100 times as intense (d) 1000 times as intense (e) 10 000 times as intense
- 4-68) About how many octaves are present between 100 hertz and 1600 hertz? (a) 4 (b) 5 (c) 6 (d) 7 (e) 8
- 4-69) What is the wavelength of the fourth harmonic of a 340 hertz note? (The speed of sound is 340 m/s.) (a) 0.25 m (b) 0.33 m (c) 0.5 m (d) 1.0 m (e) none of these
- 4-70) A string vibrating at its third harmonic frequency has a node at each end and, between these, (a) no additional nodes (b) 1 additional node (c) 2 additional nodes (d) 3 additional nodes (e) 4 additional nodes
- 4-71) A cello string 0.75 m long has a fundamental frequency of 220 hertz. The speed of a wave on the string is (a) 165 m/s (b) 220 m/s (c) 294 m/s (d) 330 m/s (e) none of these
- 4-72) The wave speed on a tightened guitar string is 880 m/s. What is the shortest length of string that will produce standing waves of 440 hertz frequency? (a) 0.5 m (b) 1.0 m (c) 1.5 m (d) 2.0 m (e) none of these
- 4-77) The primary purpose of a lightning rod is to (a) attract lightning and guide it to the ground (b) discharge the structure to which it is attached (c) cancel the electric field within the structure to which it is attached (d) induce within the structure to which it is attached a charge opposite to that of charged clouds overhead
- 4-78) To say that an object is electrically polarized is to say (a) it is electrically charged (b) its charges have been rearranged (c) its internal electric field is zero (d) it is only partially conducting (e) it is to some degree magnetic
- 4-79) When a car is struck by lightning, the resulting electric field inside the car is (a) normally huge, but for a brief time (b) normally huge for a time longer than the lightning stroke itself (c) small enough to be safe for an occupant inside (d) zero
- 4-80) Electric potential, measured in volts, is the ratio of electric energy to amount of electric (a) current (b) resistance (c) charge (d) voltage (e) none of these
- 4-81) The electric field inside the dome of a Van de Graaff generator (a) depends on the amount of charge on it (b) depends on its size (c) both of these (d) neither of these
- 4-82) An uncharged pith ball is suspended by a nylon fiber. When a negatively charged rubber rod is brought nearby, without touching it, the pith ball (a) becomes charged by induction (b) becomes polarized (c) is repelled by the rod (d) all of these (e) none of these
- 4-83) The net charge on a charged capacitor (a) depends on the area of the capacitor plates (b) depends on the distance between the capacitor plates (c) depends on the medium between the capacitor plates (d) all of these (e) none of these - the net charge is zero
- 4-84) When the distance between two charges is halved, the electrical force between the charges (a) quadruples (b) doubles (c) halves (d) is reduced by 1/4 (e) none of these



## Chapter 21 Electrostatics

- 4-73) Which force binds atoms together to form molecules? (a) gravitational (b) nuclear (c) electrical (d) centripetal (e) none of these
- 4-74) To say that electric charge is quantized is to say that the charge on an object (a) may occur in an infinite variety of quantities (b) is a whole-number multiple of the charge of one electron (c) will interact with neighboring electric charges (d) can be neither created nor destroyed
- 4-75) A transistor is an example of (a) a resistor (b) a superconductor (c) a semiconductor (d) a dry cell (e) electrostatic shielding
- 4-76) Superconductors are noted for their (a) high electric resistance (b) low electric resistance (c) absence of electric resistance
- 4-85) Particle A and Particle B interact with each other. Particle A has twice the charge of particle B. Compared to the force on Particle A, the force on Particle B is (a) four times as much (b) two times as much. (c) the same (d) half as much (e) none of these
- 4-86) To say that electric charge is conserved means that no case has ever been found where (a) the total charge on an object has changed (b) the net amount of negative charge on an object is unbalanced by a positive charge on another object (c) the total amount of charge on an object has increased (d) net charge has been created or destroyed (e) none of these
- 4-87) A conductor differs from an insulator in that a conductor (a) has more electrons than protons (b) has more protons than electrons (c) has more energy than an insulator (d) has faster moving molecules (e) none of these

- 4-88) A negatively charged rod is brought near a metal can that rests on a wood table. You touch the opposite side of the can momentarily with your finger. The can is then (a) positively charged (b) negatively charged (c) uncharged (d) charged the same as it was
- 4-89) Every proton in the universe is surrounded by its own (a) electric field (b) gravitational field (c) both of these (d) none of these
- 4-90) The direction of an electric field is the direction of the force that it would exert on (a) a neutron (b) an electron (c) an atom (d) a proton (e) a molecule



- 4-91) An electrostatic test tube is charged positively as shown by foil leaves that stand apart (Fig 21A-3). As a negative charge is brought close to the electrostatic test tube, the leaves (a) fall closer together (b) spread apart further (c) do not move
- 4-92) To be safe in the unlikely case of a lightning strike, it is best to be inside a building framed with (a) steel (b) wood (c) both the same
- 4-93) Normally a balloon charged to several thousand volts has a relatively small amount of (a) charge (b) energy (c) both (d) neither
- 4-94) Two charges separated by one meter exert 1N forces on each other. If the charges are pulled to 3m separation distance, the force on each charge will be (a) 0.33 N (b) 0.11 N (c) 0N (d) 3 N (e) 9 N
- 4-95) The electrical force on a 2 C charge is 60 N. What is the value of the electric field at the place where the charge is located? (a) 20 N/C (b) 30N/C (c) 60 N/C (d) 120 N/C (e) 240 N/C
- 4-96) When a single charge  $q$  is placed on one corner of a square, the electric field at the center of the square is  $F/q$ . If three other equal charges are placed on the other corners, the electric field at the center of the square due to these four equal charges is (a)  $F/q$  (b)  $4F/q$  (c)  $F/(2q)$  (d)  $F/(4q)$  (e) none of these
- 4-97) When a single charge  $q$  is placed at one corner of a square, the electric field at the center of the square is  $F/q$ . If two other equal charges are placed at the adjacent corners of the square, the electric field at the center of the square due to these three equal charges is (a)  $F/q$  (b)  $4F/q$  (c)  $F/(2q)$  (d)  $F/(4q)$  (e) none of these
- 4-98) An electron is pushed into an electric field where it acquires a 1 V electrical potential. If two electrons are pushed the same distance into the same electric field, the

electrical potential of the two electrons is (a) 0.25 V (b) 0.5V (c) 1 V (d) 2 V (e) 4 V

- 4-99) The electric field inside an uncharged metal ball is zero. If the ball is negatively charged, the electric field inside the ball is then (a) less than zero (b) zero (c) greater than zero
- 4-100) Two charged particles held near each other are released. As they move, the acceleration of each decreases. Therefore, the particles have (a) the same sign! (b) opposite signs (c) not enough information given
- 4-101) A proton and an electron are placed in an electric field. Which undergoes the greater acceleration? (a) electron (b) proton (c) both accelerate equally (d) neither accelerates

## Chapter 22 Electric Current

- 4-102) Electrons are made to flow in a wire when there is (a) an imbalance of charges in the wire. (b) more potential energy at one end of the wire than the other (c) a potential difference across its ends
- 4-103) A coulomb of charge that passes through a 6 volt battery is given (a) 6 joules (b) 6 amperes (c) 6 ohms (d) 6 watts (e) 6 newtons
- 4-104) Which statement is correct? (a) Charge flows in a circuit (b) Voltage flows through a circuit (c) Resistance is established across a circuit (d) Current causes voltage
- 4-105) Electrons move in an electrical circuit (a) by being bumped by other electrons (b) by colliding with molecules (c) by interacting with an established electric field (d) because the wires are so thin (e) none of these
- 4-106) The current through a 10 ohm resistor connected to a 120 V power supply is (a) 1 A (b) 10 A (c) 12A (d) 120 A (e) none of these
- 4-107) A 10 ohm resistor has a 5 A current in it. What is the voltage across the resistor? (a) 5 V (b) 10 V (c) 15 V (d) 20 V (e) more than 20 V
- 4-108) When a 10 V battery is connected to a resistor, the current in the resistor is 2 A. What is the resistor's value? (a) 2 ohms (b) 5ohms (c) 10 ohms. (d) 20 ohms (e) more than 20 ohms
- 4-109) The source of electrons in an ordinary electrical circuit is (a) a dry cell, wet cell or battery (b) the back emf of motors (c) the power station generator (d) the electrical conductor itself (e) none of these
- 4-110) The source of electrons lighting an incandescent ac light bulb is (a) the power company (b) electrical outlet (c) atoms in the light bulb filament (d) the wire leading to the lamp (e) the source voltage
- 4-111) A woman experiences an electrical shock. The electrons making the shock come from the (a) woman's

body (b) ground (c) power plant (d) hairdryer (e) electric field in the air

4-112) In a common dc circuit, electrons move at speeds of (a) a fraction of a centimeter per second (b) many centimeters per second (c) the speed of a sound wave (d) the speed of light (e) none of these

4-113) When a light switch is turned on in a dc circuit, the average speed of electrons in the lamp is (a) the speed of sound waves in metal (b) the speed of light (c) 1000 cm/s (d) less than 1 cm/s (e) dependent on how quickly each electron bumps into the next electron

4-114) The electric power of a lamp that carries 2 A at 120 V is (a) 1/6 watts (b) 2 watts (c) 60 watts (d) 20 watts (e) 240 watts

4-115) When two lamps are connected in series to a battery, the electrical resistance that the battery senses is (a) more than the resistance of either lamp (b) less than the resistance of either lamp (c) none of these

4-116) Modern automobile headlights are connected in (a) parallel (b) perpendicular (c) series (d) none of these

4-117) A 100 Watt lamp glows brighter than a 25 Watt lamp. The electrical resistance of the 100 Watt lamp must be (a) less (b) greater (c) the same

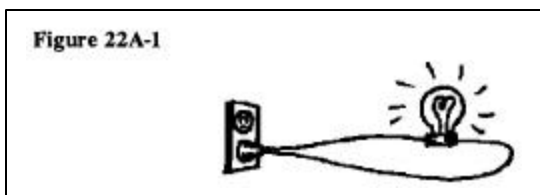
4-118) In an electric circuit, the safety fuse is connected to the circuit in (a) series (b) parallel

4-119) When a pair of 1 ohm resistors are connected in series, their combined resistance is (a) 1 ohm, and when connected in parallel, 2 ohms (b) 2 ohms, and when in parallel, 1 ohm (c) 1/2 ohm, and when in parallel, 2 ohms (d) 2 ohms, and when in parallel, 1/2 ohm (e) none of these

4-120) A circuit breaker serves the same purpose as (a) a switch (b) a fuse (c) a capacitor (d) a battery (e) none of these

4-121) A capacitor is useful in (a) boosting the energy output of a circuit (b) increasing the current in a resistor (c) smoothing pulsed current (d) switching dc to ac in a circuit (e) increasing or decreasing voltage

4-122) An electrical diode is useful for (a) storing electrical energy (b) boosting voltage (c) limiting current (d) voltage modification (e) changing ac to dc



