Wizard Test Maker

AP PHYSICS B & C

QUESTION CATALOGUE

eduware

AP Physics B/C

Question Catalogue Contents

II. FLUID MECHANICS AND THERMAL PHYSICS [B]

B. Conductors, Capacitors, and Resistors

C. Electric Circuits

D. Magnetostatics

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5. A car traveling at 30 m/s decelerates uniformly to 20 m/s in 300 m. The amount of time it took to decelerate is closest to
(A) 5 s
(B) 6 s
(C) 10 s
(D) 12 s
(E) 30 s

68. A motorist driving at 50 m/s applies the brakes so that the car decelerates at a rate of 2 m/s^2. The time for the car to stop is closest to
(A) 5 s
(B) 10 s
(C) 13 s
(D) 25 s
(E) 50 s

69. An airplane initially at rest accelerates at a constant rate of 6 m/s^2. When its speed is 30 m/s, the distance it has traveled is closest to
(A) 5 m
(B) 38 m
(C) 75 m
(D) 150 m
(E) 180 m

70. A train starts at rest and accelerates at a uniform rate of 4 m/s^2. Which of the following is closest to its speed after it has traveled 25 meters?
(A) 10 m/s
(B) 14 m/s
(C) 70 m/s
(D) 100 m/s
(E) 200 m/s

71. An airplane traveling at 52 m/s slows to 32 m/s in a time span of 4 s. What is the magnitude of its average acceleration?
(A) 5 m/s^2
(B) 8 m/s^2
(C) 13 m/s^2
(D) 20 m/s^2
(E) 52 m/s^2

72. A ball is thrown straight up with an initial velocity of 14 m/s. The maximum height attained by the ball is closest to
(A) 0.7 m
(B) 1.4 m
(C) 10 m
(D) 20 m
(E) 30 m

84. A gun fires a bullet directly upward. Which of the following best characterizes its motion at the highest point of its trajectory?
(A) Its velocity is downward and its acceleration is upward.
(B) Its velocity is upward and its acceleration is downward.
(C) Both its velocity is and its acceleration are downward.
(D) Its velocity is zero and its acceleration is downward.
(E) Both its velocity and its acceleration are zero.

83. Which of the following statements are true?

I. An object with zero acceleration moves at a constant speed.
II. An object with constant acceleration must move in a straight line.
III. An object with an acceleration always perpendicular to its velocity must move in a circle.

(A) I, only
(B) II, only
(C) I and III, only
(D) I, II, and III
(E) None of the above

85. A car is traveling along a straight road with a velocity of 10 m/s. It begins to accelerate uniformly at time $t = 0$ and covers a distance of 300 m in 5 s. What is the magnitude of the acceleration?
(A) 10 m/s^2
(B) 12 m/s^2
(C) 20 m/s^2
(D) 24 m/s^2
(E) 60 m/s^2

86. A car is traveling with a velocity of 5 m/s along a straight road. Another car starting at rest 250 m behind it begins to accelerate uniformly. What is the magnitude of its acceleration if it catches the first car after 10 seconds?
(A) 0.5 m/s^2
(B) 1 m/s^2
(C) 2 m/s^2
(D) 2.5 m/s^2
(E) 6 m/s^2

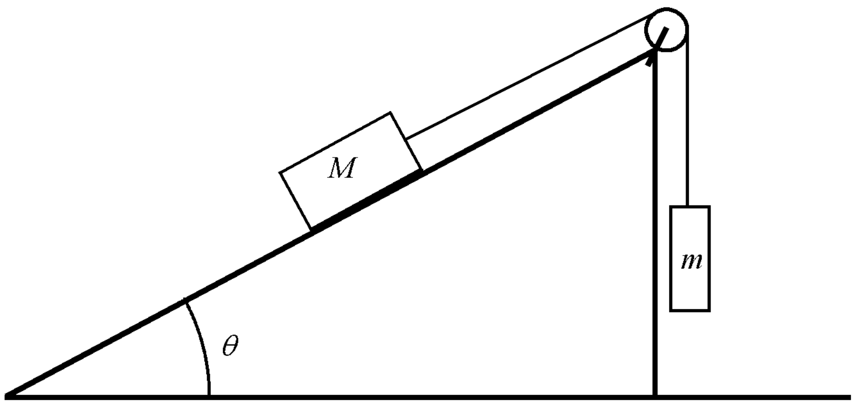
87. An object is thrown off a cliff with an initial upward velocity of 15 m/s. It strikes the ground with a downward velocity of 25 m/s. If air resistance is negligible, the height of the cliff is most nearly
(A) 10 m
(B) 20 m
(C) 30 m
(D) 40 m
(E) 50 m

307. An object is released from rest on a planet that has no atmosphere. The object falls 8 m in the first second. What is the acceleration due to gravity on the planet?
(A) 2 m/s^2
(B) 4 m/s^2
(C) 8 m/s^2
(D) 10 m/s^2
(E) 16 m/s^2

529. A street car driver is traveling at a speed of 25 m/s when he sees a road block. He applies the brakes causing a magnitude of deceleration of 5 m/s^2. If the roadblock is 70 m away, which of the following will happen?
(A) The car will hit the road block.
(B) The car will stop immediately before the roadblock.
(C) The car will stop 2.5 m before the roadblock.
(D) The car will stop 5 m before the roadblock.
(E) The car will stop 7.5 m before the roadblock.

Base your answers to questions **1278** and **1279** on the following.

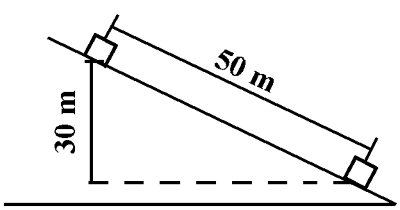
A block of mass M on a frictionless ramp that makes an angle of θ to the horizontal. It is held at rest by a massless string which passes over a frictionless pulley and is attached to a block of mass m as shown in the diagram below.



1278. The normal force on the block of mass M is
(A) $\frac{Mg}{\cos\theta}$ (B) $\frac{Mg}{\sin\theta}$ (C) Mg **(D) $Mg\cos\theta$** (E) $Mg\sin\theta$

1279. The mass m is equal to
(A) $\frac{M}{\cos\theta}$ (B) $\frac{M}{\sin\theta}$ (C) $M\tan\theta$ (D) $M\cos\theta$ **(E) $M\sin\theta$**

11. Base your answer to the following question on the picture below which shows a 3 kg block sliding 50 m down a frictionless inclined plane dropping a distance of 30 m.



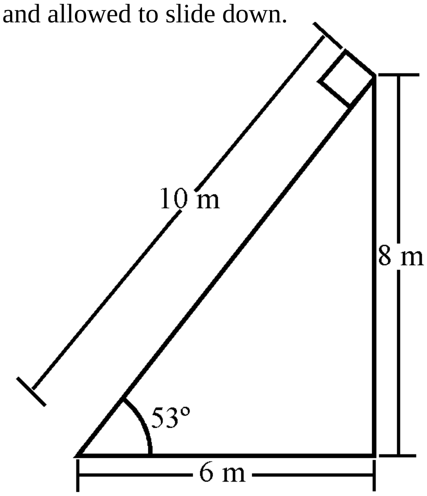
What is the magnitude of the normal force of the plane on the block?
(A) 5 N
(B) 8 N
(C) 16 N
(D) 24 N
(E) 30 N

673. A 5.0 kg object rests on a an inclined plane that makes an angle of 30º to the horizontal. The net force felt by the object is most nearly
(A) 2.5 N
(B) 5 N
(C) 25 N
(D) 50 N
(E) 75 N

674. The top of a 50 m long inclined plane is 5 m off the ground. If a 10 kg mass is at the top of this plane, the net force it feels is most nearly
(A) 1 N
(B) 5 N
(C) 10 N
(D) 25 N
(E) 50 N

1797. What force is required to push a block (mass m) up an inclined plane that makes an angle of θ with the horizon at a constant velocity, if the coefficient of friction between the plane and the block is μ?
(A) $mg(\mu\cos\theta + \sin\theta)$
(B) $mg\mu\cos\theta$
(C) $mg(\mu\sin\theta + \cos\theta)$
(D) $mg(\mu\cos\theta + \mu\sin\theta)$
(E) $g(\mu\cos\theta + m\sin\theta)$

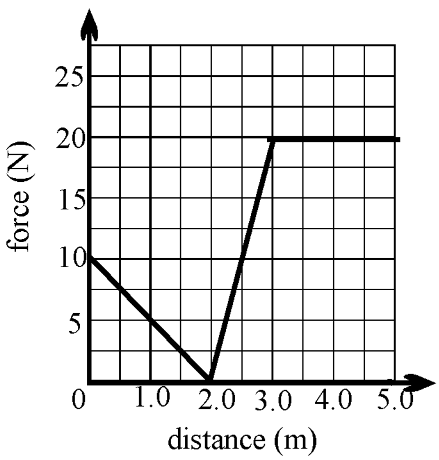
383. Base your answer to the following question on the picture below, which represents a plane 10 m in length with a coefficient of kinetic friction of 0.2, inclined at an angle of 53°. A block of weight 30 N is placed at the top of the plane and allowed to slide down.



