PART I
Total Value: 50%

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

1. What is the vertical speed component of a projectile that is launched at an angle of 20.0° to the horizontal with an initial speed of 30.0 m/s?

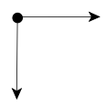
   (A) 30.0 cos 20.0°

✔ (B) 30.0 sin 20.0°

   (C) $\dfrac{30.0}{\sin 20.0^{\circ}}$

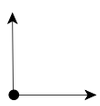
   (D) $\dfrac{30.0}{\cos 20.0^{\circ}}$

2. Which best represents the velocity components of a projectile at its maximum height?

   (A) 

   (B) 

✔ (C)

   (D) 

3. A projectile is shot horizontally at 40.0 m/s from a cannon located on a cliff 155 m high. How many seconds is the projectile in the air?

   (A) 0.258 s
✔ (B) 5.62 s
   (C) 11.0 s
   (D) 31.6 s

4. A ball thrown into the air has a horizontal velocity component of 12 m/s. What is the range of the ball if it lands after 3.0 s?

   (A) 4.0 m
✔ (B) 36 m
   (C) 51 m
   (D) 80 m

5. An arrow is fired at 45.5 m/s from a 5.75 m high tree branch, at an angle of 60° above the horizontal. What maximum height, above the ground, will the arrow reach?

   (A) 32.1 m
   (B) 73.4 m
   (C) 79.1 m
✔ (D) 84.9 m

6. A ball is launched at a 60° angle to the horizontal. If, 3.0 s later, it lands 12 m from the launch site, what was the magnitude of the initial velocity?

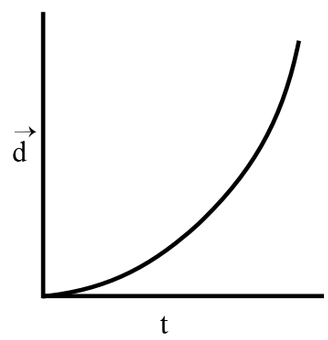
(A) 2.3 m/s
(B) 4.0 m/s
(C) 4.6 m/s
✔ (D) 8.0 m/s

7. What is the frictional force for a 24 kg object on a horizontal surface if $\mu_k = 0.25$?

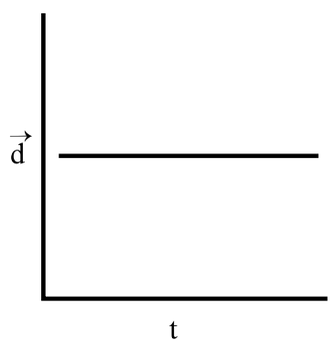
(A) 6.0 N
(B) 24 N
✔ (C) 59 N
(D) 96 N

8. Assuming no friction, which graph best represents the horizontal displacement of a projectile?

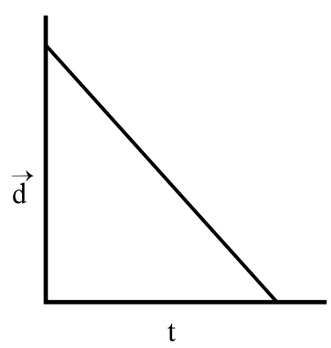
(A)



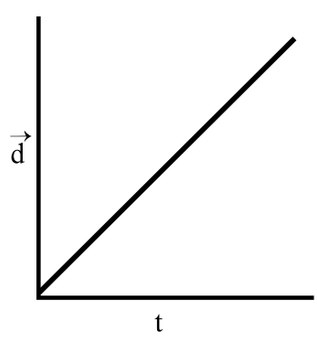
(B)



(C)



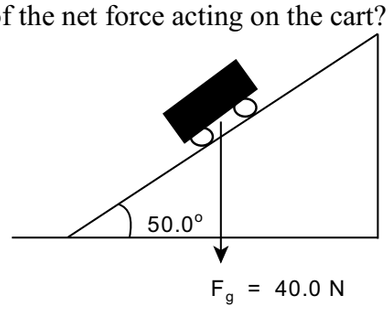
✔ (D)



9. Assuming no friction, which is constant for all projectiles?

(A) horizontal displacement
✔ (B) horizontal velocity
(C) vertical displacement
(D) vertical velocity

10. The diagram below represents a cart moving down on a ramp. Assuming no friction, what is the magnitude of the net force acting on the cart?

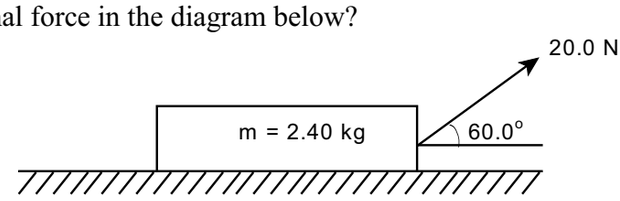


(A) 25.7 N
✔ (B) 30.6 N
(C) 32.1 N
(D) 38.3 N

11. A 75 kg skier accelerates at 1.25 m/s^2 from rest while descending a uniform 16° slope. What is the magnitude of the frictional force between the skis and the slope surface?