4-123) In the 110 volt circuit shown (Fig 22A-1) (a) 110 coulombs of charge flow through the lamp every second (b) 110 joules of energy are converted to heat and light in the

circuit every second (c) 110 joules of energy are given up by each coulomb of charge making up the current in the circuit (d) 110 joules of energy are shared among all the coulombs in the circuit at any instant (e) none of the above

4-124) In the circuit of Figure 22A-1 energy is given to the moving charges by (a) the bulb (b) the wires (c) a generator which is not shown (d) none of these

4-125) A capacitor is used to store (a) charge (b) energy (c) both (d) neither

4-126) The number of electrons delivered daily to an average American home by an average power utility in the mid 1980s was (a) zero (b) 110 (c) 220 (d) billions of billions (e) none of these

4-127) Two lamps, one with a thick filament and one with a thin filament, are connected in series. The current is greater in the lamp with the (a) thick filament (b) thin filament (c) the same in each

4-128) Two lamps, one with a thick filament and one with a thin filament, are connected in parallel to a battery. The voltage is greatest across the lamp with the (a) thick filament (b) thin filament (c) both voltages are the same

4-129) Two lamps, one with a thick filament and one with a thin filament of the same material, are connected in parallel to a battery. The current is larger in the lamp with the (a) thick filament (b) thin filament (c) current is the same in both

4-130) Two lamps, one with a thick filament and one with a thin filament of the same material, are connected in series to a battery. The voltage is greater across the lamp with the (a) thick filament (b) thin filament (c) voltage is the same for both

4-131) As more lamps are put into a series circuit, the overall current in the power source (a) increases (b) decreases (c) stays the same

4-132) As more lamps are put into a parallel circuit, the overall current in the power source (a) increases (b) decreases (c) stays the same

4-133) A circuit is powered with a battery. Charge flows (a) out of the battery and into the circuit (b) from the negative battery terminal to the positive terminal (c) after a couple seconds passes (d) through both the battery and the rest of the circuit (e) none of these

4-134) When we say an appliance "uses up electricity," we really are saying that (a) current disappears (b) electric charges are dissipated (c) the main power supply voltage is lowered (d) electrons are taken out of the circuit and put somewhere else (e) electron kinetic energy is changed into heat

4-135) If you plug an electric toaster rated at 110 V into a 220 V outlet, the current in the toaster will be about half what it

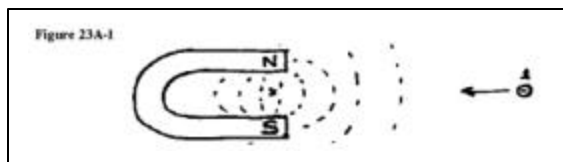
- should be (b) the same as if it were plugged into 110 V (c) more than twice what it should be (d) twice what it should be
- 4-136) A 60 watt light bulb is connected to a 120 volt plug. What is the current in the light bulb? (a) 0.25 A (b) 0.5 A (c) 2A (d) 4 A (e) more than 4 A
- 4-137) What is the power rating of a light bulb if 0.8 A flow through it when it is connected to a 120 volt outlet? (a) 12 W (b) 15 W (c) 60 W (d) 96 W (e) 120 W
- 4-138) The headlights, radio, and defroster fan in an automobile are connected in (a) series (b) parallel
- 4-139) A 4 ohm resistor is connected in parallel with a 6 ohm resistor. This combination produces an equivalent resistance of (a) 2.4 ohms (b) 4 ohms (c) 5 ohms (d) 5.5 ohms (e) 10 ohms
- 4-140) The power dissipated in a 4 ohm resistor carrying 3 A is (a) 7 W (b) 18W (c) 36 W (d) 48 W (e) not enough information to say
- 4-141) A 60 W light bulb and a 100 W light bulb are each rated at 120 V. Which light bulb has a larger resistance? (a) the 60 W bulb (b) the 100 W bulb (c) both have the same resistance
- 4-142) A 60 W light bulb and a 100 W light bulb are each connected to a 120 V outlet. Which light bulb has more current in it? (a) the 60 W bulb (b) the 100 W bulb (c) both have the same current
- 4-143) Compared to the filament thickness of a 60 W light bulb, the filament of a 100 W light bulb will be (a) thinner (b) thicker (c) the same
- 4-144) Compared to a single lamp connected to a battery, two identical lamps connected in series to the same battery will have (a) more current (b) less current (c) the same current
- 4-145) Compared to a single lamp connected to a battery, two lamps connected in parallel to the same battery will have (a) more current (b) less current (c) the same current
- 4-146) An electric heater is rated at 300 W when used in a 110 V circuit. The safety fuse in the circuit can handle 15 A of current. How many heaters can be safely operated in the circuit? (a) 2 (b) 3 (c) 4 (d) 5 (e) more than 5
- 4-147) A heater has a current of 20 A when used in a 110 V line. If electric power costs 10 cents per kilowatt hour the cost of running the heater for 10 hours is (a) \$0.22 (b) \$0.55 (c) \$2.20 (d) \$5.50 (e) none of these
- 4-148) The current through two identical light bulbs connected in series is 0.25 A. The voltage across both bulbs is 110 V. The resistance of a single light bulb is (a) 22 ohms (b) 44 ohms (c) 220 ohms (d) 440 ohms (e) none of these
- 4-149) A power line with a resistance of 2 ohms has a current of 80 A in it. The power is (a) 40 W (b) 160 W (c) 320 W (d) 12 800 W (e) none of these.
- 4-150) What is the resistance of a 120 W incandescent lamp connected to a 120 V power supply? (a) 1 ohm (b) 60ohms (c) 100 ohms. (d) 144 ohms. (e) none of these
- 4-151) Compared to the amount of electric current in the filament of a lamp, the amount of current in the connecting wire is (a) definitely less (b) often less (c) more (d) the same (e) incredibly, all of these.
- 4-152) Connect a pair of lamps in series and you have a current from the connected battery. Connect the same lamps in parallel and you have (a) the same current (b) more current (c) less current (d) sometimes more, sometimes less.

### Chapter 23 Magnetism

- 4-153) The source of all magnetism is (a) tiny pieces of iron (b) tiny domains of aligned atoms (c) ferromagnetic materials (d) moving electric charge (e) none of these
- 4-154) Magnetic compasses apparently were first used by (a) Columbus (b) Greeks (c) Australian aborigines (d) Vikings (e) pigeons, then Chinese
- 4-155) Moving electric charges will interact with (a) an electric field (b) a magnetic field (c) both of these (d) none of these
- 4-156) If a steady magnetic field exerts a force on a moving charge, that force is directed (a) opposite the motion (b) in the direction of the motion (c) at right angles to the direction of the motion
- 4-157) If a steady magnetic field exerts a force on a moving charge, that force is directed (a) in the direction of the field (b) opposite the direction of the field (c) at right angles to the direction of the field
- 4-158) An iron rod becomes magnetic when (a) positive ions accumulate at one end and negative ions at the other end (b) its atoms are aligned having plus charges on one side and negative charges on the other (c) the net spins of its electrons are in the same direction (d) its electrons stop moving and point in the same direction (e) none of these
- 4-159) Like kinds of magnetic poles repel while unlike kinds of magnetic poles (a) attract (b) repel also (c) may attract or repel
- 4-160) Several paper clips dangle from the north pole of a magnet. The induced pole in the bottom of the lower most paper clip is a (a) north pole (b) south pole (c) north or south pole - no difference really
- 4-161) Surrounding every moving electron is (a) a magnetic field (b) an electric field (c) both of these (d) none of these

- 4-162) Magnetism is due to the motion of electrons as they (a) move around the nucleus (b) spin on their axes (c) both of these (d) none of these
- 4-163) Magnetic domains normally occur in (a) iron (b) copper (c) silver (d) all of these (e) none of these
- 4-164) Magnetic field lines about a current-carrying wire (a) extend radially from the wire (b) circle the wire in closed loops (c) both of these (d) neither of these
- 4-165) The force on an electron moving in a magnetic field will be the largest when its direction is (a) the same as the magnetic field direction (b) exactly opposite to the magnetic field direction (c) perpendicular to the magnetic field direction (d) at an angle other than 90 degrees to the magnetic field direction (e) none of these
- 4-166) The magnetic north pole of the earth is nearest (a) the Hudson Bay region of Canada (b) Australia (c) both of these
- 4-167) Which pole of a compass needle points to a south pole of a magnet? (a) north pole (b) south pole (c) both of these
- 4-168) Compared to the huge force that attracts an iron tack to a strong magnet, the force that the tack exerts on the magnet is (a) relatively small (b) equally huge (c) more information is needed

Below (Fig 23A-1) is shown part of the magnetic field of a "horseshoe" magnet.



- 4-169) An electron is shot from the right, toward a spot just between the ends of the magnet. The electron (a) is unaffected by the field (b) is attracted to one of the poles, and repelled from the other (c) is repelled by both poles, and therefore is turned back (d) is deflected into the plane of the page (e) accelerates straight toward the spot
- 4-170) If a compass is moved from the northern hemisphere to the southern hemisphere, its magnetic needle will change direction (a) by 180 degrees (b) depending on where the measurement is taken (c) by 90 degrees (d) hardly at all (e) none of these
- 4-171) A possible cause for the existence of the earth's magnetic field is (a) moving charges in the liquid part of the earth's core (b) great numbers of very slow moving charges in the earth (c) convection currents in the liquid part of the earth's core (d) all of these (e) none of these
- 4-172) Outside a magnet, magnetic field lines are conventionally drawn from (a) north to south (b) south to north (c) either way

- 4-173) Which force field can increase a moving electron's speed? (a) Electric field (b) Magnetic field (c) Both of these (d) None of these

- 4-174) Which force field can accelerate an electron, but never change its speed? (a) Electric field (b) Magnetic field (c) Both of these (d) None of these

## Chapter 24 Electromagnetic Induction

- 5-1) When there is a change in the magnetic field in a closed loop of wire (a) a voltage is induced in the wire (b) current is made to flow in the loop of wire (c) electromagnetic induction occurs (d) all of these (e) none of these
- 5-2) Thrust a magnet into a coil of wire and the coil (a) becomes an electromagnet (b) has a current in it (c) both of these (d) neither of these
- 5-3) When a magnet is thrust into a coil of wire, the coil tends to (a) attract the magnet as it enters (b) repel the magnet as it enters (c) both of these (d) neither of these
- 5-4) Electromagnetic induction occurs in a coil when there is a change in (a) electric field intensity in the coil (b) magnetic field intensity in the coil (c) voltage in the coil (d) the coil's polarity (e) electromagnetic polarity
- 5-5) Voltage can be induced in a wire by (a) moving the wire near a magnet (b) moving a magnet near the wire (c) changing the current in a nearby wire (d) all of these (e) none of these
- 5-6) A wire moving sidewise in a magnetic field has NO induced voltage if (a) it is moving in the direction of the field. (b) it is moving opposite the direction of the field (c) it is made of copper (d) it is moving very fast (e) two of these
- 5-7) The magnetic field strength inside a current-carrying coil will be greater if the coil encloses a (a) vacuum (b) wooden rod (c) glass rod (d) rod of iron (e) none of these
- 5-8) If a magnet is pushed into a coil, voltage is induced across the coil. If the same magnet is pushed into a coil with twice the number of loops, (a) one half as much voltage is induced (b) the same voltage is induced (c) twice as much voltage is induced (d) four times as much voltage is induced (e) none of these
- 5-9) A device that transforms electrical energy to mechanical energy is a (a) generator (b) motor (c) transformer (d) magnet (e) none of these
- 5-10) A device that transforms mechanical energy into electrical energy is a (a) generator (b) motor (c) transformer (d) magnet (e) none of these
- 5-11) If the voltage produced by a generator alternates, it does so because (a) unlike a battery, it produces alternating current (b) the changing magnetic field that produces it alternates (c) alterations in the mechanical energy input (d)

in effect it is an ac motor in reverse (e) the current it produces alternates

secondary coil is (a) 2 A (b) 5 A (c) 10 A (d) 25 A (e) none of these

5-12) A principle difference between an MHD generator and a conventional generator is that the MHD generator (a) has no moving parts (b) operates more efficiently at high temperatures (c) both of these (d) neither of these

