

PART I
Total Value: 50%

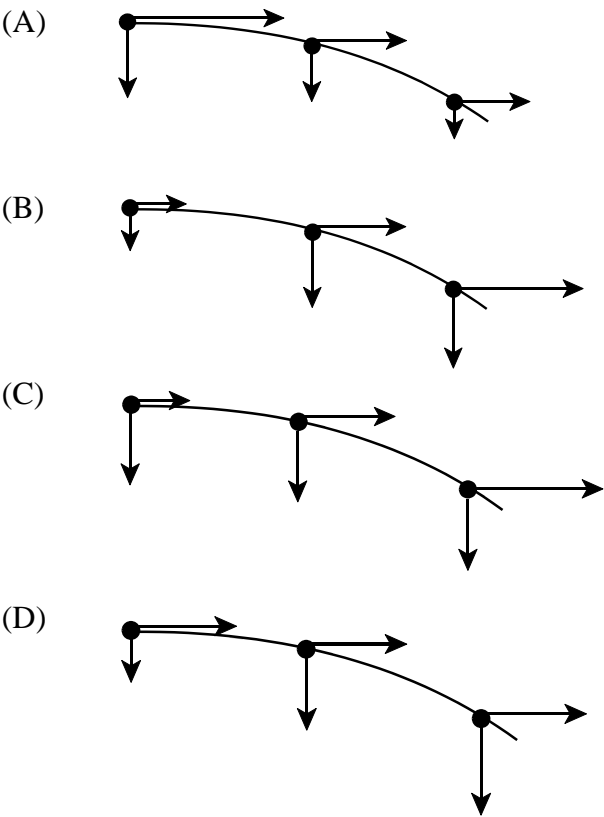
Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided.

1. If a ball is thrown at an initial speed of 8.0 m/s at an angle of 35° above the ground, what is the speed of the ball when it returns to its original height?
- (A) 4.6 m/s
(B) 6.6 m/s
(C) 8.0 m/s
(D) 9.8 m/s

2. A rock is thrown horizontally from the top of a hill. If air friction is negligible, which best represents the horizontal and vertical accelerations?

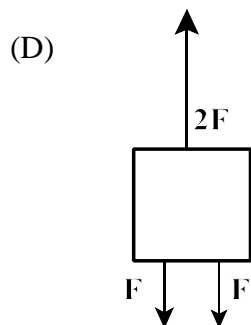
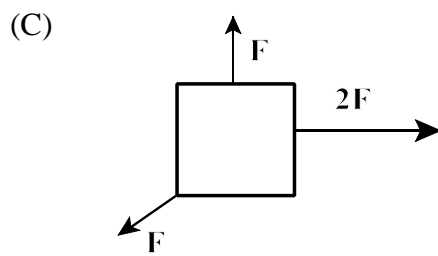
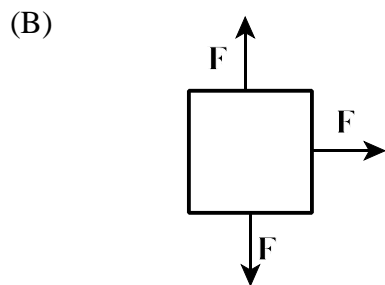
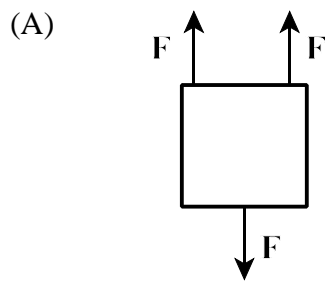
	horizontal acceleration (m/s ²)	vertical acceleration (m/s ²)
(A)	0	-9.8
(B)	0	0
(C)	9.8	-9.8
(D)	9.8	0

3. Which diagram best represents the vertical and horizontal velocity components shortly after a ball is kicked from a cliff?

