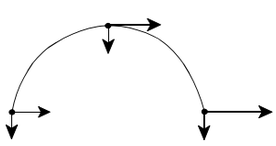
PART I
Total Value: 50%

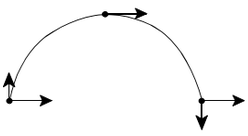
Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided.

1. Which represents the velocity components of a projectile?

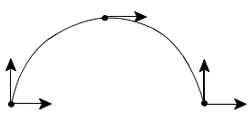
(A)



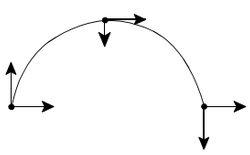
(B)



(C)



(D)



2. An arrow is shot horizontally with a velocity of 12 m/s. If the range is 24 m, how long is the arrow in the air?

(A) 0.50 s
(B) 2.0 s
(C) 12 s
(D) 24 s

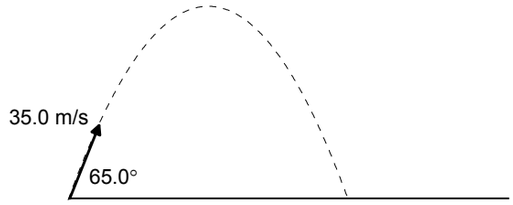
3. What are the horizontal and vertical components of a projectile launched with a velocity of 16.0 m/s at an angle of 40.0° above the horizontal?

	v_x (m/s)	v_y (m/s)
(A)	10.3	12.3
(B)	12.3	10.3
(C)	12.3	16.0
(D)	16.0	12.3

4. A soccer ball is kicked with a speed of 15.0 m/s at 30.0° above the ground. What is its height at 0.60 s?

(A) 1.6 m
(B) 2.7 m
(C) 6.0 m
(D) 6.3 m

5. A catapult fires a large stone as shown. What is the maximum height reached by the stone?



(A) 1.62 m
(B) 11.2 m
(C) 51.3 m
(D) 103 m

6. A golf ball is launched with an initial velocity, v_o, at an angle θ above the ground. Which expression describes the time required for the golf ball to land on the ground?

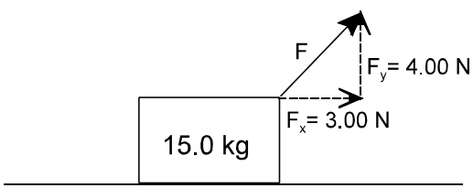
(A) $\dfrac{-2v_o}{a}$

(B) $\dfrac{-2v_o \cos\theta}{a}$

(C) $\dfrac{-2v_o \sin\theta}{a}$

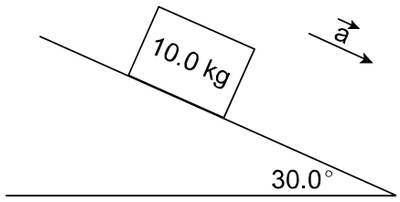
(D) $\dfrac{-v_o \sin\theta}{a}$

7. A 15.0 kg box is resting on a horizontal surface with an applied force, F, as shown. What is the magnitude of the normal force acting on the box?



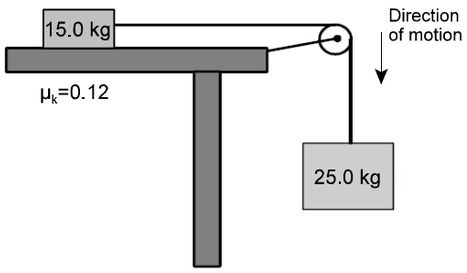
(A) 11 N
(B) 15 N
(C) 143 N
(D) 147 N

8. A 10.0 kg box is accelerating down a frictionless incline as shown. What are the magnitudes of the parallel and perpendicular components of the gravitational force acting on the box?



