

PART I
Total Value: 50%

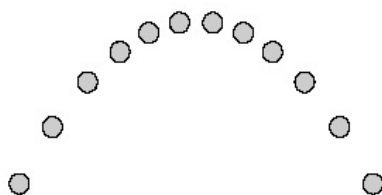
Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided.

1. A person runs horizontally off the end of a cliff and lands in the water 1.3 s later. How high is the cliff?

(A) 1.6 m
(B) 6.4 m
(C) 8.3 m
(D) 13 m
2. A marble is launched horizontally from a table at 12 m/s and lands on the floor 0.25 s later. What is the range of the marble?

(A) 0.021 m
(B) 0.31 m
(C) 3.0 m
(D) 48 m

3. Which describes a ball thrown in the air that traces the path shown?



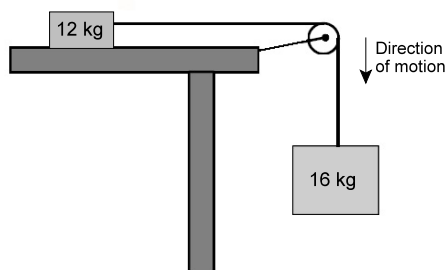
- (A) The acceleration of the ball at the top of its motion is zero.
 - (B) The acceleration of the ball keeps changing.
 - (C) The velocity of the ball at the top of its motion is zero.
 - (D) The velocity of the ball keeps changing.
4. A projectile is launched with an initial velocity of 14 m/s at an angle of 25° above the horizontal. What is the speed of the projectile at its maximum height?

(A) 0 m/s
(B) 5.9 m/s
(C) 13 m/s
(D) 14 m/s
5. A golf ball is hit from ground level with an initial velocity of 63 m/s at an angle of 31° above the horizontal. How long will it take the ball to hit the ground?

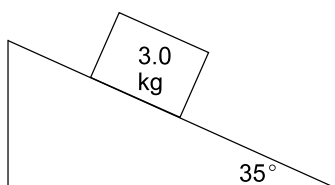
(A) 3.3 s
(B) 5.5 s
(C) 6.6 s
(D) 11 s
6. A marble is launched horizontally from the top of a building. How far has the marble fallen when the vertical component of its velocity is 16 m/s [down]?

(A) 0.82 m
(B) 1.6 m
(C) 13 m
(D) 26 m

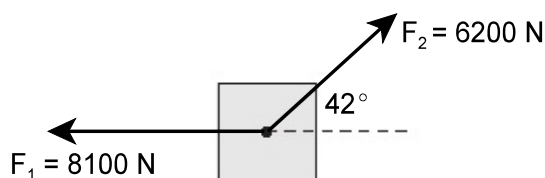
7. If the table below is frictionless, what is the acceleration of the 12 kg mass?



- (A) 1.4 m/s^2
(B) 5.6 m/s^2
(C) 9.8 m/s^2
(D) 13 m/s^2
8. What force of friction acts on the object shown, if it slides down the incline at a constant velocity?

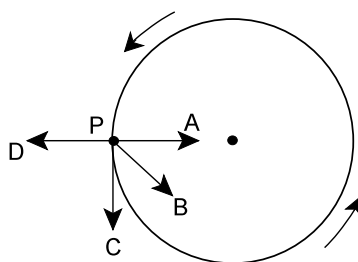


- (A) 17 N
(B) 21 N
(C) 24 N
(D) 29 N
9. Two forces act on an object of negligible mass as shown below. What is the magnitude of a third force which must act on the object so that it will be in translational equilibrium?

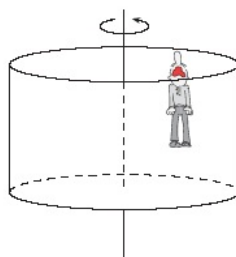


- (A) 3500 N
(B) 4100 N
(C) 4600 N
(D) 5400 N
10. An object travels along a horizontal circular path at a constant speed. By what factor will the centripetal force change if the radius is halved?
- (A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 2
(D) 4
11. What is the acceleration of a car that goes around a curve of radius 150 m at a constant speed of 30.0 m/s?
- (A) 0 m/s^2
(B) 0.20 m/s^2
(C) 5.0 m/s^2
(D) 6.0 m/s^2

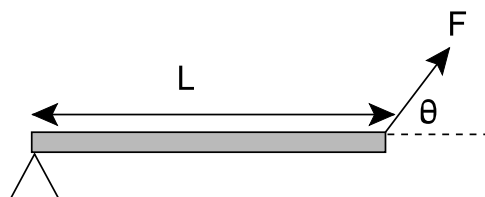
12. The diagram below shows an object moving at a constant speed in a horizontal circle. What is the direction of the acceleration at point P?



