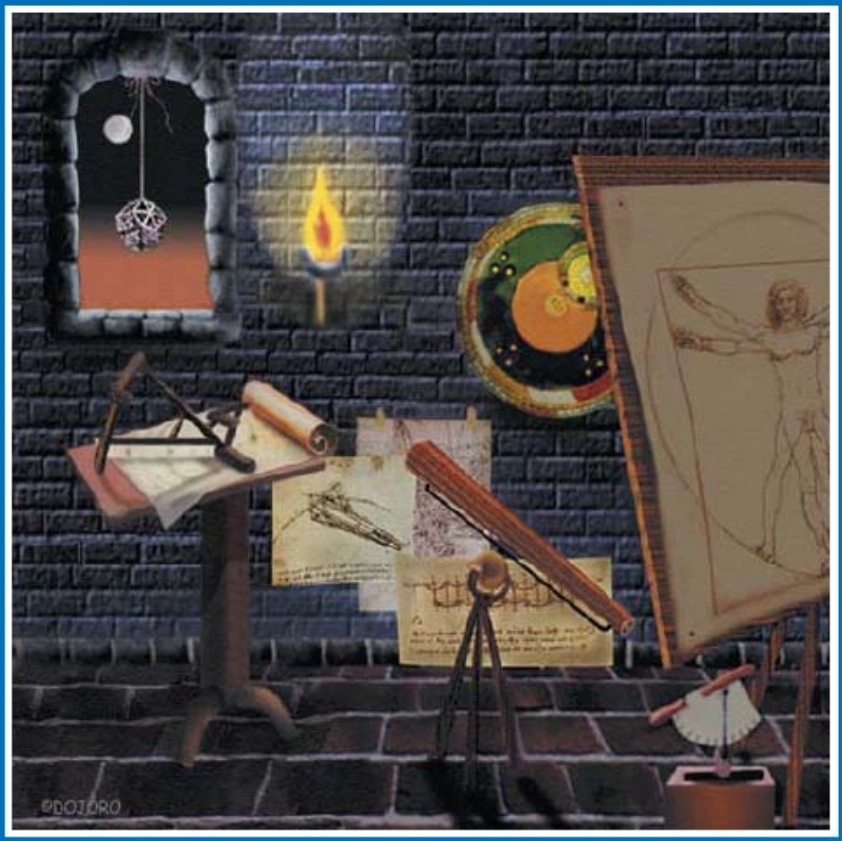
PHYSICS



QUESTION CATALOGUE

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Tools for the Intelligent Classroom

Wizard TEST MAKER

Physics

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5335 A motorboat, which has a speed of 5.0 meters per second in still water, is headed east as it crosses a river flowing south at 3.3 meters per second. What is the magnitude of the boat's resultant velocity with respect to the starting point?
(1) 3.3 m/s **(3) 6.0 m/s**
(2) 5.0 m/s (4) 8.3 m/s

5334 A baseball player runs 27.4 meters from the batter's box to first base, overruns first base by 3.0 meters, and then returns to first base. Compared to the total distance traveled by the player, the magnitude of the player's total displacement from the batter's box is
(1) 3.0 m shorter (3) 3.0 m longer
(2) 6.0 m shorter (4) 6.0 m longer

5263 A high-speed train in Japan travels a distance of 300. kilometers in 3.60×10^3 seconds. What is the average speed of this train?
(1) 1.20×10^{-2} m/s (3) 12.0 m/s
(2) 8.33×10^{-2} m/s **(4) 83.3 m/s**

5260 On a highway, a car is driven 80. kilometers during the first 1.00 hour of travel, 50. kilometers during the next 0.50 hour, and 40. kilometers in the final 0.50 hour. What is the car's average speed for the entire trip?
(1) 45 km/h **(3) 85 km/h**
(2) 60. km/h (4) 170 km/h

4589 In a 4.0-kilometer race, a runner completes the first kilometer in 5.9 minutes, the second kilometer in 6.2 minutes, the third kilometer in 6.3 minutes, and the final kilometer in 6.0 minutes. The average speed of the runner for the race is approximately
(1) 0.16 km/min (3) 12 km/min
(2) 0.33 km/min (4) 24 km/min

4443 One car travels 40. meters due east in 5.0 seconds, and a second car travels 64 meters due west in 8.0 seconds. During their periods of travel, the cars definitely had the same
(1) average velocity (3) change in momentum
(2) total displacement **(4) average speed**

4307 A car travels 90. meters due north in 15 seconds. Then the car turns around and travels 40. meters due south in 5.0 seconds. What is the magnitude of the average velocity of the car during this 20.-second interval?
(1) 2.5 m/s (3) 6.5 m/s
(2) 5.0 m/s (4) 7.0 m/s

4049 A group of bike riders took a 4.0-hour trip. During the first 3.0 hours, they traveled a total of 50. kilometers, but during the last hour they traveled only 10. kilometers. What was the group's average speed for the entire trip?
(1) 15 km/hr (3) 40. km/hr
(2) 30. km/hr (4) 60. km/hr

3828 Two cars, *A* and *B*, are 400. meters apart. Car A travels due east at 30. meters per second on a collision course with car B, which travels due west at 20. meters per second. How much time elapses before the two cars collide?
(1) 8.0 s (3) 20. s
(2) 13 s (4) 40. s

3628 As a cart travels around a horizontal circular track, the cart *must* undergo a change in
(1) velocity (3) speed
(2) inertia (4) weight

2967 How long will it take an object to move 100 meters if the object is traveling with an average speed of 0.5 meter per second?
(1) 200 s (3) 5 s
(2) 2 s (4) 50 s

2761 What is the average velocity of a car that travels 30. kilometers due west in 0.50 hour?
(1) 15 km/hr (3) 15 km/hr west
(2) 60. km/hr **(4) 60. km/hr west**

2662 The average speed of a plane was 600 kilometers per hour. How long did it take the plane to travel 120 kilometers?
(1) 0.2 hour (3) 0.7 hour
(2) 0.5 hour (4) 5 hours

2463 A car travels between the 100.-meter and 250.-meter highway markers in 10. seconds. The average speed of the car during this interval is
(1) 10. m/s (3) 25 m/s
(2) 15 m/s (4) 35 m/s

2235 A baseball pitcher throws a fastball at 42 meters per second. If the batter is 18 meters from the pitcher, approximately how much time does it take for the ball to reach the batter?
(1) 1.9 s (3) 0.86 s
(2) 2.3 s **(4) 0.43 s**

2009 A car travels 20. meters east in 1.0 second. The displacement of the car at the end of this 1.0-second interval is
(1) 20. m **(3) 20. m east**
(2) 20. m/s (4) 20. m/s east

1896 A car travels a distance of 98 meters in 10. seconds. What is the average speed of the car during this 10.-second interval?
(1) 4.9 m/s (3) 49 m/s
(2) 9.8 m/s (4) 98 m/s

1731 A runner completed the 100.-meter dash in 10.0 seconds. Her average speed was
(1) 0.100 m/s (3) 100. m/s
(2) 10.0 m/s (4) 1,000 m/s

1613 A cart starting from rest travels a distance of 3.6 meters in 1.8 seconds. The average speed of the cart is
(1) 0.20 m/s (3) 0.50 m/s
(2) 2.0 m/s (4) 5.0 m/s

1516 What is the distance traveled by an object that moves with an average speed of 6.0 meters per second for 8.0 seconds?
(1) 0.75 m (3) 14 m
(2) 1.3 m **(4) 48 m**

957 A moving body must undergo a change of
(1) velocity **(3) position**
(2) acceleration (4) direction

4816 A 60-kilogram student jumps down from a laboratory counter. At the instant he lands on the floor, his speed is 3 meters per second. If the student stops in 0.2 seconds, what is the average force on the student?
(1) 1×10^{-2} N
(3) 9×10^{2} N
(2) 1×10^{2} N
(4) 4 N

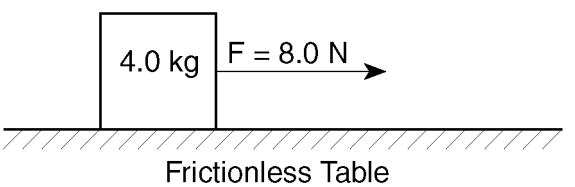
4662 A 2.0-kilogram body is initially traveling at a velocity of 40. meters per second east. If a constant force of 10. newtons due east is applied to the body for 5.0 seconds, the final speed of the body is
(1) 15 m/s
(3) 65 m/s
(2) 25 m/s
(4) 130 m/s

4313 A spring scale reads 20. Newtons as it pulls a 5.0-kilogram mass across a table. What is the magnitude of the force exerted by the mass on the spring scale?
(1) 49 N
(3) 5.0 N
(2) 20. N
(4) 4.0 N

4310 A net force of 10. Newtons accelerates an object at 5.0 meters per second^2. What net force would be required to accelerate the same object at 1.0 meter per second^2?
(1) 1.0 N
(3) 5.0 N
(2) 2.0 N
(4) 50. N

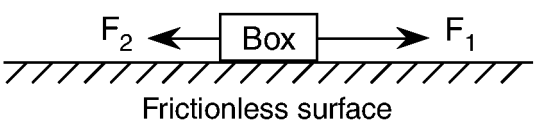
4239 A net force of 25 Newtons is applied horizontally to a 10.-kilogram block resting on a table. What is the magnitude of the acceleration of the block?
(1) 0.0 m/s^2
(3) 0.40 m/s^2
(2) 0.26 m/s^2
(4) 2.5 m/s^2

4179 The diagram below shows a horizontal 8.0-newton force applied to a 4.0-kilogram block on a frictionless table.



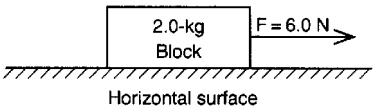
What is the magnitude of the block's acceleration?
(1) 0.50 m/s^2
(3) 9.8 m/s^2
(2) 2.0 m/s^2
(4) 32 m/s^2

4055 In the diagram below, a box is on a frictionless horizontal surface with forces F_1 and F_2 acting shown.



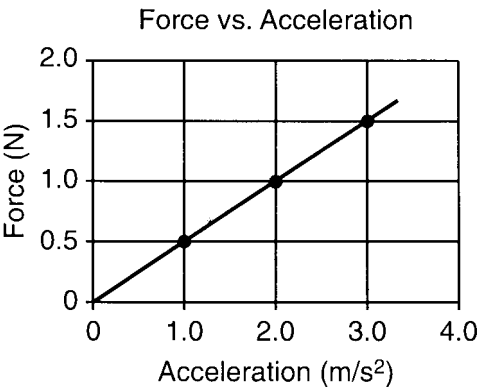
If the magnitude of F_1 is greater than the magnitude of F_2, then the box is
(1) moving at constant speed in the direction of F_1
(2) moving at constant speed in the direction of F_2
(3) accelerating in the direction of F_1
(4) accelerating in the direction of F_2

3970 The diagram below shows a 2.0-kilogram block being moved across a frictionless horizontal surface by a 6.0-newton horizontal force.