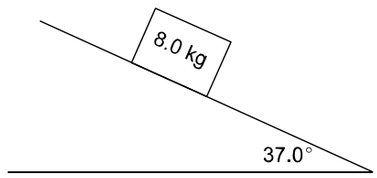
	$F_{parallel}$ (N)	$F_{perpendicular}$ (N)
(A)	49.0	84.9
(B)	49.0	98.0
(C)	84.9	49.0
(D)	98.0	49.0

9. What is the tension in the string if the system of blocks below is accelerating at 5.68 m/s^2?



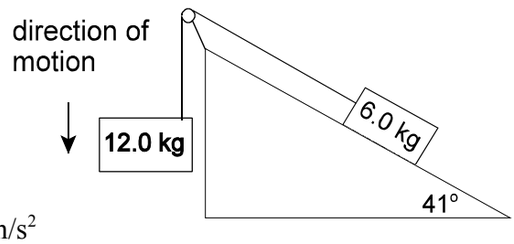
(A) 80.9 N
(B) 85.9 N
(C) 91.9 N
(D) 103 N

10. What is the force of friction acting on the 8.0 kg cart shown if it is moving at a constant speed down the incline?



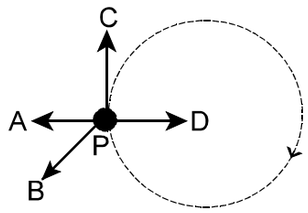
(A) 47 N
(B) 59 N
(C) 63 N
(D) 78 N

11. What is the acceleration of the system of masses shown on the frictionless incline below?



(A) 3.3 m/s^2
(B) 4.4 m/s^2
(C) 6.7 m/s^2
(D) 9.8 m/s^2

12. What is the direction of the velocity at point P if the object shown moves uniformly in a horizontal circle?



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

13. A 25.0 kg girl is spinning around at 1.25 m/s on a merry-go-round with a radius of 2.39 m. What is the centripetal force on the girl?

(A) 13.1 N
(B) 16.3 N
(C) 32.5 N
(D) 47.8 N

14. An object is moving in uniform circular motion at a speed of 6.20 m/s around a path having radius 3.85 m. How long does it take to make one complete revolution?

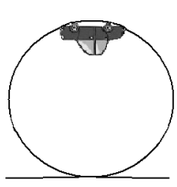
(A) 0.256 s
(B) 0.621 s
(C) 1.61 s
(D) 3.90 s

15. A 1.20 kg ball on a string is swung at a speed of 3.57 m/s in a vertical circle of radius 1.10 m. What is the tension in the string at the top of the circle?

(A) 2.1 N
(B) 11.8 N
(C) 13.9 N
(D) 25.7 N

16. A roller coaster car of mass, m, is on a track that forms a circular loop of radius r in a vertical plane. If the car is to just maintain contact with the track, what expression represents the minimum speed at the top of the loop?

(A) rg
(B) $\sqrt{rg}$
(C) rmg
(D) $\sqrt{rmg}$

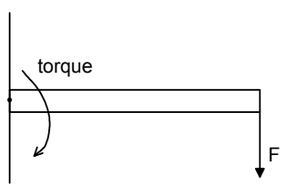


17. Which best explains why a doorknob is located far away from the hinge?

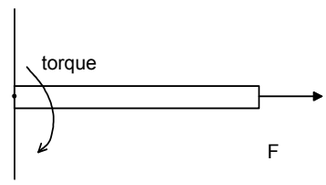
(A) friction
(B) gravity
(C) tension
(D) torque

18. Which applied force, F, creates a torque on the beam in the direction indicated?

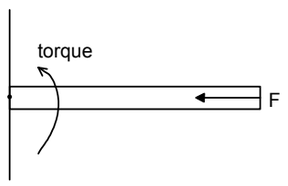
(A)



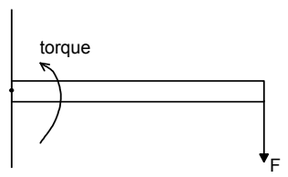
(B)



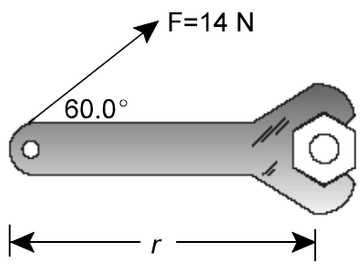
(C)



(D)

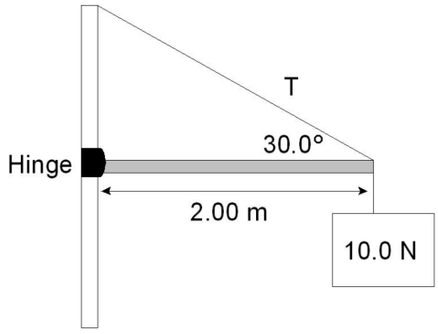


19. A plumber applies a force of 14 N to a wrench at an angle of 60.0° as shown. What is the length, r, if the plumber produces a torque of 4.6 N·m?



