

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE
NAME

CLASS

INDEX NUMBER

PHYSICS

8866/01

Paper 1 Multiple Choice

15 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **14** printed pages.



Data

speed of light in free space,

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$

elementary charge,

$$e = 1.60 \times 10^{-19} \text{ C}$$

the Planck constant,

$$h = 6.63 \times 10^{-34} \text{ J s}$$

unified atomic mass constant,

$$u = 1.66 \times 10^{-27} \text{ kg}$$

rest mass of electron,

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

rest mass of proton,

$$m_p = 1.67 \times 10^{-27} \text{ kg}$$

acceleration of free fall,

$$g = 9.81 \text{ m s}^{-2}$$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

hydrostatic pressure,

$$p = \rho gh$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

- 1 The following physical quantities can be either positive or negative.

s : displacement of a particle along a straight line

θ : temperature on the Celsius scale

q : electric charge

V : readings on a digital voltmeter

Which of these quantities are vectors?

- A** s, θ, q, V **B** s, q, V only **C** θ, V only **D** s only
- 2 The resistance R of a resistor is determined by measuring the potential difference V across it and the current I in it. The value of R is then calculated using the equation

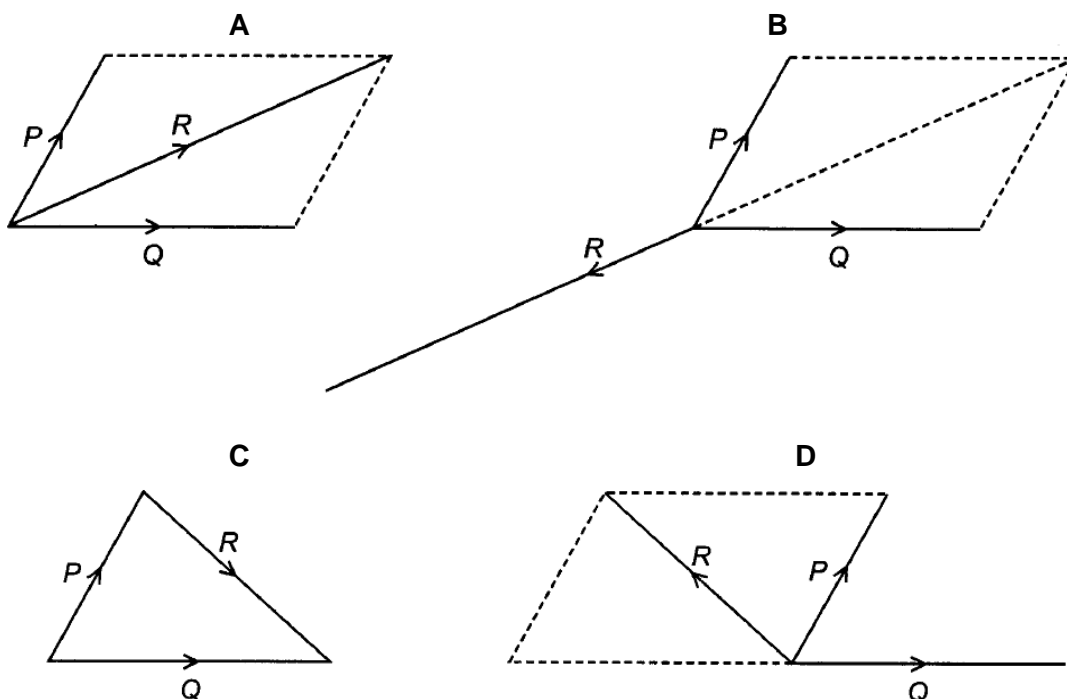
$$R = \frac{V}{I}$$

The values measured are $V = 1.00 \pm 0.05$ V and $I = 0.50 \pm 0.01$ A.

What is the percentage uncertainty in the value of R ?

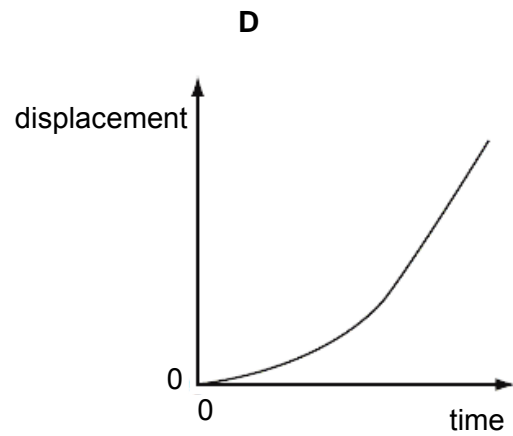
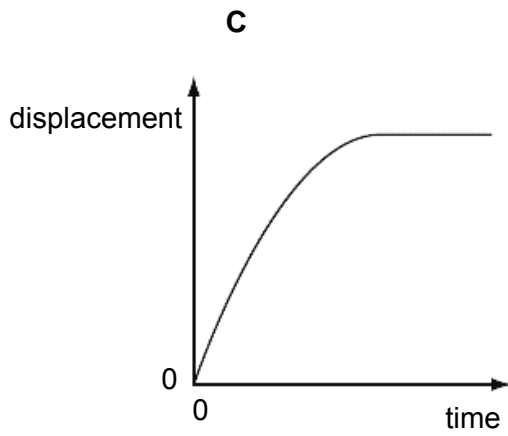
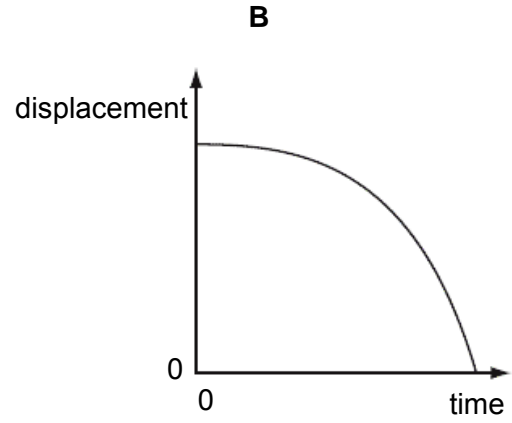
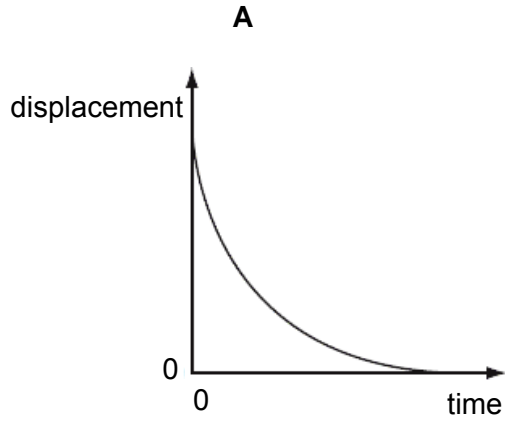
- A** 2.5 % **B** 3.0 % **C** 7.0 % **D** 10.0 %
- 3 Vectors P and Q represent two forces.