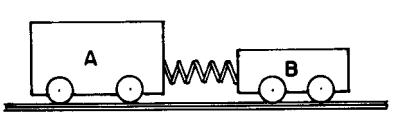
What is the magnitude of the acceleration of the block?
(1) 0.33 m/s^2
(3) 3.0 m/s^2
(2) 6.0 m/s^2
(4) 12 m/s^2

3701 The graph below represents the relationship between the forces applied to an object and the corresponding accelerations produced.



What is the inertial mass of the object?
(1) 1.0 kg
(3) 0.50 kg
(2) 2.0 kg
(4) 1.5 kg

3241 Two carts, *A* and *B*. are joined by a compressed spring as shown in the diagram below. The mass of cart *A* is twice that of cart *B*. Which of the following statements is true about their change in velocity when the spring is released?

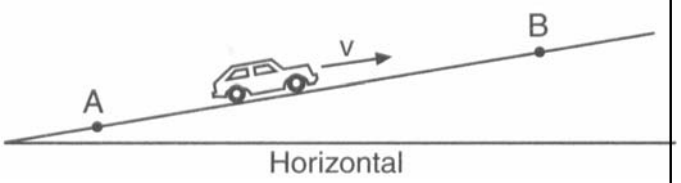


(1) *A* will have the greater change in velocity.
(2) *B* will have the greater change in velocity.
(3) Both carts will have the same change in velocity.
(4) Neither cart will experience a change in velocity.

2970 When a force of 50 Newtons acts on a mass of 10 kilograms, the resulting acceleration will be
(1) 500 m/s^2
(3) 40 m/s^2
(2) 60 m/s^2
(4) 5 m/s^2

2969 Which mass would have the greatest acceleration if the same unbalanced force was applied to each?
(1) 1 kg
(3) 3 kg
(2) 2 kg
(4) 4 kg

5128 A car travels at constant speed *v* up a hill from point *A* to point *B*, as shown in the diagram below.



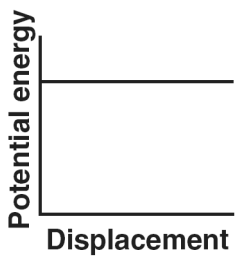
As the car travels from *A* to *B*, its gravitational potential energy

(1) increases and its kinetic energy decreases
(2) increases and its kinetic energy remains the same
(3) remains the same and its kinetic energy decreases
(4) remains the same and its kinetic energy remains the same

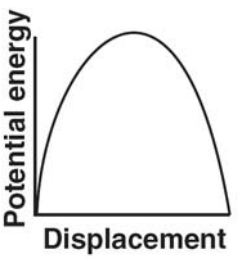
5049 While riding a chairlift, a 55-kilogram skier is raised a vertical distance of 370 meters. What is the total change in the skier's gravitational potential energy?

(1) $5.4 \cdot 10^1$J (3) $2.0 \cdot 10^4$ J
(2) $5.4 \cdot 10^2$ J **(4) $2.0 \cdot 10^5$ J**

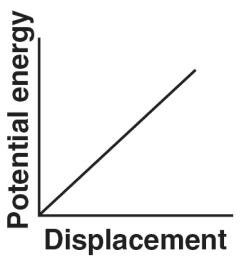
5001 A pendulum is pulled to the side and released from rest. Which graph best represents the relationship between the gravitational potential energy of the pendulum and its displacement from its point of release?



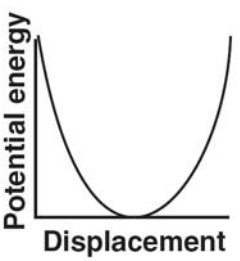
(1)



(3)



(2)



(4)

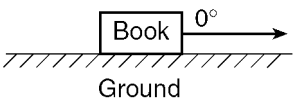
4925 A 1.00-kilogram ball is dropped from the top of a building. Just before striking the ground, the ball's speed is 12.0 meters per second. What was the ball's gravitational potential energy, relative to the ground, at the instant it was dropped? [Neglect friction.]

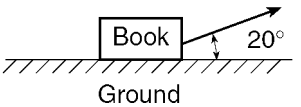
(1) 6.00 J **(3) 72.0 J**
(2) 24.0 J (4) 144 J

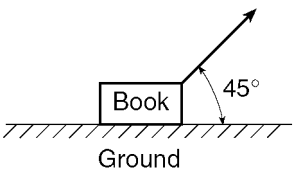
4751 Two students of equal weight go from the first floor to the second floor. The first student uses an elevator and the second student walks up a flight of stairs. Compared to the gravitational potential energy gained by the first student, the gravitational potential energy gained by the second student is

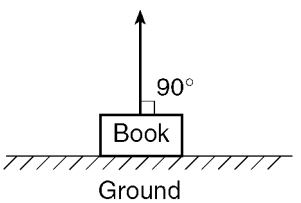
(1) less **(3) the same**
(2) greater

4678 A 1.0-kilogram book resting on the ground is moved 1.0 meter at various angles relative to the horizontal. In which direction does the 1.0-meter displacement produce the greatest increase in the book's gravitational potential energy?

(1)


(2)


(3)


(4)


4607 What is the gravitational potential energy with respect to the surface of the water of a 75.0 kilogram diver located 3.00 meters above the water?

(1) 2.17×10^4 J (3) 2.25×10^2 J
(2) 2.21×10^3 J (4) 2.29×10^1 J

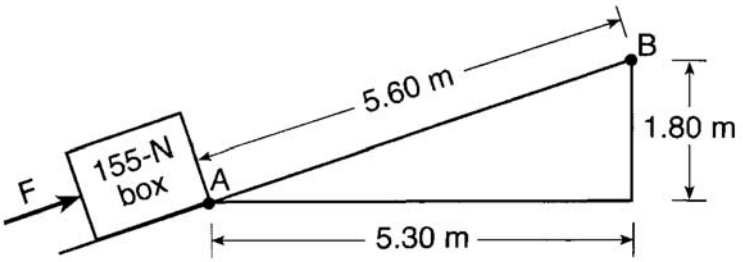
4320 An object weighing 15 Newtons is lifted from the ground to a height of 0.22 meter. The increase in the object's gravitational potential energy is approximately

(1) 310 J **(3) 3.3 J**
(2) 32 J (4) 0.34 J

3457 A girl rides an escalator that moves her upward at constant speed. As the girl rises, how do her gravitational potential energy and kinetic energy change?

(1) Gravitational potential energy decreases and kinetic energy decreases.
(2) Gravitational potential energy decreases and kinetic energy remains the same.
(3) Gravitational potential energy increases and kinetic energy decreases.
(4) Gravitational potential energy increases and kinetic energy remains the same.

5350 The diagram below represents a l55-newton box on a ramp. Applied force *F* causes the box to slide from point *A* to point *B*.



What is the total amount of gravitational potential energy gained by the box?
(1) 28.4 J **(2) 279 J** (3) 868 J (4) 2740 J

5378 A l5.0-kilogram mass is moving at 7.50 meters per second on a horizontal, frictionless surface. What is the total work that must be done on the mass to increase its speed to 11.5 meters per second?
(1) 120. J **(3) 570. J**
(2) 422 J (4) 992 J

5226 A child does 0.20 joule of work to compress the spring in a pop-up toy. If the mass of the toy is 0.010 kilogram, what is the maximum vertical height that the toy can reach after the spring is released?
(1) 20. m (3) 0.20 m
(2) 2.0 m (4) 0.020 m

4970 A horizontal force of 5.0 newtons acts on a 3.0-kilogram mass over a distance of 6.0 meters along a horizontal, frictionless surface. What is the change in kinetic energy of the mass during its movement over the 6.0-meter distance?
(1) 6.0 J **(3) 30. J**
(2) 15 J (4) 90. J

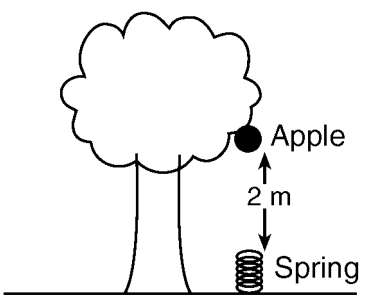
4894 The work done in accelerating an object along a frictionless horizontal surface is equal to the change in the object's
(1) momentum (3) potential energy
(2) velocity **(4) kinetic energy**

4820 A person weighing 6.0×10^2 newtons rides an elevator upward at an average speed of 3.0 meters per second for 5.0 seconds. How much does this person's gravitational potential energy increase as a result of this ride?
(1) 3.6×10^2 J (3) 3.0×10^3 J
(2) 1.8×10^3 J **(4) 9.0×10^3 J**

4346 The spring of a toy car is wound by pushing the car backward with an average force of 15 Newtons through a distance of 0.50 meter. How much elastic potential energy is stored in the car's spring during this process?
(1) 1.9 J (3) 30. J
(2) 7.5 J (4) 56 J

4070 A 0.10-kilogram ball dropped vertically from a height of l.00 meter above the floor bounces back to a height of 0.80 meter. The mechanical energy lost by the ball as it bounces is
(1) 0.080 J (3) 0.30 J
(2) 0.20 J (4) 0.78 J

4457 The diagram below shows a 0.1-kilogram apple attached to a branch of a tree 2 meters above a spring on the ground below.



The apple falls and hits the spring, compressing it 0.1 meter from its rest position. If all of the gravitational potential energy of the apple on the tree is transferred to the spring when it is compressed, what is the spring constant of this spring?
(1) 10 N/m (3) 100 N/m
(2) 40 N/m **(4) 400 N/m**

4250 A catapult with a spring constant of 1.0×10^4 newtons per meter is required to launch an airplane from the deck of an aircraft carrier. The plane is released when it has been displaced 0.50 meter from its equilibrium position by the catapult. The energy acquired by the airplane from the catapult during takeoff is approximately
(1) 1.3×10^3 J (3) 2.5×10^3 J
(2) 2.0×10^4 J (4) 1.0×10^4 J

2878 Sixteen joules of work was required to lift a 2.0-kilogram object from the floor to a table. How much potential energy was gained by the 2.0-kilogram object?
(1) 0.80 joule **(3) 16 joules**
(2) 8.0 joules (4) 32 joules

2588 A 10.-kilogram mass falls freely a distance of 6.0 meters near the Earth's surface. The total kinetic energy gained by the mass as it falls is approximately
(1) 60. J (3) 720 J
(2) 590 J (4) 1,200 J

5220 If an object has a net negative charge of 4.0 coulombs, the object possesses
(1) 6.3×10^{18} more electrons than protons
(2) 2.5×10^{19} more electrons than protons
(3) 6.3×10^{18} more protons than electrons
(4) 2.5×10^{19} more protons than electrons

5144 Which fundamental force is primarily responsible for the attraction between protons and electrons?
(1) strong (3) gravitational
(2) weak **(4) electromagnetic**

5064 A subatomic particle could have a charge of
(1) 5.0×10^{-20} C **(3) 3.2×10^{-19} C**
(2) 8.0×10^{-20} C (4) 5.0×10^{-19} C

4990 Which quantity of excess electric charge could be found on an object?
(1) 6.25×10^{-19} C (3) 6.25 elementary charges
(2) 4.80×10^{-19} C (4) 1.60 elementary charges

4914 What is the net electrical charge on a magnesium ion that is formed when a neutral magnesium atom loses two electrons?
(1) -3.2×10^{-19} C (3) $+1.6 \times 10^{-19}$ C
(2) -1.6×10^{-19} C **(4) $+3.2 \times 10^{-19}$ C**