(A) 0.33 m
(B) 0.38 m
(C) 0.66 m
(D) 0.72 m

20. What is the tension, T, in the cable when a 10.0 N sign is suspended from the end of the massless beam as shown?



(A) 20.0 N
(B) 23.0 N
(C) 40.0 N
(D) 98.0 N

21. What happens to a neutral electroscope when it is briefly touched by a positively charged glass rod?

(A) gains electrons
(B) gains protons
(C) loses electrons
(D) loses protons

22. Two charged particles are separated by a distance, d. What happens to the magnitude of the force between the particles if the distance between the particles is divided in two, $\frac{1}{2}d$?

(A) decreases by a factor of 2
(B) decreases by a factor of 4
(C) increases by a factor of 2
(D) increases by a factor of 4

23. How far apart are two charges of 0.150 C and 0.0750 C if the force between them is 4.25 N?

(A) 4.20×10^{-8} m
(B) 2.05×10^{-4} m
(C) 4.88×10^{3} m
(D) 2.38×10^{7} m

24. What is the electric field strength at 6.7 m from a 6.0×10^{-6} C charged object?

(A) 1.3×10^{-7} N/C
(B) 9.0×10^{-7} N/C
(C) 1.2×10^{3} N/C
(D) 8.1×10^{3} N/C

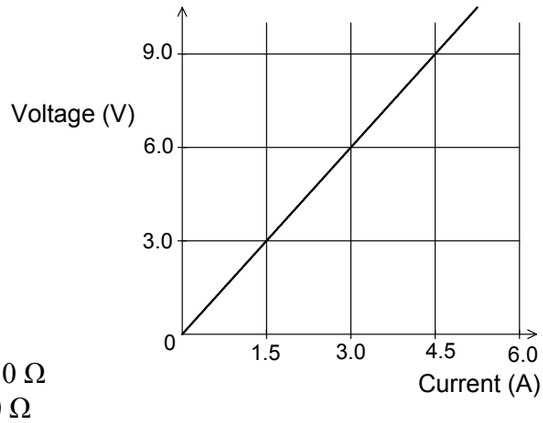
25. Which refers to the work required to move a charge from one point to another in an electric field?

(A) charge
(B) electric current
(C) electric potential
(D) resistance

26. What amount of energy is gained by a proton that moves through a potential difference of 1.0 V?

(A) 2.7×10^{-46} J
(B) 1.6×10^{-19} J
(C) 1.4×10^{-9} J
(D) 6.3×10^{18} J

27. The graph provided represents voltage and current data for a resistor R. What is the resistance of R?



(A) 0.50 Ω
(B) 2.0 Ω
(C) 4.5 Ω
(D) 9.0 Ω

28. What is the resistance of a 25 W soldering iron that runs on 110 V?

(A) 0.0021 Ω
(B) 4.4 Ω
(C) 480 Ω
(D) 2800 Ω

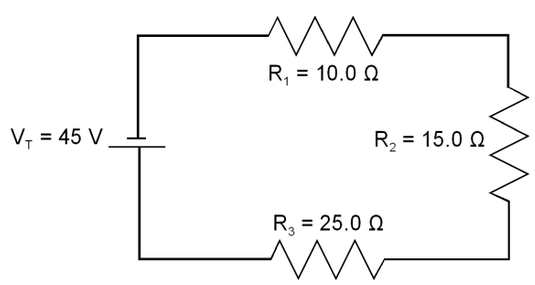
29. How does the resistance of two copper wires compare if wire X has twice the length and twice the cross-sectional area of wire Y?

(A) Wire X has half the resistance of wire Y.
(B) Wire X has four times the resistance of wire Y.
(C) Wire X has the same resistance as wire Y.
(D) Wire X has twice the resistance of wire Y.

30. What is the equivalent resistance of four 16 Ω resistors connected in parallel?

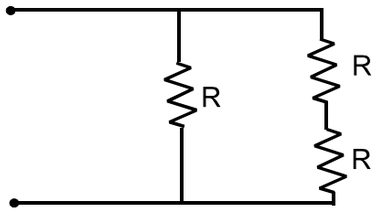
(A) 0.25 Ω
(B) 4.0 Ω
(C) 16 Ω
(D) 64 Ω

31. What is the voltage drop across R_1 in the circuit below?



(A) 4.5 V
(B) 9.0 V
(C) 11 V
(D) 15 V

32. Three identical resistors shown below each have resistance R. What is the total resistance of the arrangement as shown?