5-24) A step-up transformer has a ratio of one to ten. Neglecting slight losses, if 100 W of power go into the primary coil, the power coming from the secondary coil is (a) 1 W (b) 10 W (c) 100 W (d) 1000 W (e) none of these

5-13) A transformer actually transforms (a) voltage (b) magnetic field lines (c) generators into motors (d) non-safe forms of energy to safe forms of energy (e) all of these

5-25) Metal detectors, like the ones used at airports, are activated by (a) electric fields (b) magnetic fields (c) electromagnetic induction (d) alternating current

5-14) Transformers use ac so there will be the required (a) transfer of energy from coil to coil (b) voltage for transformation (c) change in magnetic field for operation (d) change in input current (e) magnetic field intensities

5-26) The principal advantage of ac power over dc power is that (a) less energy is dissipated during transmission (b) ac voltage oscillates while dc voltage does not (c) ac voltage can be transformed via conventional transformers (d) ac circuits multiply power more easily (e) ac circuits are safer

5-15) Compared to the primary voltage, the secondary voltage may be (a) larger (b) smaller (c) the same (d) the same or smaller, but not larger (e) larger, smaller, or the same

5-27) The major advantage of MHD generators over conventional generators is that MHD generators (a) do not use electromagnetic induction (b) do not require magnets (c) require no power input (d) all of these (e) none of these

5-16) The output power of a transformer is (a) greater than the input power (b) equal to the input power (c) smaller than the input power (d) may be any of these

5-28) The voltage across the input terminals of a transformer is 110 V. The primary has 50 loops and the secondary has 25 loops. The voltage the transformer puts out is (a) 25 V (b) 55 V (c) 110 V (d) 220 V (e) none of these

5-17) Disconnect a small-voltage battery from a coil of many loops of wire and a large voltage is produced by (a) the large collapse in the magnetic field (b) latent energy in the battery (c) the resistance of the battery to a change in polarity (d) electrons already in the wire (e) the electric field between the battery terminals

5-29) Four amperes of current exist in the primary coil of a transformer. The voltage across the primary coil is 110 V. What is the power output of the secondary coil? (a) 27.5 W (b) 110 W (c) 440 W (d) 880 W (e) not enough information to say

5-18) Power is transmitted at high voltages because the corresponding current in the wires is (a) also high to deliver appreciable power to distant places (b) low so that overheating of the wires is minimized (c) both of these (d) neither of these

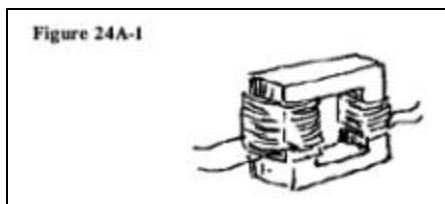
5-30) As a motor armature turns faster and faster, net current in the motor windings (a) increases (b) decreases (c) remains unchanged

5-19) Electric energy can be transmitted from one place to another without the need for connecting wires in between. This statement is (a) true (b) false

5-31) If the primary of a transformer were connected to a dc source, the transformer would have a voltage output (a) at a higher efficiency than with an ac source (b) the same (c) that is also dc (d) only while being connected or disconnected (e) none of these

5-20) Rapid change of a magnetic field induces (a) a magnetic field of greater magnitude (b) a magnetic field of the same magnitude (c) an electric field

5-21) The metal detectors that people walk through at airports operate via (a) Ohm's law (b) Faraday's law (c) Coulomb's law (d) Newton's laws (e) civil laws



5-22) A step-up transformer (Fig 24A-1) increases (a) power (b) energy (c) both of these (d) neither of these

## Chapter 25 Properties of Light

5-32) The fact that light travels at 300 000 km/s is a consequence of (a) electromagnetic wave propagation (b) electromagnetic field induction (c) Maxwell's laws (d) energy conservation (e) none of these

5-33) The source of all electromagnetic waves is (a) changes in atomic energy levels (b) vibrating atoms (c) accelerating electric charges (d) crystalline fluctuations (e) none of these

5-23) A certain transformer doubles input voltage. If the primary coil has 10 A of current, then the current in the

5-34) Which of these electromagnetic waves has the shortest wavelength? (a) radio waves (b) infrared waves (c) X-rays (d) ultraviolet waves (e) light waves

- 5-35) If an electric charge is shaken up and down, (a) sound is emitted (b) light is emitted (c) electron excitation occurs (d) a magnetic field is created (e) its mass decreases
- 5-36) The source of all electromagnetic waves is (a) heat (b) magnetic fields (c) electric fields (d) vibrating charges (e) none of these
- 5-37) When ultraviolet light is incident upon glass, atoms in the glass (a) are forced into vibration (b) resonate (c) pass the light energy along practically undiminished (d) freely absorb and re-emit most of the ultraviolet light
- 5-38) When visible light is incident upon clear glass, atoms in the glass (a) are forced into vibration (b) resonate (c) convert the light energy into internal energy
- 5-39) Consider light energy that is momentarily absorbed in glass and then re-emitted. Compared to the absorbed light, the frequency of the re-emitted light is (a) considerably less (b) slightly less (c) the same (d) slightly more (e) considerably more
- 5-40) The speed of light in the void between molecules in glass is (a) more than its speed in a vacuum (b) the same as its speed in a vacuum (c) less than its speed in a vacuum
- 5-41) A lunar eclipse occurs when the (a) sun passes into the earth's shadow (b) moon passes into the earth's shadow (c) earth passes into the sun's shadow (d) earth passes into the moon's shadow
- 5-42) A solar eclipse occurs when the (a) sun passes into the earth's shadow (b) moon passes into the earth's shadow (c) earth passes into the moon's shadow
- 5-43) A partial solar eclipse occurs for people in the sun's (a) umbra (b) penumbra (c) none of these
- 5-44) While earth is experiencing a total solar eclipse an observer on the moon would see (a) earth disappear from the sky (b) earth dim and turn reddish (c) nothing unusual (d) a tiny dark spot move across the face of earth
- 5-45) The sensation of color is seen when light falls on the eye's (a) rods (b) cones (c) both (d) neither
- 5-46) Red-hot and blue-hot stars appear white to the eye because (a) the eye has difficulty seeing color at night (b) they are too dim to fire the cones (c) they are too dim to fire the rods (d) they are overwhelmed by the blackness of the nighttime sky (e) eye receptivity peaks in the yellow-green part of the spectrum
- 5-47) In the periphery of our vision, we are (a) more sensitive to low frequencies than high ones (b) insensitive to color and movement (c) sensitive to movement, but cannot see color (d) sensitive to both movement and color (e) none of these
- 5-48) Information-carrying nerves are connected to the retina at (a) the fovea (b) the blind spot (c) the cornea (d) the iris (e) the periphery
- 5-49) The main difference between a radio wave and a sound wave is their different (a) frequencies (b) wavelengths (c) energies (d) amplitudes (e) basic natures
- 5-50) Glass is transparent to wave frequencies that (a) match its natural frequencies (b) are below its natural frequencies (c) both of these (d) none of these
- 5-51) The moon would be at its fullest just before the time of a (a) solar eclipse (b) lunar eclipse (c) both of these (d) none of these
- 5-52) What is the wavelength of an electromagnetic wave that has a frequency of 3 kilohertz? (a) less than 1 km (b) 1 km (c) more than 1 km
- 5-53) What is the frequency of an electromagnetic wave that has a wavelength of 300,000 km? (a) less than 1 Hz (b) 1 Hz (c) more than 1 Hz
- 5-54) The main difference between the retina of a human eye and that of a dog's eye is the (a) predominance of cones in a dog's retina (b) absence of cones in a dog's retina (c) more intricate optic nerve in a human's eye (d) absence of cones in a human's eye (e) none of these
- 5-55) Things seen by moonlight usually aren't colored because moonlight (a) doesn't have very many colors in it (b) is too dim to activate the retina's cones (c) photons don't have enough energy to activate the retina's cones (d) all of these (e) none of these
- 5-56) At the same time an astronaut on the moon sees a solar eclipse, observers on earth see (a) a lunar eclipse (b) a solar eclipse (c) no eclipse at all

## Chapter 26 Color

- 5-57) When the frequency of light matches the natural frequency of molecules in a material, light is (a) absorbed (b) transmitted (c) reflected (d) none of these
- 5-58) The brightest color emitted by the sun is (a) red (b) orange (c) yellow-green (d) green-blue (e) violet
- 5-59) The colored dots that make up the color on a TV screen are (a) red, blue, yellow (b) red, blue, green (c) yellow, blue, green (d) magenta, cyan, yellow (e) red, green, yellow
- 5-60) If three primary colors of light are to shine on a white wall to produce a white spot, the primaries must be (a) additive (b) subtractive (c) multiplicative (d) divisive
- 5-61) Complementary colors are two colors that (a) look good together (b) are additive primary colors (c) are subtractive primary colors (d) produce white light when added together (e) are right for each other

