PART I
Total Value: 50%

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

1. A golfer hits a golf ball with a velocity of 75 m/s at an angle of 15° to the horizontal. What are the horizontal and vertical components of the initial velocity?

	Horizontal (m/s)	Vertical (m/s)
(A)	0	75
(B)	19	72
(C)	72	19
(D)	75	0

2. A stone is thrown horizontally from the edge of a cliff and lands in the water below. If the stone is in the air for 2.8 s, how high is the cliff?

   (A)   14 m
   (B)   27 m
   (C)   38 m
   (D)   77 m

3. A swimmer runs horizontally off the end of a wharf at 1.2 m/s and lands in the water 2.4 s later. How far does she have to swim to get back to the wharf?
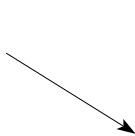
   (A)   0.50 m
   (B)   2.0 m
   (C)   2.9 m
   (D)   5.8 m

4. A football is kicked and follows a parabolic path. Which represents the velocity of the football at its maximum height?

   (A)

   (B)

   (C)

   (D)

5. A plane flying horizontally with a speed of 50.0 m/s at a height of 161 m, drops a package when it is directly over a tent. How far from the tent will the package land?

    (A)   161 m
    (B)   169 m
    (C)   287 m
    (D)   1640 m

6. A stone is thrown upward from the top of a building at an angle of 30.0° to the horizontal with an initial speed of 20.0 m/s. If the stone lands on the ground 4.22 s later, how tall is the building?

   (A)   14.2 m
    (B)   21.5 m
    (C)   45.1 m
    (D)   129 m

7. What normal force acts on the object shown, when it is pulled to the right on a frictionless surface by a force of 211 N at an angle of 25.0° to the horizontal?

    211 N

    25.0°

    40.0 kg
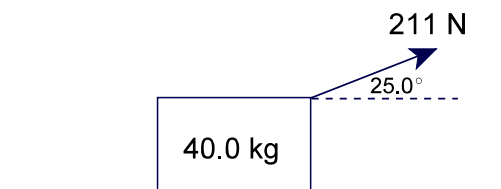
    (A)   201 N
    (B)   303 N
    (C)   392 N
    (D)   481 N

8. In the diagram shown, the acceleration of the system is 4.6 m/s². What is the force of friction acting on the 6.0 kg box?
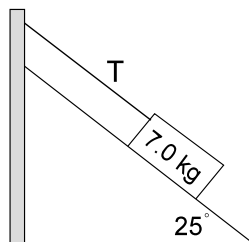
    6.0 kg

    Direction of motion

    8.0 kg
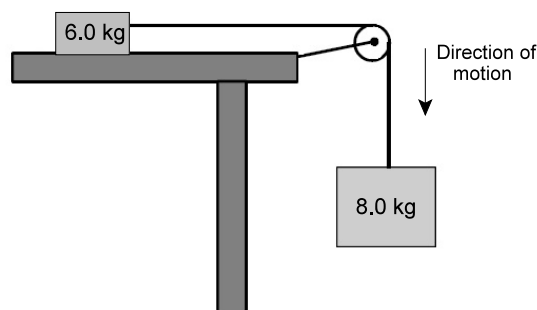
    (A)   14 N
    (B)   42 N
    (C)   64 N
    (D)   78 N

9. If the box shown below slides down the frictionless incline with an acceleration of 4.90 m/s², what is the angle of the incline?

    4.00 kg
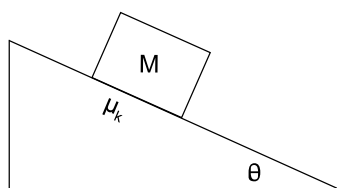
    θ
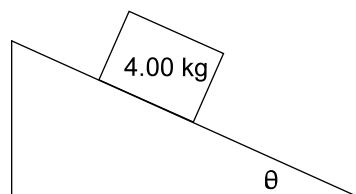
   (A)   15.0°
    (B)   30.0°
    (C)   45.0°
    (D)   60.0°

10. A box is held at rest on a frictionless incline as shown below. What is the tension, T, in the rope?

(A) 29 N
(B) 32 N
(C) 62 N
(D) 69 N

11. A block of mass M slides down an incline having a coefficient of kinetic friction, μ_k. What is the acceleration of the block?