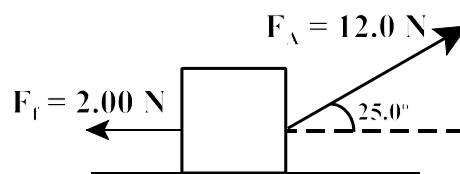


4. If a coin is tossed horizontally from a 1.2 m high table and lands 0.68 m from the base, what was the speed at which it left the table?
- (A) 1.4 m/s
(B) 1.9 m/s
(C) 2.8 m/s
(D) 5.7 m/s

5. For which free body diagram is $\vec{F}_{\text{Net}} = 0$?

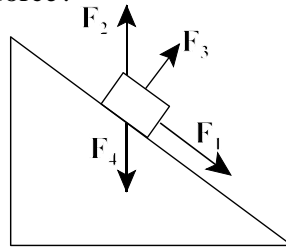


6. What is the net horizontal force acting on the object below?

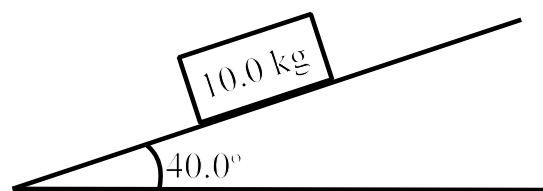


- (A) 3.07 N
- (B) 8.88 N
- (C) 10.0 N
- (D) 12.0 N

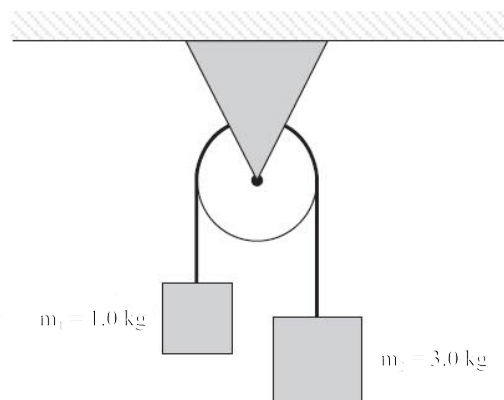
7. The free body diagram below represents an object sliding down a rough incline. Which vector represents the normal force?



- (A) F_1
 (B) F_2
 (C) F_3
 (D) F_4
8. A 10.0 kg box is at rest on an inclined plane as shown in the diagram below. What is the force of friction acting on the box?

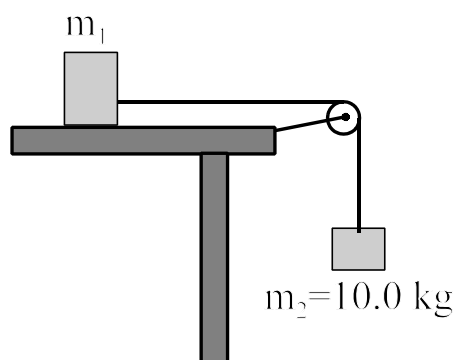


- (A) 6.43 N
 (B) 7.66 N
 (C) 63.0 N
 (D) 75.1 N
9. In the diagram below, two objects are suspended from the ends of a massless string passing over a frictionless pulley. What is the magnitude of the acceleration of these masses?

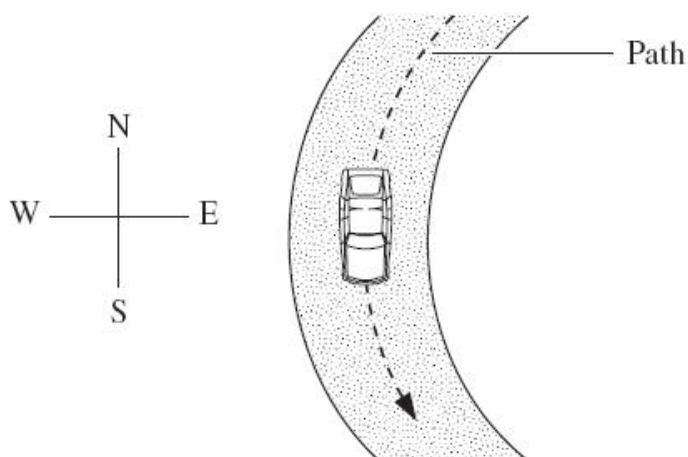


- (A) 2.5 m/s^2
 (B) 4.9 m/s^2
 (C) 7.4 m/s^2
 (D) 9.8 m/s^2

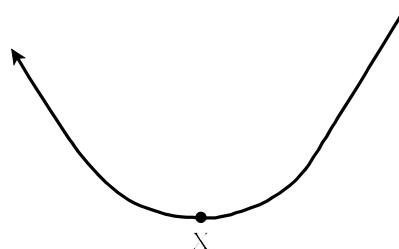
10. In the diagram below, the tension in the string joining the two masses is 12.0 N. If friction is negligible, what is the mass of m_1 ?