- (A) A
(B) B
(C) C
(D) D
13. What is the centripetal force on an object of mass 0.200 kg, that is spinning at 6.40 m/s in a horizontal circle of radius 0.350 m?
- (A) 2.87 N
(B) 3.66 N
(C) 23.4 N
(D) 117 N
14. What banking angle is required for a car to complete a 110.0 m radius frictionless turn at 24.5 m/s without skidding?
- (A) 29.1°
(B) 33.8°
(C) 56.2°
(D) 60.9°
15. A person of mass, m , on a carnival ride stands inside a large drum that begins to rotate. When a safe speed is reached, the floor of the drum falls away and the rider is left “stuck” to the wall. What is the minimum speed at which the drum can turn so that the person does not fall?



- (A) $v = \sqrt{rg}$
(B) $v = \frac{rg}{\mu_s}$
(C) $v = \sqrt{\frac{rg}{\mu_s}}$
(D) $v = rg$
16. Which expression gives the torque about the pivot produced by the force, F , in the diagram below?

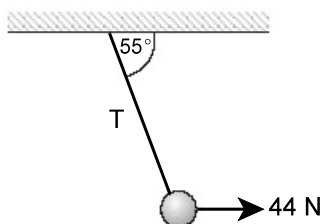


- (A) $\tau = FL$
(B) $\tau = \frac{F}{L}$
(C) $\tau = FL \cos \theta$
(D) $\tau = FL \sin \theta$

17. A 6.2 kg mass rests on a beam at 1.6 m from the pivot point. What mass must rest at 2.3 m on the opposite side of the pivot in order to balance the beam?

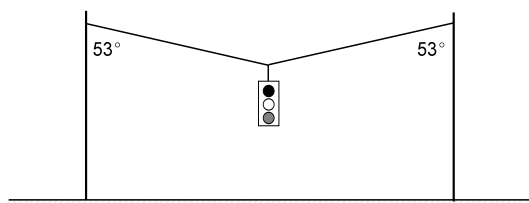
(A) 0.11 kg
(B) 0.23 kg
(C) 4.3 kg
(D) 8.9 kg

18. A mass suspended by a rope is held stationary by a horizontal force of 44 N as shown. What is the magnitude of the tension, T , in the rope?



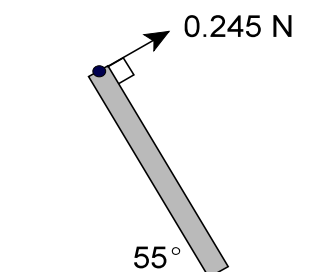
(A) 25 N
(B) 36 N
(C) 54 N
(D) 77 N

19. A traffic light is held stationary by two wires as shown below. What is the mass of the traffic light if the tension in each wire is 235 N?



(A) 14 kg
(B) 19 kg
(C) 29 kg
(D) 38 kg

20. The uniform beam shown below is 1.0 m long and is held stationary by a force of 0.245 N as shown. What is the mass of the beam?



(A) 0.044 kg
(B) 0.050 kg
(C) 0.061 kg
(D) 0.087 kg

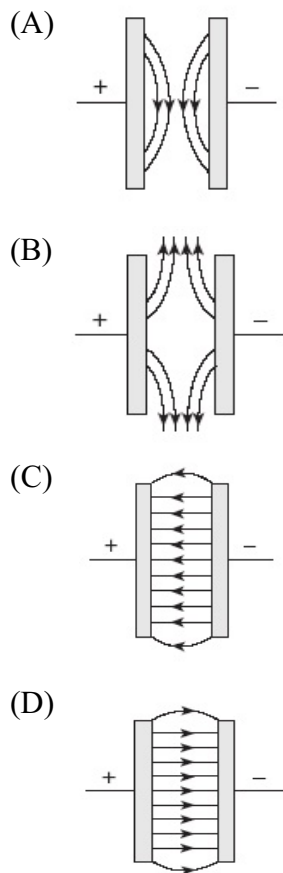
21. A neutral electroscope becomes positively charged after it is briefly touched by a charged rod. Which explains the flow of charge?