In which vector diagram does the vector R represent the difference between P and Q , such that $R = P - Q$?



- 4 A sphere is released and falls. Its initial acceleration reduces until it eventually begins to travel at constant terminal velocity.

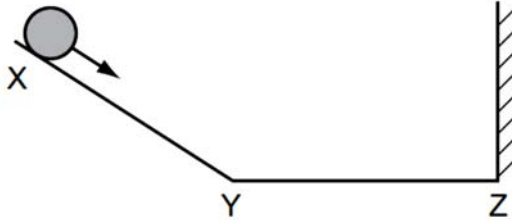
Which displacement-time graph best represents the motion of the sphere?



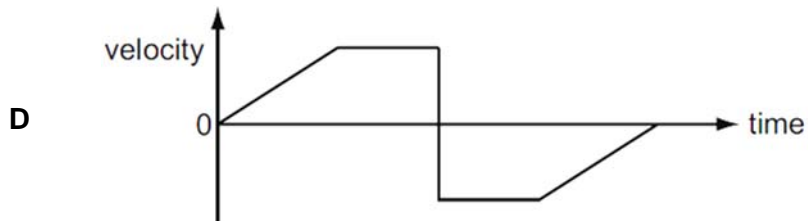
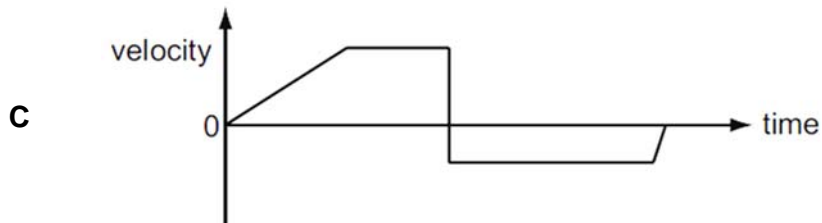
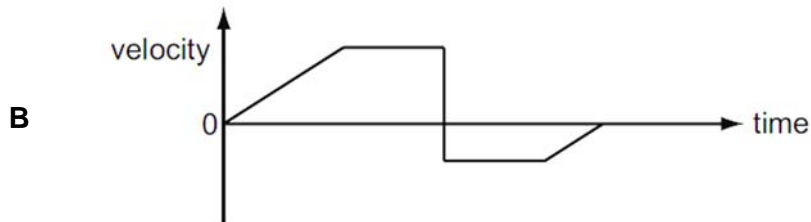
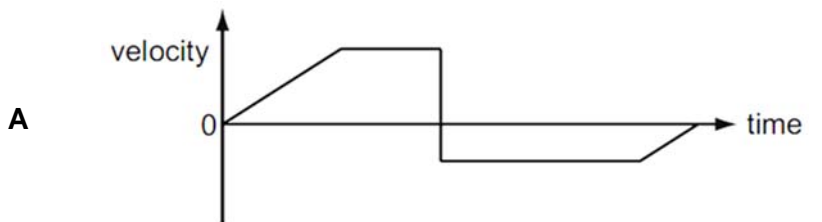
5 A ball is released from rest on a smooth slope XY.

It moves down the slope, along a smooth horizontal surface YZ and rebounds at Z. The collision is in-elastic.

Then it moves back to Y and comes to rest momentarily somewhere on XY.



Which velocity-time graph represents the motion of the ball?



- 6 A football on a level playing field is kicked so that it leaves the ground at an angle 45° to the horizontal. It then travels a horizontal distance of 95 m before it hits the ground again.

How far will the ball travel when launched at the same speed on the same field if launched at an angle of 35° to the horizontal?

Neglect the effect of air resistance.

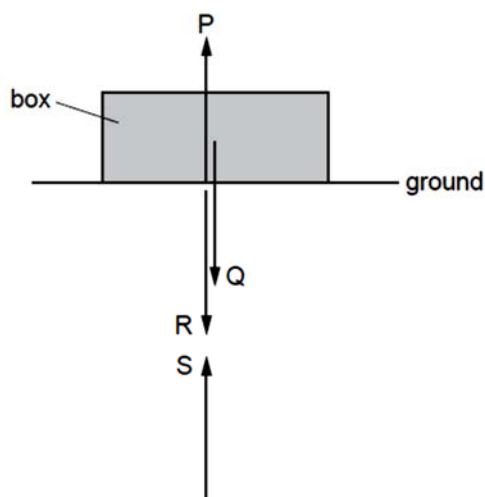
- A 89 m B 78 m C 54 m D 32 m
- 7 A car has mass m . A person needs to push the car with force F in order to give the car acceleration a . The person needs to push the car with force $2F$ in order to give the car acceleration $3a$.

Which expression gives the constant resistive force opposing the motion of the car?

- A ma B $2ma$ C $3ma$ D $4ma$
- 8 A box is shown resting on the ground. Newton's third law implies that four forces of equal magnitude are involved. These forces are labelled P, Q, R and S.

Forces P and Q act on the box. Forces R and S act on the Earth.

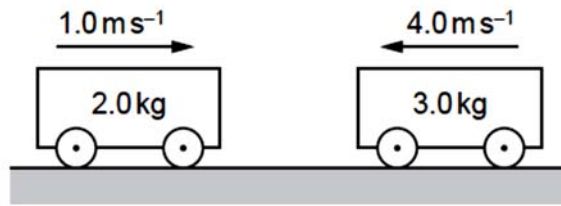
For clarity, the forces are shown slightly separated.



Which statement about the forces is correct?

- A P is the equal and opposite force to Q and both are forces of contact.
- B Q is the equal and opposite force to P and both are gravitational forces.
- C R is the equal and opposite force to S and both are forces of contact.
- D S is the equal and opposite force to Q and both are gravitational forces.

- 9 Two frictionless trolleys are moving towards each other along the same horizontal straight line. Their masses and velocities are shown.