The velocity of the block after its 10 m slide down the plane is most nearly

(A) 8.2 m/s
(B) 8.6 m/s
(C) 8.9 m/s
(D) 9.7 m/s
(E) 10.0 m/s

58. Base your answer to the following question on the force vs. distance graph below, which is for an object being pushed along a straight line, starting at rest.



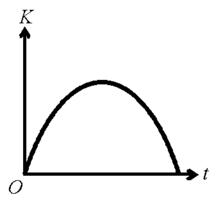
If the object has a mass of 1.4 kg, what is its velocity at 5.0 m?

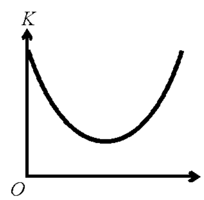
(A) 0.2 m/s
(B) 2.0 m/s
(C) 5.0 m/s
(D) 9.25 m/s
(E) 15 m/s

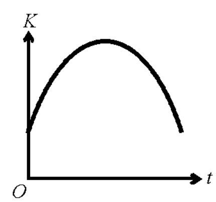
353. A block of mass m moving with initial velocity v_0 moves over a rough surface with coefficient of kinetic friction μ. How long does it take for the block to come to a complete stop?

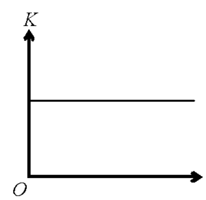
(A) $\dfrac{v_0^{\,2}}{2\mu g}$
(B) $\dfrac{v_0^{\,2}}{2m\mu g}$
(C) $\dfrac{v_0^{\,2}}{\mu g}$
(D) $\dfrac{v_0}{2\mu g}$
(E) $\dfrac{v_0}{2m\mu g}$

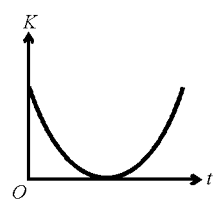
112. A particle is fired straight up out of a cannon. Which of the following graphs best represents its kinetic energy K as a function of time t?

(A)


(D)


(B)


(E)


(C)


583. A car with kinetic energy 20,000 J travels along a horizontal road. How much work is required to stop the car in 5 s?

(A) 0 J
(B) 20,000 J
(C) 4,000 J
(D) 8,000 J
(E) 16,000 J

505. Base your answer to the following question on the following information. A proton is accelerated from rest for a time of 10^{-8} s by a uniform electric field that exerts a force of 6.4×10^{-14} N on the proton.

The distance over which the proton accelerated is most nearly

(A) 2.0×10^{-7} m
(B) 2.0×10^{-5} m
(C) 2.0×10^{-3} m
(D) 2.0×10^{-1} m
(E) 2.0×10^{0} m

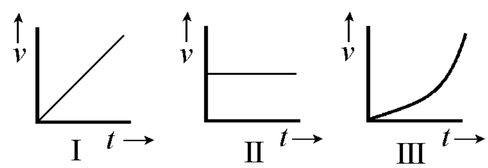
1410. Two skaters are on ice with negligible friction. One skater has a mass *m*, the other, a mass *M* where $M > m$. The skaters are at rest when they simultaneously push each other horizontally. Which is true about their subsequent motion?

(A) The center of mass of the two-skater system will move in the direction of the less massive skater.
(B) The more massive person will have a greater initial acceleration than the less massive.
(C) The velocities of both skaters will be equal.
(D) The speeds of both skaters will be equal.
(E) The momenta of the two skaters are equal in magnitude.

1402. A cannonball with mass 25 kg is initially at rest. It is fired out of a cannon with a speed of 40 m/s in a direction 30° above the horizontal. The magnitude of the impulse imparted to the cannonball by the cannon is most nearly

(A) 5,000 N•s
(B) $1{,}000\sqrt{3}$ N•s
(C) 1,000 N•s
(D) $10{,}000\sqrt{3}$ N•s
(E) 20,000 N•s

1381. Base your answer to the following question on the graphs below, which plot the velocity of a particle with respect to time.



In which of these cases is the object's rate of change of momentum constant?

(A) I only
(B) II only
(C) I and II
(D) I and III
(E) I, II, and III

1053. An experiment is performed with two trials. In the first, an object has a force F applied to it in a time *t*. In the second, F is applied to the same object in time 2*t*. The ratio between the acceleration of the object in the first trial to the second is

(A) 1:4
(B) 1:2
(C) 1:1
(D) 2:1
(E) 4:1

599. An object of mass *M* starts is dropped from rest off of a cliff. After 5 s it is a distance *L* from its initial location, what is its momentum?

(A) 25*Mg* s
(B) 15*Mg* s
(C) 5*Mg* s
(D) *Mg* s
(E) *MgL* s

1052. Airbags inflating in a motor vehicle accedent protect the passengers because

(A) The increased area of the airbag reduces the force on the passenger.
(B) The change in the momentum of the passenger is reduced by the presence of the airbag.
(C) The airbag increases the time of impact, decreasing the average force on the passenger.
(D) The airbag decreases the time of impact, reducing the impulse delivered to the passenger.
(E) The impulse delivered to the passenger is reduced by the presence of the airbag.

1029. Two objects collide, one being more massive than the other. The magnitude of which of the following would necessarily be greater for the smaller mass than for the larger?

(A) impulse
(B) acceleration
(C) change in momentum
(D) force
(E) change in kinetic energy

1028. A ball with mass *m* collides with another, larger ball, with mass *M*. Which of the following is/are true about the collision?

I. The larger ball will experience a greater impulse than the smaller ball.
II. The magnitude of the force felt by the small ball from the large ball will be greater than the magnitude of the force felt by the large ball from the small ball.
III. The magnitude of the acceleration of the small ball will be greater than the magnitude of the acceleration of the large ball.

(A) I only
(B) III only
(C) I and III
(D) II and III
(E) I, II, and III

722. An object has a linear momentum of 10 kg•m/s^2 and a kinetic energy of 25 J. It's mass is equal to:

(A) 2 kg
(B) 2.5 kg
(C) 5 kg
(D) 10 kg
(E) Cannot be determined from the information provided.

721. An object with a mass of 4 kg has a kinetic energy of 18 J. The object's linear momentum is

(A) 6 kg•m/s^2
(B) 9 kg•m/s^2
(C) 12 kg•m/s^2
(D) 20 kg•m/s^2
(E) 72 kg•m/s^2

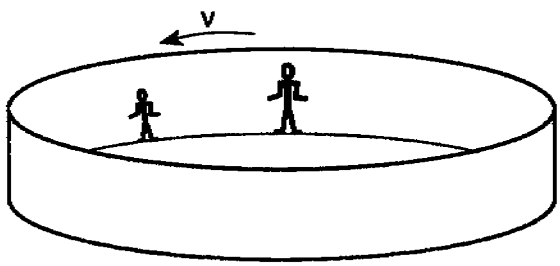
724. An object has its momentum increased by 6 kg•m/s^2 in 0.3 s. The force applied to the object in this time was

(A) 2 N
(B) 5 N
(C) 10 N
(D) 20 N
(E) 25 N

2007. The centrifugal force felt by an object in uniform circular motion is

(A) always directed away from the center of the circle
(B) always directed toward the center of the circle
(C) always directed in the direction of the velocity
(D) inversely proportional to the radius of the circle
(E) zero

1235. A 60 kg adult and a 30kg child are passengers on a rotor ride at an amusement park as shown in the diagram above. When the rotating hollow cylinder reaches a certain constant speed, v, the floor moves downward. Both passengers stay "pinned" against the wall of the rotor, as shown in the diagram below.



The magnitude of the frictional force between the adult and the wall of the spinning rotor is F. What is the magnitude of the frictional force between the child and the wall of the spinning rotor?

(A) $\frac{1}{4}F$
(B) $\frac{1}{2}F$
(C) F
(D) $2F$
(E) $4F$

946. A particle travels in a circular path at constant speed with a constant kinetic energy of 20 J. If the net force on the particle is 40 N, what is the radius of the particle's path?

(A) 0.2 m
(B) 0.5 m
(C) 1 m
(D) 1.5 m
(E) 2 m

945. A particle travels in a circular path of radius 4 m at constant speed. The net force on the particle is 60 N. The kinetic energy of the particle is

(A) 40 J
(B) 60 J
(C) 120 J
(D) 140 J
(E) Cannot be determined from the given information.

Base your answers to questions **695** through **694** on the following situation.

An engineer wishes to design a roller coaster so that the cars will not fall when they are at the top of their circular path.

695. A 500 kg roller coaster car is designed to travel at 20 m/s at the top of the circle. The engineer wants to make the circle as large as possible while still being at least one quarter the maximum radius for safety reasons. How large can the radius of the circle be?

(A) 5 m
(B) 10 m
(C) 20 m
(D) 40 m
(E) 80 m

694. Which of the following will have no effect on whether the cars remains on the track?

(A) The velocity of the cars as the pass the top of the circle.
(B) The radius of the circular track.
(C) The mass of the cars.
(D) The distance from the top of the circle to the bottom.
(E) The acceleration due to gravity.

Base your answers to questions **693** through **692** on the following situation.

An object with a mass of 5 kg is attached to a 1 meter long rope and whirled in a vertical circle.

693. Of the following, which is the greatest speed of the object for which the rope would become slack at the top of its circular path?