(A) Electrons flow from the electroscope to the rod.
(B) Electrons flow from the rod to the electroscope.
(C) Protons flow from the electroscope to the rod.
(D) Protons flow from the rod to the electroscope.

22. What is the electric force between two point charges of $1.5 \times 10^{-6} \text{ C}$ and $2.0 \times 10^{-6} \text{ C}$ that are separated by a distance of 0.50 m?

(A) $6.0 \times 10^{-12} \text{ N}$
(B) $1.2 \times 10^{-11} \text{ N}$
(C) $5.4 \times 10^{-2} \text{ N}$
(D) $1.1 \times 10^{-1} \text{ N}$

23. Which shows the electric field between two oppositely charged parallel plates?



24. The electric force between two charges is 0.012 N. What is the new electric force if the distance between the charges is doubled, and the value of one charge is tripled?

(A) 0.0080 N
(B) 0.0090 N
(C) 0.016 N
(D) 0.018 N

25. What is the electric field strength 0.50 m away from an object having a charge of $2.5 \times 10^{-6} \text{ C}$?

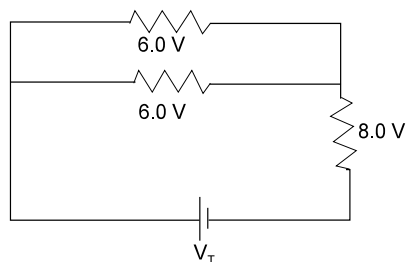
(A) $5.0 \times 10^{-6} \text{ N/C}$
(B) $1.0 \times 10^{-5} \text{ N/C}$
(C) $4.5 \times 10^4 \text{ N/C}$
(D) $9.0 \times 10^4 \text{ N/C}$

26. What energy is transferred by a 6.0 V battery to run an appliance that draws 2.0 A of current in 1.0 minute?

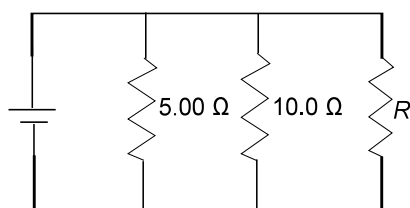
(A) 3.0 J
(B) 12 J
(C) 180 J
(D) 720 J

27. What will be the new resistance if the radius of a piece of copper wire having resistance R is doubled?
- (A) $\frac{1}{4} R$
 (B) $\frac{1}{2} R$
 (C) $2 R$
 (D) $4 R$
28. What charge flows past a point in a wire in 6.0 s if the wire carries a current of 2.0 A?
- (A) 0.33 C
 (B) 3.0 C
 (C) 12 C
 (D) 24 C
29. What is the potential difference across a 2.5Ω resistor that carries 3.0 A of current?
- (A) 0.83 V
 (B) 1.2 V
 (C) 5.5 V
 (D) 7.5 V
30. What is the voltage drop across one of three identical resistors that are connected in series to a 6.0 V source?
- (A) 2.0 V
 (B) 3.0 V
 (C) 6.0 V
 (D) 18 V

31. What is the voltage, V_T , across the source in the circuit below?

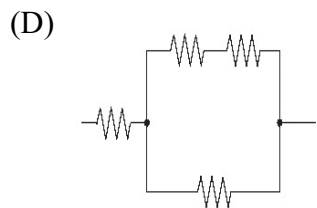
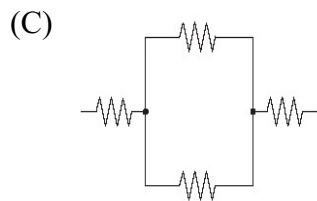
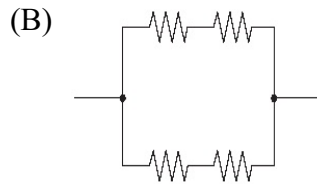
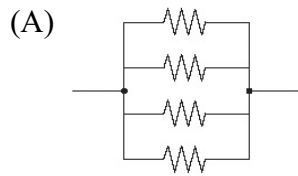


- (A) 2.2 V
 (B) 11.0 V
 (C) 14.0 V
 (D) 20.0 V
32. What resistor, R , must be added to the circuit below to give a total resistance of 2.00Ω ?