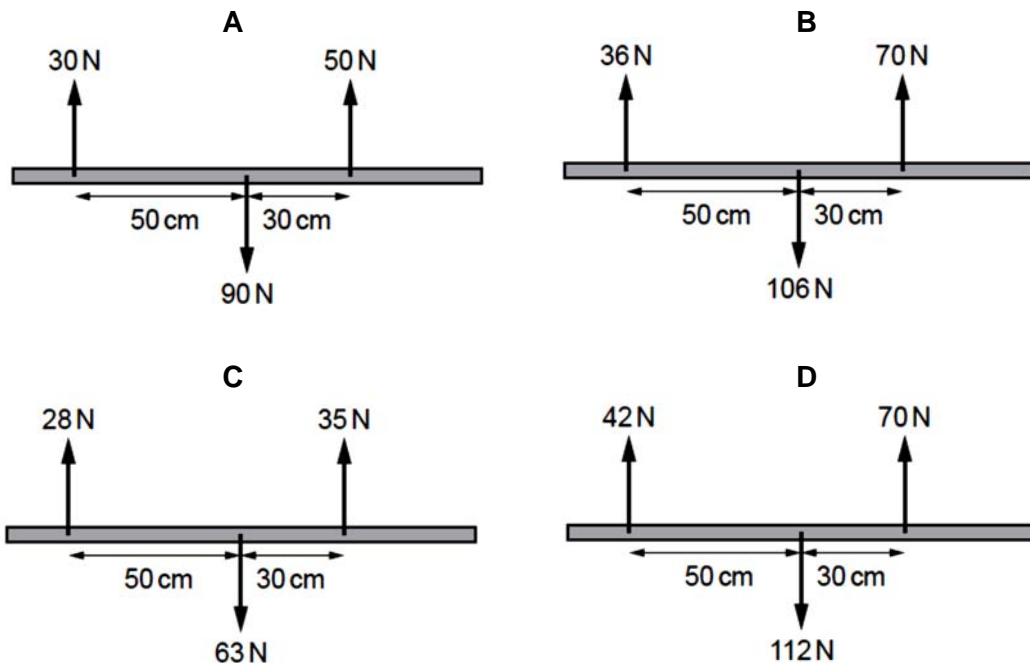


The trolleys collide and stick together.

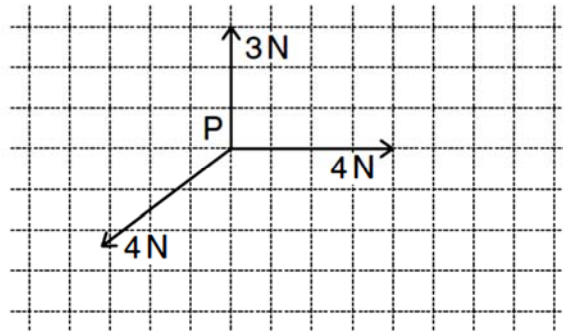
What is the velocity of the trolleys after the collision?

- A 2.0 m s⁻¹ to the left
 B 2.0 m s⁻¹ to the right
 C 2.8 m s⁻¹ to the left
 D 2.8 m s⁻¹ to the right
- 10 Four beams of the same length each have three forces acting on them.

Which beam is in static equilibrium?



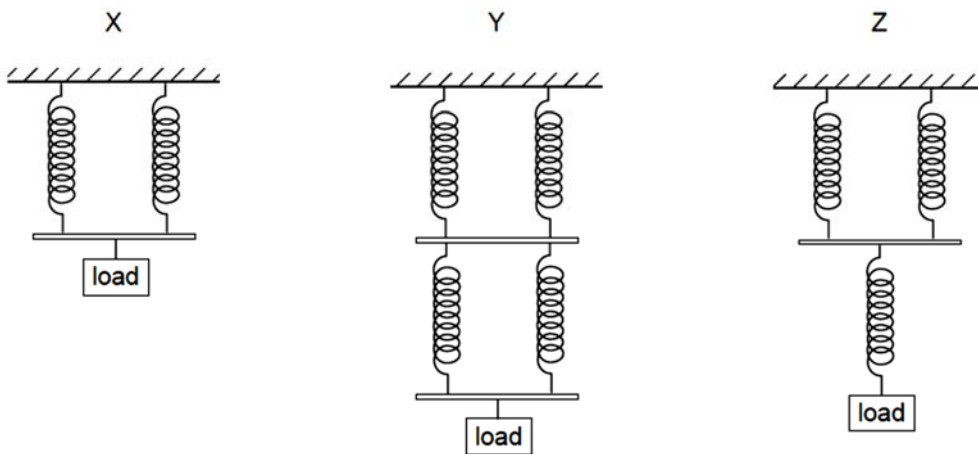
- 11 The vector diagram shows three coplanar forces acting on an object at P.



The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant?

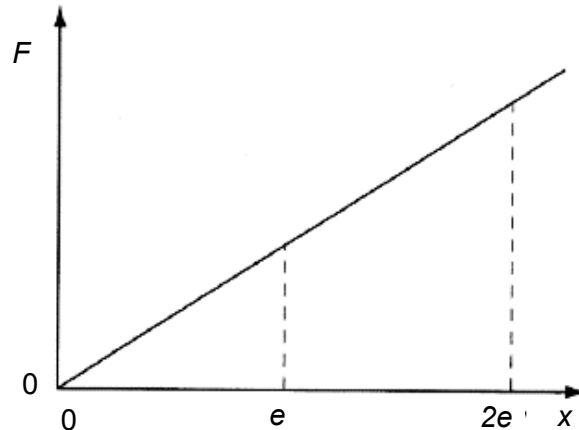
- A \uparrow B \searrow C \swarrow D \nearrow
- 12 A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.



Which is the order of increasing extension for these arrangements?

	smallest	\longrightarrow	largest
A	X	Y	Z
B	Z	X	Y
C	Z	Y	X
D	Y	X	Z

- 13 The extension x of a particular spring is related to the stretching force as shown in the graph.



When the extension of the spring is e , the elastic potential energy stored in the spring is E . What is the increase in the elastic potential energy when the extension is increased from e to $2e$?

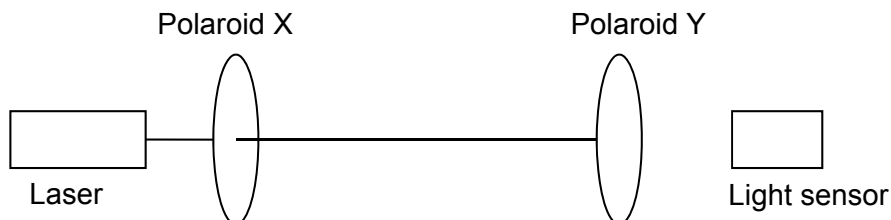
- A E B $2E$ C $3E$ D $4E$
- 14 An airplane has two jet engines. If each of the jet engines has an efficiency of 80%, what is the power input of each engine required to allow the plane to fly with a thrust of 200 kN at a speed of 250 m s^{-1} ?

- A 20.0 MW B 31.3 MW C 40.0 MW D 62.5 MW

- 15 The figure below shows a setup where a laser beam is directed towards two polaroids.

The polaroids are adjusted such that zero intensity is detected by the light sensor.

Without changing the orientation of either Polaroid X or Polaroid Y, how may we adjust the setup such that the light sensor detects a non-zero intensity?



- A Place another Polaroid between Polaroid X and Polaroid Y.
- B Place another Polaroid between the laser and Polaroid X.
- C Place another Polaroid between Polaroid Y and the light sensor.
- D Rotate both Polaroid X and Y by 90° but in different direction.

- 16 A tube which is open at both ends is held vertically and partially submerged in a beaker of water.