- 5-62) The complementary color of blue is (a) red (b) green (c) yellow (d) cyan (e) magenta
- 5-63) Colors seen on the cover of our physics book result from color (a) addition (b) subtraction (c) either of these (d) neither of these
- 5-64) A mixture of cyan and yellow pigments appears (a) orange (b) green (c) magenta (d) blue (e) blackish brown
- 5-65) Look at a full-color picture in a magazine with a magnifying glass and you'll see that the inks used are (a) red, green, and blue (b) red, green, blue, and black (c) magenta, cyan, and yellow (d) magenta, cyan, yellow, and black (e) none of these
- 5-66) The sky is blue because air molecules in the sky act as tiny (a) mirrors which reflect only blue light (b) resonators which scatter blue light (c) sources of white light (d) prisms (e) none of these
- 5-67) A whitish sky is evidence that the atmosphere contains (a) predominantly small particles (b) predominantly large particles (c) a mixture of particle sizes (d) water vapor (e) pollutants
- 5-68) The sky is the deepest blue (a) just before a rainstorm (b) during a rainstorm (c) just after a rainstorm (d) when the air is humid (e) just before sunset
- 5-69) The sun is more likely to appear red at sunset than in the middle of the day as a result of the (a) scattering of lower frequencies by larger particles in the air (b) longer path of air through which sunlight travels (c) lower frequencies of light emitted late in the day by the sun (d) pollutants emitted by humans in daylight hours (e) absorption effects of the smaller particles in the air
- 5-70) A variety of sunset colors is evidence for a variety of (a) elements in the sun (b) apparent atmospheric thicknesses (c) atmospheric particles (d) atmospheric temperatures (e) primary colors
- 5-71) The greenish blue of water is evidence for the (a) reflection of greenish-blue light (b) reflection of red light (c) absorption of greenish-blue light (d) absorption of red light (e) interaction between green and blue frequencies of light
- 5-72) The part of the electromagnetic spectrum most absorbed by water is (a) infrared (b) lower frequencies in the visible (c) middle frequencies in the visible (d) higher frequencies in the visible (e) ultraviolet
- 5-73) A sheet of red paper will look black when illuminated with (a) red light (b) yellow light (c) magenta light (d) cyan light (e) none of these
- 5-74) The fact that you can get sunburned while in the shade is evidence that the atmosphere (a) scatters infrared light (b) absorbs infrared light (c) scatters ultraviolet light (d) absorbs ultraviolet light
- 5-75) Distant dark colored hills appear blue because that is the color of the (a) atmosphere between the observer and the hills (b) selectively reflected light that reaches a distant observer (c) reflected light that survives scattering (d) sky that is reflected off the hills
- 5-76) Distant snow covered hills appear yellowish because that is the color of the (a) atmosphere between the observer and the hills (b) selectively reflected light that reaches a distant observer (c) reflected light that survives scattering (d) sky that is reflected off the hills
- 5-77) The yellow clothes of a stage performer can be made to look black if illuminated only by light that is (a) blue (b) magenta plus cyan (c) both of these (d) none of these
- 5-78) The worst thing you can do for the health of a green-leafed plant is to illuminate it with only (a) red light (b) green light (c) blue light (d) all are equally naughty (e) none of these
- 5-79) If molecules in the sky scattered orange light instead of blue light, sunsets would be colored (a) orange (b) yellow (c) green (d) blue (e) none of these
- 5-80) On a planet where atmospheric gases are red, distant dark colored hills would look (a) bluish (b) greenish (c) yellowish (d) reddish (e) untinted
- 5-81) On a planet where atmospheric gases are yellow, distant snow covered hills would look (a) bluish (b) greenish (c) yellowish (d) reddish (e) untinted
- 5-82) The redness of the lunar eclipse is evidence for the (a) refraction of sunsets and sunrises all around the world (b) infrared light continually emitted by the moon (c) scattering of lower frequencies of light by the moon (d) faintly radiating atoms in our own atmosphere when sunlight is not incident upon them (e) dim light that is incident upon the moon by Jupiter and other planets

## Chapter 27 Reflection and Refraction

### a) Reflection

- 5-83) Light is emitted when (a) electron clouds of atoms are forced into oscillation (b) atomic nuclei are made to vibrate (c) electromagnetic waves emanate from matter (d) high frequency sound waves strike matter
- 5-84) Light will almost always travel from one place to another along a path of least (a) distance (b) time (c) effort (d) expense (e) complication
- 5-85) The amount of light reflected from the front surface of a common windowpane is about (a) 4 percent (b) 8 percent (c) 40 percent (d) 92 percent (e) 96 percent
- 5-86) A surface that is considered rough for infrared waves may be polished for (a) radio waves (b) light waves (c) both of these (d) none of these

5-87) If you walk towards a mirror at a certain speed, the relative speed between you and your image is (a) half your speed (b) your speed (c) twice your speed (d) none of these

5-88) The shortest plane mirror in which you can see your entire image is (a) half your height (b) about 3/4 your height (c) about 1/3 your height (d) equal to your height (e) dependent on your distance from the mirror

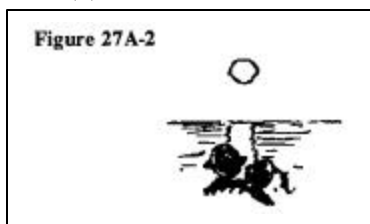
5-89) You wish to photograph the image of your little sister, who is standing 2 meters from a plane mirror. Holding the camera beside her head, you should set the distance for (a) 1 meter (b) 2 meters (c) 3 meters (d) 4 meters (e) none of these

5-90) When you look at yourself in a pocket mirror, and then hold the mirror farther away, you see (a) more of yourself (b) less of yourself (c) the same amount of yourself

5-91) It is difficult to see the roadway in front of you when you are driving on a rainy night mainly because (a) light scatters from raindrops and cuts down the light to reach your eyes (b) of added condensation on the inner surface of the windshield (c) the film of water on your windshield provides an additional reflecting surface (d) the film of water on the roadway makes the road less diffuse (e) none of these

5-92) Standing at the shore of a still lake, the reflected view of scenery on the far side of the lake is the view you would see if you were upside down with your eye in the line of sight (a) where it presently is (b) at the surface of the water where the light reflects (c) directly beneath you, as far below water level as you are above (d) close to the distant shore (e) none of these

5-93) The inversion of your image in a plane mirror is actually an inversion of (a) left and right (b) up and down (c) front and back (d) all of these



5-94) Reflected light from the moon in a lake often appears as a vertical column (Fig 27A-2) when the water is (a) perfectly still (b) slightly rough (c) very rough - churning with waves

## Chapter 27 Reflection and Refraction

### b) Refraction

5-95) Atmospheric refraction makes the daylight hours a bit (a) longer (b) shorter (c) longer in summer but shorter in winter

5-96) A mirage is a result of atmospheric (a) reflection (b) refraction (c) scattering (d) dispersion (e) aberrations

5-97) The twinkling of the stars is a result of atmospheric (a) reflection (b) refraction (c) scattering (d) dispersion (e) aberrations

5-98) Light refracts when traveling from air into glass because light (a) has greater intensity in air than in glass (b) has greater intensity in glass than in air (c) has greater frequency in air than in glass (d) has greater frequency in glass than in air (e) travels slower in glass than in air

5-99) A beam of light emerges from water into air at an angle. The beam is bent (a) towards the normal (b) away from the normal (c) 48 degrees upward (d) 96 degrees upward (e) not at all

5-100) Refraction causes the bottom of a swimming pool to appear (a) farther down than it actually is (b) closer to the surface than it actually is (c) neither

5-101) The average speed of light is greatest in (a) red glass (b) orange glass (c) green glass (d) blue glass (e) is the same in all of these

5-102) Rainbows are not usually seen as complete circles because (a) the ground is usually in the way (b) they are actually elliptical (c) they have no bottom part (d) raindrops are not perfectly round (e) rainbows are actually arched shaped

5-103) A single raindrop illuminated by sunshine disperses (a) a single color (b) either low, middle, or high frequency colors in most cases (c) all the colors of the rainbow

5-104) When you view a distant rainbow, you view from each single water drop that contributes to the bow (a) a single color (b) either low, middle, or high frequency colors in most cases (c) all the colors of the rainbow

5-105) The secondary rainbow is dimmer than the primary rainbow because (a) its colors are inverted (b) it is larger, and its energy is spread over more area (c) it is farther from the viewer (d) it simply has much less energy than the primary bow (e) of an extra reflection and refraction in the drops

5-106) The critical angle is least in which of the following? (a) Glass (b) Water (c) Diamond (d) Vacuum

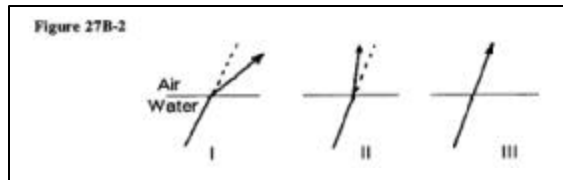
5-107) In an optical fiber, light actually (a) curves in a direction parallel to the central axis of the fiber (b) travels in straight line segments (c) travels along the outer surface of the fiber (d) all of these, depending on the type of fiber (e) none of these

5-108) Your image in a plane mirror is (a) virtual (b) real (c) both of these (d) neither of these

5-109) Which of the following can be projected onto a viewing screen? (a) A real image (b) A virtual image (c) Both (d) Neither

5-110) Your vision is sharpest when your pupil is (a) dilated (b) constricted (c) same either way

5-111) Chromatic aberration is a consequence of different colors in a lens having different (a) aberrations (b) frequencies (c) energies (d) critical angles (e) speeds



5-112) Fermat's principle of least time applies to (a) reflection (b) refraction (c) both of these (d) neither of these

5-113) When seen from an airplane, a rainbow sometimes forms a complete circle. When this happens, the plane's shadow is (a) in the center of the rainbow (b) in the lower part of the rainbow (c) in the upper part of the rainbow (d) totally outside the rainbow (e) nowhere, for there is no shadow

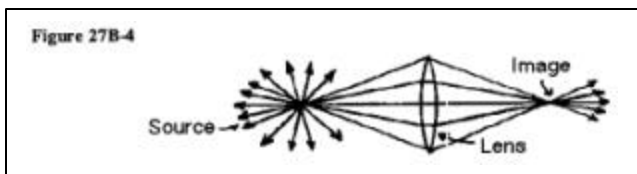
5-114) If a fish looks upward at 45 degrees with respect to the water's surface, it will see (a) the bottom of the pond (b) another fish in the pond (c) the sky and possibly some hills (d) only the water's surface (e) none of these

5-115) The reason diamonds display many colors is that (a) diamonds are extremely hard (b) a diamond reflects much more light than it absorbs (c) diamonds are forever (d) different colors of light undergo different changes of speed when exiting a diamond (e) none of these

5-116) When white light goes from air into water, the color that refracts the most is (a) red (b) orange (c) green (d) violet (e) all refract the same amount

5-117) If you wish to spear a fish with a regular spear, you should compensate for refraction between the air and water and throw your spear (a) directly at the sighted fish (b) above the sighted fish (c) below the sighted fish

*A lens can be used to take light emanating from a point source and bring it back to another point (Fig 27B-4). This second point is called the first point's image*



5-118) From what you know about the refraction of various wavelengths of visible light, would red light and blue light from the same source produce images at the same place? (a) Yes (b) No. Blue light would make an image closer to the lens (c) No. Red light would make an image closer to the lens

5-119) If you wish to hit a red fish with a red laser beam, you should compensate for refraction between the air and water by aiming your laser (a) directly at the sighted fish (b) above the sighted fish (c) below the sighted fish

5-120) If you wish to hit a blue fish with a red laser beam, you should compensate for refraction between the air and water by aiming your laser (a) directly at the sighted fish (b) above the sighted fish (c) below the sighted fish

5-121) A person who sees more clearly under water without eyeglasses or a face mask is (a) nearsighted (b) farsighted (c) neither

5-122) When light is refracted, there is a change in its (a) frequency (b) wavelength (c) both of these (d) neither of these

5-123) The moon's redness during a lunar eclipse results from (a) only lower frequencies being reflected from the moon (b) infrared radiation that is normally blocked (c) an optical illusion (d) refraction by the earth's atmosphere of earth's sunrises and sunsets (e) none of these

5-124) When a pulse of white light is incident on a piece of glass, the first color to emerge is (a) red (b) orange (c) green (d) violet (e) they all emerge at the same time

5-125) Magnification from a lens would be greater if light (a) propagated instantaneously (b) traveled faster in glass than it does (c) traveled slower in glass than it does (d) beams spread out more (e) none of these