(A) 1 m/s
(B) 2 m/s
(C) 4 m/s
(D) 5 m/s
(E) 10 m/s

692. At the bottom of its path, the rope has a tension of 95 N. The object is moving most nearly

(A) 2 m/s
(B) 3 m/s
(C) 6 m/s
(D) 9 m/s
(E) 15 m/s

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94. If the length of a simple pendulum is doubled but the mass remains constant, its period is multiplied by a factor of
(A) $\frac{1}{2}$
(B) $\frac{1}{\sqrt{2}}$
(C) 1
(D) $\sqrt{2}$
(E) 2

105. A mass oscillating on a spring has a period of T. What is the ratio of the maximum velocity of the mass to the maximum displacement?
(A) T
(B) $\frac{T}{2\pi}$
(C) 1
(D) $\frac{2\pi}{T}$
(E) $\frac{1}{T}$

116. A simple pendulum has a period of oscillation of approximately 2.0 s. When the length of the pendulum is doubled, the period of oscillation is most nearly
(A) 0.5 s
(B) 1.0 s
(C) 1.4 s
(D) 2.0 s
(E) 2.8 s

486. The length of a simple pendulum with a period of 6 seconds on earth is most nearly
(A) 4.5 m
(B) 8.9 m
(C) 18 m
(D) 36 m
(E) 90 m

487. A simple pendulum has a period of 3.0 seconds on earth. On the moon, where the acceleration due to gravity is approximately one-sixth of its value on earth, its period would be most nearly
(A) 0.50 s
(B) 1.2 s
(C) 3.0 s
(D) 7.3 s
(E) 18 s

626. A simple pendulum of mass M swings with a period of 20 seconds on Earth. This pendulum is brought to a planet with an acceleration due to gravity 4 times that of the earth. What is the period of the pendulum on this planet?
(A) 20 s
(B) 10 s
(C) 15 s
(D) 200 s
(E) 2 s

765. A pendulum swings in simple harmonic motion with period T and angular displacement θ. If the same pendulum is instead raised to an initial displacement of 3θ, the new period will be
(A) $\frac{T}{9}$
(B) $\frac{T}{3}$
(C) T
(D) $3T$
(E) $9T$

767. A simple pendulum in simple harmonic motion on the Earth's surface has a period of 1 s. If the same pendulum is undergoing simple harmonic motion on the Moon, with an acceleration due to gravity $\frac{1}{6}$ that of the Earth, under which of the following modifications would the pendulum have the same period?
(A) Increase the length of the pendulum by a factor of 6.
(B) Decrease the length of the pendulum by a factor of 6.
(C) Increase the length of the pendulum by a factor of $\sqrt{6}$.
(D) Decrease the length of the pendulum by a factor of $\sqrt{6}$.
(E) No change would be necessary.

960. A simple harmonic oscillator has a frequency of 2 Hz and an amplitude of 0.04 m. What is the period of the oscillations?
(A) 0.5 s
(B) 0.2 s
(C) 2 s
(D) 5 s
(E) 10 s

961. A simple harmonic oscillator has a period of 5 s and an amplitude of 1.2 m. What is the frequency of the oscillations?
(A) 0.1 Hz
(B) 0.2 Hz
(C) 0.5 Hz
(D) 1 Hz
(E) 5 Hz

Base your answers to questions **1032** through **1034** on the following situation.

A simple pendulum undergoes harmonic motion as it oscillates through small angles. The maximum angular displacement of the pendulum is θ_{max}. The displacement of the pendulum is θ.

1032. At which values of θ is the speed of the pendulum maximized?
(A) $\theta = \theta_{max}/4$ and $\theta = -\theta_{max}/4$.
(B) $\theta = \theta_{max}/2$ and $\theta = -\theta_{max}/2$.
(C) $\theta = \theta_{max}$ and $\theta = -\theta_{max}$.
(D) $\theta = \theta_{max}$, $\theta = -\theta_{max}$, and $\theta = 0$.
(E) $\theta = 0$ only.

201. A column of water 3.2 m high with a cross sectional area of 0.1 m^2 is able to support a column of an unknown liquid 1.6 m high with a cross sectional area of 0.3 m^2. What is the ratio of the density of the unknown liquid to the density of water?

(A) $\frac{1}{6}$ (D) 3
(B) $\frac{1}{2}$ (E) 6
(C) $\frac{2}{3}$

202. A force of 300 N is applied to a piston in a hydraulic jack with a cross sectional area of 0.01 m^2. If the piston at the other end has a cross sectional area of 0.05 m^2, what is the maximum mass that can be lifted by the jack?

(A) 6 kg **(D) 150 kg**
(B) 50 kg (E) 1500 kg
(C) 60 kg

203. A fluid is kept in a completely enclosed container. Which of the following is true about it?

(A) Any change in external pressure produces an equal change in pressure at all points within the fluid.
(B) The pressure at all points within the fluid is independent of any external pressure.
(C) The pressure in the fluid is the same at all points within the fluid.
(D) An increase in pressure in one part of the fluid results in a decrease in pressure in another part
(E) Any change in the applied pressure of the fluid produces a change in pressure that depends on direction

277. A large tank is filled to a depth of 8 m with water with an atmospheric pressure equal to zero. If point *X* is 1 m from the bottom of the tank and point Y is 3 m from the bottom of the tank, how does p_X, the hydrostatic pressure at point *X*, compare to p_Y, the hydrostatic pressure at point *Y*?

(A) $p_X = p_Y$ (D) $7p_X = 5p_Y$
(B) $2p_X = p_Y$ **(E) $5p_X = 7p_Y$**
(C) $p_X = 2p_Y$

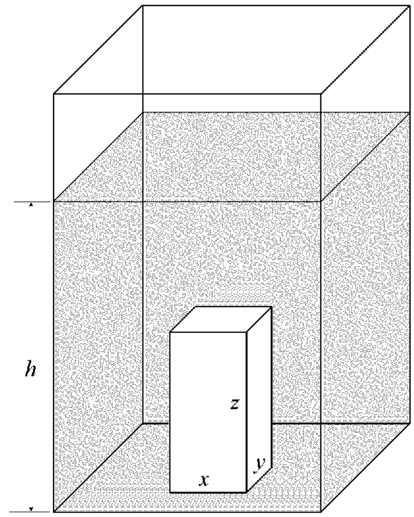
1857. A tank is filled to a depth of *m* meters with an atmospheric pressure equal to zero. If point *X* is 2 m from the bottom of the tank and point *Y* is 4 meters from the bottom of the tank, and the ratio of P_x to P_y is 3:2, then *m* must be

(A) 6 m (D) 12 m
(B) 8 m (E) 16 m
(C) 10 m

2017. A manometer measures which of the following?

(A) very small objects (D) radioactive emissions
(B) fluid pressure (E) wavelength of light
(C) very small charges

Base your answers to questions **278** and **279** on the diagram below of a box with dimensions *x*, *y*, and *z* that rests on the bottom of a tank filled to a depth *h* with a fluid of density ρ. The tank is open to the atmosphere which is at a pressure of *P*.



278. What is the force on the front face of the block?

(A) $yz\,(P + \rho gh)$ **(D) $yz\,[P + \rho g\,(h - \frac{1}{2}z)]$**
(B) $yz\,(P + \rho gz)$ (E) $yz\,[P + \rho g\,(h + z)]$
(C) $yz\,[P + \rho g\,(h - z)]$

279. What is the pressure on the top of the block?

(A) $P + \rho gh$ (D) ρgh
(B) $P + \rho g\,(h - z)$ (E) $\rho g\,(h - z)$
(C) $P + \rho gz$

1861. A flat piece of sheet metal with an area of 6 m^2 lies at the bottom of a salt water lake with a specific gravity of 1.02. The lake is 24.5 m deep. What is the force on the metal due to pressure?

(A) 1.5×10^5 N **(D) 2.1×10^6 N**
(B) 2.1×10^5 N (E) 1.5×10^7 N
(C) 1.5×10^6 N

1862. A flat piece of sheet metal lies at the bottom of a salt water lake with a specific gravity of 1.02. The lake is 24.5 m deep. It experiences a force of 4×10^5 N due to total pressure. The area of the metal is most nearly

(A) 0.95 m^2 (D) 2.25 m^2
(B) 1.2 m^2 (E) 2.63 m^2
(C) 1.62 m^2

1006. Which of the following statements is **NOT** true concerning phase changes?
(A) When a liquid freezes, it releases thermal energy into its immediate environment.
(B) When a liquid vaporizes, it absorbs thermal energy from its immediate environment.
(C) For most substances, the latent heat of vaporization is greater than the latent heat of fusion.
(D) The latent heat of fusion is the temperature increase as a solid melts.
(E) When a solid melts, it absorbs thermal energy from its immediate environment.

261. The melting point of copper is 1080ºC. If it takes 2400 J of heat to completely melt 0.012 kg of copper, what is the latent heat of fusion for copper?
(A) 100 KJ/kg
(B) 200 KJ/kg
(C) 250 KJ/kg
(D) 500 KJ/kg
(E) 1000 KJ/kg

262. A .05 kg sample of a solid substance with a specific heat capacity in the solid state of 300 J/kg•K, a specific heat capacity in the liquid state of 100 J/kg•K and a latent heat of fusion of 1600 J/kg. If the substance begins in a solid state at its melting point, how much heat must be added in order to raise the temperature of the substance 20K?
(A) 80 J
(B) 100 J
(C) 180 J
(D) 300 J
(E) 360 J

1005. Which of the following statements is true concerning phase changes?
(A) When a liquid vaporizes, it releases thermal energy into its immediate environment.
(B) When a solid sublimates, it absorbs thermal energy from its immediate environment.
(C) As a solid melts, its temperature increases.
(D) As a liquid freezes, its temperature decreases.
(E) The latent heat of fusion is the thermal energy absorbed as a liquid freezes.