(A) $Mg\sin\theta$
(B) $g\sin\theta - \mu_k g$
(C) $g(\sin\theta - \mu_k\cos\theta)$
(D) $g(\cos\theta - \mu_k\sin\theta)$

12. A rubber stopper spins in a horizontal circle on the end of a 1.2 m long string. If the stopper moves at a speed of 3.2 m/s, what is its acceleration?

(A) 0.12 m/s^2
(B) 0.38 m/s^2
(C) 2.7 m/s^2
(D) 8.5 m/s^2

13. The diagram below shows a ball on the end of a string moving at a constant speed in a horizontal circle. A target is located near the path of the ball as shown. At which point should the ball be released in order to hit the target?
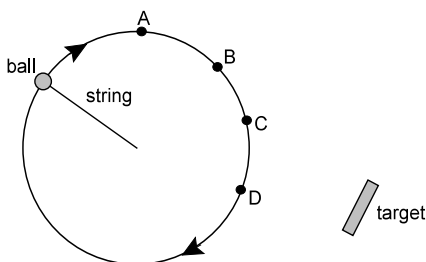
(A) A
(B) B
(C) C
(D) D

14. What is the speed of a planet that travels in a circular path of radius 3.85×10^8 m, and has a period of 27.3 days?

(A) 5.13×10^2 m/s
(B) 1.03×10^3 m/s
(C) 2.46×10^4 m/s
(D) 2.80×10^4 m/s

15. The diagram below shows a ball, suspended by a string, travelling in a horizontal circular path at a constant speed. Which is the free body diagram for the ball at P?
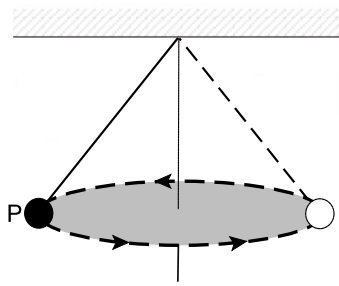
(A)

(B)

(C)

(D)

16. A pilot moving at a speed of 2.50×10^2 m/s, experiences a normal force of seven times his weight at the bottom of a vertical dive. What is the radius of curvature of the dive if it follows a semi-circular path as shown?


    (A)   425 m
    (B)   797 m
    (C)   911 m
    (D)   1060 m

17. If a 75.0 kg boy sits 2.0 m from the pivot point on one side of a seesaw, where must a 50.0 kg girl sit on the other side of the pivot in order to balance the seesaw?

    (A)   0.33 m
    (B)   0.75 m
    (C)   1.5 m
   (D)   3.0 m

18. Which defines static equilibrium?

(A) $\vec{F}_{net} \neq 0, \vec{\tau}_{net} \neq 0$

(B) $\vec{F}_{net} \neq 0, \vec{\tau}_{net} = 0$

(C) $\vec{F}_{net} = 0, \vec{\tau}_{net} \neq 0$

(D) $\vec{F}_{net} = 0, \vec{\tau}_{net} = 0$

19. An 8.50 m long uniform beam of weight 126 N is supported by a rope at each end. If a 433 N person sits 2.00 m from the left end, what is the tension, T, in the rope on the right?
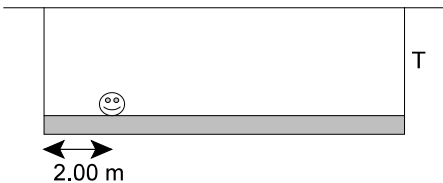

(A) 102 N
(B) 165 N
(C) 228 N
(D) 559 N

20. An object is suspended by two ropes from a ceiling and a wall as shown. What is the tension, T_1, in the rope connected to the ceiling?
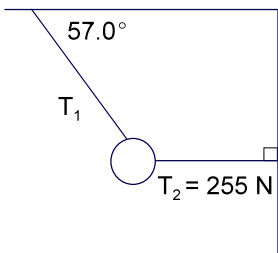