4766 Oil droplets may gain electrical charges as they are projected through a nozzle. Which quantity of charge is *not* possible on an oil droplet?
(1) 8.0×10^{-19} C (3) 3.2×10^{-19} C
(2) 4.8×10^{-19} C **(4) 2.6×10^{-19} C**

4692 A metal sphere has a net negative charge of 11×10^{-6} coulomb. Approximately how many more electrons than protons are on the sphere?
(1) 1.8×10^{12} **(3) 6.9×10^{12}**
(2) 5.7×10^{12} (4) 9.9×10^{12}

4339 An object possessing an excess of 6.0×10^{6} electrons has a net charge of magnitude
(1) 2.7×10^{-26} C (3) 3.8×10^{-13} C
(2) 5.5×10^{-24} C **(4) 9.6×10^{-13} C**

4260 An object can *not* have a charge of
(1) 3.2×10^{-19} C (3) 8.0×10^{-19} C
(2) 4.5×10^{-19} C (4) 9.6×10^{-19} C

4199 What is the smallest electric charge that can be put on an object?
(1) 9.11×10^{-31} C (3) 9.00×10^{9} C
(2) 1.60×10^{-19} C (4) 6.25×10^{18} C

4077 What is the net static electric charge on a metal sphere having an excess of +3 elementary charges?
(1) 1.60×10^{-19} C (3) 3.00×10^{0} C
(2) 4.80×10^{-19} C (4) 4.80×10^{19} C

3994 If a small sphere possesses an excess of 5 electrons, the charge on the sphere is
(1) -3.2×10^{-20} C (3) -8.0×10^{19} C
(2) -8.0×10^{-19} C (4) -3.2×10^{20} C

3838 An alpha particle consists of two protons and two neutrons. The alpha particle's charge of +2 elementary charges is equivalent to
(1) 8.0×10^{-20} C (3) 1.2×10^{19} C
(2) 3.2×10^{-19} C (4) 3.2×10^{19} C

3717 Which net charge could be found on an object?
(1) $+3.2 \times 10^{-18}$ C (3) -1.8×10^{-18} C
(2) $+2.4 \times 10^{-19}$ C (4) -0.80×10^{-19} C

3649 The Millikan oil drop experiment was designed to determine the
(1) sign of the charge of an electron
(2) mass of a proton
(3) ratio of charge to mass of an electron
(4) magnitude of the charge of an electron

3592 A metal sphere having an excess of +5 elementary charges has a net electric charge of
(1) 1.6×10^{-19} C (3) 5.0×10^{0} C
(2) 8.0×10^{-19} C (4) 3.2×10^{19} C

3516 What did Millikan conclude after performing his oil-drop experiment?
(1) The charge on an electron is 1.0 C.
(2) The mass of an electron is 1.7×10^{-27} kg.
(3) The charge on any oil drop is an intregal multiple of the charge on an electron.
(4) The charge on an oil drop may have any value larger that 1.6×10^{-19} kg.

3465 Compared to the charge on a proton, the charge on an electron has the
(1) opposite sign and a smaller magnitude
(2) opposite sign and same magnitude
(3) same sign and a smaller magnitude
(4) same sign and the same magnitude

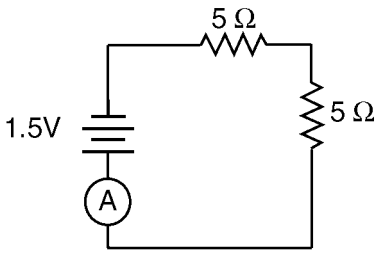
2992 The coulomb is a unit of
(1) resistance **(3) charge**
(2) power (4) force

2779 A sphere has a net excess charge of -4.8×10^{-19} coulomb. The sphere must have an excess of
(1) 1 electron **(3) 3 electrons**
(2) 1 proton (4) 3 protons

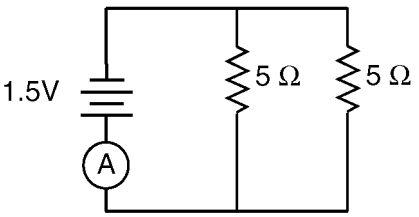
2086 After Millikan performed his oil drop experiment, he concluded that
(1) there is a minimum amount of charge that particles can acquire
(2) oil drops exhibit gravitational attraction for other oil drops
(3) oil drops are largely empty space
(4) there is a minimum amount of mass that particles can acquire

1536 What is the charge of a proton?
(1) 9.1×10^{-31} C **(3) 1.6×10^{-19} C**
(2) 1.7×10^{-27} C (4) 6.3×10^{18} C

4456 In which circuit would ammeter A show the greatest current?



(1)



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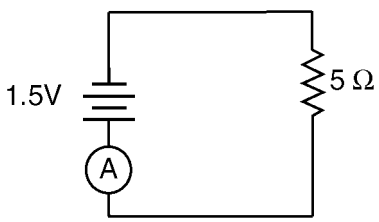

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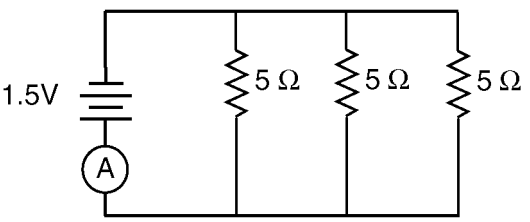
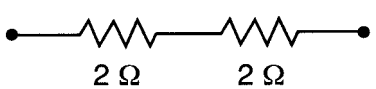


(4)

5306 Which combination of resistors has the *smallest* equivalent resistance?

(1)



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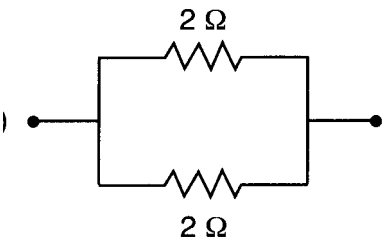

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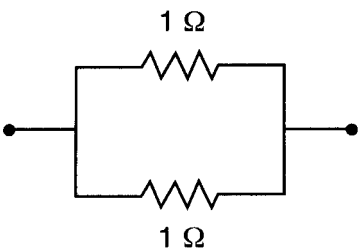

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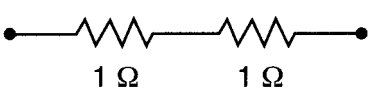


5130 Three resistors, 4 ohms, 6 ohms, and 8 ohms, are connected in parallel in an electric circuit. The equivalent resistance of the circuit is

(1) less than 4 Ω
(2) between 4 Ω and 8 Ω
(3) between 10 Ω and 18 Ω
(4) 18 Ω

5203 Three identical lamps are connected in parallel with each other. If the resistance of each lamp is *X* ohms, what is the equivalent resistance of this parallel combination?

(1) $X\ \Omega$
(3) $3X\ \Omega$
(2) $\frac{X}{3}\ \Omega$
(4) $\frac{3}{X}\ \Omega$

5054 A circuit consists of a 10.0-ohm resistor, a 15.0-ohm resistor, and a 20.0-ohm resistor connected in parallel across a 9.00-volt battery. What is the equivalent resistance of this circuit?

(1) 0.200 Ω
(2) 1.95 Ω
(3) 4.62 Ω
(4) 45.0 Ω

4830 Two identical resistors connected in series have an equivalent resistance of 4 ohms. The same two resistors, when connected in parallel, have an equivalent resistance of

(1) 1 Ω
(2) 2 Ω
(3) 8 Ω
(4) 4 Ω

4394 Two identical resistors connected in parallel have an equivalent resistance of 40. ohms. What is the resistance of each resistor?

(1) 20. Ω
(2) 40. Ω
(3) 80. Ω
(4) 160 Ω

4083 A physics student is given three 12-ohm resistors with instructions to create the circuit that would have the lowest possible resistance. The correct circuit would be a

(1) series circuit with an equivalent resistance of 36 Ω?
(2) series circuit with an equivalent resistance of 4.0 Ω?
(3) parallel circuit with an equivalent resistance of 36 Ω?
(4) parallel circuit with an equivalent resistance of 4.0 Ω?

5282 Which color of light has a wavelength of 5.0×10^{-7} meter in air?
(1) blue
(2) **green**
(3) orange
(4) violet

5136 An electromagnetic AM-band radio wave could have a wavelength of
(1) 0.005 m
(2) 5 m
(3) **500 m**
(4) 5 000 000 m

4984 A microwave and an x ray are traveling in a vacuum. Compared to the wavelength and period of the microwave, the x ray has a wavelength that is
(1) longer and a period that is shorter
(2) longer and a period that is longer
(3) shorter and a period that is longer
(4) **shorter and a period that is shorter**

4929 Which wavelength is in the infrared range of the electromagnetic spectrum?
(1) 100 nm
(2) 100 mm
(3) 100 m
(4) **100 μm**

4836 Electromagnetic radiation having a wavelength of 1.3×10^{-7} meter would be classified as
(1) infrared
(2) orange
(3) blue
(4) **ultraviolet**

4824 Radio waves are propagated through the interaction of
(1) nuclear and electric fields
(2) **electric and magnetic fields**
(3) gravitational and magnetic fields
(4) gravitational and electric fields

4703 Compared to the period of a wave of red light the period of a wave of green light is
(1) **less**
(2) greater
(3) the same

4691 Radio waves diffract around buildings more than light waves do because, compared to light waves, radio waves
(1) move faster
(2) move slower
(3) have a higher frequency
(4) **have a longer wavelength**

4688 Which pair of terms best describes light waves traveling from the Sun to Earth?
(1) **electromagnetic and transverse**
(2) electromagnetic and longitudinal
(3) mechanical and transverse
(4) mechanical and longitudinal

4628 Electrons oscillating with a frequency of 2.0×10^{10} hertz produce electromagnetic waves. These waves would be classified as
(1) infrared
(2) visible
(3) **microwave**
(4) x-ray

3736 A beam of green light may have a frequency of
(1) 5.0×10^{-7} Hz
(2) 1.5×10^{2} Hz
(3) 3.0×10^{8} Hz
(4) **6.0×10^{14} Hz**

4427 Exposure to ultraviolet radiation can damage skin. Exposure to visible light does not damage skin. State *one* possible reason for this difference.

Examples: — Visible light has less energy.; — Visible light has lower frequency. — Visible light has longer wavelength. — Ultraviolet has higher energy. — Ultraviolet has higher frequency. — Ultraviolet has shorter wavelength. — Ultraviolet radiation resonates with the cell membrane.