(A) 94 N
✔ (B) 110 N
(C) 610 N
(D) 640 N

12. What is the normal force in the diagram below?



✔ (A) 6.20 N
(B) 10.0 N
(C) 13.2 N
(D) 23.5 N

13. A car goes around a curve with a radius of 84 m at a speed of 22 m/s. What is the centripetal acceleration of the car?

(A) 0.17 m/s^2
(B) 0.26 m/s^2
(C) 3.8 m/s^2
✔ (D) 5.8 m/s^2

14. If an object is on a 27° frictionless incline, what will be the acceleration of the object on the incline?

(A) 0.45 m/s^2
(B) 0.55 m/s^2
✔ (C) 4.4 m/s^2
(D) 8.7 m/s^2

15. If a student swings a ball, attached by a string, in a horizontal circle, in which direction would the ball travel if the string breaks?

(A) in the circular path
(B) towards the student's hand
✔ (C) tangent to the circular path
(D) tangent to the student's hand

16. What is true of the velocity of an object experiencing uniform circular motion?

	Magnitude	Direction
(A)	changing	changing
(B)	changing	constant
✔ (C)	constant	changing
(D)	constant	constant

17. A runner completes one lap of a circular track in 37s at a speed of 9.0 m/s. What is the radius of the track?

(A) 26 m
✔ (B) 53 m
(C) 330 m
(D) 490 m

18. An 85 kg person swings on an 8.0 m vine. What is the tension force in the vine as the person passes the lowest point of the circular path, traveling at 12.5 m/s?

(A) 830 N
(B) 1700 N
✔ (C) 2500 N
(D) 6700 N

19. What torque is provided by a 60.0 kg person standing on a diving board 1.4 m from the pivot?

(A) 84 N·m
(B) 420 N·m
(C) 590 N·m
✔ (D) 820 N·m

20. Which describes the ability to turn a body about a pivot?

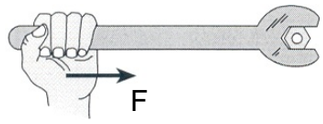
(A) centripetal force
(B) net force
(C) orbit
✔ (D) torque

21. A door is opened by a 25.0 N force acting on the door knob at a 30.0° angle to the door's surface. If the door knob is 0.800 m from the hinge, what is the magnitude of the torque about the hinge?

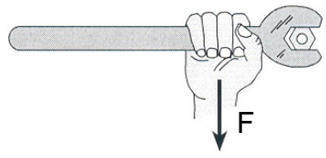
✔ (A) 10.0 N
(B) 12.5 N
(C) 17.4 N
(D) 21.7 N

22. In which situation would the greatest torque be exerted on the bolt?

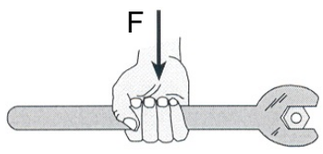
(A)



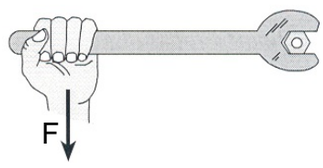
(B)



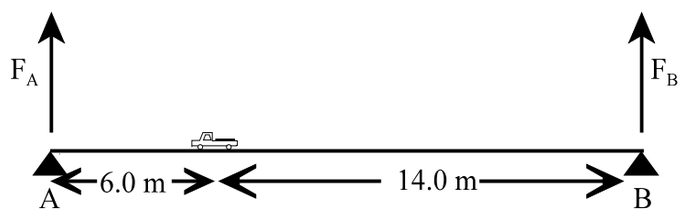
(C)



✔ (D)



23. The diagram below shows a 2.0×10^3 kg truck on a 20.0 m long uniform bridge that has a mass of 8.0×10^3 kg. If the truck is 6.0 m from support A, what is the magnitude of the upward force at support B?



✔ (A) 4.6×10^3 N
(B) 5.9×10^3 N
(C) 4.5×10^4 N
(D) 8.4×10^4 N

24. What happens to a neutral electroscope that is briefly touched with a positively charged glass rod?

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

25. What is the electrical potential difference required to increase the energy of a 0.20 C charged particle by 7.0 J?

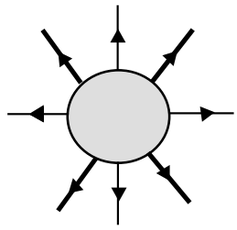
(A) 0.028 V
(B) 1.4 V
(C) 3.5 V
✔ (D) 35 V

26. A Van de Graaf generator creates an electric field about a metal sphere. A 3.0 μC charge, near the sphere, experiences a force of 5.4×10^{-4} N. What is the strength of the electric field at the location of the charge?