- (A) 0.200Ω
 (B) 0.800Ω
 (C) 1.25Ω
 (D) 5.00Ω

33. Which arrangement of four identical resistors has the least total resistance?



34. What are the correct units for electric potential?

- (A) J/s
- (B) J/C
- (C) N/m
- (D) N/C

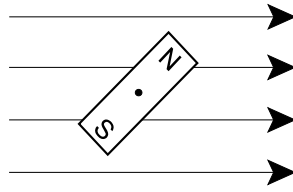
35. What is the power rating of an electric kettle that draws a 12.5 A current in a 120 V circuit?

- (A) 0.10 W
- (B) 9.6 W
- (C) 1200 W
- (D) 1500 W

36. Which occurs when protons and electrons enter a magnetic field that is parallel to their direction of motion?

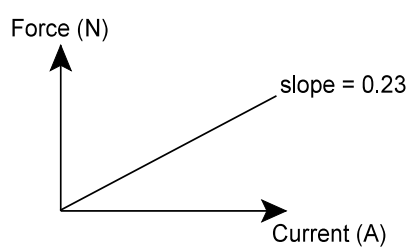
- (A) Both protons and electrons are deflected.
- (B) Neither protons nor electrons are deflected.
- (C) Only electrons are deflected.
- (D) Only protons are deflected.

37. Which shows the final position of a bar magnet that is free to rotate in a magnetic field and is initially positioned as shown below?



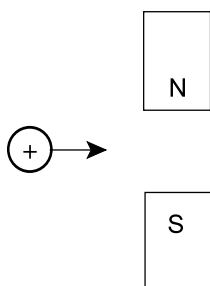
- (A)
- (B)
- (C)
- (D)

38. A 2.0 m long current-carrying conductor is placed perpendicular to an external magnetic field. The graph below shows how the force on the conductor changes as the current is varied. What is the magnitude of the external magnetic field?

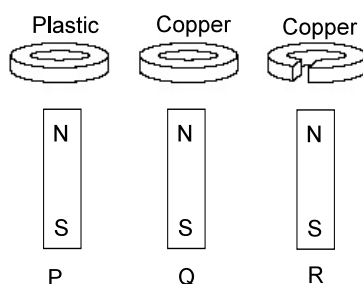


- (A) 0.12 T
 (B) 0.23 T
 (C) 0.46 T
 (D) 8.7 T

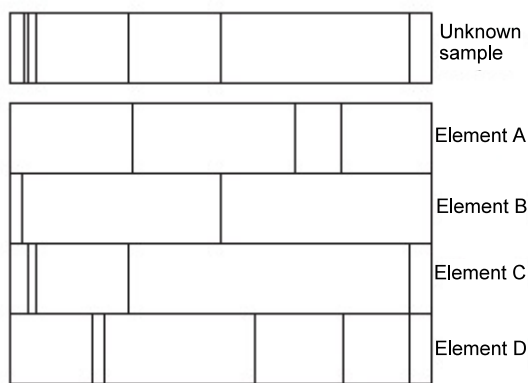
39. A proton is shot through a magnetic field as shown below. In what direction will the proton be deflected?



- (A) into the page
 (B) out of the page
 (C) towards the top of the page
 (D) towards the bottom of the page
40. Three rings are dropped at the same time over identical magnets, P, Q and R, as shown below. Which describes the order in which the rings reach the bottom of the magnets?



- (A) They arrive in the order P, Q, R.
 (B) They arrive in the order P, R, Q.
 (C) Rings P and R arrive at the same time, followed by Q.
 (D) Rings Q and R arrive at the same time, followed by P.
41. Which occurs when an opaque object with a temperature above absolute zero emits photons?
- (A) black-body radiation
 (B) Compton effect
 (C) photoelectric effect
 (D) UV catastrophe
42. What is the energy of a photon having a frequency of 7.50×10^{14} Hz?
- (A) 8.83×10^{-49} J
 (B) 4.97×10^{-19} J
 (C) 6.75×10^{31} J
 (D) 1.13×10^{48} J
43. The diagram below shows the bright line spectra of four elements along with the spectrum of an unknown gaseous sample. Which elements are found in the unknown sample?