4345 A photon of which electromagnetic radiation has the most energy?
(1) ultraviolet
(2) **x-ray**
(3) infrared
(4) microwave

4101 Compared to the wavelength of red light, the wavelength of yellow light is
(1) **shorter**
(2) longer
(3) the same

3744 Compared to wavelengths of visible light, the wavelengths of ultraviolet light are
(1) **shorter**
(2) longer
(3) the same

3609 A monochromatic beam of light has a frequency of 6.5×10^{14} hertz. What color is the light?
(1) yellow
(2) orange
(3) violet
(4) **blue**

2601 Which electromagnetic radiation has the *shortest* wavelength?
(1) infrared
(2) radio
(3) **gamma**
(4) ultraviolet

2384 Which of the following electromagnetic waves has the lowest frequency?
(1) violet light
(2) green light
(3) yellow light
(4) **red light**

2158 In a vacuum, a monochromatic beam of light has a frequency of 6.3×10^{14} hertz. What color is the light?
(1) red
(2) yellow
(3) green
(4) **blue**

2060 As the color of light changes from red to yellow, the frequency of the light
(1) decreases
(2) **increases**
(3) remains the same

1775 Compared to visible light, ultraviolet radiation is more harmful to human skin and eyes because ultraviolet radiation has a
(1) **higher frequency**
(2) longer period
(3) higher speed
(4) longer wavelength

1656 In a vacuum, the wavelength of green light is 5×10^{-7} meter. What is its frequency?
(1) 2×10^{-15} Hz
(2) 2×10^{-14} Hz
(3) **6×10^{14} Hz**
(4) 6×10^{15} Hz

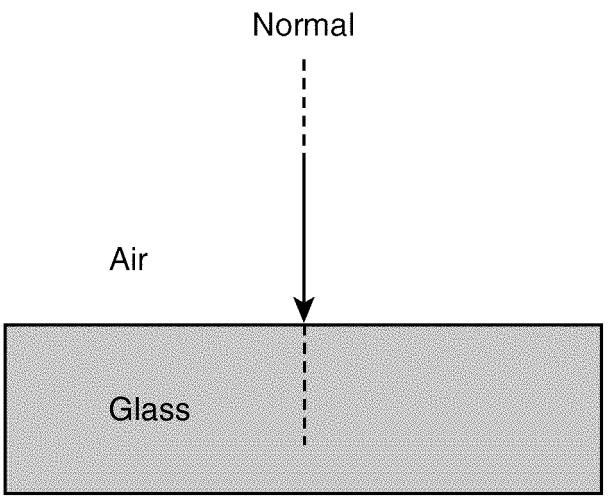
758 Which is not in the electromagnetic spectrum?
(1) light waves
(2) radio waves
(3) **sound waves**
(4) x-rays

5287 In which way does blue light change as it travels from diamond into crown glass?
(1) Its frequency decreases. (3) Its speed decreases.
(2) Its frequency increases. **(4) Its speed increases.**

5138 When a light wave enters a new medium and is refracted, there must be a change in the light wave's
(1) color (3) period
(2) frequency **(4) speed**

4908 What happens to the speed and frequency of a light ray when it passes from air into water?
(1) The speed decreases and the frequency increases.
(2) The speed decreases and the frequency remains the same.
(3) The speed increases and the frequency increases.
(4) The speed increases and the frequency remains the same.

4686 The diagram below shows a ray of light passing from air into glass at an angle of incidence of 0°.



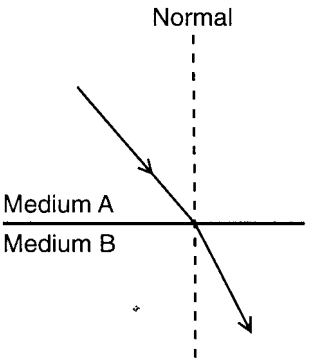
Which statement best describes the speed and direction of the light ray as it passes into the glass?
(1) Only speed changes.
(2) Only direction changes.
(3) Both speed and direction change.
(4) Neither speed nor direction changes.

3617 What occurs as a ray of light passes from air into water?
(1) The ray must decrease in speed.
(2) The ray must increase in speed.
(3) The ray must decrease in frequency.
(4) The ray must increase in frequency.

2385 Which characteristic of a wave changes as the wave travels across a boundary between two different media?
(1) frequency (3) phase
(2) period **(4) speed**

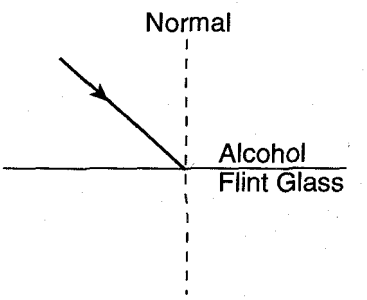
1424 As a wave travels into a different medium with a change in direction, there will be a change in the wave's
(1) speed (3) period
(2) frequency (4) phase

3746 The diagram below shows a ray of light passing through two media.



When the wave travels from medium *A* into medium *B*, its speed
(1) decreases (3) remains the same
(2) increases

2274 The diagram below shows a ray of monochromatic light incident on an alcohol-flint glass interface.



What occurs as the light travels from alcohol into flint glass?
(1) The speed of the light decreases and the ray bends toward the normal.
(2) The speed of the light decreases and the ray bends away from the normal.
(3) The speed of the light increases and the ray bends toward the normal.
(4) The speed of the light increases and the ray bends away from the normal.

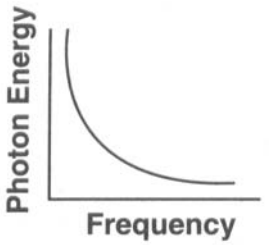
1005 As monochromatic light passes from air into glass, its speed
(1) decreases (3) remains the same
(2) increases

175 As a wave enters a different medium with no change in velocity, the wave will be
(1) reflected but not refracted
(2) refracted but not reflected
(3) both reflected and refracted
(4) neither reflected nor refracted

174 The speed of light in water is closest to the speed of light in
(1) a vacuum (3) carbon tetrachloride
(2) lucite **(4) alcohol**

5159 Which graph best represents the relationship between photon energy and photon frequency?

(1)



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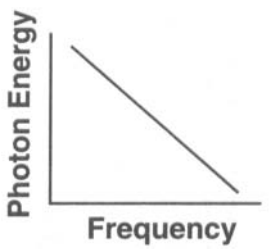

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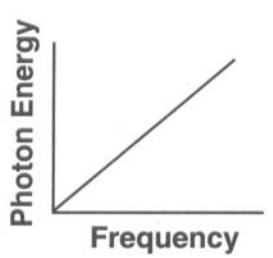

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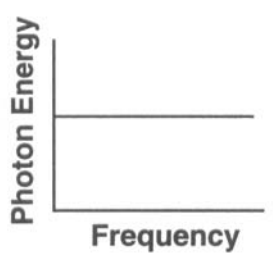


5067 A variable-frequency light source emits a series of photons. As the frequency of the photon increases, what happens to the energy and wavelength of the photon?

(1) The energy decreases and the wavelength decreases.
(2) The energy decreases and the wavelength increases.
(3) The energy increases and the wavelength decreases.
(4) The energy increases and the wavelength increases.

4913 A photon of light traveling through space with a wavelength of 6.0×10^{-7} meter has an energy of

(1) 4.0×10^{-40} J
(2) 3.3×10^{-19} J
(3) 5.4×10^{10} J
(4) 5.0×10^{14} J

4767 All photons in a vacuum have the same

(1) speed
(2) wavelength
(3) energy
(4) frequency

4693 Light of wavelength 5.0×10^{-7} meter consists of photons having an energy of

(1) 1.1×10^{-48} J
(2) 1.3×10^{-27} J
(3) 4.0×10^{-19} J
(4) 1.7×10^{-5} J

4539 The energy of a photon is inversely proportional to its

(1) wavelength
(2) frequency
(3) speed
(4) phase

4402 Compared to a photon of red light, a photon of blue light has a

(1) greater energy
(2) longer wavelength
(3) smaller momentum
(4) lower frequency

4200 Which characteristic of electromagnetic radiation is directly proportional to the energy of a photon?

(1) wavelength
(2) period
(3) frequency
(4) path

4098 What is the energy of a photon with a frequency of 5.00×10^{14} hertz?

(1) 3.32 eV
(2) 3.20×10^{-6} eV
(3) 3.00×10^{48} J
(4) 3.32×10^{-19} J

3748 What is the energy of a quantum of light having a frequency of 6.0×10^{14} hertz?

(1) 1.6×10^{-19} J
(2) 4.0×10^{-19} J
(3) 3.0×10^{8} J
(4) 5.0×10^{-7} J

2699 What is the energy of a photon with a frequency of 5.0×10^{15} hertz?

(1) 3.3×10^{-18} J
(2) 2.0×10^{-16} J
(3) 1.5×10^{24} J
(4) 7.5×10^{48} J

2698 According to the quantum theory of light, the energy of light is carried in discrete units called

(1) alpha particles
(2) protons
(3) photons
(4) photoelectrons

2400 The wavelength of photon *A* is greater than that of photon *B*. Compared to the energy of photon *A*, the energy of photon *B* is

(1) less
(2) greater
(3) the same

1779 Blue light has a frequency of approximately 6.0×10^{14} hertz. A photon of blue light will have an energy of approximately

(1) 1.1×10^{-48} J
(2) 6.0×10^{-34} J
(3) 5.0×10^{-7} J
(4) 4.0×10^{-19} J

1326 The energy of a photon varies directly with its

(1) frequency
(2) wavelength
(3) speed
(4) rest mass

893 When incident on a given photoemissive surface, which color of light will produce photoelectrons with the greatest energy?

(1) red
(2) orange
(3) violet
(4) green

776 An atom changing from an energy state of –0.54 eV to an energy state of –0.85 eV will emit a photon whose energy is

(1) 0.31 eV
(2) 0.54 eV
(3) 0.85 eV
(4) 1.39 eV

5291 An electron in the *c* level of a mercury atom returns to the ground state. Which photon energy could *not* be emitted by the atom during this process?
(1) 0.22 eV (3) 4.86 eV
(2) 4.64 eV **(4) 5.43 eV**

5219 An electron in a mercury atom drops from energy level *f* to energy level *c* by emitting a photon having an energy of
(1) 8.20 eV **(3) 2.84 eV**
(2) 5.52 eV (4) 2.68 eV

4911 A photon having an energy of 9.40 electronvolts strikes a hydrogen atom in the ground state. Why is the photon *not* absorbed by the hydrogen atom?
(1) The atom's orbital electron is moving too fast.
(2) The photon striking the atom is moving too fast.
(3) The photon's energy is too small.
(4) The photon is being repelled by electrostatic force.