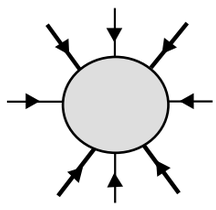
(A) 1.6×10^{-9} N/C
(B) 1.8×10^{-4} N/C
(C) 5.4×10^{-4} N/C
✔ (D) 1.8×10^{2} N/C

27. Which diagram shows the gravitational field lines about a spherical object?

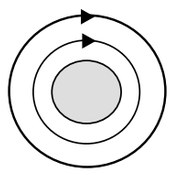
(A)



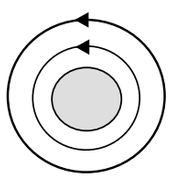
✔ (B)



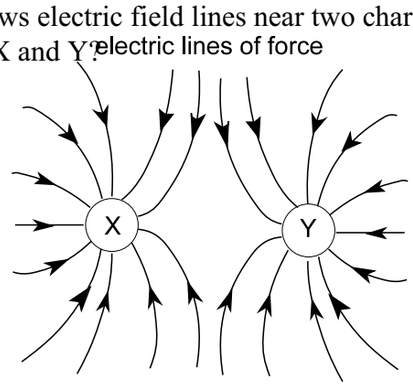
(C)



(D)



28. The diagram below shows electric field lines near two charged spheres, what type of charges are present on X and Y?



		X	Y
✔	(A)	negative	negative
	(B)	negative	positive
	(C)	positive	negative
	(D)	positive	positive

29. What is the electrostatic force between two protons separated by a distance of 1.0×10^{-6} m?

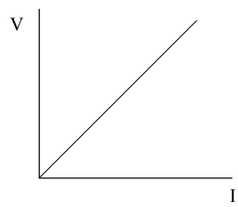
(A) -9.0×10^{21} N
✔ (B) -2.3×10^{-16} N B or C since sign is irrelevant.
✔ (C) $+2.3 \times 10^{-16}$ N
(D) $+9.0 \times 10^{21}$ N

30. Two charged objects attract each other with a force, F. By what factor would the force increase if one charge is doubled, the other charge is tripled, and the distance between their centres is reduced to one quarter its original value?

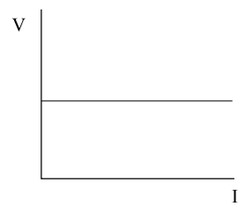
(A) 6
(B) 16
(C) 24
✔ (D) 96

31. Which graph illustrates Ohm's Law?

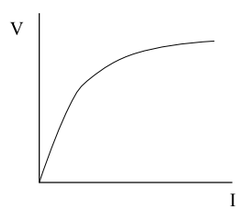
✔ (A)



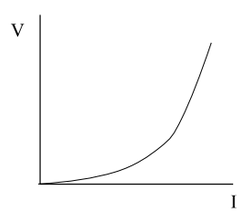
(B)



(C)



(D)



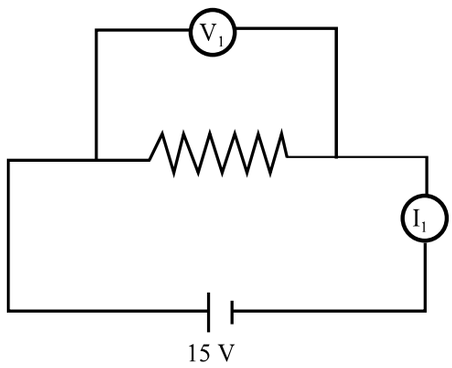
32. Given the resisitivity of copper is $1.72 \times 10^{-8}\ \Omega \cdot$m, what is the resistance of a 2.00 m long copper extension cord that has a diameter of 2.00×10^{-3} m?

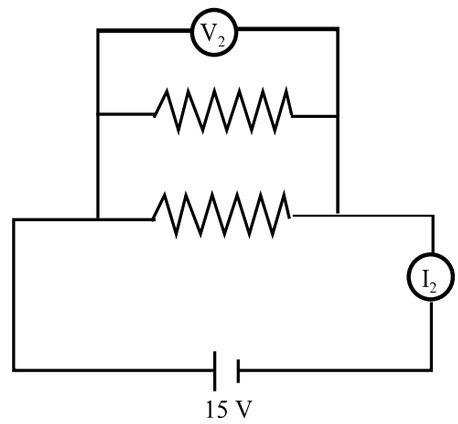
(A) $1.72 \times 10^{-11}\ \Omega$
(B) $6.88 \times 10^{-11}\ \Omega$
(C) $1.72 \times 10^{-5}\ \Omega$
✔ (D) $1.10 \times 10^{-2}\ \Omega$

33. An electric clothes dryer uses a 30.0 A current for 12 minutes to dry a load of clothes. This process uses 5184 kJ of energy. What is the potential difference across the dryer?

(A) 12 V
(B) 14 V
(C) 120 V
✔ (D) 240 V

34. Which best describes the relationship between the two circuits below if all resistors are identical, V_1 and V_2 are readings from ideal voltmeters, and I_1 and I_2 are readings from ideal ammeters?





✔ (A) $V_2 = V_1$ and $I_2 > I_1$
(B) $V_2 = V_1$ and $I_2 < I_1$
(C) $V_2 > V_1$ and $I_2 > I_1$
(D) $V_2 > V_1$ and $I_2 < I_1$

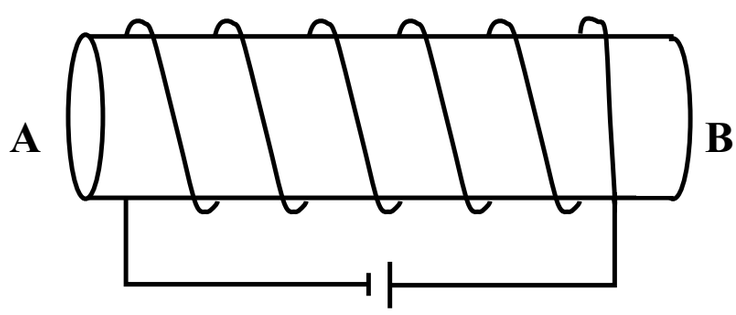
35. How much electrical energy does a 75 W motor use in 15 minutes?