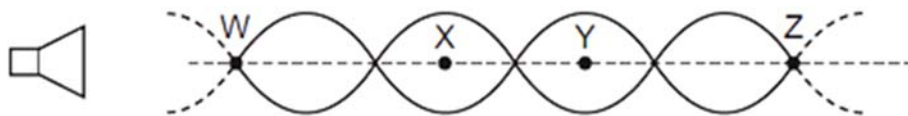
A speaker producing waves of wavelength 24.0 cm is placed near the top end of the tube.

The tube is slowly raised from the water until a loud sound is heard from the tube.

What is the shortest possible length of tube above the water that produces this loud sound?

- A 6.0 cm B 12.0 cm C 16.0 cm D 24.0 cm

- 17 The diagram represents a stationary wave formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown).



W, X, Y and Z are four points on the line through the centre of this wave.

Which statement about this stationary wave is correct?

- A A displacement antinode is formed at the surface of the metal sheet.
- B A node is a quarter of a wavelength from an adjacent antinode.
- C The oscillations at X are in phase with those at Y.
- D The particles of the waves oscillate at right angles to the line WZ.
- 18 If one of the slits of a standard Young's double slit demonstration of interference in light is painted over so that it transmits only half the light intensity of the other, which of the following is correct?
- A Only the bright lines will become brighter.
- B Only the bright lines will become dimmer.
- C The dark lines will remain dark and the bright lines will become brighter.
- D The dark lines will become brighter and the bright lines will become dimmer.

- 19 A power cable has length 2000 m. The cable is made of twelve parallel strands of copper wire, each with diameter 0.51 mm.

Given that the resistivity of copper is $1.7 \times 10^{-8} \Omega \text{ m}$, what is the resistance of the cable?

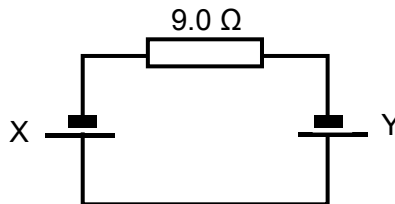
- A 0.014 Ω B 3.5 Ω C 14 Ω D 166 Ω

- 20 Two heating coils X and Y, of resistance R_X and R_Y respectively, deliver the same power when 12 V is applied across X and 6 V is applied across Y.

What is the ratio of R_X / R_Y ?

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

- 21 Two cells X and Y are connected in series with a resistor of resistance 9.0 Ω , as shown.

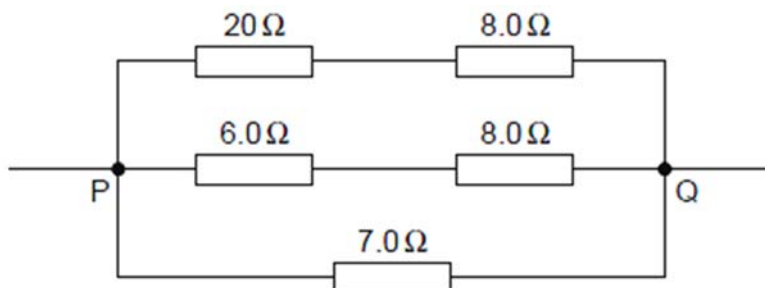


Cell X has an e.m.f. of 1.0 V and an internal resistance of 1.0 Ω . Cell Y has an e.m.f. of 2.0 V and an internal resistance of 2.0 Ω .

What is the current in the circuit?

- A 0.083 A B 0.10 A C 0.17 A D 0.25 A

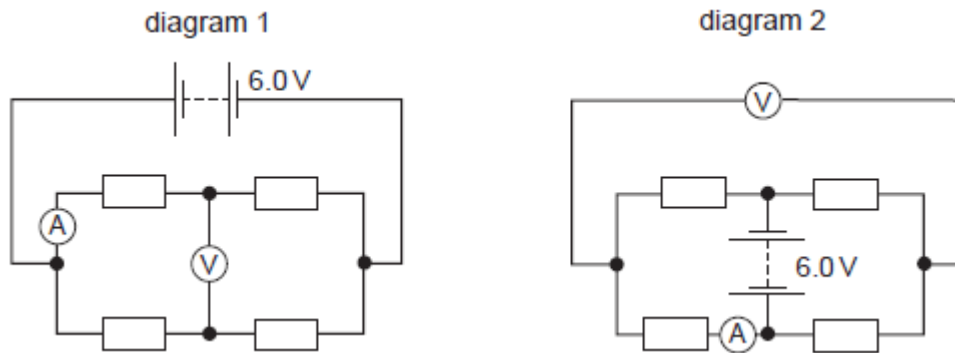
- 22 Five resistors are connected as shown.



What is the total resistance between P and Q?

- A 0.25 Ω B 0.61 Ω C 4.0 Ω D 16 Ω

- 23 When four identical resistors are connected as shown in diagram 1, the ammeter reads 1.0 A and the voltmeter reads zero.

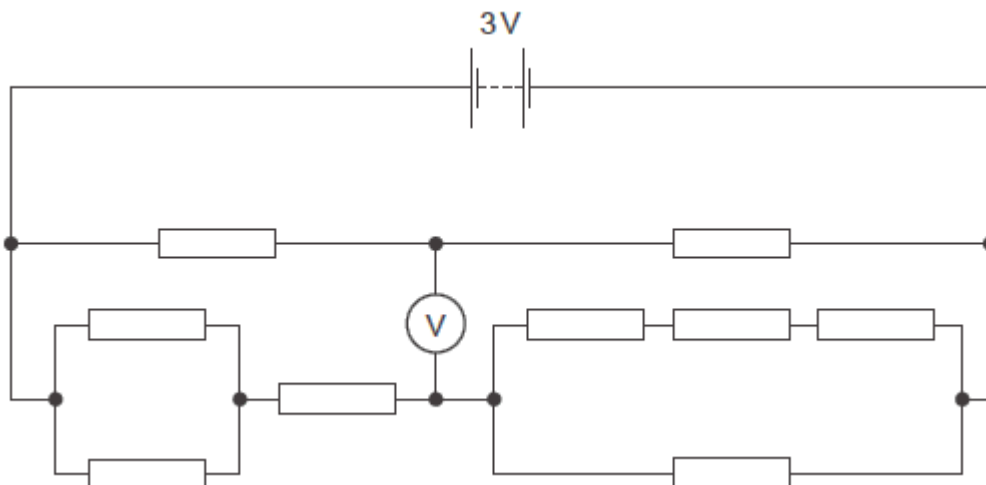


The resistors and meters are reconnected to the supply as shown in diagram 2.

What are the meter readings in diagram 2?

	voltmeter reading / V	ammeter reading / A
A	0	1.0
B	3.0	0.5
C	3.0	1.0
D	6.0	0

- 24 A circuit is set up as shown, supplied by a 3 V battery. All resistances are 1 k Ω .