4859 Which type of photon is emitted when an electron in a hydrogen atom drops from the $n = 2$ to the $n = 1$ energy level?
(1) ultraviolet (3) infrared
(2) visible light (4) radio wave

4704 A hydrogen atom with an electron initially in the $n = 2$ level is excited further until the electron is in the $n = 4$ level. This energy level change occurs because the atom has
(1) absorbed a 0.85-eV photon
(2) emitted a 0.85-eV photon
(3) absorbed a 2.55-eV photon
(4) emitted a 2.55-eV photon

4488 An electron in a mercury atom drops from energy level *i* to the ground state by emitting a single photon. This photon has an energy of
(1) 1.56 eV (3) 10.38 eV
(2) 8.82 eV (4) 11.94 eV

4401 White light is passed through a cloud of cool hydrogen gas and then examined with a spectroscope. The dark lines observed on a bright background are caused by
(1) the hydrogen emitting all frequencies in white light
(2) the hydrogen absorbing certain frequencies of the white light
(3) diffraction of the white light
(4) constructive interference

4261 After electrons in hydrogen atoms are excited to the $n = 3$ energy state, how many different frequencies of radiation can be emitted as the electrons return to the ground state?
(1) 1 **(3) 3**
(2) 2 (4) 4

4209 What is the minimum energy needed to ionize a hydrogen atom in the n = 2 energy state?
(1) 13.6 eV **(3) 3.40 eV**
(2) 10.2 eV (4) 1.89 eV

4097 An electron in a hydrogen atom drops from the $n = 3$ energy level to the $n = 2$ energy level. The energy of the emitted photon is
(1) 1.51 eV (3) 3.40 eV
(2) 1.89 eV (4) 4.91 eV

3870 The electron in a hydrogen atom drops from energy level $n = 2$ to energy level $n = 1$ by emitting a photon having an energy of approximately
(1) 5.4×10^{-19} J (3) 2.2×10^{-18} J
(2) 1.6×10^{-18} J (4) 7.4×10^{-18} J

3622 What is the minimum energy required to excite a mercury atom initially in the ground state?
(1) 4.64 eV (3) 10.20 eV
(2) 5.74 eV (4) 10.38 eV

2801 An excited hydrogen atom returns to its ground state. A possible energy change for the atom is a
(1) loss of 10.20 eV (3) loss of 3.40 eV
(2) gain of 10.20 eV (4) gain of 3.40 eV

2513 What is the minimum energy required to ionize a hydrogen atom in the n = 3 state?
(1) 13.60 eV (3) 5.52 eV
(2) 12.09 eV **(4) 1.51 eV**

2284 A hydrogen atom could have an electron energy-level transition from n = 2 to n = 3 by absorbing a photon having an energy of
(1) 1.51 eV (3) 4.91 eV
(2) 1.89 eV (4) 10.20 eV

1560 A hydrogen atom in the ground state receives 10.2 electron volts of energy. To which energy level may the atom become excited?
(1) n = 5 (3) n = 3
(2) n = 2 (4) n = 4

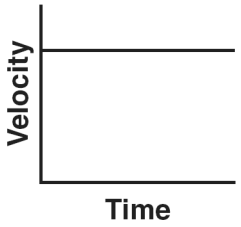
1447 A photon having an energy of 15.5 electron volts is incident upon a hydrogen atom in the ground state. If the photon is absorbed by the atom, it will
(1) ionize the atom (3) excite the atom to n = 3
(2) excite the atom to n = 2 (4) excite the atom to n = 4

1329 What is the minimum amount of energy required to ionize a hydrogen atom in the n = 2 state?
(1) 13.6 eV **(3) 3.4 eV**
(2) 10.2 eV (4) 0 eV

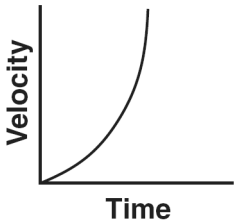
1228 Photons incident upon hydrogen atoms in the n = 2 level raise the energy of the atoms to the n = 4 level. What is the energy of the incident photons?
(1) 1.89 eV (3) 3.40 eV
(2) 2.55 eV (4) 4.25 eV

1177 A hydrogen atom is excited to the n = 3 state. In returning to the ground state, the atom could not emit a photon with an energy of
(1) 1.89 eV **(3) 12.09 eV**
(2) 10.2 eV (4) 12.75 eV

4999 Which graph best represents the relationship between the velocity of an object thrown straight upward from Earth's surface and the time that elapses while it is in the air? [Neglect friction.]

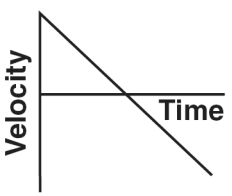


(1)



(3)

(2)

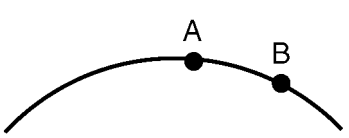


(4)

4753 A 0.25-kilogram baseball is thrown upward with a speed of 30. meters per second. Neglecting friction, the maximum height reached by the baseball is approximately
(1) 15 m (3) 74 m
(2) 46 m (4) 92 m

4520 A 0.2-kilogram red ball is thrown horizontally at a speed of 4 meters per second from a height of 3 meters. A 0.4-kilogram green ball is thrown horizontally from the same height at a speed of 8 meters per second. Compared to the time it takes the red ball to reach the ground, the time it takes the green ball to reach the ground is
(1) one-half as great **(3) the same**
(2) twice as great (4) four times as great

4519 The diagram below represents the path of an object after it was thrown.



What happens to the object's acceleration as it travels from *A* to *B*? [Neglect friction.]
(1) It decreases. **(3) It remains the same.**
(2) It increases.

3968 A ball is thrown horizontally from the top of a building with an initial velocity of 15 meters per second. At the same instant, a second ball is dropped from the top of the building. The two balls have the same
(1) path as they fall
(2) final velocity as they reach the ground
(3) initial horizontal velocity
(4) initial vertical velocity

3877 A red ball and a green ball are simultaneously thrown horizontally from the same height. The red ball has an initial speed of 40. meters per second and the green ball has an initial speed of 20. meters per second. Compared to the time it takes the red ball to reach the ground, the time it takes the green ball to reach the ground will be
(1) the same (3) half as much
(2) twice as much (4) four times as much

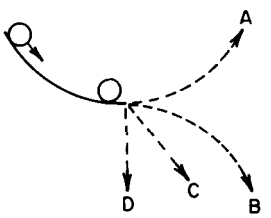
3627 A 2-kilogram block is dropped from the roof of a tall building at the same time a 6-kilogram ball is thrown horizontally from the same height. Which statement best describes the motion of the block and the motion of the ball? [Neglect air resistance.]
(1) The 2-kg block hits the ground first because it has no horizontal velocity.
(2) The 6-kg ball hits the ground first because it has more mass.
(3) The 6-kg ball hits the ground first because it is round.
(4) The block and the ball hit the ground at the same time because they have the same vertical acceleration.

2401 A 1-kilogram object is thrown horizontally and a 2-kilogram object is dropped vertically at the same instant and from the same point above the ground. If friction is neglected, at any given instant both objects will have the same
(1) kinetic energy (3) total velocity
(2) momentum **(4) height**

1951 A book is pushed with an initial horizontal velocity of 5.0 meters per second off the top of a desk. What is the initial vertical velocity of the book?
(1) 0 m/s (3) 5.0 m/s
(2) 2.5 m/s (4) 10. m/s

1950 A ball is thrown horizontally at a speed of 20. meters per second from the top of a cliff. How long does the ball take to fall 19.6 meters to the ground?
(1) 1.0 s (3) 9.8 s
(2) 2.0 s (4) 4.0 s

1569 A ball rolls down a curved ramp as shown in the diagram below. Which dotted line best represents the path of the ball after leaving the ramp?



(1) *A* (3) *C*
(2) *B* (4) *D*

4110 What is the period of orbit of a communications satellite in geosynchronous orbit about Earth?
(1) 1 year (3) 12 hours
(2) 24 hours (4) 60 minutes

3884 The Moon's orbit is *not* classified as geosynchronous because
(1) the Moon's position over Earth's surface varies with time
(2) the Moon's mass is very large compared to the mass of all other Earth satellites
(3) the Moon is a natural satellite, rather than an artificial one
(4) the Moon always has the same half of its surface facing Earth

3759 A satellite is in geosynchronous orbit. Compared to Earth's period of rotation, the satellite's period of revolution is
(1) less **(3) the same**
(2) greater

3498 A communications satellite in geosynchronous orbit around Earth remains over the same location on Earth. The satellite's period of revolution about Earth is closest to
(1) 1 hour (3) 1 month
(2) 1 day (4) 1 year

3386 An artificial satellite makes 4 complete revolutions about the Earth in 8 hours. The period of revolution of the satellite is
(1) $\frac{1}{2}$ hour (3) 8 hours
(2) 2 hours (4) 32 hours

3385 An artificial satellite must have sufficient velocity to maintain a predetermined orbit. This velocity is known as
(1) orbital velocity (3) centripetal velocity
(2) escape velocity (4) centrifugal velocity

3299 The velocity of a bullet is less than that required to put it into orbit about the Earth. Its velocity is referred to as
(1) angular (3) escape
(2) orbital **(4) suborbital**

3150 The reason for using vhf and uhf radio waves for communications between space vehicles and ground stations is that these waves
(1) travel slowly
(2) are not refracted by the ionosphere
(3) require a large antenna
(4) travel along a curved path

3149 The process of taking measurements, translating measurements, and receiving measurements at a remote place is referred to as
(1) telephony (3) telegraphy
(2) telemetry (4) telescopy

3148 For a spaceship to overcome the gravitational pull of the Earth. it must reach
(1) orbital velocity (3) suborbital velocity
(2) escape velocity (4) angular velocity

3147 Weightlessness is a condition in which an object and its environment have the same
(1) mass **(3) acceleration**
(2) weight (4) speed

3066 If the velocity of a satellite is too small to maintain an orbit, it is called
(1) a centripetal velocity (3) a launch velocity
(2) an escape velocity **(4) a suborbital velocity**

3061 The path of one body moving about another in space is
(1) centripetal acceleration **(3) an orbit**
(2) centripetal force (4) a period

2962 In order to experience weightlessness in a spaceship, an astronaut must have an acceleration that is
(1) less than that of the ship
(2) more than that of the ship
(3) the same as that of the ship

2957 In space communication systems, the process of data acquisition, transmission, and receiving is called
(1) telegraphy (3) telepathy
(2) telemetry (4) telephony

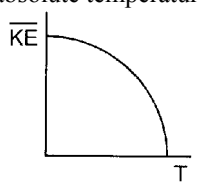
2407 Which condition is required for a satellite to be in a geosynchronous orbit about the Earth?
(1) The period of revolution of the satellite must be the same as the rotational period of the Earth.
(2) The altitude of the satellite must be equal to the radius of the Earth.
(3) The orbital speed of the satellite around the Earth must be the same as the orbital speed of the Earth around the Sun.
(4) The daily distance traveled by the satellite must be equal to the circumference of the Earth.

2406 A satellite orbits the Earth in a circular orbit. Which statement best explains why the satellite does not move closer to the center of the Earth?
(1) The gravitational field of the Earth does not reach the satellite's orbit.
(2) The Earth's gravity keeps the satellite moving with constant velocity.
(3) The satellite is always moving perpendicularly to the force due to gravity.
(4) The satellite does not have any weight.

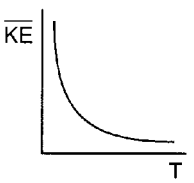
2177 What would occur as a result of the frictional drag of the atmosphere on an artificial satellite orbiting the Earth?
(1) The satellite would increase in speed and escape the gravitational field of the Earth.
(2) The satellite would increase in speed and spiral toward the Earth.
(3) The satellite would decrease in speed and escape the gravitational field of the Earth.
(4) The satellite would decrease in speed and spiral toward the Earth.

4113 Absolute zero is best described as the temperature at which
(1) water freezes at standard pressure
(2) water is at its triple point
(3) the molecules of a substance have maximum kinetic energy
(4) the molecules of a substance have minimum kinetic energy

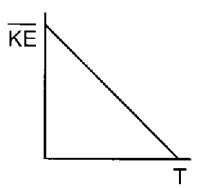
3767 Which graph best represents the relationship between the average molecular kinetic energy ($\overline{KE}$) of an ideal gas and its absolute temperature (T)?