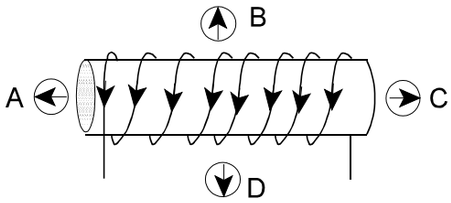


(A) $\frac{2}{3}R$
(B) R
(C) $\frac{3}{2}R$
(D) $3R$

33. Which describes the magnetic field lines around the current carrying conductor shown below?

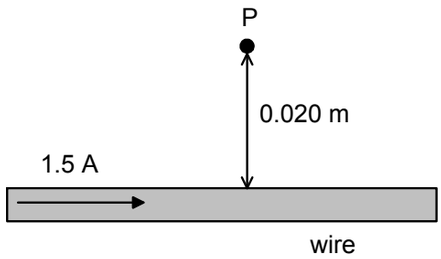
(A) clockwise concentric circles
(B) counterclockwise concentric circles
(C) parallel lines pointing down
(D) parallel lines pointing up

34. A solenoid is surrounded by four compasses as shown. Which compass reading is correct?



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

35. What is the magnetic field strength at point P, 0.020 m away from a wire carrying a 1.5 A current?



(A) 2.7×10^{-9} T
(B) 6.0×10^{-9} T
(C) 3.0×10^{-5} T
(D) 1.5×10^{-5} T

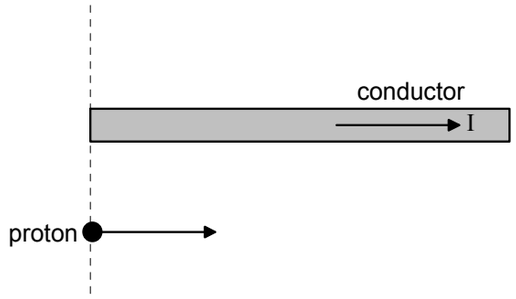
36. An electron is projected perpendicularly into a magnetic field with a velocity of 3.3×10^{7} m/s and experiences a force of 1.3×10^{-13} N. What is the magnitude of the magnetic field?

(A) 6.9×10^{-25} T
(B) 2.5×10^{-2} T
(C) 4.1×10^{1} T
(D) 2.7×10^{13} T

37. A 0.040 m long wire is placed in a 1.2×10^{-4} T magnetic field at an angle of 29° to the field and experiences a force of 9.2×10^{-6} N. What is the current in the wire?

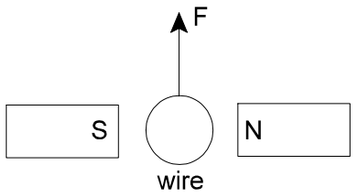
(A) 0.25 A
(B) 1.9 A
(C) 2.2 A
(D) 4.0 A

38. A proton moves parallel to a long straight current-carrying conductor as shown. In which direction will the proton be deflected?



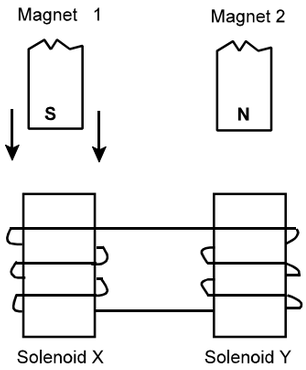
(A) into the page
(B) out of the page
(C) towards bottom of page
(D) towards top of page

39. What is the direction of the induced current in the wire below if it is pulled upwards?



(A) into the page
(B) left
(C) out of the page
(D) right

40. Two hollow-core solenoids, X and Y, are connected by a wire, as shown in the diagram provided. Two bar magnets, 1 and 2, are suspended just above the solenoids. What will happen to magnet 2 if the south pole of magnet 1 is dropped through solenoid X?



(A) attracted by a magnetic force toward solenoid Y
(B) attracted by an electric force toward solenoid Y
(C) repelled by a magnetic force away from solenoid Y
(D) repelled by an electric force away from solenoid Y

41. Which phenomenon supports the particle theory of light?

(A) diffraction
(B) interference
(C) photoelectric effect
(D) refraction

42. What is the minimum energy that will allow electrons to be ejected from a metal surface during the photoelectric effect?