5-126) When taking a picture of a nearby object, your camera lens should be moved (a) closer than one focal length from the film (b) farther than one focal length from the film (c) to one focal length from the film

## Chapter 28 Light Waves

5-127) According to Huygens' principle, every point on a wave (a) is a diffraction source (b) behaves as a source of new waves (c) is the superposition of every other part of the wave (d) all of these (e) none of these

5-128) Diffraction is more pronounced through relatively (a) small openings (b) large openings (c) same for each

5-129) Waves diffract the most when their wavelength is (a) short (b) long (c) both diffract the same

5-130) The type of radio waves that are diffracted the most around small buildings are (a) AM (b) FM (c) both diffract equally

5-131) For viewing tiny objects in a microscope, diffraction is (a) helpful (b) a hindrance (c) not a factor

5-132) Diffraction is a result of (a) refraction (b) reflection (c) interference (d) polarization (e) dispersion

- 5-133) Newton's rings are a demonstration of (a) refraction (b) reflection (c) dispersion (d) polarization (e) interference
- 5-134) Iridescent colors seen in the pearly luster of an abalone shell are due to (a) refraction (b) diffraction (c) dispersion (d) polarization (e) interference
- 5-135) Polarization is a property of (a) transverse waves (b) longitudinal waves (c) both (d) neither
- 5-136) The vibrational direction of the electron and the plane of polarization of the light it emits (a) are the same (b) are at right angles to each other (c) may or may not be at right angles to each other (d) are independent of each other
- 5-137) The glare seen from water is largely (a) horizontally polarized (b) vertically polarized (c) non-polarized
- 5-138) The polarization axes of ordinary sunglasses are (a) vertical (b) horizontal (c) at right angles to each other
- 5-139) The polarization glasses for 3-D viewing are (a) vertical (b) horizontal (c) at right angles to each other
- 5-140) The function of polarizing filters in viewing 3-D slides or movies is to provide each eye (a) the ability to see parallax (b) a balanced intensity (c) an independent left or right hand view (d) a stereoscopic view (e) with light polarized at right angles to each other
- 5-141) A property of non-cubic transparent crystals is that light travels through them (a) in mutually perpendicular directions (b) without refracting (c) and becomes polarized in the process (d) at different speeds along different optic axes (e) none of these
- 5-142) A property of non-cubic transparent crystals is that polarized light that travels through them (a) breaks up into two perpendicular planes (b) is depolarized (c) is rotated (d) slows in speed (e) none of these
- 5-143) An inventor proposes to equip an office with a polarized source of background music and let those who prefer not to hear it wear polarizing earplugs. His idea is (a) a good one - giving people a choice (b) too expensive (c) too much bother (d) nonsense - you can't polarize a sound wave
- 5-144) A hologram is simply a (a) complex diffraction grating (b) thin sheet of non-cubic transparent crystals (c) pair of semi-crossed polarization filters (d) thin photographic film with microscopic images over the entire surface (e) none of these
- 5-145) Interference colors in a soap bubble give evidence that the soap film (a) has two reflecting surfaces (b) is thin (c) both of these (d) neither of these
- 5-146) Interference colors for light are analogous to (a) resonance for sound (b) the sonic boom for sound (c) partial tones for sound (d) Fourier analysis for sound (e) beats for sound
- 5-147) When long wavelength light is seen in the interference colors of a soap bubble, the wavelength being cancelled is relatively (a) long (b) short (c) neither
- 5-148) When you view a soap film by white light coming from almost behind your head, you see a certain color. A friend on the other side of the film likely sees (a) the same color (b) a different color
- 5-149) The spacing of Newton's rings will be greater with (a) red light (b) blue light (c) white light
- 5-150) An ideal Polaroid will transmit 50% of nonpolarized light incident on it. How much light is transmitted by two ideal Polaroids that are oriented with their axes parallel to each other? (a) 0% (b) 50% (c) 100% (d) between 0% and 50% (e) between 50% and 100%
- 5-151) Holograms employ the principle of (a) diffraction (b) interference (c) both of these (d) neither of these
- 5-152) Magnification can be accomplished with a hologram when viewed with light that has a (a) longer wavelength than the original light (b) shorter wavelength than the original light (c) holograms cannot be magnified
- 5-153) The spacings between double-slit interference fringes is increased if the slits are (a) closer together (b) farther apart (c) narrower (d) wider (e) none of these
- 5-154) Light from two closely spaced stars will not produce a steady interference pattern at the earth's surface because of (a) incoherence (b) the inherent instability of the atmosphere (c) their different radial distances (d) their non-point like natures (e) but closely spaced stars do produce interference patterns
- 5-155) To study sound interference, we may use sound from separate sources. To study light interference, we must use light (a) from separate sources (b) that has come by different paths from the same source
- 5-156) Because of absorption, a Polaroid will actually transmit 40% of nonpolarized light incident on it. Two such Polaroids with their axes aligned will transmit (a) 16% (b) 24% (c) 30% (d) 32% (e) 40%

## Chapter 29 Light Emission

- 5-157) Reflection occurs when outer electrons of atoms are shaken in their shells. Glowing occurs when outer electrons of atoms are shaken (a) at a higher frequency (b) at a higher amplitude (c) out of their shells and in again (d) none of these
- 5-158) Electrons with the greater potential energies with respect to the atomic nucleus are (a) inner electrons (b) outer electrons (c) both the same
- 5-159) Light is emitted when an electron (a) is boosted to a higher energy level (b) makes a transition to a lower energy level (c) neither of these

- 5-160) An atom that absorbs a photon of a certain energy can then emit (a) only a photon of that energy (b) a photon of any energy (c) only a photon of the same or higher energy (d) only a photon of the same or lower energy
- 5-161) The energy of a photon is related to (a) the energy given to the atom that emits it (b) the energy level difference through which it falls (c) its frequency (d) all of these (e) none of these
- 5-162) Which color of light carries the most energy per photon? (a) red (b) green (c) blue (d) violet (e) all the same
- 5-163) The variety of colors seen in a burning log come from the variety of (a) multi-layered incandescent surfaces (b) electron transitions in various atoms (c) temperatures (d) chemicals in the log (e) absorbing gases between the log and the viewer
- 5-164) Discrete spectral lines occur when excitation takes place in a (a) solid (b) liquid (c) gas (d) superconductor (e) all of these
- 5-165) An atom that emits a certain frequency of light is (a) not likely to absorb that same frequency (b) an absorber of the same frequency
- 5-166) The dark lines in the sun's spectrum represent light that is (a) absorbed by the sun's atmosphere (b) emitted by the sun (c) not emitted by the sun
- 5-167) Spectral lines take the shape of vertical lines because (a) the light is vertically polarized (b) they are simply images of a vertical slit (c) the energy levels in the atom are parallel to one another (d) all of these (e) none of these
- 5-168) Astronomers can tell whether a star is approaching or receding from earth by (a) its temperature (b) its change in temperature (c) its absorption spectra (d) the Doppler effect (e) all of these
- 5-169) In the process of fluorescence, the input is high frequency light and the output is (a) higher frequency light (b) equally high frequency light (c) lower frequency light
- 5-170) The white light emitted by a fluorescent lamp is provided by the (a) mercury vapor in the lamp (b) phosphors on the inner surface of the lamp (c) high temperature of the glowing gas (d) filtering effect of the glass tubing
- 5-171) The main visible difference between phosphorescent and fluorescent materials is (a) an afterglow (b) a difference in brightness (c) the greenish color of phosphorescence
- 5-172) Light from a laser is (a) monochromatic (b) in phase (c) coherent (d) all of these (e) none of these
- 5-173) If the energy levels in the neon atom were not discrete, neon signs would glow (a) red (b) white (c) blue
- 5-174) If light in a spectroscopy passed through round holes instead of slits, spectral lines would appear (a) as thicker lines (b) round (c) dimmer
- 5-175) The fact that iron absorption lines occur in the solar spectrum directly indicates that there is iron in the solar (a) atmosphere (b) surface (c) interior
- 5-176) The radiation curve for a "blue hot" object peaks in the (a) infrared region (b) red region (c) yellow region (d) ultraviolet region (e) none of these
- 5-177) A paint pigment that absorbs red light and gives off blue light (a) is fluorescent (b) is phosphorescent (c) is used in lasers (d) is polarized (e) doesn't exist
- 5-178) The absorption of an infrared photon that excites an atom to emit a green photon (a) occurs in plants (b) occurs in the process of phosphorescence (c) violates the law of energy conservation (d) all of these (e) none of these
- 5-179) The hottest star is the star that glows (a) red (b) white (c) blue (d) cannot be determined by color alone
- 5-180) Comparing the light from a glowing tube of neon gas with light in the beam of a helium-neon laser, we find the greater number of spectral lines in light from the (a) neon gas tube (b) laser beam (c) both about the same
- 5-181) The red laser beam from a helium-neon laser corresponds to a spectral line of (a) helium (b) neon (c) both of these (d) neither of these
- 5-182) The spot you see in the middle of a TV screen just switched off is evidence of (a) fluorescence (b) phosphorescence (c) incandescence (d) all of these (e) none of these
- 5-183) Some minerals glow when illuminated with ultraviolet light. This is because (a) ultraviolet photons kick atomic electrons in the mineral into higher energy states (b) ultraviolet photons have such high energy (c) of selective reflection (d) of selective transmission (e) none of these
- 5-184) A watch dial that continues to glow after a week in the dark is almost certainly (a) fluorescent (b) phosphorescent (c) polarized (d) radioactive
- 5-185) The Doppler effect from the back-and-forth motion of atoms in a glowing discharge tube tends to make the spectral lines slightly (a) thicker (b) thinner (c) more numerous (d) none of these
- 5-186) The spectral lines are more distinct when viewed in a mercury vapor lamp under (a) high pressure (b) low pressure (c) same for each
- 5-187) Under very high pressure, the spectrum of a mercury vapor lamp begins to look like that from (a) an incandescent

source (b) a laser (c) an ultraviolet source (d) a gas other than mercury (e) a monochromatic source

to be ejected is the (a) blue light (b) violet light (c) both eject the same number (d) not enough information given

5-188) Materials can be heated until "red hot". If some material is heated until it is "green hot", then (a) it would liquefy immediately (b) it would be hotter than "white hot" (c) its molecules would be vibrating at nearly identical rates (d) it would be a strong absorber of red light (e) energy conservation would be violated

6-12) To study the energy of photoelectrons we measure (a) the potential difference required to stop them (b) the distance they travel in a given time (c) the time they take to go a given distance (d) their temperature

5-189) If the radiation curve for an incandescent object peaks in the green region, the object would appear (a) red (b) yellow (c) green (d) blue (e) white

6-13) When a clean surface of potassium metal is exposed to blue light, electrons are emitted. If the intensity of the blue light is increased, which of the following will also increase? (a) The number of electrons ejected per second (b) The maximum kinetic energy of the ejected electrons (c) The threshold frequency of the ejected electrons (d) The time lag between the absorption of blue light and the start of emission of the electrons (e) None of these

### Chapter 30 Light Quanta

6-1) Which of the following photons has the greatest energy? (a) infrared (b) red light (c) green light (d) blue light (e) ultraviolet