1208. The internal energy of a sample of water depends on its
I. temperature
II. mass
III. phase
(A) I, only
(B) II, only
(C) I and II only
(D) I and III, only
(E) I, II, and III

1711. What is the final temperature of an 4 kg object, initially at its melting point of 50°C, which has a latent heat of fusion of 100 J/kg and gains 300 J of heat from its surroundings?
(A) 50°C
(B) 50.75°C
(C) 53°C
(D) 57.5°C
(E) 80°C

1712. What is the mass of an object that has a latent heat of fusion of 300 J/kg that begins at its melting point and is half melted after it absorbs 600 J of heat?
(A) 0.5 kg
(B) 2 kg
(C) 4 kg
(D) 8 kg
(E) 18 kg

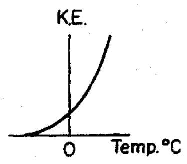
1713. What is the final temperature of an 10 kg object whose initial temperature is 30ºC (its melting point), whose latent heat of fusion is 100 J/kg, and whose specific heat capacity is 20 J/kg•K (as both a gas and a liquid), if it gains 400 J of heat?
(A) 26ºC
(B) 30º°C
(C) 34ºC
(D) 36ºC
(E) 70ºC

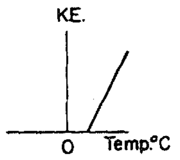
1714. How much heat does it take to completely melt a 1.7 kg object at its melting point with a latent heat of fusion of 34 kJ/kg?
(A) 0.5 kJ
(B) 2 kJ
(C) 5 kJ
(D) 20 kJ
(E) 58 kJ

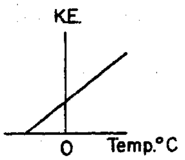
1715. As an object absorbs heat at its melting point, which of the following increases?
(A) its temperature
(B) its kinetic energy
(C) its internal energy
(D) its gravitational potential energy
(E) its momentum

1760. Water is boiled on a stovetop. The heating element is at a temperature of 576 K. The temperature of inner surface of the copper pot in which the water is boiling is
(A) 203 K
(B) 273 K
(C) 373 K
(D) 576 K
(E) 952 K

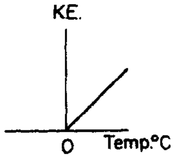
1189. Which graph best represents the relationship between the temperature of a sample of an ideal gas in degrees Celsius and the average kinetic energy of its molecules?

(A)


(D)


(B)


(E) None of the above

(C)


1271. The air pressure inside an automobile tire is lower during cold weather than during warm weather. The lower air pressure is most likely due to

(A) an increase in molecular potential energy of the air molecules in the tire.
(B) a decrease in the speed of the air molecules in the tire.
(C) salt on the roads producing a decrease in tire volume.
(D) cold air in the tire producing an increase in tire volume.
(E) A change in the composition of the air in the tire.

1407. Which of the following is NOT one of the assumptions of the classical model of an ideal gas?

(A) The molecules are in random motion.
(B) The collisions between gas molecules conserve kinetic energy.
(C) The attractive forces between gas molecules are strong.
(D) The molecules obey Newton's laws of motion.
(E) The volume of the gas molecules is negligible compared to the total volume of the gas.

1408. A sample of an ideal gas is in a tank of constant volume. If the pressure is increased by a factor of 4, the average speed of the gas molecules will

(A) increase by a factor of 4.
(B) increase by a factor of 2.
(C) remain the same.
(D) decrease by a factor of 2.
(E) decrease by a factor of 4.

1409. A sample of an ideal gas is in a tank with a constant volume. Heat energy is added so that the average kinetic energy of the gas molecules increases by a factor of 2. The pressure of the gas will

(A) increase by a factor of 4.
(B) increase by a factor of 2.
(C) remain the same.
(D) decrease by a factor of 2.
(E) decrease by a factor of 4.

1694. The average kinetic energy of the molecules in an ideal gas at temperature 150K is E. The temperature of an ideal in which the average kinetic energy of its molecules is $4E$ is

(A) 90K
(B) 150K
(C) 300K
(D) 450K
(E) 600K

1695. As the pressure of a confined gas increases while the volume remains constant

(A) the speed of the molecules increases
(B) the size of the molecules increases
(C) the density of the molecules decreases
(D) the mass of the molecules decreases
(E) the temperature decreases

1696. The proportion between the average kinetic energy of the molecules of a gas and the temperature of that gas is best described as

(A) linear
(B) exponential
(C) hyperbolic
(D) logarithmic
(E) inverse linear

1697. Which of the following are assumptions of the classical model of an ideal gas?

I. The attractive forces between gas molecules are strong.
II. The molecules are in random motion.
III. The collisions between gas molecules do not conserve kinetic energy.
IV. The molecules obey Newton’s laws of motions.

(A) I only
(B) II only
(C) I and III only
(D) II and IV only
(E) I, II, and IV only

1698. A container holding 1 mole of an ideal gas is brought from a 200K environment to a 250 K environment. The work done on the gas is most nearly

(A) 60 J
(B) 150 J
(C) 300 J
(D) 450 J
(E) 600 J

660. A –4.0 μC charge is located 0.30 m to the left of a +6.0 μC charge. The electrostatic force on the positive charge is nearest to
(A) 2.4 N to the right.
(B) 2.4 N to the left.
(C) 4.8 N to the right.
(D) 4.8 N to the left.
(E) 7.2 N to the right.

771. The distance between two negative point charges is doubled. The strength of the electrostatic force between these charges will
(A) increase by a factor of 2.
(B) increase by a factor of 4.
(C) decrease by a factor of 2.
(D) decrease by a factor of 4.
(E) remain the same.

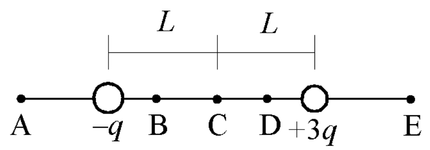
772. The electrostatic force between two positive point charges doubles. Which of the following is the most likely explanation for this?
(A) The mass of one of the particles doubled.
(B) The charge on both particles doubled.
(C) The charge on one particle was halved.
(D) The distance between the charges was doubled.
(E) The charge on one particle was quadrupled, while the other was halved.

773. Two 1 kg spheres each carry a charge of 1 C. Compared to the electrostatic force between the spheres, the gravitational force between them is
(A) much greater.
(B) about equal.
(C) much less.
(D) more dependent upon the distance.
(E) stronger if the charges are the same sign, but weaker if the charges have opposite signs.

774. The motion of large bodies at great distances is governed primarily by gravity and not by the electrostatic force because
(A) gravity is a much stronger force than the electrostatic force.
(B) the electrostatic force is felt only over short distances.
(C) of the relative scarcity of antiparticles.
(D) the majority of matter is electrically neutral.
(E) the electrostatic force is canceled out by the magnetic force.

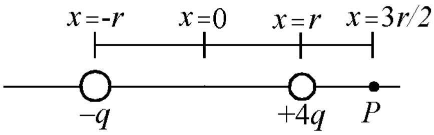
778. Two identical positive charges are brought close together, then released from rest. As the charges move away, they will have
(A) increasing velocity and increasing acceleration.
(B) increasing velocity and decreasing acceleration.
(C) decreasing velocity and decreasing acceleration.
(D) decreasing velocity and increasing acceleration.
(E) increasing velocity and constant acceleration.

775. Base your answer on the following picture (not to scale), with charges of $-q$ and $+3q$ a distance $2L$ apart along the x-axis.



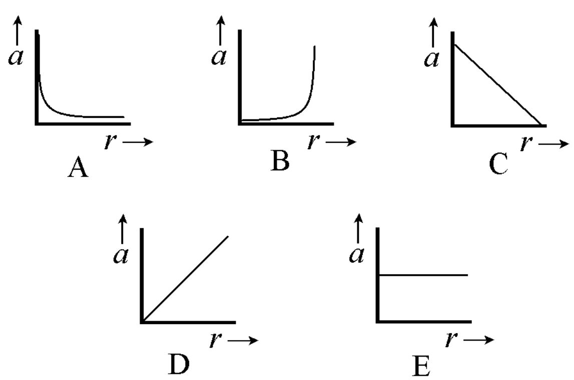
In the diagram above, at which of the points would a positive test charge most likely feel no electrostatic force?
(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

779.



In the diagram above, what is the force a small negative test charge of magnitude z would feel at point P?
(A) $\frac{12kqz}{25r^2}$
(B) $\frac{-396kqz}{25r^2}$
(C) $\frac{4kqz}{3r^2}$
(D) $\frac{-4kqz}{3r^2}$
(E) 0

974. A charge $+Q$ is fixed in position as a small charge $+q$ is brought near it and released from rest. Of the graphs shown, which best represents a, the acceleration of the $+q$ charge as a function of r, its distance from $+Q$?