- (A) 1.10 kg
(B) 1.40 kg
(C) 2.00 kg
(D) 10.0 kg
11. In the diagram below, a car is moving south at a constant speed along a circular path. In which direction is the acceleration directed?

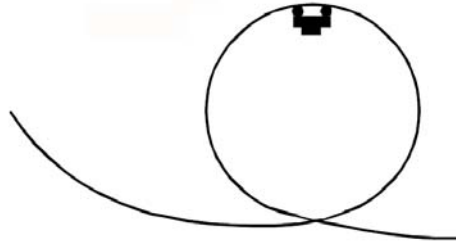


- (A) East
(B) North
(C) South
(D) West
12. A pilot executes a vertical dive and follows through a semi-circular arc as shown in the diagram below. When the plane is at the bottom of the arc (point X), what is true of the normal force on the pilot?



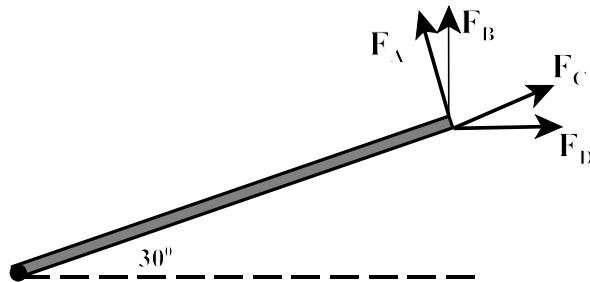
- (A) greater than F_g , and pointing down
(B) greater than F_g , and pointing up
(C) less than F_g , and pointing down
(D) less than F_g , and pointing up

13. The roller coaster cart shown below, passes the point at the very top of a loop, which has a radius of 7.00 m. If the normal force is equal to one half the weight of the cart, what is the speed of the roller coaster at this point?

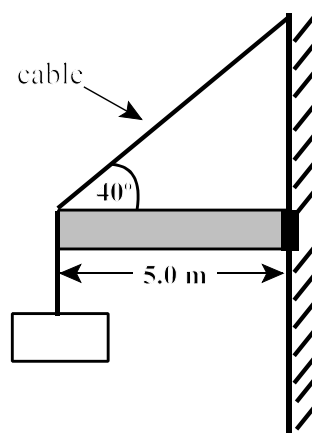


- (A) 4.14 m/s
 (B) 8.28 m/s
 (C) 10.1 m/s
 (D) 14.3 m/s
14. A car travels at 21 m/s around a banked curve. If the radius of the curve is 75 m and assuming friction is negligible, what is the banking angle?
- (A) 0.54°
 (B) 1.6°
 (C) 31°
 (D) 81°
15. Which defines static equilibrium?
- (A) $\vec{\tau}_{net} = 0, \vec{F}_{net} = 0$
 (B) $\vec{\tau}_{net} = 0, \vec{v}_{net} = 0$
 (C) $\vec{F}_{net} = 0, \vec{v}_{net} = 0$
 (D) $\vec{F}_{x_{net}} = \vec{F}_{y_{net}}$
16. A boy and girl are balanced on a uniform seesaw. Given the boy weighs more than the girl, if they both move forward so that they are one half of their original distance from the pivot point, what will happen to the seesaw?
- (A) The boy's side will tilt downward.
 (B) The girl's side will tilt downward.
 (C) The seesaw will continuously oscillate.
 (D) The seesaw will remain balanced.
17. What is the unit for torque?
- (A) $\frac{J}{s}$
 (B) $kg \cdot \frac{m}{s^2}$
 (C) J
 (D) $N \cdot m$

18. Which force in the diagram below would produce the largest torque on the lever arm?



- (A) F_A
 (B) F_B
 (C) F_C
 (D) F_D
19. What is the tension of the cable in the diagram below if a 25.0 kg mass is suspended from the end of a 5.0 m long uniform beam that is 10.0 kg?



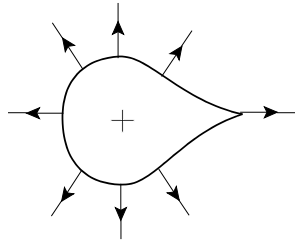
- (A) 330 N
 (B) 380 N
 (C) 460 N
 (D) 530 N
20. The structure shown below is in static equilibrium. What is the mass of object X?
 (Assume beam to be of negligible mass.)