(A) 1.1×10^3 J
(B) 1.9×10^3 J
✔ (C) 6.8×10^4 J
(D) 2.7×10^5 J

36. If a 1.50×10^3 W heater is connected to a 1.20×10^2 V line for 2.0 hours, how much heat energy is produced?

(A) 1.5 kJ
(B) 3.0 kJ
(C) 180 kJ
✔ (D) 11 000 kJ

37. What are the magnetic poles of the current-carrying solenoid in the diagram below?

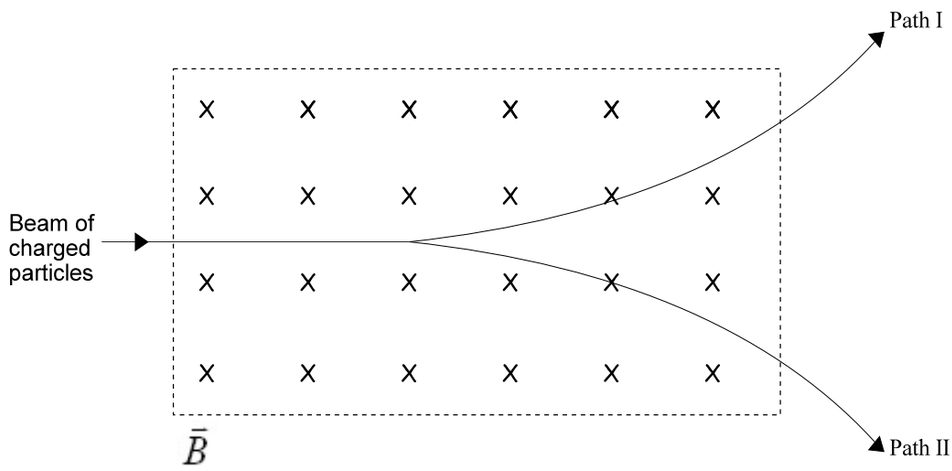


		Pole A	Pole B
	(A)	North	North
✔	(B)	North	South
	(C)	South	North
	(D)	South	South

38. If a 0.25 m wire is perpendicular to a uniform 0.20 T magnetic field, what force is exerted on this wire when it carries a 15 A current?

(A) 0.12 N
✔ (B) 0.75 N
(C) 3.0 N
(D) 6.0 N

39. Which path illustrates the positively and negatively charged particles that pass through the magnetic field in the diagram below?



	Path of Positive Charges	Path of Negative Charges
(A)	I	I
✔ (B)	I	II
(C)	II	I
(D)	II	II

40. A wire carries a current of 20.0 A in a direction of 40.0° with respect to the direction of a 50.0 T magnetic field. What is the magnitude of the force on 2.0 m of the wire?

(A) 13 N
(B) 2.0×10^1 N Drop since answer not there. Correct answer: 1.3×10^3 N
(C) 31 N
(D) 8.0×10^2 N

41. How much energy does a photon of red light have if $\lambda = 650$ nm?

(A) 2.1×10^{-19} J
✔ (B) 3.1×10^{-19} J
(C) 3.1×10^{-14} J
(D) 2.1×10^7 J

42. Which is used in the production of movie sound?

(A) deBroglie waves
(B) diffraction
✔ (C) photoelectric effect
(D) resistance

43. If the stopping potential of a photoelectric cell is 5.60 V, what is the maximum kinetic energy of the photoelectrons emitted?

(A) 2.90×10^{-20} J
✔ (B) 8.96×10^{-19} J
(C) 5.60×10^{1} J
(D) 3.50×10^{19} J

44. What happens to the deBroglie wavelength of an electron if its momentum is doubled?

✔ (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

45. Which property does the Compton Effect describe about photons?

(A) mass
✔ (B) momentum
(C) wave properties
(D) speed rates

46. What is the energy of the emitted photon when an electron drops from the third energy level to the second energy level?