(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

1506. What is the potential due to a spherical shell of radius R for $r > R$?

(A) kQ/r
(B) kQ/r^2
(C) kQ^2/r
(D) kQ/R
(E) kQ^2/R

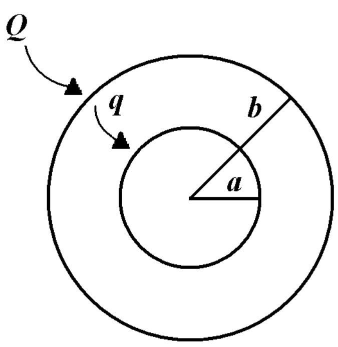
1507. What is the potential due to a spherical shell of radius R for $r < R$?

(A) kQ/r
(B) kQ/r^2
(C) kQ^2/r
(D) kQ/R
(E) kQ^2/R

1508. What is the ratio of potential due to a spherical shell of radius R and a solid conducting sphere of radius R, for $r < R$?

(A) 1:1
(B) 1:2
(C) 2:1
(D) –1:1
(E) –1:2

1509.



The figure above shows two concentric, conducting, thin spherical shells of radii a and b, and charges q and Q. What is the work required to bring a test charge of q_0 from the outer shell to the inner shell?

(A) $kQq(a-b)$
(B) $kQq(b-a)$
(C) $kQq(1/a-1/b)$
(D) $kQq/(b-a)^2$
(E) $kQq/(b-a)$

1590. What is the electric potential of a very long conducting cylinder of radius R and a uniform linear charge density λ a distance r away from the center of the cylinder?

(A) $k\lambda\ln(R/r)$
(B) $2k\lambda\ln(R/r)$
(C) $4k\lambda\ln(R/r)$
(D) $2k/\lambda\ln(R/r)$
(E) $k/\lambda\ln(R/r)$

2111. What is the potential due to a spherical shell with charge Q of radius R for $r = R$?

(A) 0
(B) kQ/R
(C) kQ^2/R
(D) $-kQ/R$
(E) $-kQ/R^2$

1591. The electric potential a distance r away from a cylinder can be calculated by dividing a charge q into

(A) the work done on the magnetic field as a charge q moves from a point on the cylinder to a point outside the cylinder.
(B) the work done on the magnetic field as a charge q moves from a point on the cylinder to a point inside the cylinder.
(C) the work done on the electric field as a charge q moves from a point on the cylinder to a point outside the cylinder.
(D) the work done on the electric field as a charge q moves from a point on the cylinder to a point inside the cylinder.
(E) the force on a charge q as it moves from a point on the cylinder to a point inside the cylinder.

1592. A conducting spherical shell of radius R carries a charge Q. What is the potential inside the sphere a distance r away from the center?

(A) KQ/r
(B) KQ/R
(C) KQ/r^2
(D) KQ/R^2
(E) $KQ/2R$

1593. All of the following about a sphere of charge that has spherical symmetry are true **EXCEPT**

(A) The electric field and the potential outside of the distribution is the same as if all the charge was concentrated at the center of the sphere
(B) A charged metal shell produces the field of an ordinary point charge
(C) Inside a charged metal shell the electric field and the potential are equal to zero
(D) All of the charge on a solid metal sphere resides on the surface
(E) The electric field inside a solid metal sphere is zero and the potential is constant

1594. All of the following are true about an infinitely long cylindrically symmetric distribution of charge **EXCEPT**

(A) The electric field is perpendicular to the axis of the cylinder
(B) For a positive charge, the electric field points away from the cylinder axis
(C) For a positive charge, the potential decreases as the distance to the cylinder axis increases
(D) The potential difference between two points outside the distribution is the derivitave of the electric field
(E) For a negative charge, the electric field points towards the cylinder axis

170. A parallel-plate capacitor has capacitance *C*. A second parallel-plate capacitor has plates with twice the area and half the separation. The capacitance of this second capacitor is most nearly

(A) $\frac{1}{4}C$ (B) $\frac{1}{2}C$ (C) C (D) $2C$ **(E) $4C$**

171. When a voltage *V* is applied to a parallel-plate capacitor, it is able to hold a charge *Q*. A second parallel plate capacitor has plates with half the area and twice the separation. What a voltage *V* must applied to it, in order to hold the same charge *Q*?

(A) $\frac{1}{4}V$ (B) $\frac{1}{2}V$ (C) V (D) $2V$ **(E) $4V$**

173. When a voltage *V* is applied to a parallel-plate capacitor, it is able to hold a charge *Q*. A second parallel plate capacitor has plates with half the area and twice the separation. When a voltage *V* is applied to it, the amount of charge that it can hold is

(A) $\frac{1}{4}Q$ (B) $\frac{1}{2}Q$ (C) Q (D) $2Q$ (E) $4Q$

355. The product of 2 ohms × 2 farads is equal to

(A) 4 volts (B) 4 amperes (C) 4 joules **(D) 4 seconds** (E) 4 watts

413. A parallel plate capacitor with plates of area *A* separated by a distance *d* is charged so that the potential difference across the plates is *V*. If the distance between the plates is decreased to $\frac{1}{2}d$, the potential across the plates is now

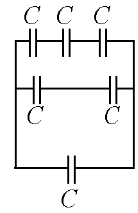
(A) $\frac{1}{4}V$ **(B) $\frac{1}{2}V$** (C) V (D) $2V$ (E) $4V$

500. The capacitance of a parallel plate capacitor can be increased by decreasing which of the following?

(A) The area of each plate
(B) The distance between the plates
(C) The charge on each plate
(D) The potential difference across the plates
(E) None of the above

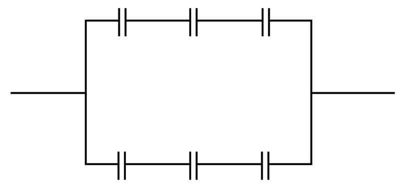
1045. The plates of a 4 µF capacitor are charged to a potential difference of 40 kV. The charge on the positive plate is

(A) 0.16 C (B) 1.6 C (C) 0.08 C (D) 0.1 C (E) 0.01 C

807. 

If the capacitance of one capacitor is C, find the capacitance of the above diagram.

(A) $\frac{C}{6}$ (B) $\frac{5C}{2}$ (C) $\frac{6C}{11}$ **(D) $\frac{11C}{6}$** (E) 6C

808. 

If the capacitance of each capacitor above is 5 pF, find the capacitance of the entire combination.

(A) $\frac{1}{6}$ pF (B) $\frac{2}{3}$ pF (C) $\frac{5}{6}$ pF (D) $\frac{3}{2}$ pF **(E) $\frac{10}{3}$ pF**

957. Which of the following would increase the capacitance of a parallel-plate capacitor?

(A) Increasing the area of the plates
(B) Increasing the voltage between the plates
(C) Decreasing the voltage between the plates
(D) Moving the plates closer together
(E) Moving the plates further apart

Base your answers to questions **958** and **959** on the following scenario. Two capacitors are made from parallel plates with surface area *A*, a distance *d* apart. Capacitor *A* has a voltage *V* across it. Capacitor *B* has a voltage 2*V* across it.

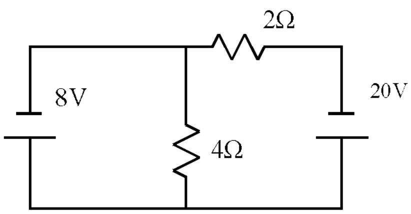
958. The ratio of the capacitance of *B* to the capacitance of *A* is

(A) 1:4 (B) 1:2 **(C) 1:1** (D) 2:1 (E) 4:1

959. The ratio of the charge that can be stored in *A* to the charge that can be stored in *B* is

(A) 1:4 **(B) 1:2** (C) 1:1 (D) 2:1 (E) 4:1

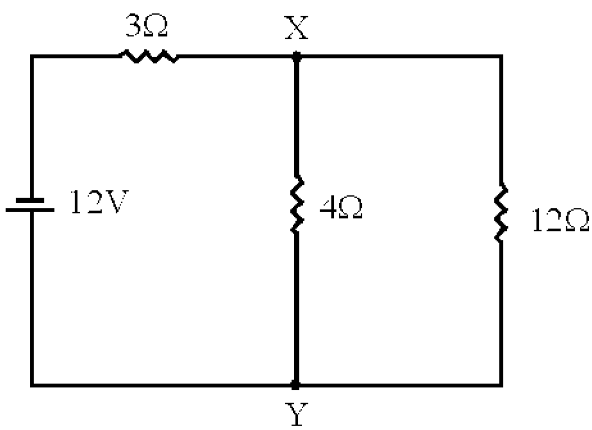
Base your answers to questions **65** and **66** on the circuit diagram below.



65. What is the current through the 2 Ω resistor?
   (A) 2 A
   (B) $\frac{10}{3}$ A
   (C) 6 A
   (D) 8 A
   (E) 10 A

66. What is the potential drop across the 4 Ω resistor?
   (A) 8 V
   (B) 12 V
   (C) 16 V
   (D) 18 V
   (E) 20 V

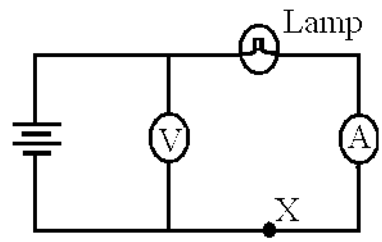
Base your answers to questions **136** and **137** on the circuit diagram shown below.