6-14) An electron and a baseball move at the same speed. Which has the longer wavelength? (a) the electron (b) the baseball (c) both have the same wavelength

6-2) The photoelectric effect best demonstrates the (a) wave nature of light (b) particle nature of light (c) both of these (d) none of these

6-15) A bullet and a proton have the same momentum. Which has the longer wavelength? (a) The bullet (b) The proton (c) Both have the same wavelength

6-3) In the photoelectric effect, the greater the frequency of the illuminating light, the greater the (a) number of ejected electrons (b) maximum velocity of ejected electrons (c) both of these (d) neither of these

6-16) According to the uncertainty principle, the more we know about a particle's position, the less we know about its (a) speed (b) momentum (c) kinetic energy (d) all of these (e) none of these

6-4) The ratio of a photon's energy to its frequency is (a) its speed (b) its wavelength (c) its amplitude (d) Planck's constant (e) none of these

6-17) According to quantum physics, measuring the velocity of a tiny particle with an electromagnet (a) affects the velocity of the particle (b) has no effect on the velocity of the particle

6-5) Light behaves primarily as a wave when it (a) travels from one place to another (b) interacts with matter

6-18) In the photoelectric effect, electrons ejected from bound states in the photosensitive material have (a) less kinetic energy than the absorbed photon's energy (b) more kinetic energy than the absorbed photon's energy (c) kinetic energy equal to the absorbed photon's energy

6-6) Light behaves primarily as a particle when it (a) travels from one place to another (b) interacts with matter

6-19) In the photoelectric effect, doubling the frequency of incident light will cause the maximum energy of ejected electrons to (a) double (b) increase, but not double (c) more than double (d) decrease

6-7) In the double-slit experiment with electrons, the electrons arrive at the screen in a (a) particle-like way with a pattern that is particle-like (b) particle-like way with a pattern that is wave-like (c) wave-like way with a pattern that is particle-like (d) wave-like way with a pattern that is wave-like

6-8) The uncertainty principle applies not only to momentum and position, but also to energy and time. This statement is (a) true (b) false

6-20) Which of the following has the longer wavelength? (a) A low energy electron (b) A high energy electron (c) Both have the same wavelength

6-9) According to the uncertainty principle, the more we know about a particle's momentum, the less we know about its (a) kinetic energy (b) mass (c) speed (d) location (e) none of these

### Chapter 31 The Atom and the Quantum

6-10) Two beams of light, a red beam and a blue beam, have the same energy. The beam with the greater number of photons is the (a) red beam (b) blue beam (c) both the same

6-21) Quantization of electron energy states in an atom is better understood in terms of the electron's (a) wave nature (b) particle nature (c) neither of these

6-11) A photosensitive surface is illuminated with both blue and violet light. The light that will cause the most electrons

6-22) An excited hydrogen atom is capable of emitting radiation of (a) a single frequency (b) 3 frequencies (c) many more than 3 frequencies

6-23) The Schroedinger equation is restricted to (a) submicroscopic particles (b) submicroscopic and

microscopic particles (c) macroscopic particles (d) none of these

approximately (a) four times as large (b) twice as large (c) the same size (d) one half as large (e) one quarter as large

6-24) Which of the following forms an interference pattern when directed toward two suitably spaced slits? (a) light (b) sound (c) electrons (d) all of these (e) none of these

6-35) Two photons are emitted as an electron de-excites from the third quantum level to the second, and then to the ground state. The sum of the frequencies of the two photons equals the frequency of the single photon that would be emitted if the de-excitation were from the third to the ground state directly. This is according to (a) energy conservation (b) the physicist W. Ritz (c) both of these (d) neither of these

6-25) Most alpha particles fired at a gold foil pass through undeflected because the (a) electric field is zero inside the gold (b) gold atoms, unlike most other metal atoms, are relatively far apart (c) atoms of gold, like any others, are mostly empty space (d) net charge of the gold atoms is zero (e) none of these

6-36) An excited atom decays to its ground state and emits a photon of green light. If instead the atom decays to an intermediate state, then the light emitted could be (a) red (b) violet (c) blue (d) any of these (e) none of these

6-26) Some alpha particles fired through a gold foil bounce backward by (a) making direct hits with gold atoms (b) electrostatic repulsion when close to gold nuclei (c) electrostatic repulsion with the electron clouds of gold atoms (d) all of these (e) none of these

6-37) If atoms were smaller, Planck's constant would be (a) larger (b) smaller (c) no different in physical size

6-27) Physics pioneers Balmer, Rydberg, and Ritz discovered in atomic spectra (a) a randomness that opened the door to the nature of probabilities in atomic reality (b) mathematical order (c) that all atoms are essentially the same size (d) that electrons occupy well-defined shells about the atomic nucleus (e) that electrons behave as standing waves

6-38) A hypothetical atom has four distinct energy states. Assuming all transitions are possible, how many spectral lines can this atom produce? (a) 5 (b) 6 (c) 7 (d) 8 (e) more than 8

6-28) The Bohr model of the atom is akin to a (a) miniature solar system (b) blob of plum pudding, where raisins represent atomic nuclei (c) central heavy ball with lighter balls connected by springs (d) all of these

### Chapter 32 Atomic Nucleus and Radioactivity

6-29) We now consider the Bohr model of the atom to be (a) an accurate picture of a hydrogen atom (b) totally useless - of historical interest only (c) defective and oversimplified, but still useful

6-39) X-rays are similar to (a) alpha rays (b) beta rays (c) gamma rays (d) all of these (e) none of these

6-30) A uranium atom is 238 times as massive as a hydrogen atom. The diameter of a uranium atom is the diameter of a hydrogen atom times about (a) 3 (b) 10 (c) 30 (d) 100 (e) 238

6-40) Which radiation has no electric charge associated with it? (a) alpha rays (b) beta rays (c) gamma rays (d) all of these (e) none of these

6-31) Compared to the average diameter of a hydrogen atom, the average diameter of a helium atom is (a) larger (b) smaller (c) about the same

6-41) The sources of X rays and gamma rays, respectively, are (a) electron clouds and the atomic nucleus (b) the atomic nucleus and electron clouds (c) both electron clouds (d) both the atomic nucleus (e) none of these

6-32) A key feature of the theory of chaos is (a) unpredictability (b) very small initial differences can lead to very large eventual differences (c) the randomness of molecular motion makes prediction difficult. (d) even orderly systems are seen to be disorderly when carefully studied

6-42) A quark is (a) an elementary particle (b) a building block of nucleons (c) a building block of hadrons (d) all of these (e) none of these

6-33) According to the correspondence principle, a new theory is valid if it (a) overlaps and agrees where the old theory works (b) accounts for confirmed results from the old theory (c) predicts the same correct results as the old theory (d) all of these (e) none of these

6-43) Deuterium and tritium are both (a) forms of hydrogen (b) isotopes of the same element (c) both of these (d) neither of these

6-34) Compared to the diameter of a zirconium atom ( $A = 40$ ), the diameter of a mercury atom ( $A = 80$ ) is

6-44) Different isotopes of an element have different numbers of (a) protons (b) hadrons (c) photons (d) neutrons (e) none of these

6-45) Electric forces within an atomic nucleus tend to (a) hold it together (b) push it apart (c) neither of these

6-46) Generally speaking, the larger a nucleus is, the greater its (a) stability (b) instability (c) neither stability nor instability

6-47) The half-life of a radioactive substance is INDEPENDENT of (a) the number (if large enough) of atoms in the substance (b) whether the substance exists in an elementary state or in a compound (c) the temperature of the substance (d) the age of the substance (e) all of these

- 6-48) The operation of a cloud chamber relies on (a) magnetization (b) evaporation (c) acceleration (d) polarization (e) condensation
- 6-49) When a beta particle is ejected from a nucleus, the nucleus then has a greater (a) mass (b) charge (c) both of these (d) neither of these
- 6-50) When a gamma ray is emitted by a nucleus, the nucleus then has appreciably less (a) mass (b) charge (c) both of these (d) neither of these
- 6-51) When a gamma ray is emitted by a nucleus, the nucleus then has less (a) energy (b) charge (c) both (d) neither
- 6-52) The fate of the world's uranium supply is to eventually become (a) alpha and beta particles (b) iron (c) lead
- 6-53) Pure elements can be transformed into entirely different elements. This statement at the present time is (a) true (b) false
- 6-54) All deposits of natural uranium contain appreciable amounts of (a) iron (b) lead (c) gold (d) all of these (e) none of these particularly
- 6-55) The amount of radiation we personally encounter that originates in the earth's and the atmosphere's natural background is (a) a trace amount (b) about a quarter (c) about half (d) more than half
- 6-56) Radioactivity in the world is something (a) relatively new (b) as old as the world itself
- 6-57) The helium in a child's balloon is composed of (a) alpha particle remnants of previous radioactive processes (b) former beta particles (c) both of these (d) none of these
- 6-58) Which body is heated in its interior by nuclear processes? (a) the sun (b) the earth (c) both (d) neither
- 6-59) When radium ( $A = 88$ ) emits an alpha particle, the resulting nucleus has atomic number (a) 86 (b) 88 (c) 90 (d) 92 (e) none of these
- 6-60) When thorium ( $A = 90$ ) emits a beta particle, the resulting nucleus has atomic number (a) 88 (b) 89 (c) 90 (d) 92 (e) none of these
- 6-61) When a nucleus emits a positron, its atomic number (a) increases by 1 (b) decreases by 1 (c) doesn't change
- 6-62) When the hydrogen isotope tritium-3 emits a beta particle, it becomes an isotope of (a) hydrogen (b) helium (c) lithium (d) carbon (e) none of these
- 6-63) Artificially induced radioactive elements generally have (a) long half lives (b) short half lives
- 6-64) Which experiences the greatest electrical force in an electric field? (a) Alpha particle (b) Beta particle (c) Electron (d) Gamma ray (e) All experience the same force
- 6-65) Which experiences the least electrical force in an electric field? (a) Alpha particle (b) Beta particle (c) Electron (d) Gamma ray (e) All experience the same force
- 6-66) If an alpha particle and a beta particle have the same energy, which particle will penetrate farther into an object? (a) Alpha particle (b) Beta particle (c) They both penetrate the same distance
- 6-67) The half lives of elements beyond uranium are too short for these elements to occur in natural deposits. But elements below uranium that have equally short half lives do occur in natural deposits. This is because they are (a) the small leftover of huge abundances when the earth formed (b) subdued and preserved by pressures beneath the earth (c) bound with longer-living elements (d) the products of uranium decay
- 6-68) An element emits 1 alpha particle, 1 positron, and 3 beta particles. Its atomic number (a) decreases by 2 (b) decreases by 1 (c) stays the same (d) increases by 1 (e) increases by 2
- 6-69) The half life of carbon 14 is 5730 years. If a 1 gram sample of old carbon is  $1/8$  as radioactive as 1 gram of a current sample, then the age of the old sample is about (a) 716 years (b) 11 500 years (c) 17 200 years (d) 22 900 years (e) 46 000 years
- 6-70) A certain radioactive isotope placed near a Geiger counter registers 160 counts per second. Eight hours later, the counter registers 10 counts per second. What is the half life of the isotope? (a) 8 hours (b) 6 hours (c) 4 hours (d) 2 hours (e) none of these
- 6-71) A Geiger counter placed 1 meter from a point source of radiation registers 100 counts per second. If the Geiger counter is moved closer - to 0.5 meter from the source, what will the count rate be? (a) 25 counts/min (b) 50 counts/min (c) 100 counts/min (d) 200 counts/min (e) 400 counts/min