(A) black-body radiation
(B) Planck's constant
(C) stopping potential
(D) work function

43. How much energy is possessed by a photon with a frequency of 1.00×10^{14} Hz?

(A) 4.73×10^{-42} J
(B) 4.37×10^{-24} J
(C) 6.63×10^{-24} J
(D) 6.63×10^{-20} J

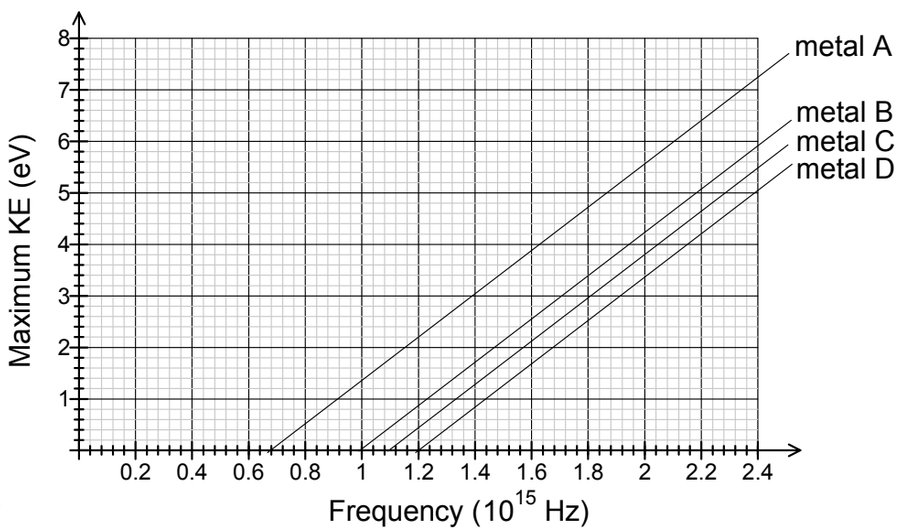
44. What wavelength of light has 4.70×10^{-25} J of energy?

(A) 0.210 m
(B) 0.423 m
(C) 63.8 m
(D) 422 m

45. What is the speed of a 50.0 kg person having a de Broglie wavelength of 4.4×10^{-37} m while running?

(A) 1.3×10^{-5} m/s
(B) 3.3×10^{-2} m/s
(C) 3.0×10^{1} m/s
(D) 7.5×10^{4} m/s

46. The graph provided shows the maximum kinetic energy of ejected electrons plotted against the frequency of the light shone on four different metals, A, B, C and D. What is the unknown metal if light of wavelength 1.87×10^{-7} m shines on it and the maximum kinetic energy of the ejected electrons is 2.5 eV?



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

47. What is true of the distance, *r*, between adjacent orbital radii in a H atom?

(A) $r \propto n$

(B) $r \propto n^2$

(C) $r \propto \frac{1}{n}$

(D) $r \propto \frac{1}{n^2}$

48. How much energy is released in a nuclear reaction if 4.37×10^{-25} kg of mass is converted to energy?

(A) 4.86×10^{-42} J
(B) 1.46×10^{-33} J
(C) 1.31×10^{-16} J
(D) 3.93×10^{-8} J

49. Which will complete the nuclear decay reaction shown?

$$^{58}_{29}\text{Cu} \rightarrow \boxed{?} + \gamma$$

(A) $^{54}_{27}\text{Co}$

(B) $^{56}_{25}\text{Mn}$

(C) $^{57}_{28}\text{Ni}$

(D) $^{58}_{29}\text{Cu}$

50. An atom having 98 protons and 249 neutrons undergoes alpha decay. What are the number of protons and neutrons in the daughter nucleus?

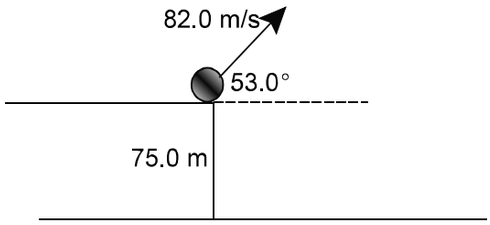
	protons	neutrons
(A)	94	251
(B)	96	247
(C)	100	251
(D)	100	249

PART II
Total Value: 50%

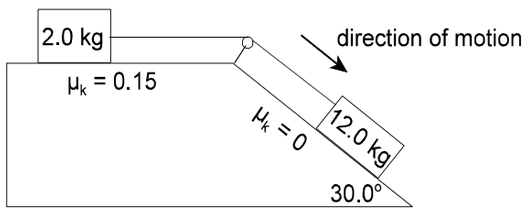
Instructions: Complete all items in this section. Your responses should be clearly presented in a well organized manner with proper use of units, formulae and significant figures where appropriate.