(A) 1.51 eV
✔ (B) 1.89 eV
(C) 2.27 eV
(D) 4.91 eV

47. How many neutrons are in the nucleus of $^{205}_{82}Pb$?

(A) 82
✔ (B) 123
(C) 205
(D) 246

48. What is missing in the nuclear decay process below?

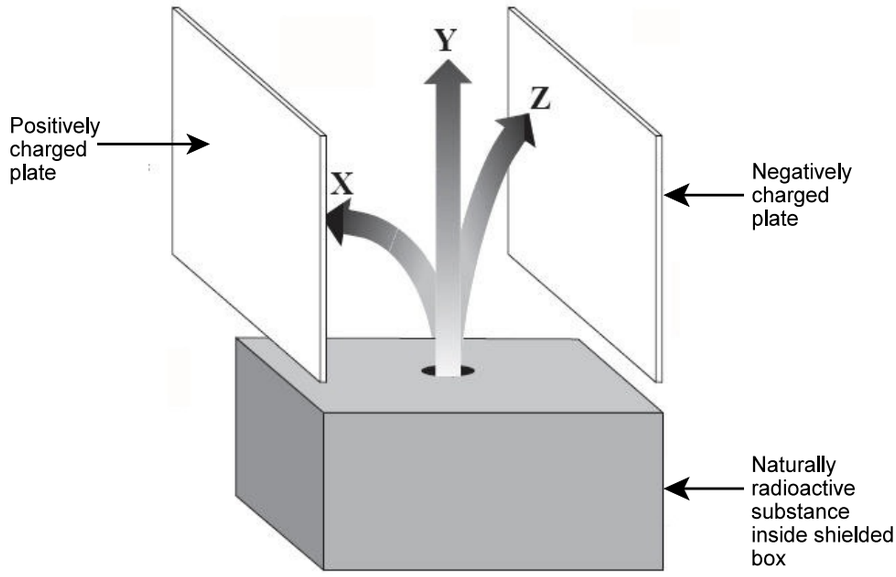
$$^{90}_{39}Y \rightarrow ^{90}_{38}Sr + ?$$

(A) photon and alpha particle
(B) photon and neutrino
(C) positron and alpha particle
✔ (D) positron and neutrino

49. An isotope of krypton has a half-life of 3 minutes. If a sample of this isotope produces 1000 counts per minute in a Geiger counter, how many counts per minute are produced after 15 minutes?

(A) 0
(B) 15
✔ (C) 30
(D) 60

50. What types of radiation are passing through the electric field in the diagram below?



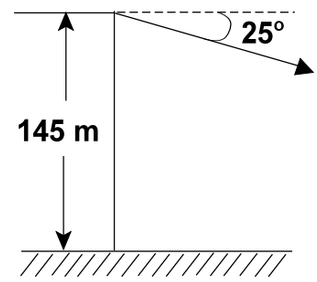
		X	Y	Z
	(A)	alpha	beta	gamma
	(B)	alpha	gamma	beta
	(C)	beta	alpha	gamma
✔	(D)	beta	gamma	alpha

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

4% 51.(a) The diagram below represents a cannon located on a 145 m high cliff. If the cannon fires a cannonball at a 25° angle below the horizontal, with an initial velocity of 75.0 m/s, how far will the cannonball travel in the horizontal direction before it hits the ground?



dy = -145 m
V_1 = 75.0 m/s
V_{1x} = cos 25° x 75.0 m/s = 68 m/s
V_{1y} = -sin 25° x 75.0 m/s = - 31.7 m/s

<u>Vertical Motion</u>:

$$\vec{v}_{2y}{}^2 = \vec{v}_{1y}{}^2 + 2\vec{a}_y\vec{d}_y$$

$$\vec{v}_{2y} = \sqrt{\vec{v}_{1y}{}^2 + 2\vec{a}_y\vec{d}_y}$$

$$v_{2y} = \sqrt{(31.7m/s)^2 + 2(-9.80m/s^2)^2(-145m)}$$

= 62.0 m/s [down] or -62 m/s

:

$$\vec{v}_{2y} = \vec{v}_{1y} + \vec{a}_y t$$

-62.0 m/s = -31.7m m/s + -9.80 m/s² x t

$\frac{-30.0\ m/s}{-9.80\ m/s^2}$ = t

3.09 s = t

<u>Horizontal Motion</u>:

$$\vec{d}_x = \vec{v}_x \times t$$

= 68 m/s x 3.09 s = 210 m

The cannonball will travel 210 m in the horizontal direction before hitting the ground.

Value

3% (b) A juggler throws a ball at a 70° angle to the horizontal from a height of 1.6 m. If the room is 2.8 m high, what is the maximum velocity at which the ball can be thrown to avoid hitting the ceiling?

Displacement in the vertical direction (dy) = 2.8 m -1.6 m = 1.2 m

$$\bar{v}_{2y}^{\,2} = \bar{v}_{1y}^{\,2} + 2\bar{a}_y\bar{d}_y \qquad \sin\theta = \frac{\bar{v}_{1y}}{\bar{v}}$$

$$v_{1y} = \sqrt{23.5 m/s}$$

$0 m/s^2 = v_{1y}^2 + 2(-9.80 m/s^2)(1.2 m)$

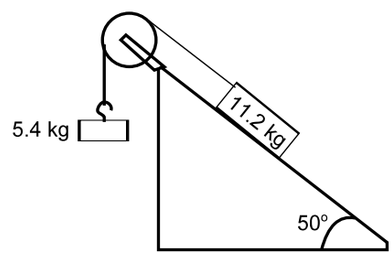
$\sin 70^0 = \frac{4.85 \text{ m/s}}{V}$

= 4.85 m/s

V = 5.2 m/s

The maximum velocity at which the ball can be thrown to avoid hitting the ceiling is 5.2 m/s.

5% 51.(c) The diagram below shows two masses connected by a string over a frictionless pulley. Given the 11.2 kg mass is sliding down the incline,



$$\bar{a} = \frac{\bar{F}_{net}}{m}$$

(i) If there is no friction on the incline, find the magnitude of the acceleration of the system.