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

44. What is the stopping potential for an ejected photoelectron that has 3.40×10^{-19} J of kinetic energy?
- (A) 0.471 V
(B) 2.13 V
(C) 3.40 V
(D) 5.44 V
45. What is the deBroglie wavelength of a 125 g baseball moving at 28.0 m/s?
- (A) 1.89×10^{-34} m
(B) 2.32×10^{-33} m
(C) 3.50×10^0 m
(D) 5.28×10^{33} m
46. What is the momentum of a photon of yellow light with a wavelength of 5.89×10^{-7} m?
- (A) 3.90×10^{-40} kg·m/s
(B) 3.90×10^{-37} kg·m/s
(C) 1.12×10^{-27} kg·m/s
(D) 1.12×10^{-25} kg·m/s
47. What is the energy of an electron in the third energy level of a hydrogen atom?
- (A) -13.6 eV
(B) -4.53 eV
(C) -2.27 eV
(D) -1.51 eV
48. Which completes the nuclear reaction shown?
- $${}_0^1\text{n} + {}_{92}^{235}\text{U} \rightarrow {}_{56}^{141}\text{Ba} + \boxed{?} + 3{}_0^1\text{n}$$
- (A) ${}_{35}^{92}\text{Br}$
(B) ${}_{35}^{94}\text{Br}$
(C) ${}_{36}^{92}\text{Kr}$
(D) ${}_{36}^{94}\text{Kr}$
49. How many neutrons are in the daughter nucleus if ${}_{92}^{235}\text{U}$ undergoes alpha decay?
- (A) 90
(B) 141
(C) 143
(D) 231
50. A sample of radioactive material has an initial activity of 1.50×10^6 Bq. After how many half-lives will the activity decrease to 3.75×10^5 Bq?
- (A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 2
(D) 4

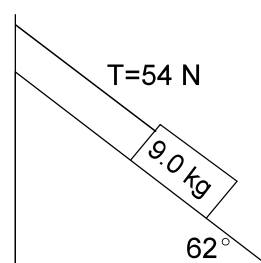
PART II
Total Value: 50%

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

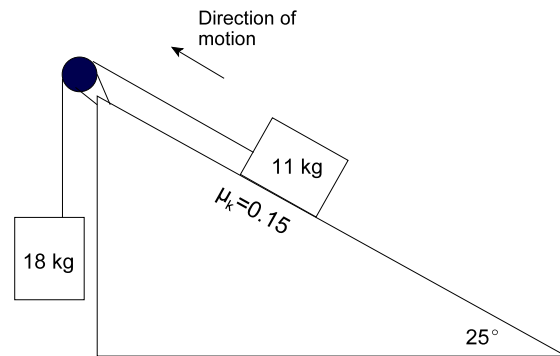
3% 51.(a) A golfer hits a golf ball from ground level with a speed of 25 m/s at 35° above the horizontal. Calculate the magnitude of the velocity of the ball when it has travelled a horizontal distance of 42 m.

3% (b) A 9.0 kg mass is at rest on a 62° incline and is attached to a wall by a string having a tension of 54 N. Calculate the coefficient of static friction between the mass and the incline.

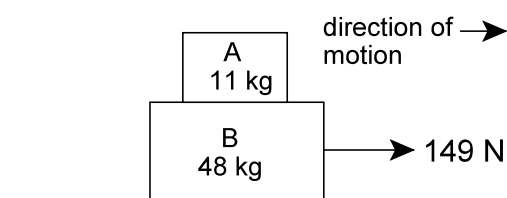


Value

- 4% 51.(c) Two objects of masses 11 kg and 18 kg are connected by a light string that passes over a frictionless pulley as shown. Calculate the magnitude of the acceleration of the 18 kg box.



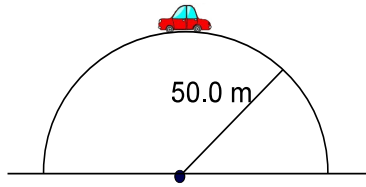
- 3% (d) Two boxes are stacked as shown below. The surface that box B rests upon is frictionless and the surface between boxes A and B is rough. If box A does not slide on box B when a maximum force of 149 N is applied as shown, calculate the coefficient of static friction between box A and box B.



Value

4% 51.(e) A car of mass 1.50×10^3 kg travelling at 18 m/s, tops a hill having a radius of curvature of 50.0 m.

- i) Calculate the normal force on the car at the top of the hill.