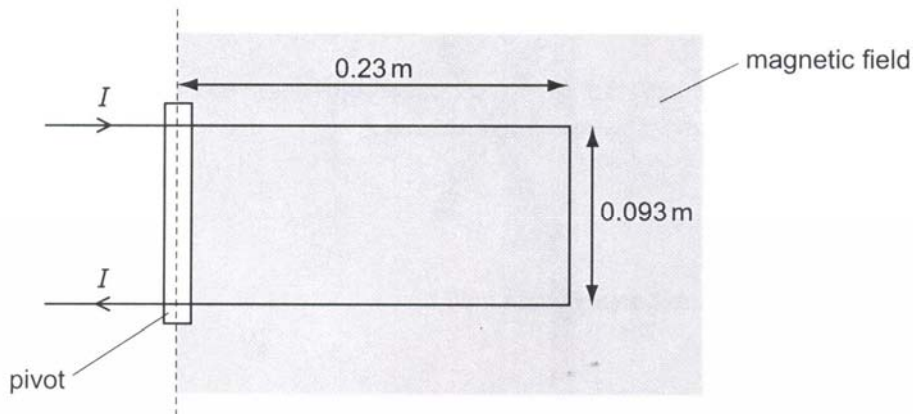


What will be the reading on the voltmeter?

- A** 0 **B** 0.5 V **C** 1.0 V **D** 1.5 V

- 25 In order to determine the value of a current I , a current balance is used. This consists of a U-shaped wire placed in a constant magnetic field of flux density 3.6×10^{-2} T.

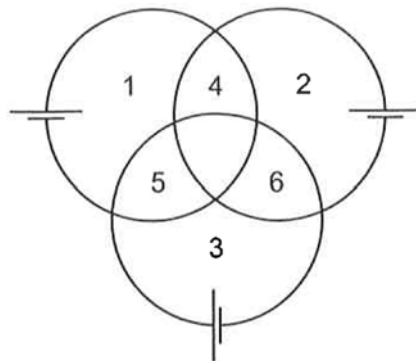
This U-shaped wire has length 0.23 m and the arms are 0.093 m apart, as shown.



This U-shaped wire experiences a turning moment about the pivot of value 7.4×10^{-3} N m.

What is the value of I ?

- A 0.044 A B 1.6 A C 2.8 A D 9.6 A
- 26 Three separate coils of insulated wire are connected to cells as shown. They are placed on a table on top of each other, partially overlapping.

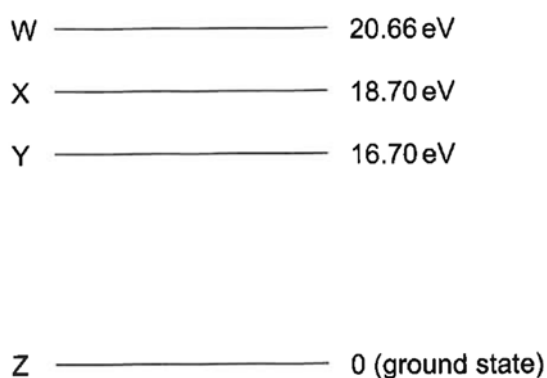


Six of the seven areas formed within the coils are numbered.

In which areas of the magnetic fields of all the coils reinforce each other?

- A 1 and 6 B 2 and 5 C 3 and 4 D 4 and 6
- 27 The work function of platinum is twice that of calcium. If the *minimum* photon energy required to emit photoelectrons from the surface of platinum is E , then that for the surface of calcium would be
- A $2E$ B $3E/2$ C $E/2$ D $E/4$

- 28 In order that an electron has a de Broglie wavelength equal to that of a proton,
- A their momenta must be equal.
 - B their kinetic energies must be equal.
 - C their velocities must be equal.
 - D the ratio of their energies must be equal to the ratio of their masses.
- 29 Some of the electron energy levels for neon in a helium-neon laser are shown in the diagram.



Which energy change for electrons results in laser light of wavelength 633 nm?

- A $W \rightarrow X$ B $X \rightarrow Y$ C $W \rightarrow Y$ D $W \rightarrow Z$
- 30 White light from a tungsten filament lamp is passed through sodium vapour and viewed through a diffraction grating.
- Which of the following best describes the spectrum that is seen?
- A coloured lines on a black background
 - B coloured lines on a white background
 - C dark lines on a coloured background
 - D dark lines on a white background

END OF PAPER

Answer Key

Qn	Ans	Qn	Ans	Qn	Ans
1	D	11	D	21	A
2	C	12	A	22	C
3	D	13	C	23	A
4	D	14	B	24	B
5	A	15	A	25	D
6	A	16	A	26	B
7	A	17	B	27	C
8	D	18	D	28	A
9	A	19	C	29	A
10	D	20	D	30	C

1. **Ans: D**

Only s is a vector quantity

Comments

2. **Ans: C**

$$\frac{\Delta R}{R} \times 100\% = \frac{\Delta V}{V} \times 100\% + \frac{\Delta I}{I} \times 100\%$$

$$\frac{\Delta R}{R} \times 100\% = \frac{0.05}{1.00} \times 100\% + \frac{0.01}{0.50} \times 100\%$$

$$= 5.0\% + 2.0\%$$

$$= 7.0\%$$

Comments

3. **Ans: D**

By drawing an appropriate vector subtraction diagram or consider that $R + Q = P$.

Comments

4 **Ans: D**

At the point of release, its displacement is zero. Hence, only option C and D are possible.

When the sphere is accelerating (though reducing), its velocity increases at a reducing rate. Hence, the gradient of the displacement-time graph should be increasing. When the sphere has achieved terminal velocity, its velocity remains constant, hence, the gradient of the displacement-time graph should be constant. Only option D fits this description of its motion.

Comments

5 **Ans: A**

XY: Velocity increases at a constant rate.

YZ: Velocity remains constant (smooth surface)

Comments

Z: Rebound velocity (decreases as rebound is inelastic)

Magnitude of negative velocity decreases.

ZY: Constant velocity. Since rebound velocity is smaller, it takes a longer time to travel from Z to Y.

YX: Velocity decreases at the same constant rate as v_{xy}

Hence, option A best describes the motion.