(A) 139 N
(B) 214 N
(C) 304 N
(D) 468 N

21. The diagram below shows four neutral spheres W, X, Y and Z on insulated stands with W touching X and Z touching Y. If a positive rod is placed between the spheres and then spheres W and Z are moved as shown, what are the resulting charges on spheres W and Z?
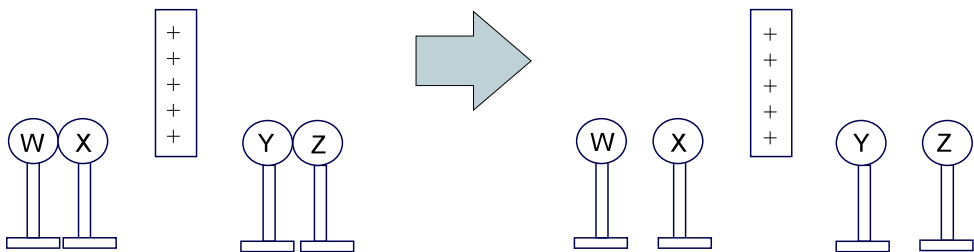
	W	Z
(A)	negative	negative
(B)	negative	positive
(C)	positive	negative
(D)	positive	positive

22. Which shows the electric field lines surrounding oppositely charged objects?

(A)

(B)

(C)

(D)
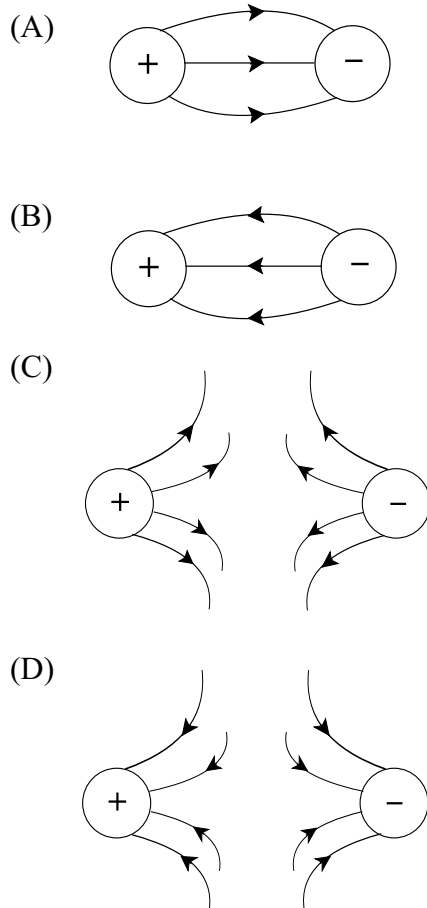
23. What is the magnitude of the electric force between two point charges of 4.5×10^{-6} C and 2.5×10^{-5} C, that are separated by a distance of 0.015 m?

   (A) 7.5×10^{-9} N
   (B) 5.0×10^{-7} N
   (C) 6.8×10^{1} N
   (D) 4.5×10^{3} N

24. Two identical spheres with charges Q_1 and Q_2 are separated by a distance, d. What will happen to the electric force experienced if the charge on one sphere is doubled, and the distance between the spheres is also doubled?

   (A) decrease by a factor of 2
   (B) decrease by a factor of 4
   (C) increase by a factor of 2
   (D) increase by a factor of 4

25. What is the electric field strength 0.25 m away from an object having a charge of 1.5×10^{-6} C?

   (A) 6.0×10^{-6} N/C
   (B) 2.4×10^{-5} N/C
   (C) 5.4×10^{4} N/C
   (D) 2.2×10^{5} N/C

26. Which shows how the electric field strength varies with distance from a charged object?

(A)

(B)

(C)

(D)
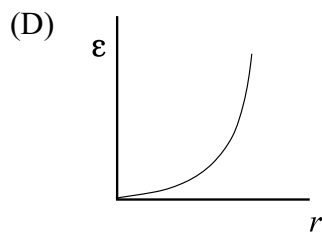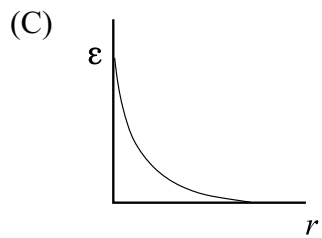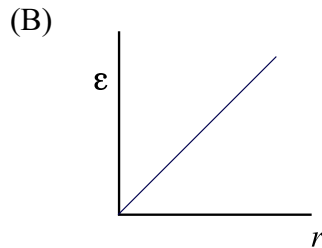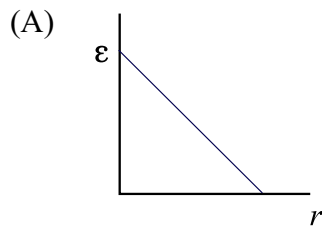
27. If the potential difference across a battery is 6.0 V, how much work is done to move 6.0×10^2 C of charge through a circuit?