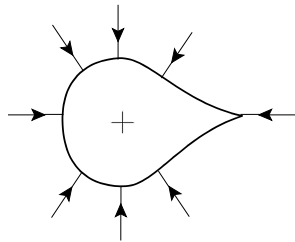
- (A) 408 kg
 (B) 1630 kg
 (C) 2040 kg
 (D) 4080 kg
21. How many electrons are transferred when an object receives a 5.0 μC charge?
- (A) 5.0×10^6
 (B) 3.1×10^{13}
 (C) 3.1×10^{19}
 (D) 8.0×10^{25}

22. Which diagram best represents the electric field around a positively charged object?

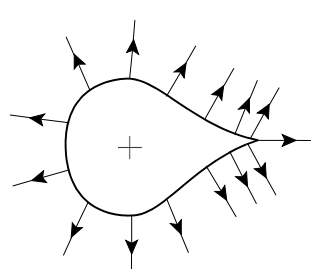
(A)



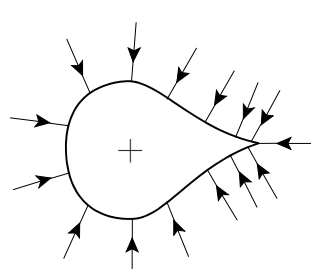
(B)



(C)



(D)



23. Why are small pieces of paper attracted to a comb that has been rubbed through human hair?

- (A) The comb becomes charged and electrons in the paper are rearranged.
- (B) The comb becomes positively charged and the paper becomes negatively charged.
- (C) The paper becomes charged and electrons in the comb are rearranged.
- (D) The paper becomes positively charged and the comb becomes negatively charged.

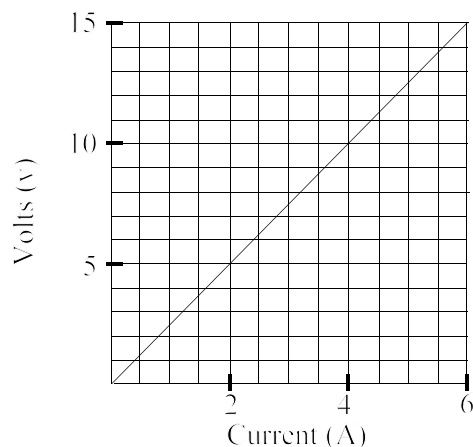
24. What is the magnitude of the electric field strength 2.40 m away from a $3.4 \mu\text{C}$ point charge?

- (A) 0.53 N/C
- (B) 130 N/C
- (C) $5.3 \times 10^3 \text{ N/C}$
- (D) $1.3 \times 10^4 \text{ N/C}$

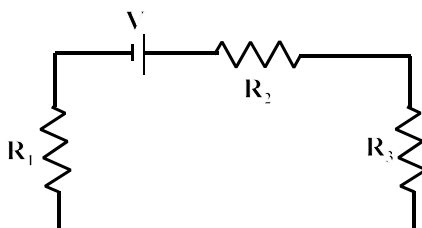
25. The magnitude of the electrostatic force between two charges is F . If the distance d between the charges is decreased to $\frac{1}{2}d$, what is the new force between the charges?

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

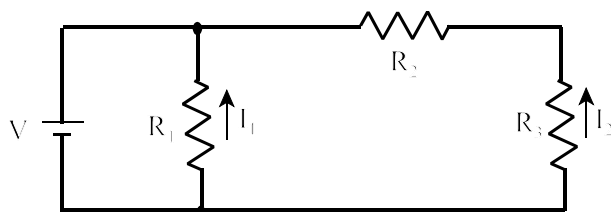
26. What is the resistance for the circuit represented in the graph below?



- (A) $0.40\ \Omega$
 (B) $2.5\ \Omega$
 (C) $6.0\ \Omega$
 (D) $15\ \Omega$
27. A wire of length L and radius r has a resistance of R . A second wire, composed of the same material, has length $2L$ and radius $2r$. What is the resistance of the second wire?
- (A) $\frac{1}{4} R$
 (B) $\frac{1}{2} R$
 (C) R
 (D) $4R$
28. What must be constant for the three different resistors connected in series as shown in the diagram below?



- (A) current flow
 (B) potential difference
 (C) power dissipated
 (D) voltage drop
29. If $I_1 = I_2$ in the circuit below, what does $I_1 R_1$ equal?