6 Ans: A

Let the launch speed be u

Using,

$$s_y = u_y t + \frac{1}{2} a_y t^2$$

$$0 = u \sin 45^\circ t - \frac{1}{2} (9.81) t^2$$

$$t = (u \sin 45^\circ) / 4.905$$

Therefore,

$$s = ut$$

$$95 = u \cos 45^\circ t = (u \cos 45^\circ)(u \sin 45^\circ) / 4.905$$

$$u^2 = 95(9.81)$$

$$u = 30.53 \text{ m s}^{-1}$$

Similarly,

$$\begin{aligned} \text{New horizontal distance} &= (u \cos 35^\circ)(u \sin 35^\circ) / 4.905 \\ &= 95(9.81)(\sin 35^\circ)(\cos 35^\circ) / 4.905 \\ &= 89 \text{ m} \end{aligned}$$

Comments

7 Ans: A

Let f be the constant resistive force

$$F - f = ma$$

$$2F - f = 3ma$$

Solving, $f = ma$

Comments

8 Ans: D

P: Normal contact force on box by Earth

Q: Gravitational force on box by Earth

R: Normal contact force on Earth by box

S: Gravitational force on Earth by box

Therefore, Q and S are equal and opposite force due to Newton's third law and both are gravitational forces

Comments

9 Ans: A

By conservation of linear momentum,

Total initial linear momentum = Total final linear momentum

$$2.0(1.0) + 3.0(-4.0) = (2.0 + 3.0)v \quad (\text{Taking right as positive})$$

$$v = -2.0 \text{ m s}^{-1}$$

Comments

(negative sign means that the trolleys are moving to the left.

10 **Ans: D**
(A): net force = 10 N
(B): net moment about mid-point = 3 N m
(C): net moment about mid-point = 3.5 N m
(D): sum of forces and torque = 0

Comments

11 **Ans: D**
Sum of forces 3 N and 4 N (vertical) forces = 5 N
Since the resultant of the three forces = 1 N, the other force of 4 N must be opposite of the force of 5 N (pointing diagonally up).

Comments

Hence the direction of the resultant force points in the direction of the 5 N.

12 **Ans: A**
X: force in each spring = $W/2$
extension = $0.5x$
Y: total extension = x
Z: total extension = $x + 0.5x = 1.5x$
Order : X, Y, Z

Comments

13 **Ans: C**

Comments

Increase in EPE = Area under the graph.
Area under the graph would be multiplied by 3

14 **Ans: B**
Power needed = $(2 \times 10^5)(250) = 5 \times 10^7$
Therefor the power input by both engines
= $(5 \times 10^7) \times 100/80 = 6.25 \times 10^7$ W

Comments

Therefor the power input by each engine
= $6.25 \times 10^7 / 2 = 3.13 \times 10^7 = 31.3$ MW

15 **Ans: A**

Comments

Place another polaroid between X and Y so that the vibration plane of the light is no more at right angle to the polaroid Y. Hence some light will pass through Y

16 **Ans: A**

Comments

When the length of the tube is 6.0 cm, it will fulfill the boundary condition of Node and Antinode at the both ends, producing a loud sound

17 **Ans: B**
Node to Antinode = $\frac{1}{4}$ wavelength

Comments

18 **Ans: D**
The bright lines would become dimmer as the amplitude of the CI would decrease and dark lines become brighter as the waves will not destruct completely

Comments

19 **Ans: C**

$$R = \frac{\rho l}{A}$$

$$R = \frac{1.7 \times 10^{-8} \times 2000}{12 \times \frac{\pi}{4} \times (0.51 \times 10^{-3})^2}$$

$$= 13.9 \approx 14 \Omega$$

Comments

20 **Ans: D**

$$P = \frac{V^2}{R}$$

Since both resistors deliver the same power,

$$\frac{V_x^2}{R_x} = \frac{V_y^2}{R_y}$$

$$\frac{12^2}{R_x} = \frac{6^2}{R_y}$$

$$\frac{R_x}{R_y} = 4$$

Comments

21 **Ans: A**

$$E_{net} = I(R + r_x + r_y)$$

$$2.0 - 1.0 = I(9.0 + 1.0 + 2.0)$$

$$I = 0.083 \text{ A}$$

Comments

22 **Ans: C**

$$\frac{1}{R_{PQ}} = \frac{1}{20 + 8.0} + \frac{1}{6.0 + 8.0} + \frac{1}{7.0}$$

$$R_{PQ} = 4.0 \Omega$$

Comments

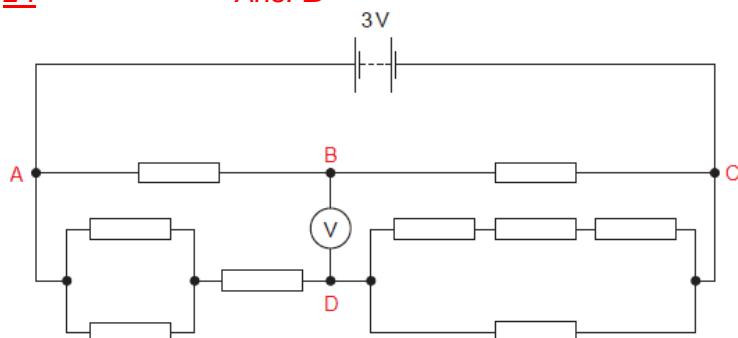
23 **Ans: A**

The four identical resistors are connected in the same arrangement in both diagram 1 and 2. As such the voltmeter and ammeter which are also placed in similar position would register the same voltage and current.

Comments

24

Ans: B



$$R_{AD} = \left(\frac{1}{1000} + \frac{1}{1000} \right)^{-1} + 1000$$

$$= 1500 \Omega$$

$$R_{DC} = \left(\frac{1}{1000 + 1000 + 1000} + \frac{1}{1000} \right)^{-1}$$

$$= 750 \Omega$$

$$V_{BC} = \frac{R_{BC}}{R_{AB} + R_{BC}} \times E$$

$$V_{BC} = \frac{1000}{1000 + 1000} \times 3 = 1.5 \text{ V}$$

$$V_{DC} = \frac{R_{DC}}{R_{AD} + R_{DC}} \times E$$

$$V_{DC} = \frac{750}{1500 + 750} \times 3 = 1.0 \text{ V}$$

Voltage across the voltmeter

$$V_{BD} = V_{BC} - V_{DC}$$

$$= 1.5 - 1.0 = 0.5 \text{ V}$$

Comments

25

Ans: D

Resultant moment = $F \times d$

$$7.4 \times 10^{-3} = B / L \times d$$

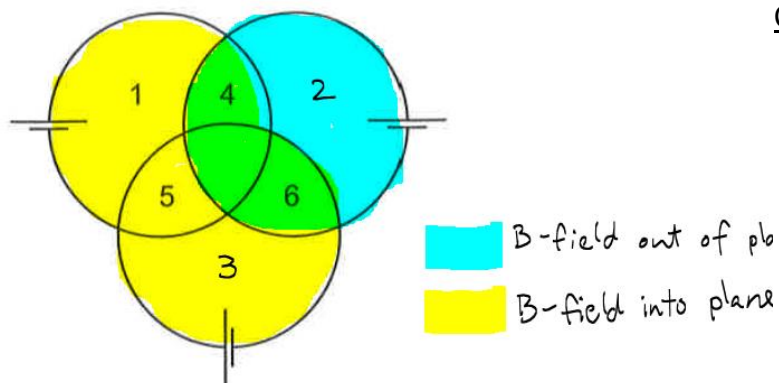
$$7.4 \times 10^{-3} = (3.6 \times 10^{-2})(l)(0.093) \times (0.23)$$

$$l = 9.6 \text{ A}$$

Comments

26

Ans: B



Comments

Referring to the shaded diagram above, the areas where the B-fields of all 3 coils reinforce each other will be:

Region 5 – inward B field inside left and bottom coil, inward B field outside right coil

Region 2 – outward B field inside right coil, outward B field outside left and bottom coil.