$F_{net} = F_{(11.2kg)} + F_{(5.4kg)}$

$m_{total} = (5.4kg + 11.2kg) = 16.6 kg$

$a = \frac{F(_{11.2kg}) + F(_{5.4kg})}{16.6 kg}$

$= \frac{(+\sin 50^0)(11.2kg)(9.80 m/s^2) + 5.4kg)(9.80)}{16.6 kg}$

$= 1.88 m/s^2$

The magnitude of the acceleration of the system is 1.88 m/s²

(ii) What is the tension in the string?

Isolate and let 5.4kg= #1: $F_{net\ \#1} = m_{\#1} \times a$

$T + -m_{\#1}g = m_{\#1} \times a$

$T = m_{\#1} \times a + m_{\#1}g$

$T = (5.4 kg) \times 1.88 m/s^2) + (5.4 kg \times 9.80 m/s^2)$

= 63 N

The tension in the string is 63 N.

Value

4% (d) A 12.0 kg object is on an incline making a 27.0° angle to the horizontal. The coefficient of kinetic friction, μ_k, is 0.200.

(i) What is the magnitude of the net force, parallel to the surface of the incline, on the object?

$$Ffr = \mu k.mg \cos\theta$$

$$F_{\parallel} = mg \sin\theta$$

F net =(mg sin θ)- (uk .mg cos θ)

= (12kg)(9.80m/s^2)(sin27^0) - (0.200)(12kg)(9.80m/s^2)(cos27^0)

= 32.4 N

The net force, parallel to the surface of the incline, on the object is 32.4N.

(ii) If the object starts from rest, what is its velocity after 1.2 s?

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$

a = $\frac{F_{net}}{m}$ = $\frac{32.4\ N}{12.0\ kg}$ = 2.70 m/s^2

$$\vec{v}_2 = \vec{v}_1 + \vec{a}t$$

$v_2 = v_1 + at$
= 0 m/s +(2.70 m/s^2)(1.2s)
= 3.2 m/s [down incline]

The velocity after 1.2 s is 3.2 m/s down the incline.

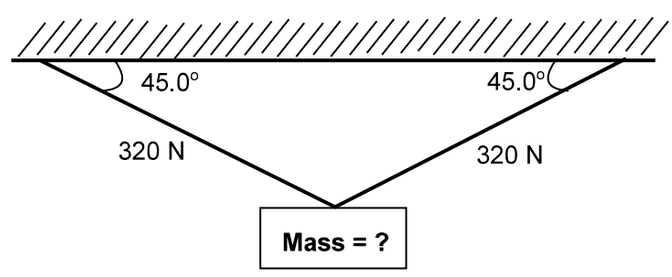
2% 51.(e) A car moves at 25 m/s around a level curve with a 50.0 m radius. The centripetal force provided by the friction between the tires and the road is 1.8 x 10^4 N. What is the mass of the car?

$$F_c = \frac{mv^2}{r}$$

m = $\frac{Fc \times r}{v^2}$ = $\frac{1.8 \times 10^4\ N \times 50.0\ m}{(25\ m/s)^2}$ = 1440 kg = 1.4 x10^3 kg

The mass of the car is 1.4 x 10^3 kg

2% (f) The object below is suspended from a ceiling by two wires. Calculate the mass of the object from the information given in the diagram.



Forces upward = Forces downward

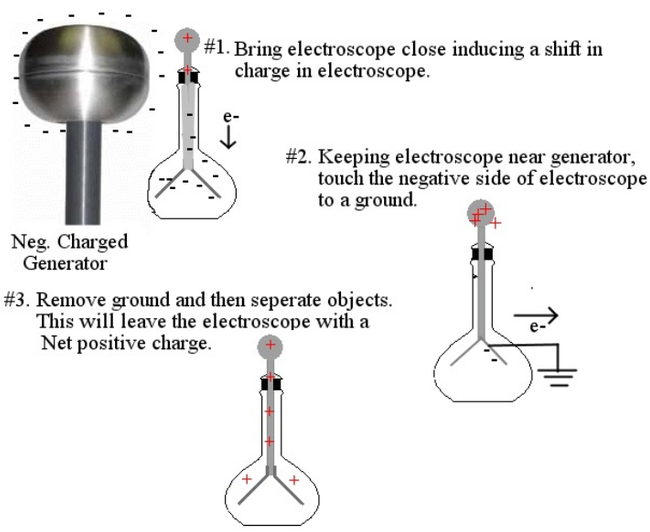
2 x (sin45^0 x 320 N) = m x 9.80 N/kg

m = $\frac{452.5\ N}{9.80\ N/kg}$ = 46 kg

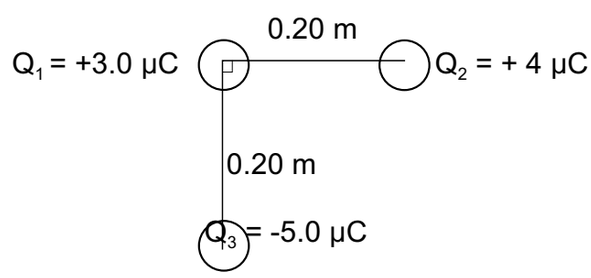
The mass of the object is 46 kg.