Value

4% 51.(a) A ball is thrown from a 75.0 m high cliff, with an initial velocity of 82.0 m/s, at an angle of 53.0° above the horizontal. Calculate the range of the ball when it hits the ground below.



4% (b) In the diagram provided, the coefficient of friction between the 2.0 kg mass and the horizontal surface is 0.15, while the incline is frictionless.

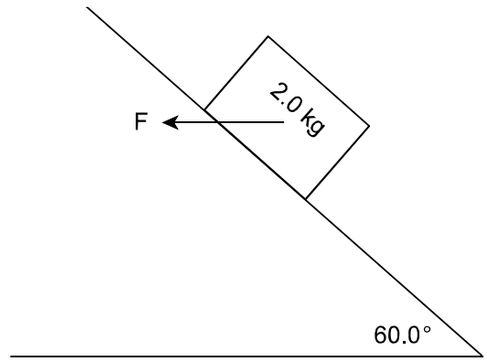


i) Calculate the magnitude of the acceleration of the system.

ii) Calculate the magnitude of the tension in the connecting string.

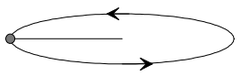
Value

3% 51.(c) A 2.0 kg block is held at rest on a frictionless incline angled at 60.0° by the horizontal force, F, shown below. Calculate the magnitude of F.



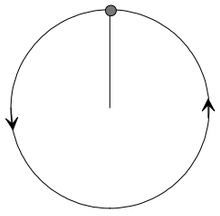
3% (d) A 0.40 kg stone is tied to a string and whirled around in a circle of radius 0.75 m with a constant speed of 5.0 m/s. In which situation is the string most likely to break? Explain.

i)



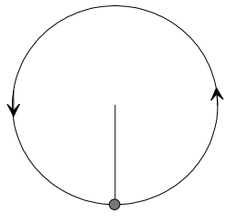
horizontal circle

ii)



top of vertical circle

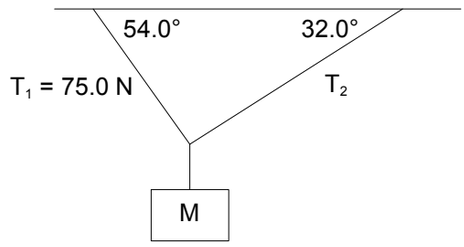
iii)



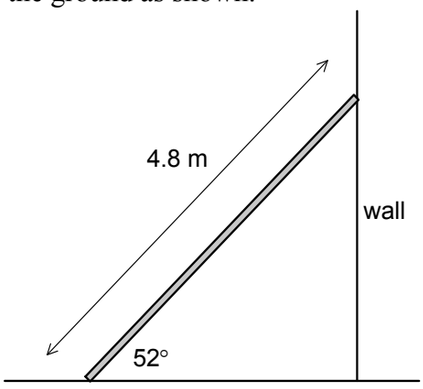
bottom of vertical circle

Value

3% 51.(e) A sign of mass M hangs from two cables as shown below. Calculate the mass of the sign if it is in static equilibrium.



3% (f) A 12.0 kg uniform ladder that is 4.8 m long rests against a frictionless wall at an angle of 52° to the ground as shown.

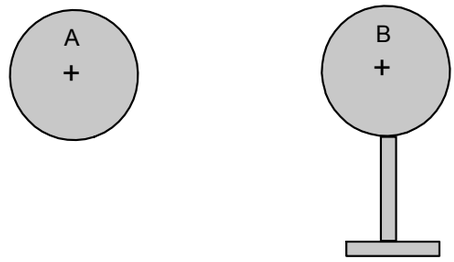


i) Calculate the force exerted on the ladder by the wall.

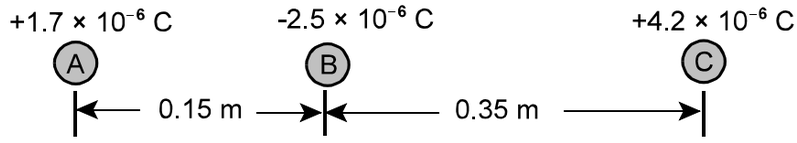
ii) Explain why the force of the wall on the ladder increases if a person stands on the ladder.