136. What is the potential drop from *X* to *Y*?
   (A) 1 V
   (B) 3 V
   (C) 6 V
   (D) 8 V
   (E) 12 V

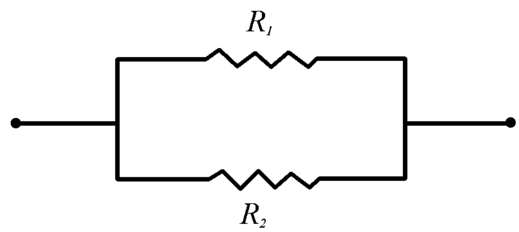
137. What is the current through the 12Ω resistor?
   (A) $\frac{1}{3}$ A
   (B) $\frac{2}{3}$ A
   (C) ½ A
   (D) 1 A
   (E) $\frac{3}{2}$ A

141.



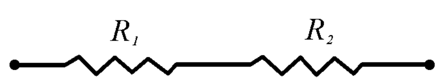
A lamp, a voltmeter *V*, a ammeter *A*, and a battery with zero internal resistance are connected as shown above. Adding a second, identical lamp at point *X* would
   (A) increase the ammeter reading.
   (B) decrease the ammeter reading.
   (C) increase the voltmeter reading.
   (D) decrease the voltmeter reading.
   (E) produce no change in either reading.

185. Base your answer to the following question on the diagram below which shows two resistors connected in parallel. A voltage *V* is applied to the pair.



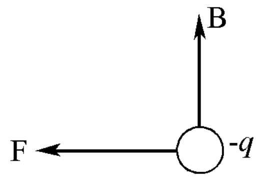
What is the ratio of the current through R_1 to the current through R_2 when $R_1 = 1.5R_2$?
   (A) $\frac{4}{9}$
   (B) $\frac{2}{3}$
   (C) 1
   (D) $\frac{3}{2}$
   (E) $\frac{9}{4}$

187. Base your answer to the following question on the diagram below which shows two resistors connected in series. A voltage *V* is applied to the pair.



What is the ratio of the voltage drop over R_1 to the voltage drop over R_2 when $R_1 = 1.5R_2$?
   (A) $\frac{4}{9}$
   (B) $\frac{2}{3}$
   (C) 1
   (D) $\frac{3}{2}$
   (E) $\frac{9}{4}$

843.



In the figure above, what is the direction of the particle's velocity?

(A) To the left.
(B) To the right.
(C) Upward, in the plane of the page.
(D) Into the page.
(E) Out of the plane of the page.

844. A positron executes uniform circular motion due to the influence of a magnetic force within a uniform magnetic field *B*. If the positron's charge is *q*, and the linear momentum of the positron is *p*, find an expression for the radius of the positron's path.

(A) $\frac{p}{qB}$
(B) $\frac{p^2}{qB}$
(C) $\frac{2p}{qB}$
(D) $\frac{qB}{p}$
(E) $\frac{qB}{p^2}$

845. A particle executes uniform circular motion with speed *v* due to the influence of a magnetic force within a uniform magnetic field *B*. If the particle's charge is *q*, and the radius of the path of the particle is *r*, find an expression for the mass of the particle.

(A) $\frac{rqB}{v}$
(B) $\frac{rqB}{v^2}$
(C) $rqvB$
(D) $\frac{v}{rqB}$
(E) $\frac{v^2}{rqB}$

1023. A proton traveling at 1.6×10^7 m/s enters a region with a uniform magnetic field of strength 4 T. If the proton's initial velocity vector makes an angle of 45º with the magnetic field, what is the speed of the proton 1 s after entering the magnetic field?

(A) 2.4×10^6 m/s
(B) 3.2×10^6 m/s
(C) 1.6×10^7 m/s
(D) 2.4×10^7 m/s
(E) 3.2×10^7 m/s

Base your answers to questions **1024** and **1025** on the following.

Traveling at an initial speed of 1.2×10^6 m/s, a particle (mass = 6×10^{-10} kg, charge = 1.0×10^{-10} C) enters a region of uniform magnetic field with a strength of 300 T at an angle of 30º to the field.

1024. What is the magnitude of the acceleration of the particle?

(A) 9.0×10^{-3} m/s^2
(B) 1.8×10^{-2} m/s^2
(C) 3.0×10^7 m/s^2
(D) 7.2×10^7 m/s^2
(E) 3.0×10^{17} m/s^2

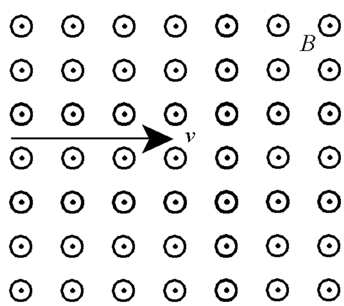
1025. What is the speed of the particle after 1 s?

(A) 6.0×10^5 m/s
(B) 1.2×10^6 m/s
(C) 3.0×10^6 m/s
(D) 4.2×10^6 m/s
(E) 5.4×10^6 m/s

1339. An electron enters a uniform magnetic field *B* pointing out of the page while traveling at a velocity *v* to the right, perpendicular to the field. Which of the following best describes the path of the electron within the uniform magnetic field *B*?

(A) The path of the particle is unchanged, but it speeds up.
(B) The path of the particle is unchanged, but it slows down.
(C) A clockwise circular path.
(D) A counterclockwise circular path.
(E) The electron will come to rest.

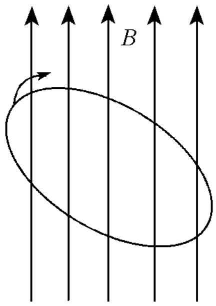
1340.



A particle with charge +*q* is traveling through a uniform magnetic field *B* that points out of the page in the direction indicated by the arrow in the plane of the page. In what direction is the force on the particle?

(A) towards the bottom of the page
(B) towards the top of the page
(C) up out of the page
(D) down into the page
(E) towards the left of the page

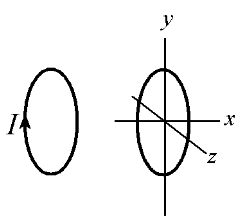
858. Base your answer to the following question on the diagram below, in which a circular loop of wire with a radius of 5 cm rotates clockwise at a constant angular velocity through a magnetic field B = 5 T. The plane of the loop goes from being perpendicular to the field to being at a 45º angle with the field in 0.25 s.



The average emf induced in the loop will be

(A) 0 V
(B) 1.2×10^{-2} V
(C) 2.3×10^{-2} V
(D) 4.6×10^{-2} V
(E) 9.2×10^{-1} V

1142.



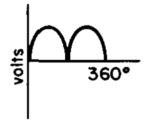
In the above diagram, two loops of wire are shown. One is fixed along the *x*-axis, and carries a current *I*. The other is initially in the *yz*-plane with its center at the origin. Which of the following motions would NOT induce emf in this second loop?

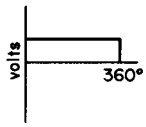
(A) Translation along the *x*-axis
(B) Rotation about the *x*-axis
(C) Translation along the *y*-axis
(D) Rotation about the *y*-axis
(E) Rotation about the *z*-axis

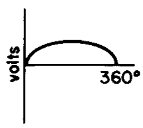
2057. The magnetic field from a loop of current carrying wire in the plane of the page is directed out of the page. In which direction do the electrons in the wire loop move?

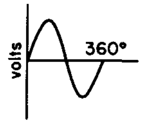
(A) counterclockwise
(B) clockwise
(C) they all move to the right side of the loop
(D) they all move to the left side of the loop
(E) they are stationary

1199. A conducting loop in a uniform magnetic field is rotated at a constant rate. Which graph best represents the induced potential difference across the ends of the loop as a function of the angle it is rotated during one full rotation?

(A)


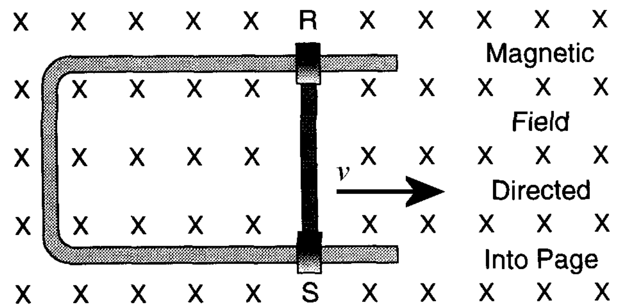
(B)


(C)


(D)


(E) none of the above

1255. In the diagram below, a segment of wire, *RS*, which is 0.20 m in length, is free to slide along a U-shaped wire located in a uniform 0.60-T magnetic field directed into the page.