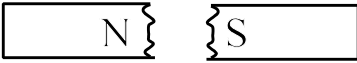
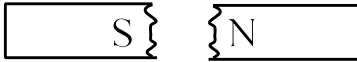
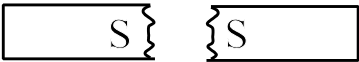
- (A) $I_2 R_2$
 (B) $I_2 R_3$
 (C) $\frac{1}{2} I_2 (R_2 + R_3)$
 (D) $I_2 (R_2 + R_3)$
30. If a $6.0\ \Omega$ and a $12\ \Omega$ resistor are connected in parallel to a 36 V battery, what power is dissipated by the $6.0\ \Omega$ resistor?
- (A) 24 W
 (B) 48 W
 (C) 220 W
 (D) 320 W

31. A 1200 W stereo is operating for 6.0 hours. If charge for electricity is 7.0 ¢/kW·h, what is the total cost of energy consumed?

(A) \$0.05
(B) \$0.50
(C) \$5.00
(D) \$50.00

32. If the magnet below was broken, what would be the polarity at the break point?

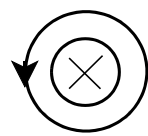
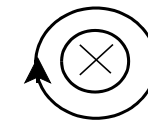
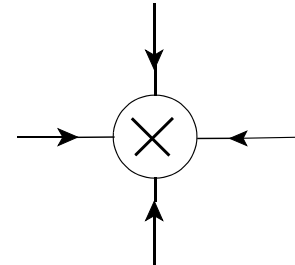
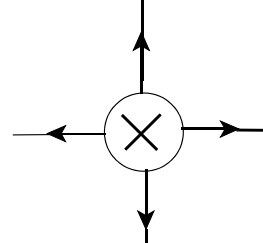


- (A) 
- (B) 
- (C) 
- (D) 

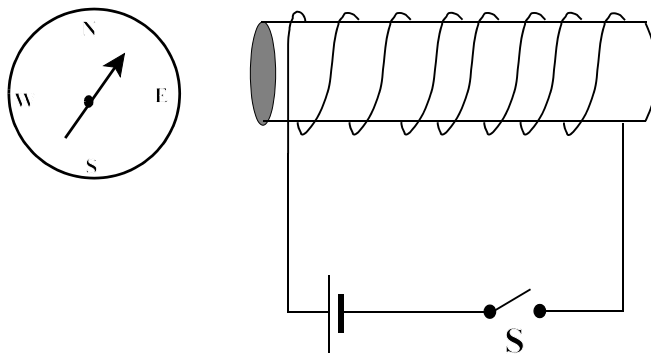
33. Which scientist proved that a charge moving through a straight conductor produces a circular magnetic field around the conductor?

(A) Coulomb
(B) Oersted
(C) Ohm
(D) Volta

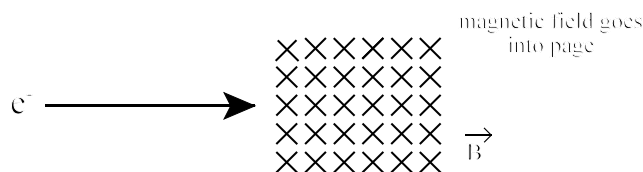
34. Which correctly shows the magnetic field around a straight wire carrying a current into the page?

- (A) 
- (B) 
- (C) 
- (D) 

35. As switch S is closed in the diagram below, in which direction does the compass needle point?



- (A) East
(B) North
(C) South
(D) West
36. At what distance from a power line carrying 1.0×10^2 A will the magnetic field be 1.3×10^{-4} T?
- (A) 0.15 m
(B) 0.31 m
(C) 0.39 m
(D) 0.94 m
37. In which direction will the electron be deflected in the diagram below?

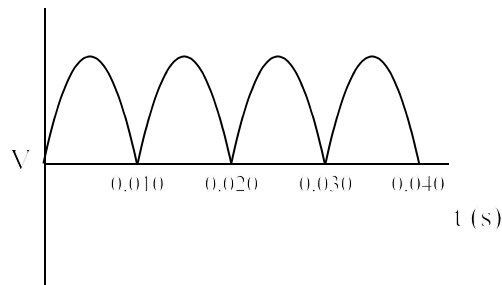


- (A) into the page
(B) out of the page
(C) toward the bottom of page
(D) toward the top of page
38. A wire is placed in a magnetic field as shown. To induce a current out of the page, in what direction must the wire be moved?