(A) 3.6×10^{-3} J
(B) 1.0×10^{-2} J
(C) 1.0×10^2 J
(D) 3.6×10^3 J

28. If a circuit element can withstand a maximum current of 15 A, how many electrons can pass through it each second?

(A) 2.4×10^{-18}
(B) 1.5×10^1
(C) 6.3×10^{18}
(D) 9.4×10^{19}

29. What potential difference must be applied to a 26 Ω resistor to cause a current of 0.50 A to flow through it?

(A)   6.5 V
(B)   13 V
(C)   26 V
(D)   52 V

30.   Copper has a resistivity of 1.7×10^{-8} Ω·m. What is the resistance of a piece of copper wire of length 4.5 m and cross-sectional area 3.1×10^{-6} m²?

   (A) 1.2×10^{-14} Ω
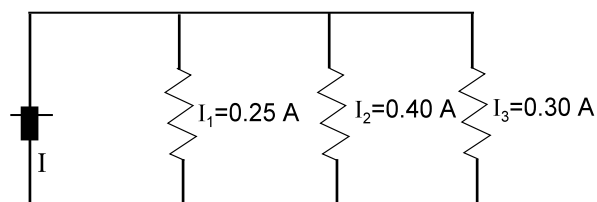   (B) 1.7×10^{-8} Ω
   (C) 2.5×10^{-2} Ω
   (D) 4.1×10^{1} Ω

31.   What is the voltage, V, across the source for the circuit below?
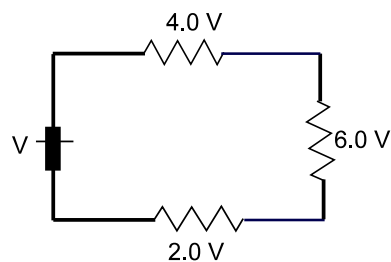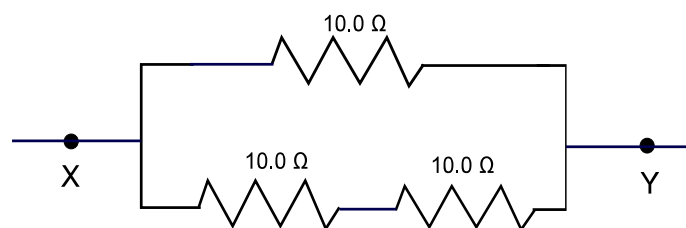

   (A)   1.1 V
   (B)   4.0 V
   (C)   6.0 V
   (D)   12.0 V

32.   What current, I, is coming from the source in the circuit below?

   (A)   0.10 A
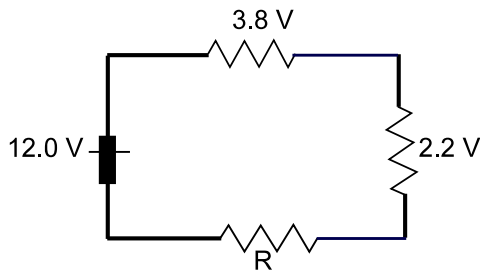   (B)   0.95 A
   (C)   1.1 A
   (D)   9.8 A

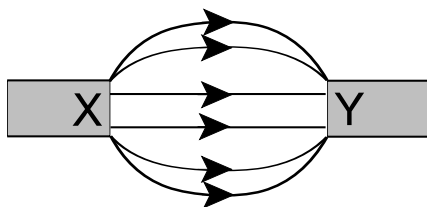33.   What is the total resistance between points X and Y below?

   (A)   3.33 Ω
   (B)   6.67 Ω
   (C)   15.0 Ω
   (D)   30.0 Ω

34.	What value of resistor, R, must be added in the circuit below to give a total resistance of 32 Ω?

(A)	2.0 Ω
(B)	8.0 Ω
(C)	16 Ω
(D)	26 Ω

35.	What is the polarity of X and Y for the magnetic field lines shown below?

	X	Y
(A)	north	north
(B)	north	south
(C)	south	north
(D)	south	south

36.	Which is a similarity between Earth's magnetic and gravitational fields?

(A)	Field lines point only away from Earth.
(B)	Field lines point only toward Earth.
(C)	Field strength is dependent on distance from Earth.
(D)	Field strength is independent of distance from Earth.