If wire segment *RS* is slid to the right at a constant speed of 4.0 meters per second, the potential difference induced across the ends of the wire segment is

(A) 0.12 V
(B) 0.48 V
(C) 1.2 V
(D) 2.4 V
(E) 4.8 V

1969. Under which of the following circumstances could EMF be induced in a loop of wire?

(A) The loop moves parallel to a constant magnetic field
(B) There is a change in the magnetic flux through the loop
(C) The loop is moved through a perpendicular electric field
(D) The loop moves perpendicular to a constant, infinitely large magnetic field
(E) A magnetic field parallel to the loop changes in magnitude

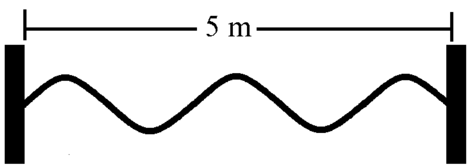
153. A cord of fixed length and uniform density, when held under a tension T, vibrates with a fundamental frequency f. If the mass of the cord is doubled, but the length and the tension remain constant, then the fundamental frequency is

(A) $2f$
(B) $\sqrt{2}f$
(C) f
(D) $\frac{f}{\sqrt{2}}$
(E) $\frac{f}{2}$

154. A cord of fixed length L and uniform density, when held under a tension, vibrates with a fundamental frequency f. What is the speed of sound in the cord?

(A) $2fL$
(B) $\sqrt{2}fL$
(C) fL
(D) $\frac{fL}{\sqrt{2}}$
(E) $\frac{fL}{2}$

Base your answers to questions **339** through **341** on a standing wave with frequency 30 Hz that is set up on a string 5 meters in length and fixed at both ends as shown below.



339. The speed at which waves propagate on the string is

(A) 6 m/s
(B) 15 m/s
(C) 60 m/s
(D) 100 m/s
(E) 150 m/s

340. The fundamental frequency of vibrations in this string would be

(A) 3 Hz
(B) 6 Hz
(C) 12 Hz
(D) 15 Hz
(E) 30 Hz

341. If one end of the string were free, its fundamental frequency would be

(A) 3 Hz
(B) 6 Hz
(C) 12 Hz
(D) 20 Hz
(E) 30 Hz

654. A 10 m rope is clamped on both of its sides. What is the maximum wavelength that can exist on this rope?

(A) 4 m
(B) 7.5 m
(C) 10 m
(D) 20 m
(E) 40 m

871. A string, fixed at both ends, supports a standing wave with a wavelength of 4 m and a total of 3 nodes. What is the length of the string?

(A) 2 m
(B) 4 m
(C) 6 m
(D) 8 m
(E) 12 m

872. A 14 m long string, fixed at both ends, supports a standing wave with a wavelength of 2 m. How many nodes will this standing wave have?

(A) 5
(B) 11
(C) 13
(D) 14
(E) 15

873. A 10 m long rope is fixed at both ends and supports a standing wave with a total of 5 nodes. If a transverse wave travels at 15 m/s down the rope, determine the frequency of the standing wave.

(A) 0.3 Hz
(B) 0.5 Hz
(C) 2.5 Hz
(D) 3 Hz
(E) 5 Hz

874. A string is fixed at both ends and supports a 10 Hz standing wave with a total of 4 nodes. If a transverse wave travels down this string at 60 m/s, find the length of the rope.

(A) 5 m
(B) 9 m
(C) 12 m
(D) 18 m
(E) 20 m

875. A 12 m long string is fixed at both ends and supports a 4 Hz standing wave. If a transverse wave travels down this string at 32 m/s, find the total number of nodes in the standing wave.

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

881. An instrument consisting of a pipe open at both ends has a length of 1.7 m. If the speed of sound is 340 m/s in the pipe, what is the fundamental frequency of the instrument?

(A) 17 Hz
(B) 34 Hz
(C) 100 Hz
(D) 170 Hz
(E) 340 Hz

155. Two point sources of monochromatic light radiate in phase with a constant wavelength of 500 nm. The first order interference maximum appears at 14º (use sin 14º = 0.25). The separation of the sources is most nearly
(A) 125 nm
(B) 250 nm
(C) 500 nm
(D) 1000 nm
(E) 2000 nm

156. Two point sources of monochromatic light radiate in phase with a constant wavelength of 500 nm. The first order interference minimum appears at 6º (use sin 6º = 0.1). The separation of the sources is most nearly
(A) 50 nm
(B) 100 nm
(C) 500 nm
(D) 2500 nm
(E) 5000 nm

377. Observations that indicate that visible light has a wavelength much shorter than a centimeter include which of the following?

I. The bending of light when it passes through water.
II. The colored pattern seen in an oil slick.
III. The colored pattern seen when light is reflected off of the back of a compact disk.

(A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) I, II, and III

437. Two slits 2.0×10^{-4} m apart are illuminated by a monochromatic light. The distance between the central maximum in the interference pattern on a screen 1.0 m away and the maximum 3 fringes away from is 7.5×10^{-3} m. The wavelength of this light is most nearly
(A) 50 nm
(B) 250 nm
(C) 500 nm
(D) 1000 nm
(E) 5000 nm

438. Which of the following would happen to an interference pattern if the distance between the slits was decreased?
(A) The fringes would appear closer together.
(B) The fringes would appear further apart.
(C) The fringes would appear brighter.
(D) The fringes would appear dimmer.
(E) There would be no change in the pattern.

512. Young's double slit experiment did much to the confirm the
(A) wave nature of light
(B) structure of the atom
(C) existence of the photon
(D) invariance of the speed of light
(E) law of universal gravitation

1007. One way to increase the widths of the fringes of the diffraction pattern in a double-slit experiment would be to
(A) use light of a longer wavelength
(B) move the screen closer to the slits
(C) increase the separation between the slits
(D) fill the area between the slits and the screen with a material with a higher index of refraction
(E) increase the intensity of the light

1008. One way to decrease the distance between the bright and dark bands of the diffraction pattern seen on the screen in a double slit experiment would be to
(A) use light of a longer wavelength
(B) increase the intensity of the light
(C) move the screen away from the slits
(D) increase the separation of the slits
(E) use light with a lower frequency

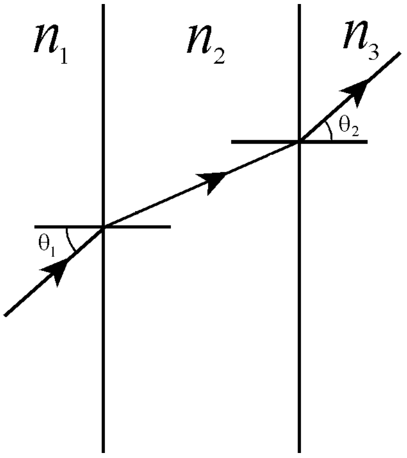
1807. Two point sources of monochromatic light with equivalent wavelengths radiate in phase. The first order interference appears at 8.5º (use sin 8.5º = 0.15). The separation of the sources is 4,000 nm. The wavelength of the light is most nearly
(A) 60 nm
(B) 400 nm
(C) 600 nm
(D) 3,000 nm
(E) 6,000 nm

1808. Two point sources of monochromatic light with equal wavelengths radiate in phase. The second order interference appears at 10.5° (use sin 10.5° = 0.18). The separation of the sources is 8,000 nm. The wavelength of the light is most nearly
(A) 540 nm
(B) 600 nm
(C) 660 nm
(D) 720 nm
(E) 760 nm

2039. Beats result from
(A) constructive interference
(B) destructive interference
(C) diffraction
(D) refraction
(E) both constructive and destructive interference

2040. Which of the following is NOT illustrated by Young's Double Slit Experiment?
(A) the wave-particle duality of light
(B) diffraction
(C) constructive interference
(D) destructive interference
(E) the wave nature of light

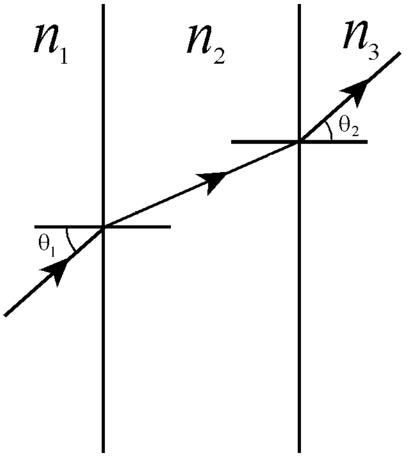
1360.



A light ray passes through substances 1, 2, and 3, as shown above. The indices of refraction for these three substances are n_1, n_2, and n_3, respectively. The angles that the first ray and the last ray make with the normal are indicated by θ_1 and θ_2, respectively. If θ_1 and θ_2 are equal, which of the following must be true?

(A) $n_2 < n_1$
(B) $n_2 < n_3$
(C) $n_1 = 1$
(D) $n_1 = n_3$
(E) $n_1 = n_2 = n_3$

1361.

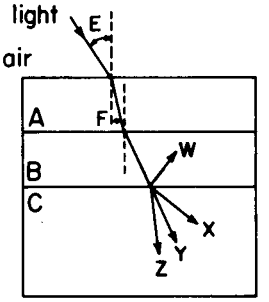


A light ray passes through substances 1, 2, and 3, as shown above. The indices of refraction for these three substances are n_1, n_2, and n_3, respectively. The angles that the first ray and the last ray make with the normal are indicated by θ_1 and θ_2, respectively. If n_1 and n_3 are equal, which of the following must be true?

(A) $\theta_1 > \theta_2$
(B) $\theta_1 < \theta_2$
(C) $\theta_1 = \theta_2$
(D) $n_1 = 1$
(E) $n_1 = n_2 = n_3$

Base your answers to questions **1741** and **1742** on the following information.