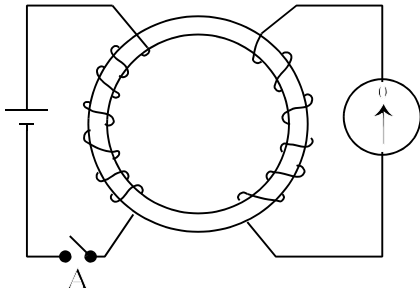
- (A) left
(B) right
(C) up
(D) down

39. The diagram below illustrates the output from a generator. What is true of the generator?



	Type of Generator	Rotational Rate of Armature (Hz)
(A)	AC	50
(B)	AC	100
(C)	DC	50
(D)	DC	100

40. When switch A is closed and then opened, which describes the movement of the galvanometer needle?



	As switch is closed	→	While switch is closed	→	As switch is opened
(A)	deflects left	→	points to 0	→	deflects right
(B)	deflects left	→	remains pointing left	→	deflects right
(C)	deflects right	→	points to 0	→	deflects left
(D)	deflects right	→	remains pointing right	→	deflects left

41. If the frequency of photon is doubled, what happens to its energy?

- (A) decreases by a factor of four
- (B) decreases by a factor of two
- (C) increases by a factor of four
- (D) increases by a factor of two

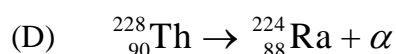
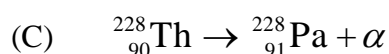
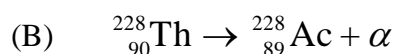
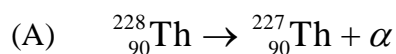
42. What happens to a high energy photon after it strikes an electron?

- (A) decreases frequency
- (B) decreases wavelength
- (C) increases energy
- (D) increases momentum

43. If the mass of the products in a fission reaction is 3.2×10^{-28} kg less than the reactants, how much energy is released in the reaction?

- (A) 3.6×10^{-45} J
- (B) 1.1×10^{-38} J
- (C) 9.6×10^{-20} J
- (D) 2.9×10^{-11} J

44. Which represents the alpha decay of thorium-228?



45. If a photon of light has a wavelength of 750 nm, what is its momentum?

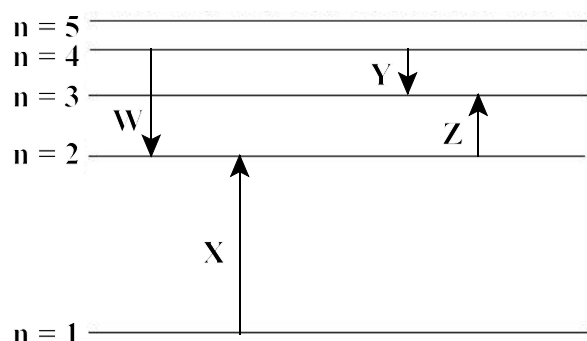
(A) $8.8 \times 10^{-31} \text{ kg}\cdot\text{m/s}$

(B) $8.8 \times 10^{-28} \text{ kg}\cdot\text{m/s}$

(C) $6.8 \times 10^{10} \text{ kg}\cdot\text{m/s}$

(D) $1.1 \times 10^{27} \text{ kg}\cdot\text{m/s}$

46. The diagram below shows the energy level diagram of a hydrogen atom. The arrows (W, X, Y, Z) indicate transitions of electrons in the atom. Which transition would result from the absorption of a photon with the least amount of energy?



(A) W

(B) X

(C) Y

(D) Z

47. If an element with an atomic number of 88 goes through beta negative decay, what will be the resulting atomic number?