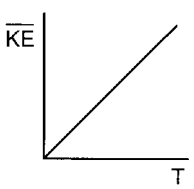
(1)



(3)



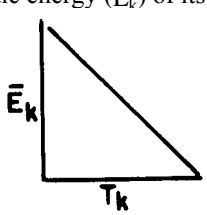
(2)



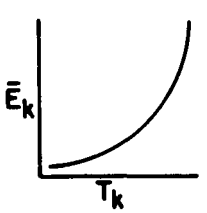
(4)

3349 Raising the temperature of most solids causes the amplitude of vibration of the molecules to
(1) decrease
(3) remain the same
(2) increase

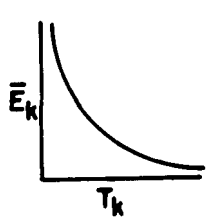
2679 Which graph best represents the relationship between the absolute temperature (T_k) of an ideal gas and the average kinetic energy (E_k) of its molecules?



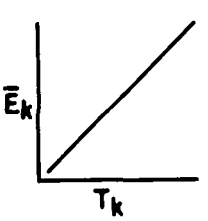
(1)



(3)



(2)

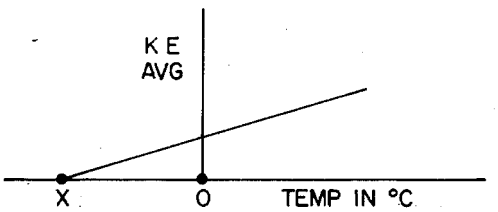


(4)

2590 A sample of an ideal gas at a temperature of 200 K has an average molecular kinetic energy of E. If the temperature of the gas were lowered to 50 K, its average molecular kinetic energy would change to
(1) E/2
(3) E/4
(2) 2E
(4) 4E

2528 If the temperature of 1 liter of an ideal gas is increased from 4 K to 16 K, the average kinetic energy of the molecules of the gas will be
(1) half as great
(3) one-fourth as great
(2) twice as great
(4) four times as great

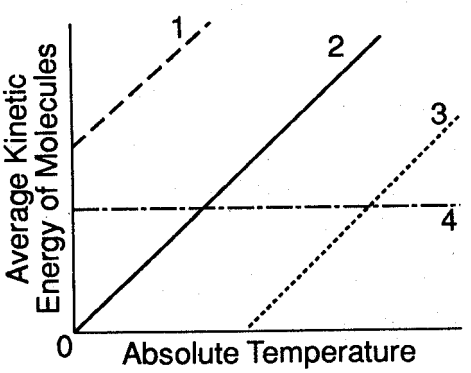
2412 The graph below represents the relationship between the temperature of a gas and the average kinetic energy (KE) of the molecules of the gas.



The temperature represented at point X is approximately
(1) 273°C
(3) –273°C
(2) 0°C
(4) –373°C

2411 For object A to have a higher absolute temperature than object B, object A must have a
(1) higher average internal potential energy
(2) higher average internal kinetic energy
(3) greater mass
(4) greater specific heat

2072 Which line on the graph below best represents the relationship between the average kinetic energy of the molecules of an ideal gas and absolute temperature?



(1) 1
(3) 3
(2) 2
(4) 4

1968 Oxygen molecules are about 16 times more massive than hydrogen molecules. An oxygen gas sample is in a closed container and a hydrogen gas sample is in a second closed container of different size. Both samples are at room temperature. Compared to the average speed of the oxygen molecules, the average speed of the hydrogen molecules will be
(1) less
(3) the same
(2) greater

4119 The total effect of all the processes that occur in the universe is an increase in
(1) entropy (3) order
(2) temperature (4) energy

4115 Heat will spontaneously flow from object *A* to object *B* if object *B* has a lower
(1) mass **(3) temperature**
(2) total energy (4) specific heat

3894 When a box of beakers was dropped, the beakers broke into many pieces. Dropping the box a second time could *not* cause the pieces to reform into the original beakers because this would require entropy to
(1) decrease (3) remain the same
(2) increase

3892 Heat will flow from a region of low temperature to a region of higher temperature if
(1) the specific heat of the cooler region is greater than the specific heat of the warmer region
(2) the temperature of the cooler region is near absolute zero
(3) work is done to produce the flow
(4) the cooler region is liquid and the warmer region is solid

3765 Which property determines the direction of the exchange of internal energy between two objects?
(1) temperature (3) mass
(2) specific heat (4) density

3642 In a diesel engine, the piston compresses gases in a cylinder. Why does the temperature of the gases rise during this process?
(1) Heat enters the cylinder from the surroundings.
(2) Heat is expelled through the exhaust system.
(3) Work is done on the surroundings by the gases.
(4) Work is done by the piston on the gases.

3639 A 1.0-kilogram sample of water is boiling at 100.ºC in an open container. If a 0.50-kilogram piece of lead at 300.ºC is placed in the boiling water, how will the temperature of the two substances be affected?
(1) The temperature of the water will decrease, and the temperature of the lead will remain the same.
(2) The temperature of the water will increase, and the temperature of the lead will remain the same.
(3) The temperature of the water will remain the same, and the temperature of the lead will decrease.
(4) The temperature of the water will remain the same, and the temperature of the lead will increase.

3637 When a solid sample was heated, its temperature increased but it did not melt. Which statement best describes the changes in the average kinetic and potential energies of the molecules of the sample?
(1) Potential energy decreased and kinetic energy remained the same.
(2) Potential energy increased and kinetic energy remained the same.
(3) Kinetic energy decreased and potential energy remained the same.
(4) Kinetic energy increased and potential energy remained the same.

3512 What do the laws of thermodynamics indicate about the energy and entropy of the universe?
(1) Energy is decreasing and entropy is increasing.
(2) Energy is increasing and entropy is decreasing.
(3) Energy is constant and entropy is decreasing.
(4) Energy is constant and entropy is increasing.

2831 A cylinder fitted with a piston contains a fixed mass of an ideal gas. Heat is added to the gas, causing it to expand and raise the piston. If all the added heat is converted to work done in raising the piston, the internal energy of the gas will
(1) decrease **(3) remain the same**
(2) increase

2305 Which phase change represents a decrease in entropy?
(1) solid to gas **(3) gas to liquid**
(2) solid to liquid (4) liquid to gas

2188 According to the second law of thermodynamics, which phenomenon will most likely occur?
(1) The entropy of the universe will steadily decrease.
(2) The universe will steadily become more disordered.
(3) The universe will eventually reach equilibrium at absolute zero.
(4) Within the universe, more heat will flow from colder to warmer regions than from warmer to colder regions.

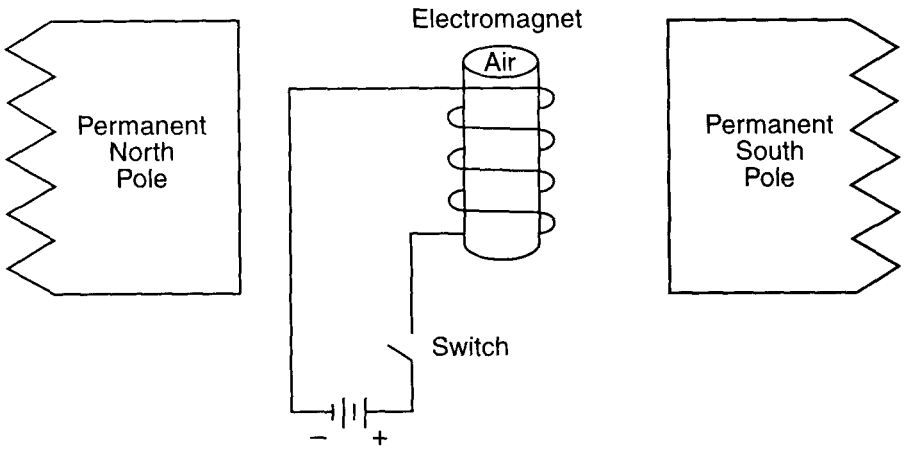
2078 According to the second law of thermodynamics, as time passes, the total entropy in the universe
(1) decreases, only
(2) increases, only
(3) remains the same
(4) cyclically increases and decreases

1804 A quantitative measure of the disorder of a system is called
(1) entropy (3) equilibrium
(2) fusion (4) vaporization

1685 In an ideal gas, entropy is a measure of the
(1) volume of the molecules
(2) mass of the molecules
(3) forces of attraction between the molecules
(4) disorder of the molecules

Base your answers to questions **3895** and **3896** on the information and diagram below.

An electromagnet with an air core is located within the magnetic field between two permanent magnets.

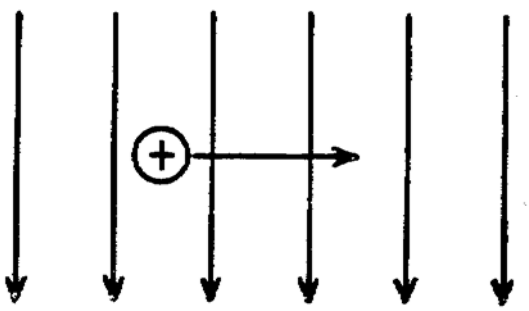


3895 At the instant the switch is closed and a current begins to flow through the coil of the electromagnet, the coil will experience
(1) no electromagnetic force
(3) a counterclockwise torque
(2) a force directed out of the page
(4) a clockwise torque

3896 The air core of the electromagnet is replaced with an iron core. Compared to the strength of the magnetic field in the air core, the strength of the magnetic field in the iron core is
(1) less
(2) greater
(3) the same

Base your answers to questions **141** through **144** on the diagram and information below.

The diagram shows a unit positive charge moving at a constant speed perpendicular to the direction of a magnetic field in a vacuum.



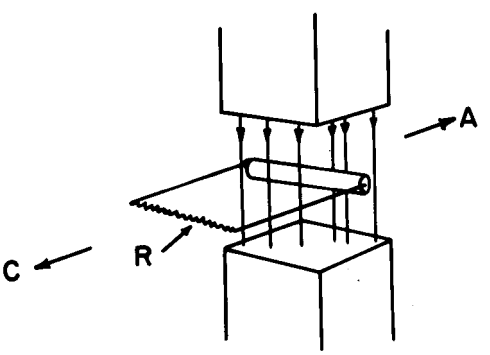
141 If the unit positive charge on the particle were replaced by a unit negative charge, the magnitude of the force exerted on the particle would be
(1) quartered
(3) doubled
(2) halved
(4) unaffected

142 If the magnetic field strength were doubled, the force exerted on the particle would be
(1) halved
(3) doubled
(2) unaffected
(4) quadrupled

143 If the charge on the particle were doubled, the force exerted on the particle would be
(1) halved
(3) doubled
(2) unaffected
(4) quadrupled

144 If the speed of the particle were doubled the force exerted on the particle would be
(1) halved
(3) doubled
(2) unaffected
(4) quadrupled

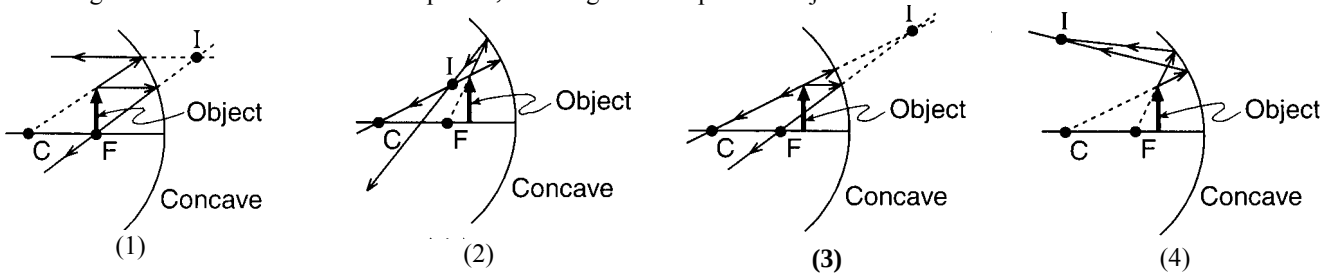
Base your answers to questions **338** through **340** on the diagram below which shows a conductor that is moving toward point *A* through a uniform magnetic field with a speed of 2 meters per second. The direction of the magnetic field is downward and the conductor is moving perpendicularly to the direction of the magnetic field.