Value

3% 52.(a) Using diagrams, explain how a negatively charged Van de Graaf generator can be used to induce a permanent positive charge on a neutral electroscope.



3% 52.(b) What is the magnitude of the net force on Q_1 in the diagram below?



$$\vec{F} = \frac{kq_1q_2}{r^2}$$

$$F_{2on1} = \frac{(9.0 \times 10^9\ N.m^2/C^2)(3.0 \times 10^{-6}\ C)(4.0 \times 10^{-6}\ C)}{(0.2\ m)^2} = 2.7\ N$$

$$\vec{F} = \frac{kq_1q_3}{r^2}$$

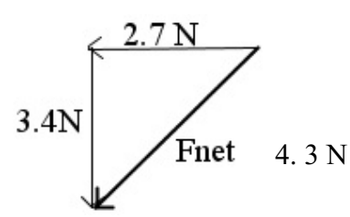
$$F_{3on1} = \frac{(9.0 \times 10^9\ N.m^2/C^2)(3.0 \times 10^{-6} C)(5.0 \times 10^{-6} C)}{(0.2\ m)^2} = 3.4\ N$$

$$\vec{F}_{net} = \vec{F}_{2on1} + \vec{F}_{3on1}$$

= 2.7 N [L] + 3.4 N [S]

$$\vec{F}net = \sqrt{(2.7N)^2 + (3.4N)^2}$$

=

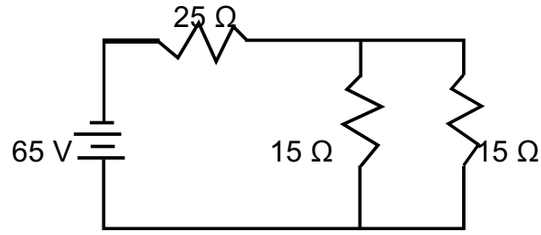


4. 3 N

The magnitude of the net force on Q_1 is 4.3 N.

Value

3% (c) For the circuit below, calculate:



(i) the total resistance;

$$\frac{1}{R_{\|}} = \frac{1}{15}\Omega + \frac{1}{15}\Omega = \frac{2}{15}\Omega \qquad R_0 = R_1 + R_{\|} = 25\Omega + 7.5\Omega = 33\Omega$$

$$R_{\|} = \frac{15}{2}\Omega = 7.5\Omega$$

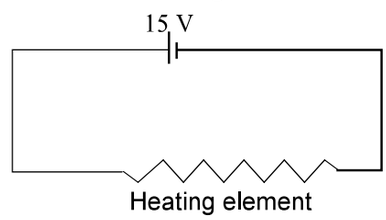
The total resistance is 33 ohms.

(ii) the current through the 25 Ω resistor;

$$I_0 = \frac{V_0}{R_0} = \frac{65v}{32.5\Omega} = 2.0A$$

The total current through the 25 ohm resistor is 2.0 A

3% 52.(d) A power supply is connected to a heating element in the diagram below.



(i) If a total of 5.0×10^{20} electrons pass any point in the heating element circuit in 40.0 s, calculate the current flowing from the element.

Q =N x e = 5.0 x 10^{20} x 1.60 x 10^{-19}C = 80.0 C

I = $\frac{Q}{t}$ = $\frac{8.0 \times 10^{1}\ C}{40.0\ s}$ = 2.0 A *The current flowing from the element is 2.0 A*

(ii) Calculate the amount of power dissipated in the circuit.

P = V x I
= 15 v x 2.0 A
= 15 J/C x 2.0 C/s
= 30 J/s = 30 W

The power dissipated in the circuit is 30 W.

Value

2% (e) Why is using a cell phone a greater risk for cancer than using a typical household telephone?

The cell phone has within it an electromagnetic or radio wave transmitter.

It is felt that prolonged exposure to high energy electromagnetic waves can cause cell damage which is related to cancer.

3% 52.(f) An electron travels in a path perpendicular to a 1.00×10^{-3} T magnetic field. If the radius of the circular path is 2.0 cm, how fast must the electron be traveling?

$$F_{mag} = F_{centripetal}$$

$$q\,v\,B = \frac{mv^2}{r}$$

$$q\,v\,B = \frac{mv^2}{r}$$

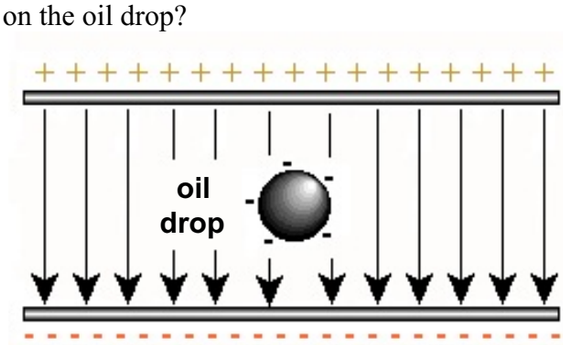
$$q\,B = \frac{m\,v}{r}$$

$$v = \frac{q\,B\,r}{m} = \frac{(1.6 \times 10^{-19}C)(1.00 \times 10^{-3}T)(2.0 \times 10^{-2}m)}{9.11 \times 10^{-31}\ kg}$$

$$v = 3.5 \times 10^{6}\ m/s$$

The electron is traveling 3.5×10^{6} m/s.