Value

3% 52.(a) Sphere A, which is positive, is held near a fixed positively charged sphere B as shown. Sphere A is then released and moves away from sphere B. Explain how and why the acceleration of sphere A changes as it moves away from sphere B.

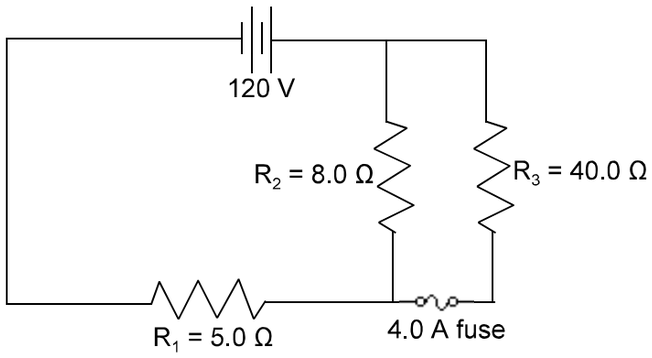


3% (b) Three charged objects are arranged as shown. Calculate the net electric force on object B due to the presence of objects A and C.



Value

5% 52.(c) In the circuit shown:



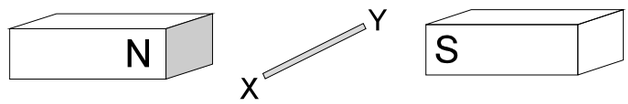
i) calculate the total resistance.

ii) calculate the voltage across resistor 2.

iii) determine whether the fuse will blow.

Value

3% 52.(d) A 0.025 m long wire segment, XY, is positioned perpendicular to a 0.750 T magnetic field as shown. When a current is passed through this wire segment, it experiences a 0.20 N force upwards. Calculate the magnitude and give the direction of the current through the wire.



3% (e) The diagrams provided show a metal rod, of mass *m,* suspended in a constant magnetic field by two identical wires. In diagram 1, there is no current in the wires, but in diagram 2, a current flows as shown. Compare the tension in the wires for diagram 2 to that for diagram 1. Explain your answer.

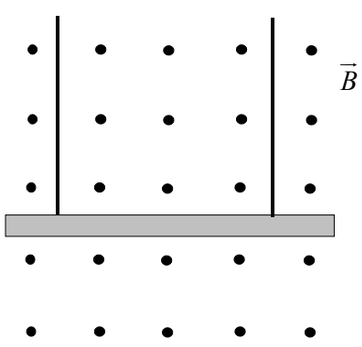


Diagram 1

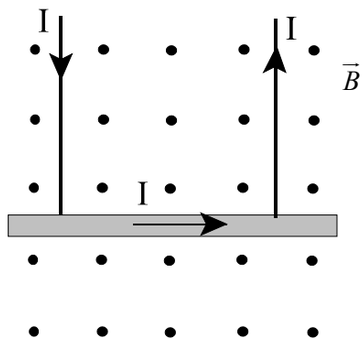
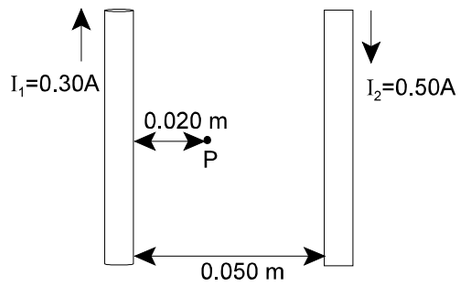


Diagram 2

Value

3% 52.(f) Calculate the magnitude and direction of the magnetic field strength at point P in the diagram provided.



3% 53.(a) When light having frequency 3.0×10^{15} Hz is shone on a certain metal, electrons are ejected. If the stopping potential of these electrons is 7.0 V, calculate the work function of this metal.

Value

3% 53.(b) Two subatomic particles with very different masses have the same de Broglie wavelength. Explain how this is possible.

2% (c) An electron in a hydrogen atom gains 0.966 eV of energy as it jumps from one energy level to another. Calculate what energy level the electron moves to if it starts at energy level 3.

2% (d) Cesium-137 has a half-life of 30.2 years and is found in the radioactive waste products of nuclear power production. Calculate the time required for the activity of a sample of cesium-137 to reduce to 18% of its original value.