338 If the speed of the conductor is increased, the induced electromotive force
(1) decreases
(3) remains the same
(2) increases

3789 An object arrow is placed in front of a concave mirror having center of curvature *C* and principal focus *F*.

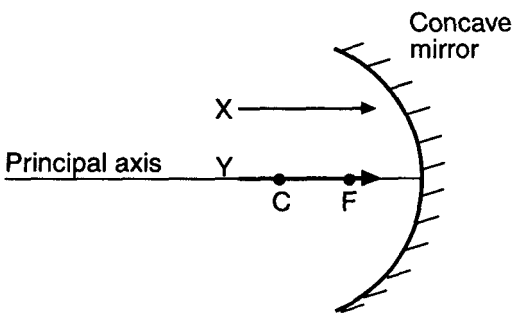
Which diagram best shows the location of point *I*, the image of the tip of the object arrow?



4134 An incident light ray travels parallel to the principal axis of a concave spherical mirror. After reflecting from the mirror, the light ray will travel

(1) through the mirror's principal focus
(2) through the mirror's center of curvature
(3) parallel to the mirror's principal axis
(4) normal to the mirror's principal axis

3910 The diagram below shows two parallel light rays, *X* and *Y*, approaching a concave spherical mirror.



Which light will reflect through the mirror's center of curvature, *C*?

(1) ray *X*, only
(2) **ray *Y*, only**
(3) both ray *X* and ray *Y*
(4) neither ray *X* nor ray *Y*

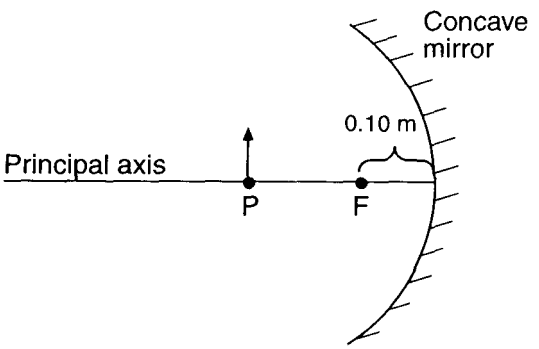
3655 The radius of curvature of a spherical mirror is *R*. The focal length of this mirror is equal to

(1) *R*/2
(2) 2*R*
(3) *R*/4
(4) 4*R*

2850 The filament in an automobile headlight radiates light that is reflected from a concave (converging) mirror. The reflected rays form a parallel beam of light because the filament is placed

(1) between the mirror and the principal focus
(2) at the mirror's principal focus
(3) at the mirror's center of curvature
(4) beyond the mirror's center of curvature

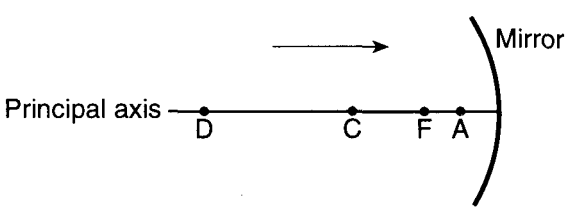
3908 The diagram below shows an object located at point *P*, 0.25 meter from a concave spherical mirror with principal focus *F*. The focal length of the mirror is 0.10 meter.



How does the image change as the object is moved from point *P* toward point *F*?

(1) It's distance from the mirror decreases and the size of the image decreases.
(2) It's distance from the mirror decreases and the size of the image increases.
(3) It's distance from the mirror increases and the size of the image decreases.
(4) It's distance from the mirror increases and the size of the image increases.

3526 The diagram below show a ray of light traveling parallel to the principal axis of a concave spherical mirror. Point *F* is the principal focus and point *C* is the center of curvature.



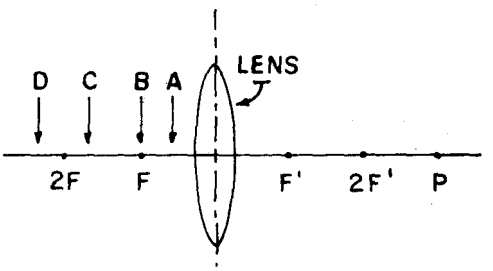
After striking the mirror, the ray of light will be reflected through point

(1) *A*
(2) *F*
(3) *C*
(4) *D*

3251 In order to produce a point of light at the focal point of a converging lens, it is necessary to have a source of light placed

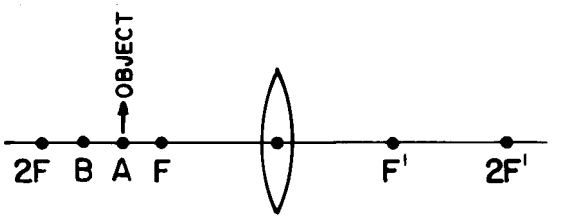
(1) less than a focal length from the lens
(2) at a focal length from the lens
(3) at twice the focal length from the lens
(4) at an infinite distance from the lens

3250 In the diagram below, at which position in front of a converging lens would an object be placed to produce an image at point *P*?



(1) *A*
(2) *B*
(3) *C*
(4) *D*

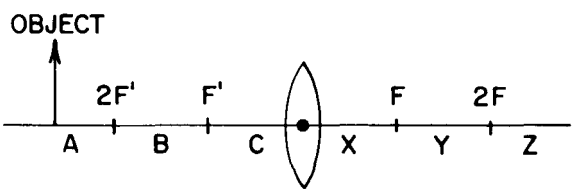
2986 An object is placed at point *A* before a converging lens as shown in the diagram below.



As the object moves from point *A* toward point *B*, the size of the image formed

(1) decreases
(2) increases
(3) remains the same

2891 The diagram below shows an object placed in area *A* before a converging lens. Where is the image produced?



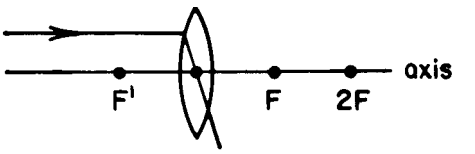
(1) at *F*
(2) at 2*F*
(3) in area *Y*
(4) in area *Z*

326 An object placed 0.07 meter from a converging lens produces a real image 0.42 meter from the lens. The focal length of the lens is

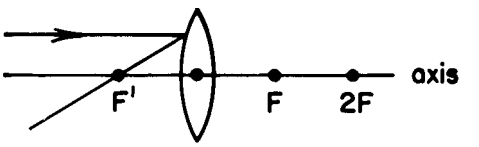
(1) 0.03 m
(2) 0.06 m
(3) 0.07 m
(4) 2.4 m

2981 Which of the diagrams below correctly shows the path of a light ray parallel to the principal axis of the lens?

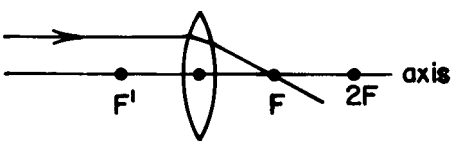
(1)



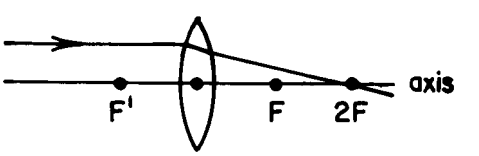
(2)



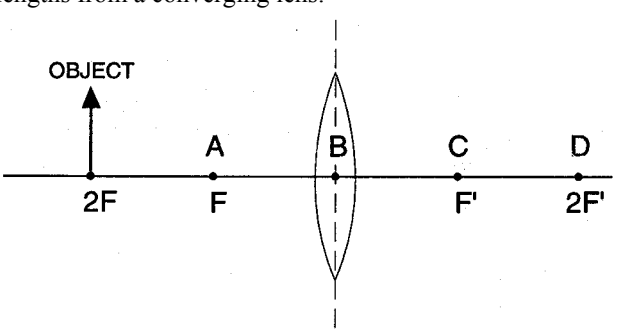
(3)



(4)



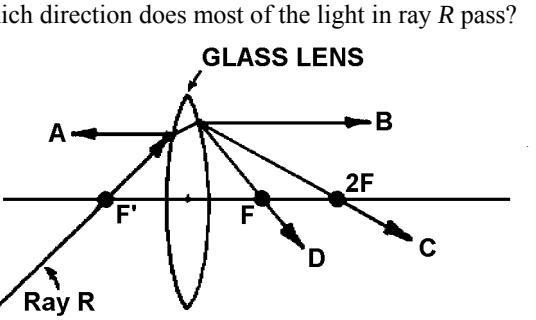
2554 The diagram below represents an object placed two focal lengths from a converging lens.



At which point will the image be located?

(1) *A*
(2) *B*
(3) *C*
(4) *D*

876 In which direction does most of the light in ray *R* pass?

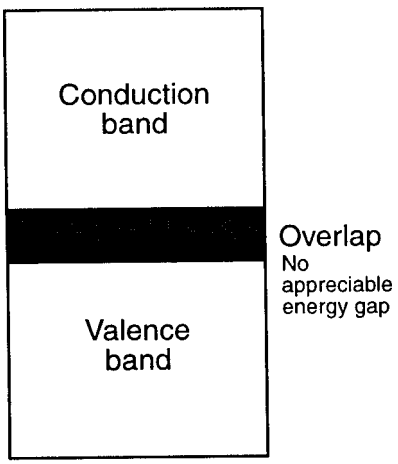


(1) *A*
(2) *B*
(3) *C*
(4) *D*

4143 Which model most successfully explains conduction in solids?
(1) electron-cloud model **(3) band model**
(2) electron-sea model (4) doping model

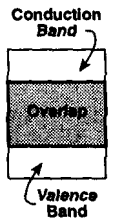
3924 As the temperature of a semiconductor increases, the number of holes in the valence band will
(1) decrease (3) remain the same
(2) increase

3916 The diagram below represents the band model of a substance.

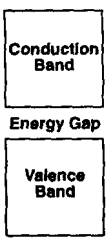


The substance is best classified as
(1) an insulator **(3) a conductor**
(2) a semiconductor (4) a nonmetal

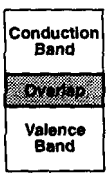
3666 Which energy band diagram best represents a semiconductor?