27

Ans: **C**

The work function of a metal corresponds to the minimum photon energy required to eject photoelectrons from the metal surface. Hence since the work function of calcium is half that for platinum, the minimum photon energy to emit photoelectrons for calcium will be half that for platinum.

Comments

28

Ans: **A**

Since $\lambda = h/p$, for their wavelength to be the same, momenta must be the same.

Comments

29

Ans: **A**

$$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34})(3.0 \times 10^8)}{633 \times 10^{-9}}$$
$$= 3.142 \times 10^{-19} \text{ J}$$
$$= 1.964 \text{ eV}$$

Comments

30

Ans: **C**

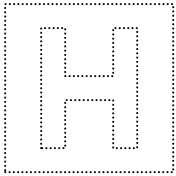
White light from tungsten filament lamp (a hot solid) will be a **continuous spectrum**.

Sodium vapour is a **cool** gas (atoms at ground state).

Passing white light through a cool gas is similar to the **absorption spectrum** experiment.

So the observation will be dark lines on a coloured background.

Comments



INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
 in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME

CLASS INDEX NUMBER

PHYSICS

8866/02

Paper 2 Structured Questions

25 August 2017

2 hours

Candidates answer on the Question Paper

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
 Write in dark blue or black pen on both sides of the paper.
 You may use a soft pencil for any diagrams, graphs or rough working.
 Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
 Answer **all** questions.

Section B
 Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
 The number of marks is given in the brackets [] at the end of each question or part question.

For Examiner's Use	
Section A	
1	10
2	10
3	8
4	6
5	6
Section B	
6	20
7	20
8	20
Penalty	
Total	80
Percentage	

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho g h$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

Section A

Answer **all** questions in this section.

- 1 (a) A boat travels across a river in which the water is moving at a speed of 1.8 m s^{-1} . The velocity vectors for the boat and the river water are shown in Fig. 1.1.

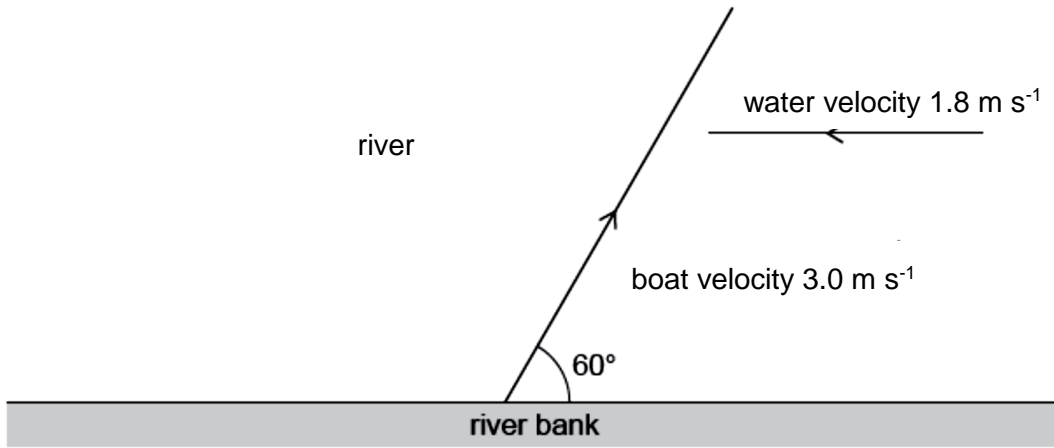


Fig. 1.1 (not to scale)

In still water the speed of the boat is 3.0 m s^{-1} . The boat is directed at an angle of 60° to the river bank.

- (i) Sketch a labelled vector triangle to show the resultant velocity of the boat. [1]

- (ii) Determine the resultant velocity of the boat.

resultant velocity = m s^{-1} [2]

direction = [2]

- (b) The volume V of liquid flowing in time t through a pipe of radius r is given by the equation

$$\frac{V}{t} = \frac{\pi Pr^4}{8Bl}$$

where P is the pressure difference between the ends of the pipe of length l , and B depends on the frictional effects of the liquid.

An experiment is performed to determine B . The measurements made are shown in Fig. 1.2.

$\frac{V}{t} / 10^{-6} \text{ m}^3 \text{ s}^{-1}$	$P / 10^3 \text{ N m}^{-2}$	$r / \text{ mm}$	$l / \text{ m}$
1.20 ± 0.01	2.50 ± 0.05	0.75 ± 0.01	0.250 ± 0.001

Fig. 1.2

- (i) Show that the value of B is $1.04 \times 10^{-3} \text{ N s m}^{-2}$. [1]

- (ii) Calculate the absolute uncertainty in B .

absolute uncertainty = N s m^{-2} [3]

- (iii) State the value of B and its uncertainty to the appropriate number of significant figures.

$B = \dots \pm \dots \text{ N s m}^{-2}$ [1]

2 The variation with time t of the velocity v of a ball is shown in Fig. 2.1.

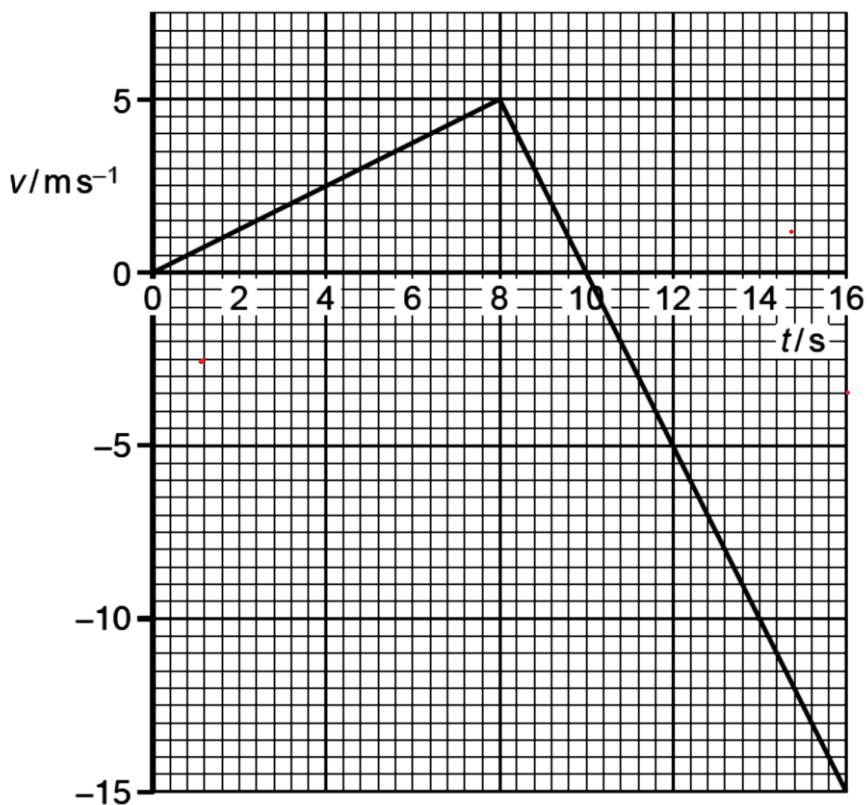


Fig. 2.1

The ball moves in a straight line from a point P at $t = 0$. The mass of the ball is 400 g.