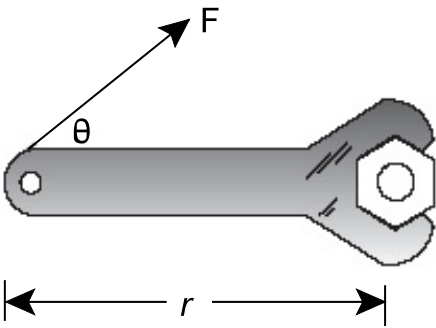


- ii) Calculate the maximum speed that will allow the car to stay on the road at the top of the hill.

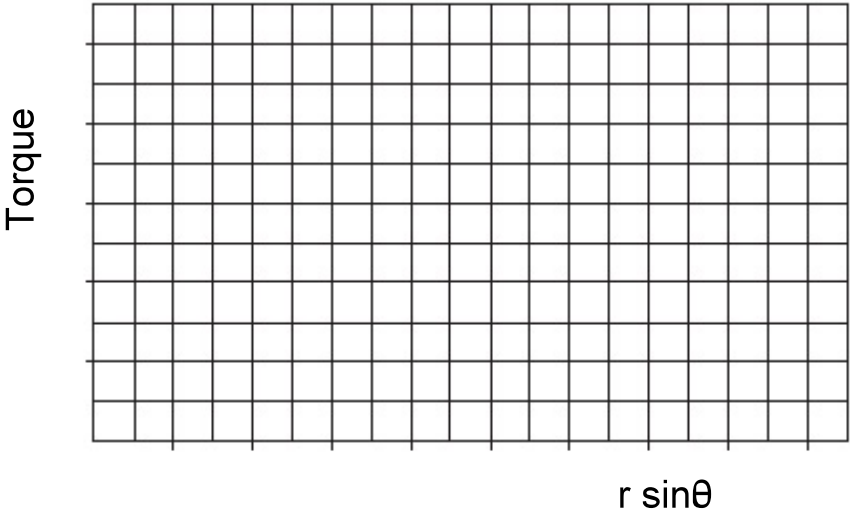
Value

3% 51.(f) A student applies a constant force to a wrench of length r , in order to tighten a nut as shown. The force is applied at various angles and the measurement of torque applied is read from the wrench. The data collected are shown below.

$r \cdot \sin \theta$ (m)	Torque (N·m)
0.14	4
0.42	11
0.66	17
0.86	22



i) Graph this data on the grid below, including the line of best fit.

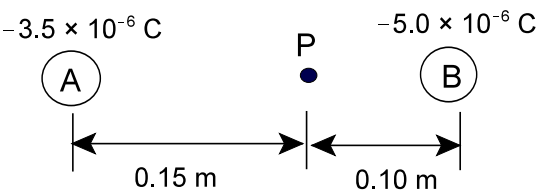


ii) Use the graph in (i) to determine the constant force that was applied to the wrench.

Value

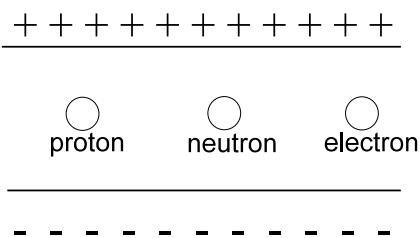
4%

52.(a) Two charged spheres, A and B, are arranged as shown. Calculate the magnitude and direction of the electric field strength at point P.



3%

(b) In the diagram below a proton, neutron and electron are located between two horizontal charged parallel plates.

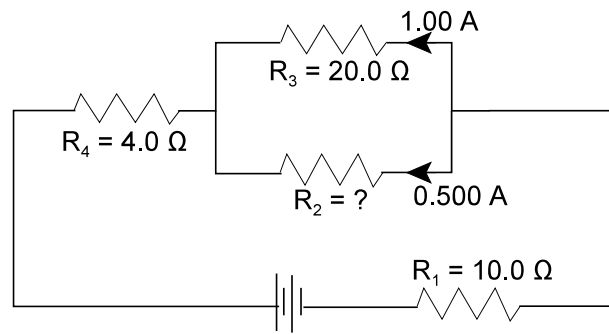


i) Describe what will happen to each particle in the field.

ii) Explain which particle will have the greatest acceleration.