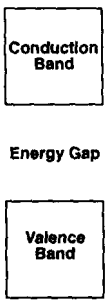
(1)



(3)



(2)



(4)

3535 For a solid to be an efficient carrier of electric current, its electronic conduction band should
(1) overlap its valence band
(2) have a large gap with its valence band
(3) be smaller than its valence band
(4) be at a higher energy level than it's valence band

3374 Conduction in semiconductors is due to the presence of
(1) electrons, only (3) protons and electrons
(2) holes, only **(4) electrons and holes**

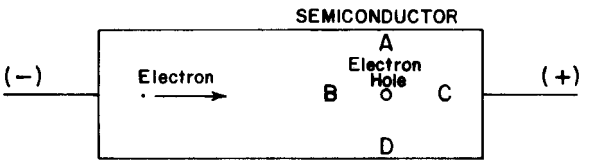
3372 An atom in a semiconductor completes its valence shell by
(1) losing electrons **(3) sharing electrons**
(2) gaining electrons (4) transferring protons

3371 When an electron breaks away from an atom in a semiconductor, it leaves behind a vacancy. This "hole" may be viewed as a
(1) resistance **(3) positive current carrier**
(2) source of energy (4) negative current carrier

3295 Conduction in semiconductors is due to the movement of
(1) electrons and protons (3) electrons and neutrons
(2) neutrons and protons **(4) electrons and holes**

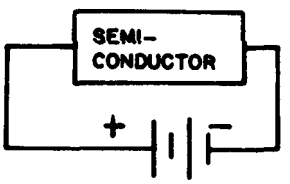
3131 The conductivity of a semiconductor will increase if the
(1) temperature is increased (3) temperature is decreased
(2) pressure is increased (4) pressure is decreased

3130 An electron moves through the semiconductor shown in the diagram below. Toward which point will the electron hole move?



(1) *A* (3) *C*
(2) *B* (4) *D*

3046 What permits current to flow through a semiconductor when it is connected to a battery as shown in the diagram at the right?

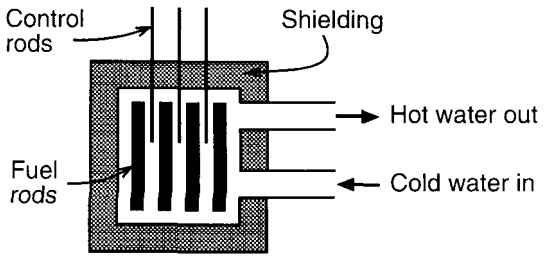


(1) holes moving toward the right, only
(2) electrons moving toward the left, only
(3) both electrons and holes moving toward the left
(4) electrons moving left and holes moving right

3045 The valence shell of an atom in a semiconductor crystal is completed by
(1) losing electrons
(2) losing protons
(3) sharing electrons with another atom
(4) sharing protons with another atom

4157 The half-life of a particular radioactive material is 6.0 hours. What fraction of a sample of the material would remain after 1 day?
(1) 1/4 (3) 3/8
(2) 2/3 **(4) 1/16**

3802 Base your answer to the following question on the diagram below, which shows a nuclear reactor designed to obtain energy in the form of heat from a nuclear fission reaction.



One of the radioactive waste products of the reactor has a half-life of 250 years. What fraction of a given sample of this product will remain after 1,000 years?
(1) $\frac{1}{2}$
(2) $\frac{1}{4}$
(3) $\frac{1}{8}$
(4) $\frac{1}{16}$

3679 A 24-gram sample of a radioactive nuclide decayed to 3.0 grams of the nuclide in 36 minutes. How much of the original nuclide sample remained after the first 12 minutes?
(1) 12 g (3) 6.0 g
(2) 2.0 g (4) 8.0 g

3549 The half-life of a radioactive nuclide is 6 hours. After one day (24 hours), approximately how much of an original 2.4×10^{-2}-kilogram sample of this nuclide remains?
(1) 1.5×10^{-3} kg (3) 4.0×10^{-3} kg
(2) 2.4×10^{-3} kg (4) 6.0×10^{-3} kg

3287 A substance has a half-life of 200 years. How much of the original sample of 40 grams will remain unchanged after a period of 600 years?
(1) 5 g (3) 20 g
(2) 10 g (4) 40 g

3121 The half-life of a radioactive sample is 10. minutes. How many grams of a 60. gram sample will remain unchanged after 20. minutes?
(1) 15 g (3) 30. g
(2) 20. g (4) 60. g

3035 Starting with 160 grams of an isotope having a half-life of 20 days, how much of the original sample will remain after 40 days?
(1) 10 g **(3) 40 g**
(2) 20 g (4) 80 g

2869 A radioactive nuclide sample has a half-life of 3.0 days. If 2.0 kilograms of the sample remains unchanged after 9.0 days, what was the initial mass of the sample?
(1) 18 kg (3) 8.0 kg
(2) 16 kg (4) 6.0 kg

2659 The half-life of a sample of radium is 1,620 years. After 3,240 years, what fraction of the original radium sample would remain?
(1) 1/2 (3) 1/8
(2) 1/4 (4) 1/16

2577 The radioactive waste strontium-90 has a half-life of 28 years. How long must a sample of strontium-90 be stored to insure that only 1/16th of the original sample remains as radioactive strontium-90?
(1) 28 years (3) 84 years
(2) 56 years **(4) 112 years**

2448 The half-life of an isotope is 14 days. How long will it take 8 grams of this isotope to decay to 1 gram?
(1) 14 days (3) 28 days
(2) 21 days **(4) 42 days**

2224 The half-life of a radium isotope is 1,600 years. After 4,800 years, approximately how much of an original 10.0-kilogram sample of this isotope will remain?
(1) 0.125 kg (3) 1.67 kg
(2) 1.25 kg (4) 3.33 kg

2116 A radioactive isotope has a half-life of 3 minutes. If 10 kilograms of this isotope remains after 15 minutes, the original mass of the isotope must have been
(1) 50 kg (3) 250 kg
(2) 160 kg **(4) 320 kg**

1832 The half-life of $^{234}_{90}$Th is 24 days. How much of a 128-milligram sample of thorium will remain after 144 days?
(1) 5.3 mg (3) 21.3 mg
(2) 2 mg (4) 64 mg

1723 If a certain radioactive isotope has a half-life of 2 days, how much of a 64-kilogram sample of the isotope will remain after 10 days?
(1) 1 kg (3) 32 kg
(2) 2 kg (4) 4 kg

1610 A 100-kilogram sample of a substance having a half-life of 300 years decays. How much time will it take to have only 25 kilograms of the original sample left?
(1) 75 years **(3) 600 years**
(2) 300 years (4) 1,200 years

1513 The half-life of $^{223}_{88}$Ra is 11.4 days. If *M* kilograms of this radium isotope are present initially, how much remains at the end of 57 days?
(1) 1/2 *M* (3) 1/5 *M*
(2) 1/4 *M* **(4) 1/32 *M***

849 A certain radioactive isotope has a half-life of 2 days. If 8 kilograms of the isotope is placed in a sealed container, how much of the isotope will be left after 6 days?
(1) 1 kg (3) 0.5 kg
(2) 2 kg (4) 4 kg

4160 If the nucleus of an atom emits a positron, the atomic number of the atom will
(1) decrease by one
(2) increase by one
(3) remain unchanged
(4) decrease by two

4153 One atomic mass unit is defined as
(1) the mass of an electron
(2) the mass of an alpha particle
(3) the mass of an atom of carbon–12
(4) 1/12 the mass of an atom of carbon-12

3932 Protons and neutrons are composed of smaller particles called
(1) quarks
(2) baryons
(3) alpha particles
(4) bosons

3925 Which nuclide has a mass number of 8?
(1) $^{6}_{2}He$
(2) $^{8}_{4}Be$
(3) $^{15}_{7}N$
(4) $^{16}_{8}O$

3901 The isotopes of an element can be separated using a
(1) cathode ray tube
(2) diffraction grating
(3) Geiger counter
(4) mass spectrometer

3804 The number of nucleons in a $^{206}_{82}Pb$ nucleus is
(1) 0
(2) 82
(3) 124
(4) 206

3553 The atomic mass unit is defined as 1/12 the mass of an atom of
(1) $^{8}_{4}Be$
(2) $^{12}_{6}C$
(3) $^{22}_{11}Na$
(4) $^{24}_{12}Mg$

3547 An atom of $^{131}_{53}I$ and an atom of $^{127}_{53}I$ contain the same number of
(1) quarks
(2) neutrons
(3) nucleons
(4) protons

3284 An atom of iron contains 26 protons and 30 neutrons. The mass number of iron is
(1) 56
(2) 30
(3) 26
(4) 4

3206 The number of nucleons in the nucleus of a $^{14}_{6}C$
(1) 6
(2) 8
(3) 14
(4) 20

3120 The number of protons and neutrons in an atom of $^{45}_{20}Ca$ is
(1) 20
(2) 25
(3) 45
(4) 65

3118 Which particles determine the atomic number of an element?
(1) protons, only
(2) neutrons, only
(3) neutrons and protons
(4) neutrons and electrons

2865 The subatomic particles that make up protons are called
(1) hyperons
(2) baryons
(3) positrons
(4) quarks

2572 A nucleus having an odd number of protons and an odd number of neutrons is likely to be radioactive. Which nuclide matches this description?
(1) $^{29}_{14}Si$
(2) $^{32}_{15}P$
(3) $^{32}_{16}S$
(4) $^{35}_{17}Cl$

2452 When a nucleus captures an electron, the mass number of the nucleus
(1) decreases
(2) increases
(3) remains the same

2444 What is the mass number of an atom with 9 protons, 11 neutrons, and 9 electrons?
(1) 9
(2) 18
(3) 20
(4) 29

2117 When an atomic nucleus captures an electron, the atomic number of that nucleus
(1) decreases by 1
(2) decreases by 2
(3) increases by 1
(4) increases by 2

1998 An element has an atomic number of 63 and a mass number of 155. How many protons are in the nucleus of the element?
(1) 63
(2) 92
(3) 155
(4) 218

1718 Which nucleus has the greatest nuclear charge?
(1) $^{2}_{1}W$
(2) $^{8}_{5}X$
(3) $^{7}_{3}Y$
(4) $^{4}_{2}Z$

1511 An atomic mass unit (amu) is approximately equal to the mass of
(1) an alpha particle
(2) an electron
(3) a photon
(4) a proton

1442 The total number of nucleons in an atom of $^{8}_{5}B$ is
(1) 5
(2) 8
(3) 3
(4) 13

1331 A lithium nucleus contains three protons and four neutrons. What is its atomic mass number?
(1) 1
(2) 7
(3) 3
(4) 4

1052 Which isotope is used in defining the atomic mass unit?
(1) $^{1}_{1}H$
(2) $^{238}_{92}U$
(3) $^{16}_{8}O$
(4) $^{12}_{6}C$

951 Base your answer to the following question on on the information below.

Mass of a proton = 1.007277 amu
Mass of a neutron = 1.008665 amu
Mass of an electron = 0.0005486 amu
Mass of a $^{4}_{2}$ He nucleus = 4.001509 amu

How many nucleons are in a $^{4}_{2}$ He nucleus?
(1) 8
(2) 2
(3) 6
(4) 4

788 When compared to the total mass of its nucleons, the mass of the nucleus is
(1) less
(2) greater
(3) the same

603 An atom consists of 9 protons, 9 electrons, and 10 neutrons. The number of nucleons in this atom is
(1) 0
(2) 9
(3) 19
(4) 28