Light passes through the air into Material A and continues through Materials B and C. Materials A, B, and C have indexes of refraction of n_1, n_2, and n_3 respectively.



1741. Based on the illustration, all the following can be said about the relationship between Material A and Material B **EXCEPT**

(A) the wavelength of the light in Material A is less than that in Material B
(B) the frequency of light in Material A is equal to that in Material B
(C) the velocity of light is greater in Material B than in Material A
(D) $n_1 < n_2$
(E) $n_2 - n_{air} < n_1 - n_{air}$

1742. If the light after hitting the interface BC follows path *Y*

(A) the frequency of light decreases
(B) the wavelength of light decreases
(C) the velocity of the light remains constant
(D) the wavelength of light increases
(E) the frequency of light increases

1809. White light separating into the full visible spectrum when incident on a prism is an example of

(A) polarization
(B) chromatic distortion
(C) dispersion
(D) wave/particle duality
(E) diffraction

1813. All of the following are true for light entering a medium with a higher index of refraction **EXCEPT**

(A) the frequency remains constant
(B) the velocity decreases
(C) the wavelength decreases
(D) the light refracts towards the normal
(E) the light is polarized

1035. A certain photoelectric material is exposed to light with a wavelength of 550 nm. No photoelectrons are emitted. If the intensity of this light is increased dramatically, which of the following will occur?

(A) Photoelectrons will be emitted immediately, with kinetic energy equal to the energy of the incident photons.
(B) Photoelectrons will be emitted immediately, with kinetic energy equal to the energy of the incident photons less the work function of the metal.
(C) After some time, photoelectrons will be emitted, with kinetic energy equal to the energy of the incident photons.
(D) After some time, photoelectrons will be emitted, with kinetic energy equal to the energy of the incident photons less the work function of the metal.
(E) There will be no effect.

1188. Which of the following phenomena gives the best evidence of the particle nature of light?

(A) interference
(B) refraction
(C) polarization
(D) photoelectric emission
(E) Doppler shift

1369. The concepts of quantum theory are essential in explaining which one of the following?

(A) Coulomb's force law
(B) Newton's law of gravitation
(C) Rutherford's gold-foil experiment
(D) the photoelectric effect
(E) Young's double-slit experiment

1398. In an experiment, electrons are emitted from a metal surface as light of a specific wavelength is shined on it. In order to increase the kinetic energy of individual electrons without increasing the number of electrons emitted, which of the following recommendations should be followed?

(A) Increase the intensity of the light only.
(B) Increase the wavelength of the light only.
(C) Decrease the intensity of the light only.
(D) Decrease the wavelength of the light only.
(E) Increase the wavelength of the light, and increase or decrease the intensity of the light, as intensity has no effect.

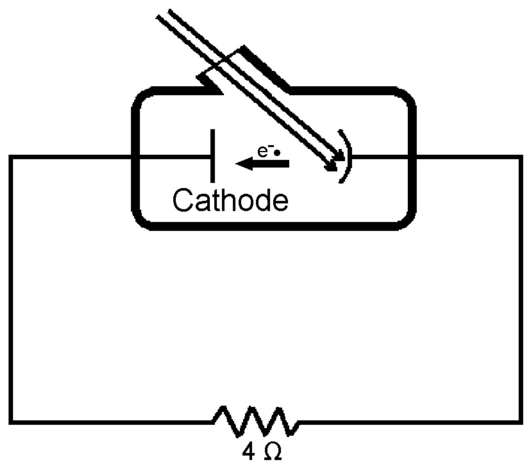
1848. Photons strike a metal surface with a work function of 8 eV. Photons with half the wavelength of the original photons strike the same surface, producing electrons with a maximum kinetic energy of 12 eV. What was the maximum kinetic energy of the electrons emitted when the initial photons struck the surface?

(A) 2 eV
(B) 6 eV
(C) 10 eV
(D) 12 eV
(E) 16 eV

1399. In an experiment, electrons are emitted from a metal surface as light of a specific wavelength is shined on it. In order to increase the kinetic energy of individual electrons while increasing the number of electrons emitted, which of the following recommendations should be followed?

(A) Increase the intensity of the light while decreasing the wavelength of the light.
(B) Decrease the intensity of the light while increasing the wavelength of the light.
(C) Increase the intensity of the light while increasing the wavelength of the light.
(D) Decrease the intensity of the light while decreasing the wavelength of the light.
(E) Increase the wavelength of the light, and increase or decrease the intensity of the light, as intensity has no effect.

1745.



A beam of photons strikes a photoelectric cell with a work function of 2.5 eV, causing electrons to be emitted. The electrons hit a cathode which completes a circuit with the cell. The total resistance of the of the circuit is 4 Ω and an ammeter measures a current of 5 A. What is energy of the photons striking the photoelectric cell?

(A) 1.5 eV
(B) 7.5 eV
(C) 17.5 eV
(D) 20 eV
(E) 22.5 eV

1847. Photons with a kinetic energy 10 eV are shone on a metal plate with a work function of 6 eV. If photons with twice the wavelength as the initial one strike the metal plate

(A) electrons with a maximum kinetic energy of 20 eV will be emitted
(B) electrons with a maximum kinetic energy of 14 eV emitted
(C) electrons with a maximum kinetic energy of 10 eV will be emitted
(D) electrons with a maximum kinetic energy of 4 eV will be emitted
(E) electrons will not be emitted

45. When a Uranium-235 nucleus is struck by a neutron, it undergoes fission. The kinetic energy of the resulting particles is equal to
(A) the kinetic energy of the incoming neutron
(B) the total energy of the incoming neutron
(C) the mass defect of the system
(D) the mass defect of the system plus the total energy of the neutron
(E) the mass defect of the system plus the kinetic energy of the neutron

46. When deuterium and tritium combine to form ^{4}He and a neutron, which of the following is not conserved?
(A) electric charge
(B) total energy
(C) linear momentum
(D) angular momentum
(E) mass

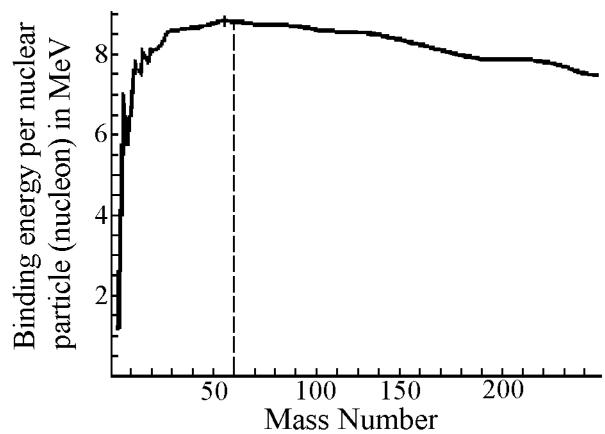
161. The mass of the He nucleus, m_{He}, is related to the neutron mass, m_n, and the proton mass, m_p, by the formula
(A) $m_{\text{He}} = m_n + 2m_p$
(B) $m_{\text{He}} = 2m_n + 2m_p$
(C) $m_{\text{He}} = 2m_n - 2m_p$
(D) $m_{\text{He}} = 2m_n + 2m_p +$ (mass equivalent to triton binding energy)
(E) $m_{\text{He}} = 2m_n + 2m_p -$ (mass equivalent to triton binding energy)

926. The difference between the mass of a deuteron (nucleus of a hydrogen-2 atom) and the masses of the individual particles of which it is made is 0.00239 u. The nuclear binding energy per nucleon is most nearly
(A) 1.1 keV
(B) 11 keV
(C) 110 keV
(D) 1.1 MeV
(E) 11 MeV

930. In an exothermic nuclear reaction, the mass difference between the reactants and products is m and the energy released is E. Another nuclear reaction releases 4E in energy. The mass difference between the reactants and products of this second reaction is
(A) $\frac{m}{4}$
(B) 4*m*
(C) 2m
(D) $4mc^2$
(E) $\frac{m}{(4c^2)}$

1067. The nuclear reaction $A + B \rightarrow C$ occurs spontaneously. If M_A, M_B, and M_C are the masses of the three particles, which of the following relationships is true?
(A) $M_C < M_A - M_B$
(B) $M_C < M_A + M_B$
(C) $M_C > M_A + M_B$
(D) $M_C - M_B > M_A$
(E) $M_C - M_A > M_B$

927. The graph below shows how the energy used in binding the nucleus of an atom together varies with atomic number.



Nuclei of which of the following elements would be the most likely to release energy if they were split into smaller nuclei?
(A) Helium-5
(B) Boron-10
(C) Chlorine-32
(D) Iron-56
(E) Bismuth-215

932. A nuclear reaction occurs, and the reactants have more mass than the products. This mass difference represents
(A) the energy lost to heat and sound
(B) the energy used to bind the nucleons
(C) the uncertain mass of the neutrino
(D) the kinetic energy of the final products
(E) the potential energy of the electrostatic force

1125. Base your answer to the following question on the following situation.

A proton and an anti-proton, each of mass 1.67×10^{-27} kg are in the same general vicinity and have very small initial speeds. They then annihilate each other, producing two photons.

What is the approximate energy of each emerging photon?
(A) 470 MeV
(B) 940 MeV
(C) 1260 MeV
(D) 1880 MeV
(E) It cannot be determined unless the frequency of the photon is known.