### Chapter 33 Nuclear Fission and Fusion

- 6-72) In nuclear fission and nuclear fusion reactions, the amount of mass converted to energy is (a) less than 1% (b) about 10% (c) about 20% (d) about 30% (e) more than 30%
- 6-73) Compared to the mass of a uranium nucleus before splitting, the pieces it splits into have (a) less mass (b) the same mass (c) more mass
- 6-74) A chain reaction grows when the fraction of liberated neutrons which go on to cause further fissions is (a) more than half (b) half (c) less than half (d) 99%

- 6-75) When a lump of uranium is broken into smaller pieces, the total surface area of the lump (a) decreases (b) remains the same (c) increases
- 6-76) Which will leak more neutrons, two separate lumps of uranium or the same two lumps stuck together? (a) Two separate lumps (b) The same two lumps stuck together (c) Both the same
- 6-77) A sphere of pure U-235 will explode if it is (a) hot enough (b) shaken hard enough (c) big enough (d) small enough
- 6-78) The function of graphite in the first atomic reactor was to (a) absorb fast neutrons (b) slow fast neutrons (c) emit fast neutrons (d) moderate uranium isotopes (e) none of these
- 6-79) Control is exercised in a nuclear reactor by (a) absorbing excess neutrons with control rods (b) emitting fast neutrons with a moderator (c) both of these (d) none of these
- 6-80) When uranium-238 absorbs a neutron, it (a) fissions (b) becomes a beta emitter (c) becomes an alpha emitter (d) emits a neutrino (e) all of these
- 6-81) Plutonium is chemically toxic when it is (a) oxidized (b) not oxidized (c) oxidized or non-oxidized (d) but plutonium in any form is not chemically toxic
- 6-82) The effect of putting small amounts of Pu-239 with U-238 is converting U-238 to (a) Th-239 (b) Pa-239 (c) U-235 (d) Pu-239 (e) Pb-206
- 6-83) In a breeder reactor (a) plutonium is converted into uranium (b) uranium is converted into plutonium (c) both of these (d) neither of these
- 6-84) Three isotopes that undergo nuclear fission are (a) Th-239, U-235, Pu-239 (b) Th-238, U-235, Pu-239 (c) Th-235, U-235, Pu-239 (d) U-233, U-235, Pu-239 (e) none of these
- 6-85) A nucleon has more potential energy with respect to a nucleus when it is (a) inside the nucleus (b) outside the nucleus (c) both the same
- 6-86) A nucleon has more mass when it is (a) inside the nucleus (b) outside the nucleus (c) both the same
- 6-87) A proton has the greatest mass in the nucleus of (a) hydrogen (b) iron (c) lead (d) uranium (e) plutonium
- 6-88) A nucleon has the least mass in the nucleus of (a) hydrogen (b) iron (c) lead (d) uranium (e) plutonium
- 6-89) The nucleus with the most tightly bound nucleons is (a) hydrogen (b) iron (c) lead (d) uranium (e) plutonium
- 6-90) When two light atoms fuse together, mass (a) is converted to kinetic energy of neutrons (b) is created from energy (c) remains the same (d) is gained
- 6-91) Between nuclear fission and nuclear fusion, radioactive by-products are more characteristic of nuclear (a) fission (b) fusion (c) both of these (d) neither of these
- 6-92) In both fission and fusion, mass (a) is created from energy of other forms (b) is changed to the form of kinetic energy (c) remains the same
- 6-93) Detonation of a fission type atomic bomb is started by (a) splitting a small piece of uranium (b) pressing together several small pieces of uranium (c) igniting a small thermonuclear bomb (d) turning on a laser cross fire (e) none of these
- 6-94) Detonation of a fusion type hydrogen bomb is started by (a) splitting a small piece of uranium (b) pressing together several small pieces of uranium (c) igniting a small fission bomb (d) turning on a laser cross fire (e) none of these
- 6-95) The energy release in both fission and fusion is mainly in the form of (a) kinetic energy of fragments (b) alpha radiation (c) beta radiation (d) gamma radiation (e) a combination of alpha, beta, and gamma radiation
- 6-96) Present-day research in nuclear fusion uses (a) laser beams (b) ultra-hot plasmas (c) both of these (d) neither of these
- 6-97) Compared to protons, the reason neutrons are effective nuclear bullets in nuclear reactions is that a neutron has (a) more mass than a proton (b) more penetrating power than a proton (c) a wider cross section than a proton (d) all of these (e) none of these
- 6-98) When U-235 undergoes fission, the two nuclei that result have a total of (a) 90 protons (b) 91 protons (c) 92 protons (d) 93 protons (e) 94 protons
- 6-99) The mass of a nucleon is greatest where its potential energy is (a) least (b) greatest
- 6-100) Fissioning helium would yield a net (a) absorption of energy (b) release of energy (c) neither absorption nor release of energy
- 6-101) Fissioning an iron nucleus yields a net (a) absorption of energy (b) release of energy (c) neither absorption nor release of energy
- 6-102) Fusing two iron nuclei yields a net (a) absorption of energy (b) release of energy (c) neither absorption nor release of energy
- 6-103) Fissioning a lead nucleus yields a net (a) absorption of energy (b) release of energy (c) neither absorption nor release of energy

- 6-104) If gold were used as nuclear fuel, it would be best (a) fused (b) fissioned (c) either fused or fissioned
- 6-105) If carbon were used as nuclear fuel, it would be best (a) fused (b) fissioned (c) either fused or fissioned
- 6-106) If iron were used as nuclear fuel, it would be best (a) fused (b) fissioned (c) neither fused nor fissioned
- 6-107) Compared to the energy produced by fissioning a single uranium atom, the energy produced by fusing two deuterium atoms is (a) more (b) less (c) the same
- 6-108) Compared to the energy produced by fissioning a gram of uranium, the energy produced by fusing a gram of deuterium is (a) more (b) less (c) the same
- 6-109) If uranium were split into three equal segments instead of two, the reaction would be (a) more energetic (b) less energetic (c) as energetic (d) not enough information is given for a reasonable estimate
- 6-110) Suppose a hydrogen bomb were exploded in a box that could contain the explosion, but conducted heat to the outside and radiated it away. Compared to the weight before the explosion, the weight of the box after it cooled to room temperature would be (a) more (b) less (c) the same
- 6-111) Which shape uses the smallest amount of material when creating a critical mass? (a) cube (b) elongated box (c) cone (d) sphere (e) none of these
- 6-112) Which element has the smaller critical mass; U-235 that releases 2.5 neutrons per fission, or Pu-239 that releases 2.7 neutrons per fission? (a) U-235 (b) Pu-239 (c) both would have the same critical mass
- 6-113) Compared to a neutron bouncing off a carbon nucleus, a neutron bouncing off a hydrogen nucleus loses (a) less speed (b) more speed (c) the same amount of speed
- 6-114) Could you get rid of plutonium contaminating a soil sample by bombarding it with neutrons? (a) No (b) Yes, but you might not like what you got in its place (c) not enough information is given
- 6-118) According to the special theory of relativity, events that are simultaneous in one frame of reference (a) are simultaneous in all frames of reference (b) are not simultaneous in other frames of reference (c) may or may not be simultaneous in other frames of reference
- 6-119) Two lightning bolts are seen to strike two distant locations at the same time. Seen from a different location, the two lightning bolts (a) will also be seen at the same time (b) will not be seen at the same time (c) may or may not be seen at the same time
- 6-120) You and a friend share the same space time when there is no (a) relative velocity between you (b) acceleration for either of you (c) difference in your rate of heartbeats
- 6-121) Suppose the time taken for light to bounce to and fro between the parallel mirrors of a light clock is 1 second, in the frame of reference of the light clock. As seen by another observer moving at high speed at right angles to the to-and-fro motion of the bouncing light, the time taken would be (a) also 1 second (b) less than 1 second (c) more than 1 second
- 6-122) The stretching out of time due to motion is called time (a) stretching (b) dilation (c) contraction (d) warp (e) expansion
- 6-123) Compared to clocks in a stationary reference frame, clocks in a moving reference frame run (a) slower (b) faster (c) at the same speed
- 6-124) Clocks on a space ship moving very fast relative to the earth run slow when viewed from (a) the space ship (b) the earth (c) both places (d) neither place
- 6-125) When a blinking light source moves relative to you, the speed of the light (a) changes but its frequency remains constant (b) remains constant but its frequency can change (c) stays the same, as does its frequency
- 6-126) When you approach a blinking light source, the frequency of its blinking (a) increases (b) decreases (c) stays the same
- 6-127) When you recede from a blinking light source, the frequency of its blinking (a) increases (b) decreases (c) stays the same
- 6-128) Harry takes a space voyage and returns to find his twin sister has aged more than he has. This is evidence that they have been in different (a) frames of reference (b) space-times (c) realms of time (d) all of these (e) none of these
- 6-129) According to special relativity, one can travel at increased rates (a) both forward and backward in time (b) backward in time (c) only forward in time
- 6-130) A woman standing on the ground sees a rocket ship move past her at 95 % of the speed of light. Compared to when the rocket is at rest, the woman measures the rocket's length as (a) longer (b) shorter (c) the same length

### Chapter 34 Special Theory of Relativity

- 6-115) The experiments of Michelson and Morley provided evidence that the speed of light is (a) invariant (b) the same whether its source approaches or recedes (c) constant (d) all of these (e) none of these
- 6-116) The ether theory of light propagation is (a) much used (b) incomplete, but still useful (c) unexplained (d) discredited
- 6-117) According to the special theory of relativity, all laws of nature are the same in reference frames that (a) accelerate (b) move in circles (c) move at constant velocity (d) oscillate (e) none of these