3% (g) An oil drop with a mass of 9.80×10^{-16} kg is suspended between two horizontal parallel charged plates. If the electric field strength is 2.0×10^{4} N/C, how many electrons are on the oil drop?



Force $_{upward}$ = Force $_{downward}$

Force $_{electric}$ = Force $_{grav}$.

$$\vec{F}_e = \vec{q}\varepsilon$$

$$F_g = mg$$

$$F_e = F_{grav}$$

$$2.0 \times 10^{4} N/C \times q = 9.80 \times 10^{-16}\ kg \times 9.80\ N/kg$$

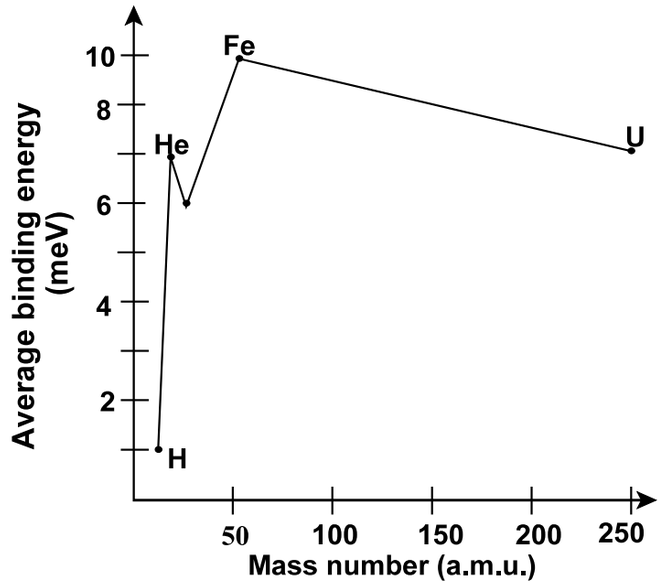
$$q = 4.8 \times 10^{-19}\ C$$

$$N_e = \frac{q}{} = \frac{4.8 \times 10^{-19}\ C}{1.6 \times 10^{-19}\ C/e} = 3 \text{ electrons}$$

There are 3 electrons on the oil drop.

Value

3% 53.(a) Use the graph below to determine the heaviest element likely to be produced from fusion. Explain your answer.



Iron (Fe) is the heaviest element likely to be produced by fusion.

As lighter, less stable nuclei fuse together, they produce larger, more stable nuclei.

Since iron has the greatest binding energy, it is the most stable nucleus and

most energy to break it apart and overcome the strong interactive force.

An attempt to fuse nuclei to form elements heavier than iron will result in a less

rather than a more stable product.

2% (b) The half-life of $^{24}_{11}Na$ is 15.0 hours. How many atoms of $^{24}_{11}Na$ will remain in a sample that decayed for 60.0 hours if it initially contained 6.40×10^{10} atoms?

$T_{½} = 15.0$ h

T = 60.0 h

No = 6.4×10^{10} atoms

$$N = No(1/2)^{T/T_{1/2}}$$

$$N = 6.40x10^{10}(1/2)^{60/15}$$

$$N = 6.40x10^{10}(1/2)^{4}$$

$$N = 6.40x10^{10}x\frac{1}{16} = 4.00x10^{9}$$

There are 4.00 x 10^9 atoms of sodium 11 remaining .

Value

3% 53.(c) Use the data below to calculate the energy released in the reaction,

$$^{3}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + 2\,^{1}_{0}n$$

mass of $^{3}_{1}H$ = 5.007×10^{-27} kg

mass of $^{4}_{2}He$ = 6.644×10^{-27} kg

mass of $^{1}_{0}n$ = 1.6749×10^{-27} kg

<u>Mass of Reactants:</u>
$2 \times 5.007 \times 10^{-27}$kg=$10.014 \times 10^{-27}$kg

<u>Mass of Products:</u>
6.644×10^{-27}kg +($2 \times 1.6749 \times 10^{-27}$kg)= 9.994×10^{-27} kg

Mass difference= Mass of Reactants - Mass of Products
= 10.014×10^{-27} kg - 9.994×10^{-27} kg = 0.020×10^{-27} kg = 2.0×10^{-29} kg

$E = mc^2 = 2.0 \times 10^{-29}$ kg x $(3.00 \times 10^{8}$m/s$)^2 = 1.8 \times 10^{-12}$ J

There are 1.8×10^{-12} J of energy released.

2% (d) Using the equation from (c) above, calculate the amount of energy released in the production of 1.00×10^{-6} kg of $^{4}_{2}He$?

4 atomic mass units = $4(1.66 \times 10^{-27}$ kg) = 6.644×10^{-27} kg

$$\frac{1.00 \times 10^{-6}\ \text{kg}}{6.644 \times 10^{-27}\ \text{kg}} = \frac{x}{1.8 \times 10^{-12}\ \text{J}}$$

$$x = 1.8 \times 10^{-12}\ \text{J} \times \frac{1.00 \times 10^{-6}}{6.644 \times 10^{-27}}$$

x = 2.7×10^{8} J of Helium produced

There are 1100 MJ per mg of Helium produced.