37.	An electron moving at 2.00×10^6 m/s through a 1.50 T magnetic field, experiences a force of 2.40×10^{-13} N. What is the angle between the electron's path and the magnetic field lines?

(A)	0°
(B)	30.0°
(C)	60.0°
(D)	90.0°

38. A 0.40 m long copper wire is held perpendicularly to a 0.082 T magnetic field as shown. What is the magnitude and direction of the magnetic force on the copper wire when the switch is closed?
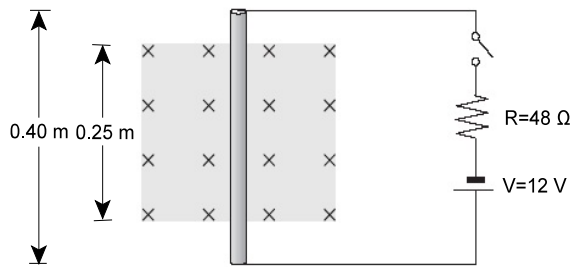
	Magnitude of Force (N)	Direction of Force
(A)	5.1×10^{-3}	left
(B)	5.1×10^{-3}	right
(C)	8.2×10^{-3}	left
(D)	8.2×10^{-3}	right

39. The bar magnet below is moved out of a solenoid as shown. What is the direction of the current induced in the solenoid?
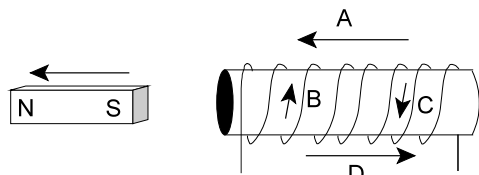
(A) A
(B) B
(C) C
(D) D

40. A student drops a bar magnet downward through a 1.0 m long plastic tube and then through a 1.0 m long copper tube of equal diameter. What will happen to the magnet in each situation?

(A) come to rest about halfway down each tube
(B) take longer to fall through the copper tube
(C) take longer to fall through the plastic tube
(D) take the same time to fall through each tube

41. What is represented by the ratio of the energy of a photon to its frequency?

(A) photon speed
(B) photon wavelength
(C) Planck's constant
(D) speed of light

42. Blue light is shone on a metal surface and electrons are ejected at a given rate and with a certain amount of energy. If the intensity of the blue light is increased, which describes the rate and the energy per electron of the ejected electrons?

	Rate	Energy per Electron
(A)	decreases	constant
(B)	increases	constant
(C)	constant	decreases
(D)	constant	increases

43. What is the wavelength of a photon having an energy of 2.12 eV?

(A) 5.86×10^{-7} m
(B) 6.04×10^{-7} m
(C) 6.42×10^{-7} m
(D) 7.12×10^{-7} m

44. By what factor does the energy of a photon change if its wavelength is halved?

(A) ¼
(B) ½
(C) 2
(D) 4

45. What is the orbital radius of an electron in the third energy level of a hydrogen atom?

(A) 1.76×10^{-11} m
(B) 5.29×10^{-11} m
(C) 1.59×10^{-10} m
(D) 4.76×10^{-10} m

46. The diagram below shows spectral lines for hydrogen when viewed through a spectroscope. Which line corresponds to an electron transition from energy level 3 to energy level 2?
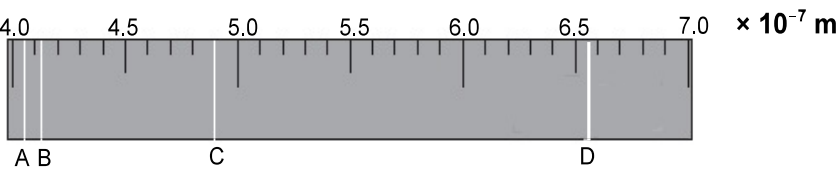
(A) A
(B) B
(C) C
(D) D

47. In case of a power failure, doors and stairways in large buildings are often outlined with special paint that glows for some time after the lights go out. What is illustrated in this situation?