Value

6% 52.(c) For the circuit below calculate:



i) the value of R_2 .

ii) the power dissipated in R_4 .

iii) the voltage across the source.

iv) Explain how the addition of another resistor in parallel will change the total resistance of the circuit.

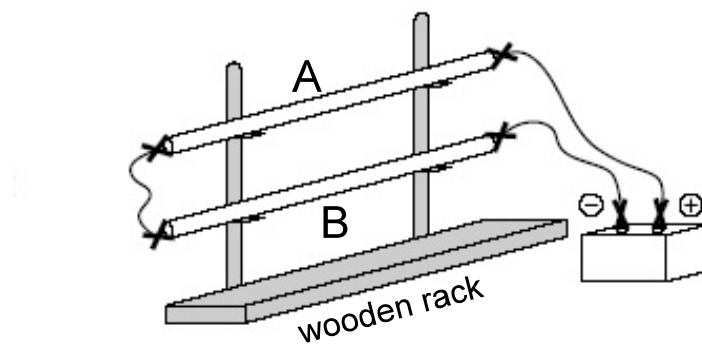
Value

2%

- 52.(d) A spacecraft orbiting Earth has a coil of wire in it. An astronaut measures a small current in the coil although there is no battery connected to it and there are no magnets on the spacecraft. Explain what causes the current.

3%

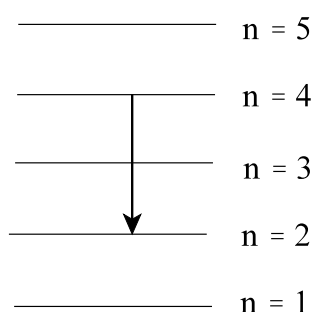
- (e) Two thin metal rods, A and B, are supported in a vertical wooden rack as shown in the diagram. The two rods are connected by a wire on one end and to a battery at the other end. It is observed that as the connection to the battery is made, one of the rods jumps upward. Identify which rod jumps upward and explain why.



Value

- 2% 52.(f) The possible hazardous effects of exposure to electromagnetic waves such as radio frequency radiation from the antenna of a cell phone have yet to be determined. Describe two ways a cell phone user could reduce their risk of exposure to electromagnetic waves from the antenna.

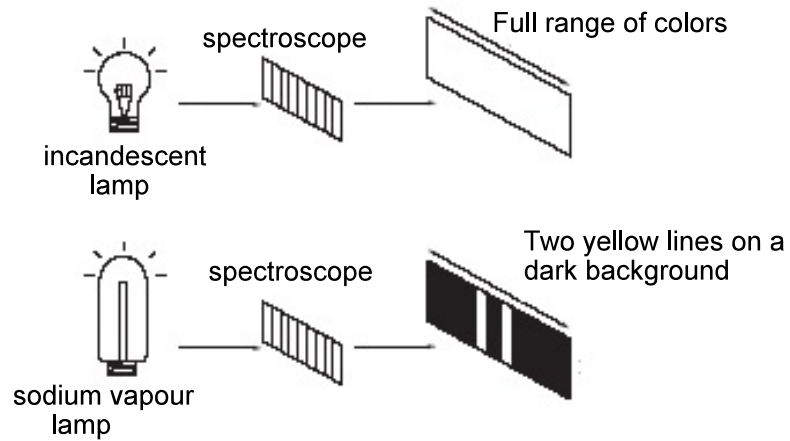
- 2% 53.(a) The diagram below shows the first five energy levels of an electron orbiting the nucleus of a hydrogen atom. Calculate the wavelength of the emitted photon for the electron transition indicated by the arrow in the diagram.



Value

3%

53.(b) The spectra of two light sources through spectrosopes are shown in the diagram below.

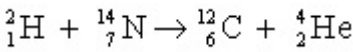


i) What type of spectra is produced in each case?

ii) Explain why the observed spectra are different.

Value

2% 53.(c) Calculate the energy produced in the reaction below.



Particle	Mass (kg)
${}^2_1\text{H}$	3.343×10^{-27}
${}^{14}_7\text{N}$	2.325×10^{-26}
${}^{12}_6\text{C}$	1.992×10^{-26}
${}^4_2\text{He}$	6.644×10^{-27}

3% (d) Cobalt-60 has a half-life of 5.27 years. If its initial activity is 4.00×10^{13} Bq, calculate how long will it take for the activity to become 3.50×10^{13} Bq.