(A) 86

(B) 87

(C) 88

(D) 89

48. What is the mass defect of a fission reaction that releases $2.9 \times 10^{-11} \text{ J}$ of energy?

(A) $3.2 \times 10^{-28} \text{ kg}$

(B) $9.7 \times 10^{-20} \text{ kg}$

(C) $9.7 \times 10^{20} \text{ kg}$

(D) $3.1 \times 10^{27} \text{ kg}$

49. What is the purpose of the moderator surrounding the fuel in a nuclear reactor?

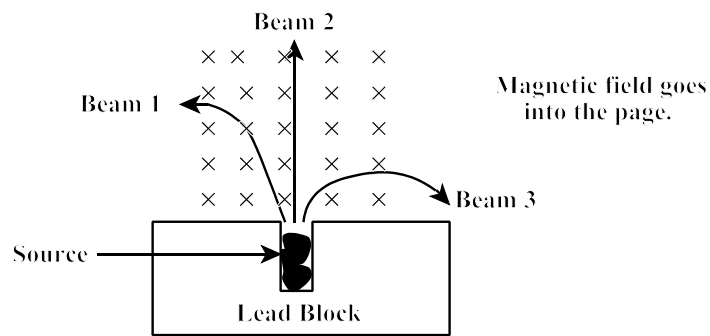
(A) absorb neutrons

(B) decrease speed of neutrons

(C) increase speed of neutrons

(D) release neutrons

50. The diagram below shows how three types of radiation emitted from a radioactive source are affected by a magnetic field. What type of radiation is emitted by each beam?



	Beam 1	Beam 2	Beam 3
(A)	alpha	beta	gamma
(B)	alpha	gamma	beta
(C)	beta	alpha	gamma
(D)	beta	gamma	alpha

PART II
Total Value: 50%

Instructions: Complete all items in this section. Your responses must be clearly presented in a well organized manner with proper use of units, formulae and significant figures where appropriate.

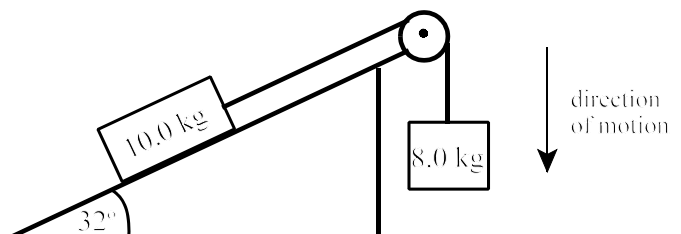
Value

5% 51.(a) As a plane flies horizontally at 65.0 m/s, it releases a package from a height of 1.20×10^3 m.

(i) What is the horizontal distance the package travels after it is released?

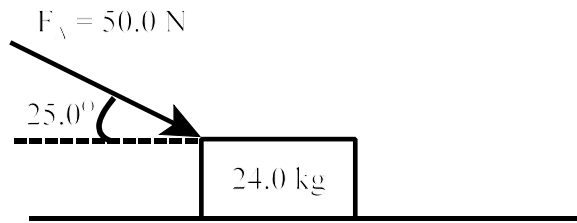
(ii) What is the final velocity of the package?

3% (b) In the diagram below a 10.0 kg mass is on a frictionless 32° incline and attached to a 8.0 kg mass with a string. What is the magnitude of the acceleration for the system?



Value

5% 51.(c) In the diagram below, a 24.0 kg box is pushed at a 25.0° angle with an applied force of 50.0. The coefficient of kinetic friction is 0.100.



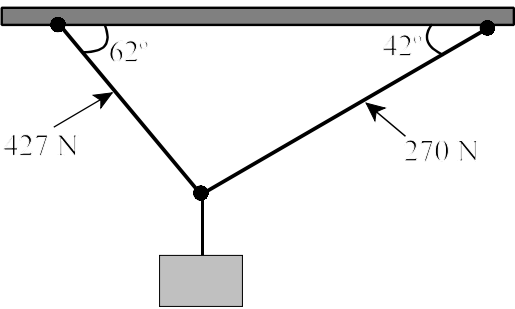
(i) Draw a free body diagram for the box. Clearly label **ALL** forces.

(ii) What is the acceleration of the box?

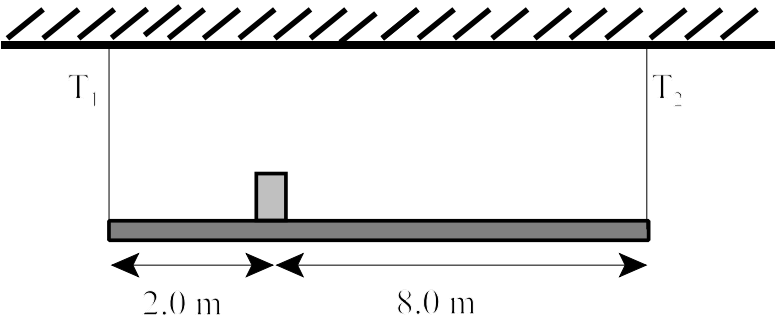
2% (d) What is the maximum speed at which a 1200 kg car can round a flat, curved road, without slipping, if the radius of the curve is 88.0 m and the coefficient of static friction is 0.50?