(A) black-body radiation
(B) fluorescence
(C) phosphorescence
(D) photoelectric effect

48.   Which isotope is produced when $^{214}_{83}\text{Bi}$ decays by emitting an alpha particle?

(A) $^{210}_{79}\text{Au}$

(B) $^{212}_{79}\text{Au}$

(C) $^{210}_{81}\text{Tl}$

(D) $^{212}_{81}\text{Tl}$

49.   Which describes the atomic number and mass number of a nucleus that has emitted a beta particle?

	Atomic Number	Mass Number
(A)	changes	changes
(B)	changes	constant
(C)	constant	changes
(D)	constant	constant

50.   The half-life of a radioactive material is 14.7 years. How long will it take for a sample of this material to decay to 2.50% of its initial amount?

(A)   29.4 years
(B)   58.8 years
(C)   78.2 years
(D)   147 years

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) Ball A is rolled down a 30.0° ramp on a 1.0 m high table, and exits the table horizontally at 2.0 m/s. A second identical ball B, is rolled down the same ramp but exits the table with a speed of 2.0 m/s at a 30.0° angle. Calculate which ball will travel the greatest horizontal distance from the base of the table.
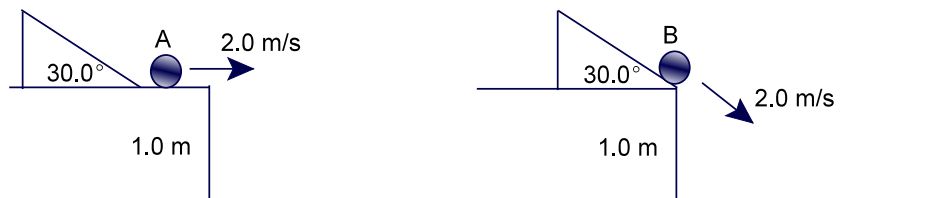
3%   (b) A fish sees a bug on a tree branch that is 4.1 m above the water, and tries to knock it down by shooting a jet of water with an initial velocity of 11.7 m/s at an angle of 35° to the surface of the water. With the aid of a diagram, calculate whether it is possible for the angler fish to hit the bug.

4%   51.(c) The diagram below shows two blocks connected by a massless string over a frictionless pulley. Calculate the acceleration of the system of blocks.
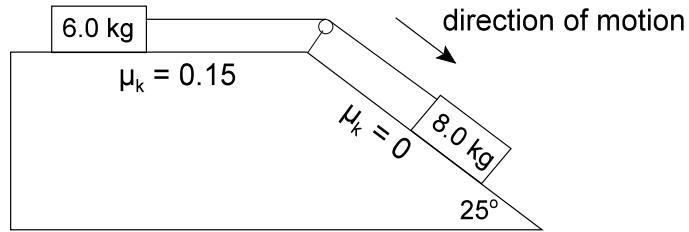

3%   (d) In an automatic clothes dryer a hollow drum moves the clothes in a vertical circle of diameter 0.75 m. The dryer is designed so that the clothes tumble and do not simply stick to the drum as it rotates. Calculate the speed at which the drum must rotate so that a 0.425 kg sweater at the top of the drum will just begin to tumble.

3%   51.(e) In the diagram below, spring scales are used to measure the tension in each string supporting the 1.95 kg mass. Calculate whether the system is in static equilibrium.

14.0 N

16.0 N

35.0 °   44.0 °

1.95 kg
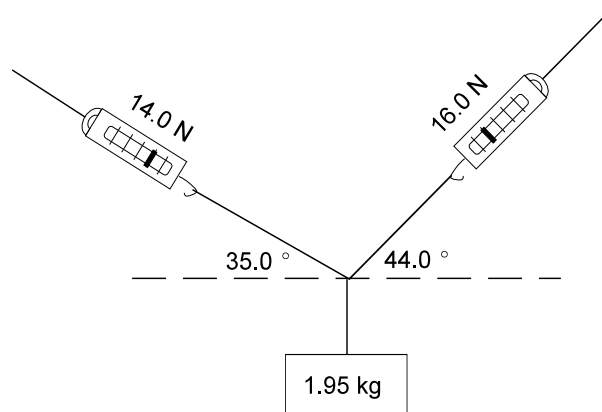
3%   (f)   A 4.00 m long uniform beam is supported by a pivot at one end and a cable at the other end. The beam has a mass of 15.0 kg and supports a 25.0 kg box as shown. Calculate the tension, T, in the cable.
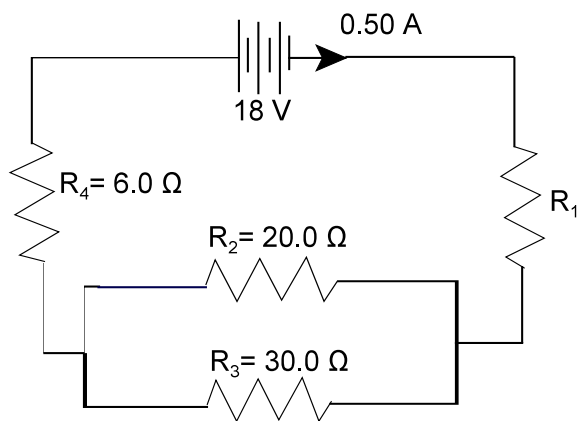
55.0°