- 6-131) According to Einstein's theory of special relativity, (a) space and time are aspects of each other (b) energy and mass are aspects of each other (c) both of these (d) none of these
- 6-132) When an object is pushed to relativistic speeds, its momentum is (a) greater than  $mv$  (b) smaller than  $mv$  (c) equal to  $mv$
- 6-133) Objects accelerated to relativistic speeds (a) live shorter (b) grow bigger (c) both of these (d) neither of these
- 6-134) According to the well known equation, energy equals mass times the speed of light squared, (a) mass and energy travel at the speed of light squared (b) energy is actually mass traveling at the speed of light squared (c) mass and energy travel at twice the speed of light (d) mass and energy are related (e) none of these
- 6-135) Relativity equations for time, length and momentum hold true for (a) relativistic speeds (b) everyday low speeds (c) both of these (d) none of these
- 6-136) An astronaut traveling at  $0.87c$  holds a meterstick in her hand, moving forward in spear-like fashion. The astronaut sees the spear's length as (a) 0.5 m (b) 0.87 m (c) 1 m (d) 1.25 m (e) 1.5 m
- 6-137) Suppose you look at the huge clock on the Big Ben Tower in London and it reads 12 noon. If you could travel away from the clock at the speed of light and view it with a telescope, it would (a) run slower than usual (b) run faster than usual (c) be frozen at 12 noon
- 6-138) A spaceship that is traveling very fast with respect to your frame of reference, fires a photon beam that travels at speed  $c$  with respect to the spaceship. You measure the photon beam's speed to be (a) less than  $c$  (b) more than  $c$  (c) equal to  $c$
- 6-139) Event A occurs before event B in a certain frame of reference. In another frame of reference, event A could occur — (a) after event B (b) simultaneous with event B (c) either of these (d) neither of these
- 6-140) According to the special theory of relativity, if you measure your own pulse while traveling at very high speeds, you would notice your pulse rate to (a) increase (b) decrease (c) be the same as usual
- 6-141) If you were to travel at speeds close to the speed of light, you would notice that your own (a) pulse decreases (b) shape changes (c) both of these (d) neither of these
- 6-142) We are actually looking into the past when we look at (a) a distant star (b) our physics book (c) both of these (d) none of these
- 6-143) When you approach a blinking light source which in turn is moving towards you, you perceive an increase in (a) both speed and frequency of the light (b) speed, but not frequency of the light (c) frequency of the light, but not speed
- 6-144) When you approach a light source, the wavelength of light emitted appears (a) longer (b) shorter (c) the same
- 6-145) The frequency of a blinking light source doubles as the light source approaches you. As the same light source moves away from you at the same speed, its frequency (a) is halved (b) is doubled (c) stays the same
- 6-146) As a blinking light source approaches you at an increasing speed (accelerating toward you) the frequency of the flashes (a) increases (b) decreases (c) stays the same
- 6-147) In some reference frame in the universe, you, right now, are traveling at speeds close to the speed of light (a) True (b) False
- 6-148) To outside observers, the overall sizes of objects traveling at relativistic speeds are (a) larger (b) smaller (c) the same size
- 6-149) Consider a planet at rest and a spaceship that whizzes past the planet at high speed. An observer on the planet sees a contracted spaceship, while an observer on the spaceship sees (a) a contracted planet (b) an expanded planet (c) a normal planet (d) could be contracted or expanded depending on the direction of travel
- 6-150) Suppose you and your sister travel in space in such a way that you notice a slowing of time for your sister. Your sister will notice that your time runs (a) faster than hers (b) slower than hers (c) the same as hers (d) not enough information given
- 6-151) Compared to standard earth time, there is a physical slowing of your time when you travel at (a) relativistic speeds (b) everyday low speeds (c) both of these (d) none of these
- 6-152) According to relativity theory, if a space trip finds a son or daughter biologically older than his or her parents, then the space trip is taken by the (a) son or daughter (b) parents (c) either (d) neither, it can't be done
- 6-153) The length of a meterstick projected like a spear at  $0.87c$  is seen by a person at rest to be (a) 0.5 m (b) 0.87 m (c) 1 m (d) 1.25 m (e) 1.5 m
- 6-154) Electrons fired in your TV tube travel at about 0.25 times the speed of light, with momentum greater than their mass times  $0.25c$ . Strictly speaking, this (a) increases your electric bill (b) does not increase your electric bill
- 6-155) Suppose two space ships approach each other at the speed of light, and each sends a beam of light to warn the other of its approach. From the frame of reference of either space ship, the light will reach the ships (a) before they collide (b) as they collide (c) after they collide

- 6-156) If you use the relativistic velocity-addition formula to add everyday velocities, you will get (a) nonsense (b) a significantly better result than if you add them classically (c) a result almost identical to the classical result
- 6-157) A heavy meter stick has a mass of 1 kg. When the meter stick is thrown like a spear past you, you measure its momentum to be  $2mv$ . What do you measure its length to be? (a) 1 m (b) 0.87 m (c) 0.5 m (d) 0.25 m (e) none of these
- 6-158) Radioactive muons formed high in the atmosphere have an average lifetime of 2 millionths of a second and travel toward earth at nearly the speed of light. They are so high they should have decayed by the time they reach the earth's surface, according to pre-relativity physics. They don't because they (a) live longer due to time dilation (b) travel a shorter distance due to length contraction (c) either of these (d) neither of these
- 6-159) There is an upper limit on the speed of a particle. This means there is also an upper limit on its (a) momentum (b) kinetic energy (c) both of these (d) neither of these
- 6-160) Suppose a blinking light source uniformly accelerates away from you. As the source gets farther and farther away, you'll notice that the frequency of the flashes (a) increases (b) decreases (c) neither increases nor decreases
- 6-161) A 10 meter long spear is thrown at relativistic speeds through a 10 meter-long pipe. (Both these dimensions are measured when each is at rest.) When the spear passes through the pipe, which of the following statements is true? (a) the spear shrinks so the pipe completely covers it (b) the pipe shrinks so the spear extends from both ends (c) both shrink equally so the pipe barely covers the spear (d) any of these, depending on the motion of the observer (moving with the spear, at rest with the pipe, etc.) (e) none of these
- 6-162) Consider a spaceship that moves away from you at half the speed of light. It fires a probe, also away from you, at half the speed of light relative to the spaceship. Relative to you, the probe moves at (a) 80% c (b) 87% c (c) 90% c (d) 95% c (e) 100% c
- 6-163) Consider a spaceship that moves toward you at half the speed of light. It fires a probe toward you, relative to itself, at 0.7 the speed of light. Relative to you, the probe approaches at about (a) 70% c (b) 87% c (c) 90% c (d) 92% c (e) 96% c
- 6-164) If a 1 microgram antimatter meteor were to strike the earth, the amount of energy of forms other than mass that would be produced would be (a) 18 joules (b) 18 thousand joules (c) 18 million joules (d) 18 billion joules (e) 180 billion joules
- 6-166) Important support for General Relativity came from studies of the precession of the orbit of (a) Mercury (b) Venus (c) the earth (d) Mars (e) Asteroids
- 6-167) Suppose at the surface of the earth a person can do 20 pushups. In a spaceship far away from any gravitational influence, accelerating at  $g$ , the same person could do (a) less than 20 pushups (b) 20 pushups (c) more than 20 pushups
- 6-168) Fire a cannonball from a cannon and it curves due to gravity. Shine a light from a flashlight and it (a) curves per second the same as the cannonball (b) follows a straight-line path with no curvature at all (c) curves half as much as the cannonball (d) curves slightly, but not as much per second as the cannonball
- 6-169) According to the principle of equivalence, observations made in a Newtonian gravitational field are indistinguishable from observations made in (a) any other gravitational field (b) an Einsteinian gravitational field (c) any uniformly moving reference frame (d) all of these (e) none of these
- 6-170) From a general relativistic point of view, a person on the ground floor of a skyscraper ages (a) faster than a person on the top floor (b) slower than a person on the top floor (c) at the same speed as a person on the top floor
- 6-171) A strong gravitational field (a) slows a clock (b) speeds up a clock (c) does not affect a clock
- 6-172) Special Relativity would predict slow running, and General Relativity would predict fast running, of a clock at the top of a tower at the (a) south pole (b) north pole (c) equator (d) none of these
- 6-173) Only General Relativity would predict "unusual" running of a clock at the top of a tower at (a) the south pole (b) the Tropic of Capricorn (c) the equator
- 6-174) A measuring stick on a rapidly rotating disk will not appear to shrink if it is oriented along the (a) circumference (b) radius (c) either of these (d) neither of these
- 6-175) The measured ratio of circumference to diameter on a disk is  $\pi$  when the disk is (a) moving at relativistic speeds (b) rapidly rotating (c) at rest (d) all of these (e) none of these
- 6-176) The two-dimensional surface of the earth is (a) positively curved (b) negatively curved (c) both of these (d) none of these
- 6-177) Compared to Newton's theory of gravitation, Einstein's theory (a) is an exception to the correspondence principle (b) obeys the correspondence principle (c) neither of these

### Chapter 35 General Theory of Relativity

- 6-165) Compared to special relativity, general relativity is more concerned with (a) acceleration (b) gravitation (c) space-time geometry (d) all of these (e) none of these
- 6-178) In a one  $g$  gravitational field, in one second, a light beam will curve beneath a perfectly straight line by (a) less than 4.9 m (b) 4.9 m (c) more than 4.9 m

- 6-179) At the top of very tall skyscraper, a sensitive watch will appear to run (a) slow (b) fast (c) the same as at 1 g (d) nearly the speed of light (e) you can never grow younger (f) none of these
- 6-180) Compared to a watch at the earth's poles, a watch at the earth's equator should run (a) a tiny bit slower (b) a tiny bit faster (c) at the same speed
- 6-181) If a star that is 10 light years away from earth explodes, gravitational waves from the explosion will reach the earth in (a) less than 10 years (b) more than 10 years (c) 10 years
- 6-182) At the bottom of a well deep enough so that the acceleration due to gravity is less than 1 g, a watch will run (a) slow (b) fast (c) the same as at 1 g
- 6-183) If a star 100 light years away explodes, time for the gravitational waves to reach the earth is 100 years as measured from (a) any uniformly moving reference frame (b) any accelerating reference frame (c) any reference frame, accelerated or not (d) the reference frame of the waves (e) the earth
- 6-184) A clock on the surface of a shrinking star will run progressively (a) slower (b) faster (c) no difference
- 6-185) Light bends when it (a) passes a massive star (b) passes through a gravitational field (c) both of these (d) neither of these
- 6-186) The quantity that undergoes a red shift is (a) wave frequency (b) wavelength (c) both of these (d) neither of these
- 6-187) The quantity that shifts in a gravitational red shift is (a) wave frequency (b) wave direction (c) field intensity (d) space-time curvature (e) none of these
- 6-188) The orbit of Mercury precesses because (a) Mercury moves in the gravitational field of the other planets (b) Mercury travels faster than any other planet (c) Mercury is closest to the sun (d) the sun's gravitational field varies along Mercury's orbit (e) none of these
- 6-189) Einstein's theory of gravitation obeys the correspondence principle because it (a) corresponds to truer description of events in very large gravitational fields (b) agrees with proven results of Newton's theory (c) has been proven in repeated experiments (d) is a special case of Newton's theory (e) none of these
- 6-190) According to the principle of equivalence, (a) mass and energy are two forms of the same thing (b) space and time are two forms of the same thing (c) electricity and magnetism are two forms of the same thing (d) observations made in an accelerating reference frame are indistinguishable from those made in a gravitational field (e) all of these
- 6-191) According to relativity theory, it is possible to reverse time and grow younger when you (a) are near a black hole (b) are near a very large gravitational field (c) travel at
- 6-192) If the orbit of Mercury were perfectly circular, its rate of precession would be (a) larger (b) smaller (c) the same (d) zero
- 6-193) If the elliptical orbit of Mercury were more eccentric, its precession rate would be (a) larger (b) smaller (c) the same (d) nonexistent
- 6-194) From a relativistic point of view, light (a) always travels in straight lines (b) sometimes travels in straight lines (c) never travels in straight lines
- 6-195) An astronaut falling into a black hole would see the universe (a) red shifted (b) blue shifted
- 6-196) If the sun collapsed to a black hole, the time required for the earth to orbit the collapsed sun would (a) increase (b) decrease (c) stay the same