Value

2% 51.(e) What is the mass of the box supported by the two wires in the diagram below?



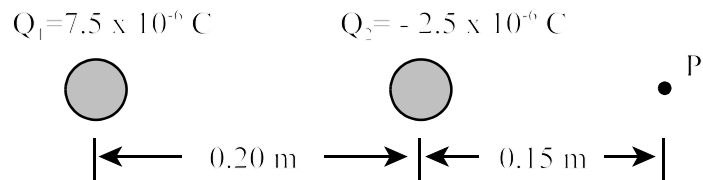
3% (f) In the diagram below, a 10.0 m uniform horizontal beam, weighing $1.00 \times 10^2\text{ N}$ is supported by a rope at each end. If a $4.00 \times 10^2\text{ N}$ box is positioned 2.0 m from the left end of the beam, what is the tension in each of the support ropes (T_1 and T_2)?



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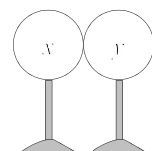
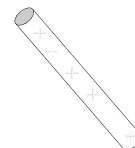
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52.(a) Given Q_1 and Q_2 arranged as shown in the diagram below, what is the electric field strength at point P?



2%

(b) The diagram below shows a positively charged glass rod and two neutral metal spheres, x, and y, in contact and on insulating stands. Describe how you could cause one sphere to obtain a negative charge and the other a positive charge, without touching either sphere with the glass rod.

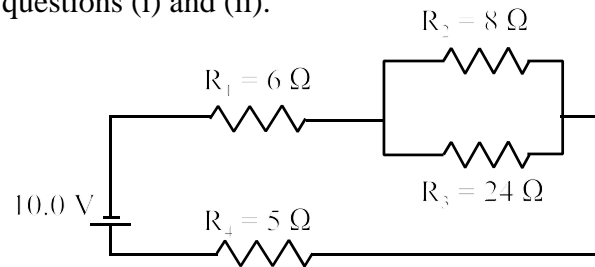


2%

(c) An electron shot into a magnetic field of 0.020 T at $5.6 \times 10^6 \text{ m/s}$, has a force of $8.96 \times 10^{-15} \text{ N}$. At what angle does the electron enter the field?

Value

5% 52.(d) Use the circuit below to answer questions (i) and (ii).



(i) What is the total resistance of the circuit?

(ii) What is the current through each resistor in the circuit?

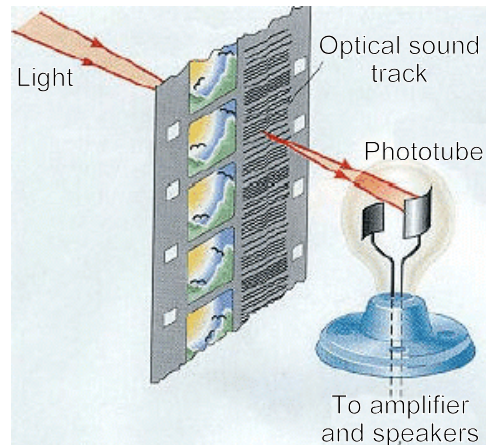
$I_1 =$ _____ $I_2 =$ _____ $I_3 =$ _____ $I_4 =$ _____

2% (e) A 100 W light bulb operates continuously for two weeks. If cost of energy is 7.2¢/kW·h, what is the total cost of the energy consumed?

3% (f) An electron travelling at 7.7×10^6 m/s enters into a uniform magnetic field at a right angle. It is deflected in a circular path with a radius of 3.5×10^{-2} m. What is the magnitude of the magnetic field it experiences?

Value

- 2% 52.(g) The analog system for the sound track of a motion picture film is shown below. How does a series of broad, clear and dark strips on the sound track affect the voltage and the current produced by the photocell?



- 2% 53.(a) An emitted photon of 122 nm hits a photocell, causing the photoelectric effect. If the work function of the metal is 3.68×10^{-19} J, what is the maximum kinetic energy of the emitted electron?

- 3% (b) What is the deBroglie wavelength of an electron emitted with a kinetic energy of 2.4 eV?

Value

2% 53.(c) A hydrogen atom in the first excited state ($n = 2$) relaxes to its ground state by emitting a photon. What is the energy of the emitted photon?

3% (d) If the mass of a carbon-14 (${}^{14}_6\text{C}$) nucleus is 2.3252×10^{-26} kg, what is the binding energy of the carbon nucleus?