25.0 kg

T

P

1.50 m
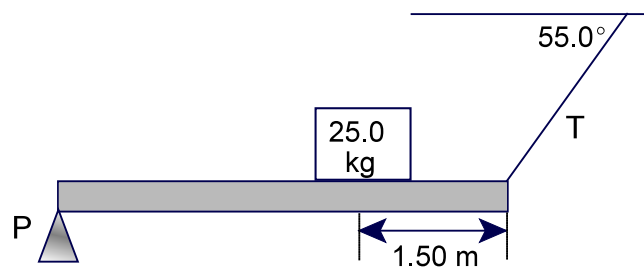
4%   52.(a) Three charged objects are arranged as shown. Calculate the magnitude and direction of the net electric force on object B due to the presence of objects A and C.

$+3.0 \times 10^{-6}$ C $+2.0 \times 10^{-6}$ C -1.5×10^{-6} C

(A)   (B)   (C)

|← —— 0.25 m ——→|← —— 0.15 m ——→|
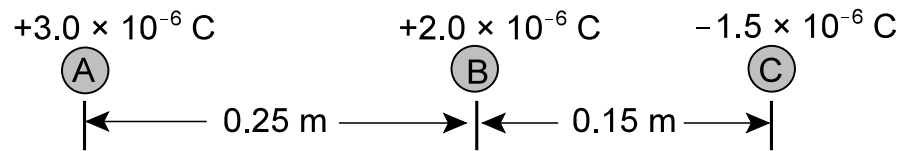
5%   (b)   For the circuit shown below, calculate:

0.50 A

18 V

$R_4 = 6.0\ \Omega$

R_1

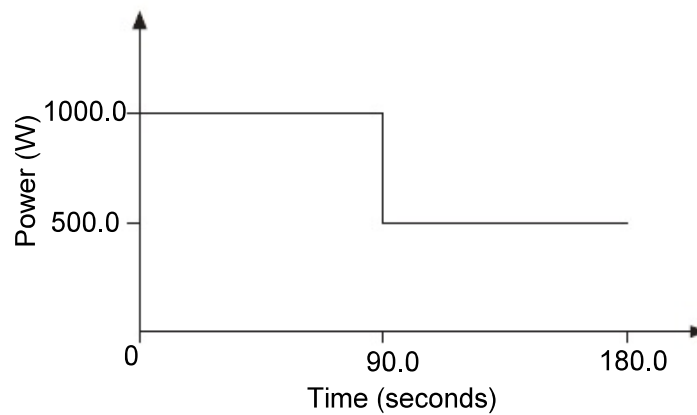$R_2 = 20.0\ \Omega$

$R_3 = 30.0\ \Omega$

i)   the resistance of R_1.

ii)   the power dissipated in R_4.

iii)   the voltage drop across R_2.

3%   52.(c) An electrical appliance runs from a 240 V power supply. A graph of power versus time for this appliance is shown below.

i)   Use the graph to determine the energy dissipated by the appliance in the first 180.0 seconds.

ii)   Determine the resistance of the appliance when its power consumption is 1000.0 W.

3%   (d)   An electron is moving parallel to a straight conductor that is carrying 8.5 A of current. The electron is 0.015 m away from the conductor and is moving at 7.5×10^5 m/s, in the same direction as the current. Calculate the force on the electron (magnitude and direction).
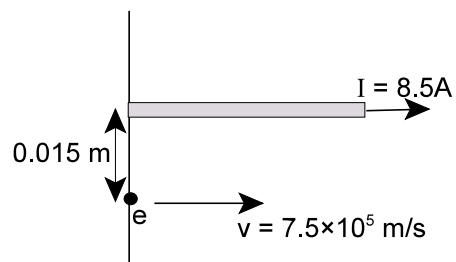
3%   52.(e) A 0.16 kg metal rod is placed in a horizontal magnetic field of 0.75 T and maintains contact with two vertical metal rails that are separated by a distance of 0.080 m. Calculate the current that must flow through the rod in order for it to remain at rest.

metal rod

metal rails   0.080 m
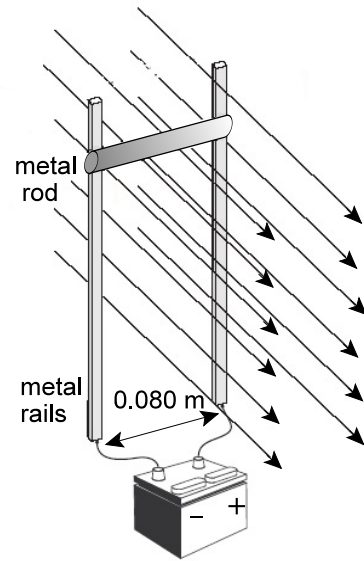
2%   (f)   Two people are talking to one another on their identical cell phones. Person A holds the phone 2.0 cm from his ear, while Person B holds it 6.0 cm from her ear. Explain which person will receive the greatest intensity of radio frequency radiation and state by what factor it is greater.
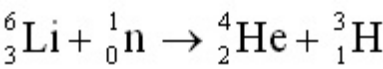
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3%   53.(a) Calculate the maximum wavelength that will cause photoelectric emission from a metal surface having a work function of 2.00 eV.

2%   (b)   Calculate the energy released in the reaction shown below.

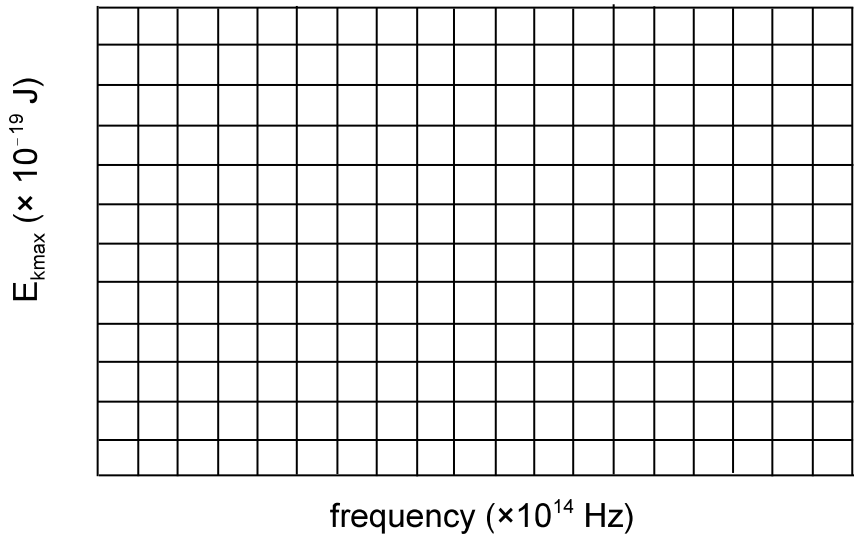$$_{3}^{6}\text{Li} + {}_{0}^{1}\text{n} \rightarrow {}_{2}^{4}\text{He} + {}_{1}^{3}\text{H}$$

Particle	Mass (u)
$_{3}^{6}\text{Li}$	6.01513
$_{0}^{1}\text{n}$	1.00867
$_{2}^{4}\text{He}$	4.0026
$_{1}^{3}\text{H}$	3.01604

3%   53.(c) In a photoelectric effect experiment, light was shone on a metal surface and the
               data below were recorded.

Frequency of incident light ($\times 10^{14}$ Hz)	Maximum kinetic energy of ejected electrons ($\times 10^{-19}$ J)
6	1
7	1.6
8	2.3
9	2.9

        i)   Graph these results, including the line of best fit.

                                frequency ($\times 10^{14}$ Hz)

        ii)   Use the graph to determine the work function for this metal surface.

2%   (d)   State two arguments to support, or two arguments to oppose, nuclear energy
               production.

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