(a) Use Fig. 2.1 to describe, without calculation, the velocity of the ball from $t = 0$ to $t = 16$ s.

.....

.....

.....

.....

.....

..... [2]

(b) Use Fig. 2.1 to calculate, for the ball,

(i) the displacement from P at $t = 10$ s,

displacement = m [2]

6

(ii) the acceleration at $t = 10$ s,

acceleration = m s^{-2} [2]

(iii) the maximum kinetic energy.

kinetic energy = J [2]

(c) Use your answers in (b)(i) and (b)(ii) to determine the time from $t = 0$ for the ball to return to P.

time = s [2]

3 (a) State two conditions for an object to be in equilibrium.

1.

.....

2.

..... [2]

(b) A uniform beam AC is attached to a vertical wall at end A. The beam is held horizontal by a rigid bar BD, as shown in Fig. 3.1.

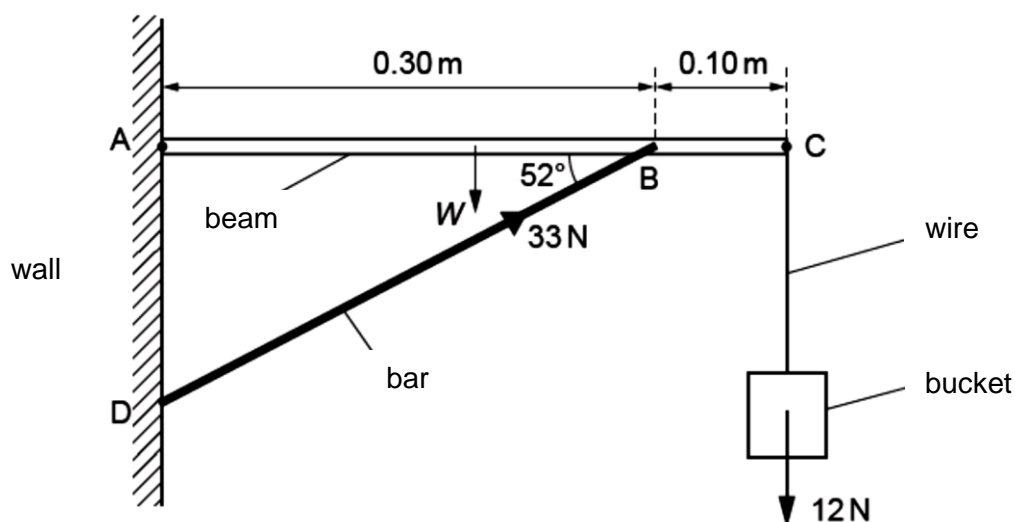


Fig. 3.1 (not to scale)

The beam is of length 0.40 m and weight W . An empty bucket of weight 12 N is suspended by a light metal wire from end C. The bar exerts a force of 33 N at 52° to the horizontal on the beam. The beam is in equilibrium.

(i) Calculate the vertical component of the force exerted by the bar on the beam.

component of the force = N [1]

(ii) By taking moments about A, calculate the weight W of the beam.

$W =$ N [2]

(iii) State and explain how the force in the bar will change when the bucket is filled with water.

.....

.....

.....

.....

.....

.....

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.....

.....

..... [3]

- 4 A long straight copper wire is placed at an angle of 90° to a uniform magnetic field of flux density 5.2×10^{-2} T, as shown in Fig. 4.1.

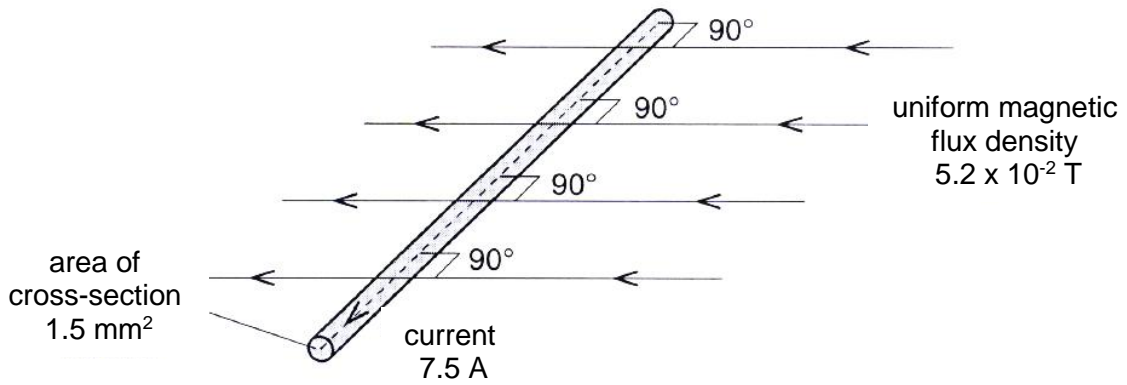


Fig. 4.1

The current in the wire is 7.5A.

There is a force on the current-carrying wire due to the magnetic field.

- (a) Determine the magnitude and direction of the force per unit length on the wire.

force per unit length = N m^{-1} [2]

direction = [1]

- (b) The current in the wire is a movement of free electrons along the wire. The electrons may be assumed to be moving with speed v along the wire.

The number of free electrons per unit volume of the wire is $7.8 \times 10^{28} \text{ m}^{-3}$.
The cross-sectional area of the wire is 1.5 mm^2 .

The force on the wire is equal to the total force on the free electrons as they move along the wire.

Use your answer in (a) to determine the magnitude of the force on each free electron as it moves along the wire in the magnetic field.

force on each free electron = N [3]

- 5 Light of frequency f and wavelength λ is incident on a metal surface having work function energy ϕ . Electrons are emitted from the surface with maximum kinetic energy E_{MAX} .

Conservation of energy for this effect may be expressed as,

$$E_{MAX} = hc \left(\frac{1}{\lambda} - \frac{1}{\lambda_0} \right)$$

where, h is the Planck constant, c is the speed of light and λ_0 is the corresponding wavelength of light at threshold frequency.

The variation with $\frac{1}{\lambda}$ of E_{MAX} is shown in Fig. 5.1.

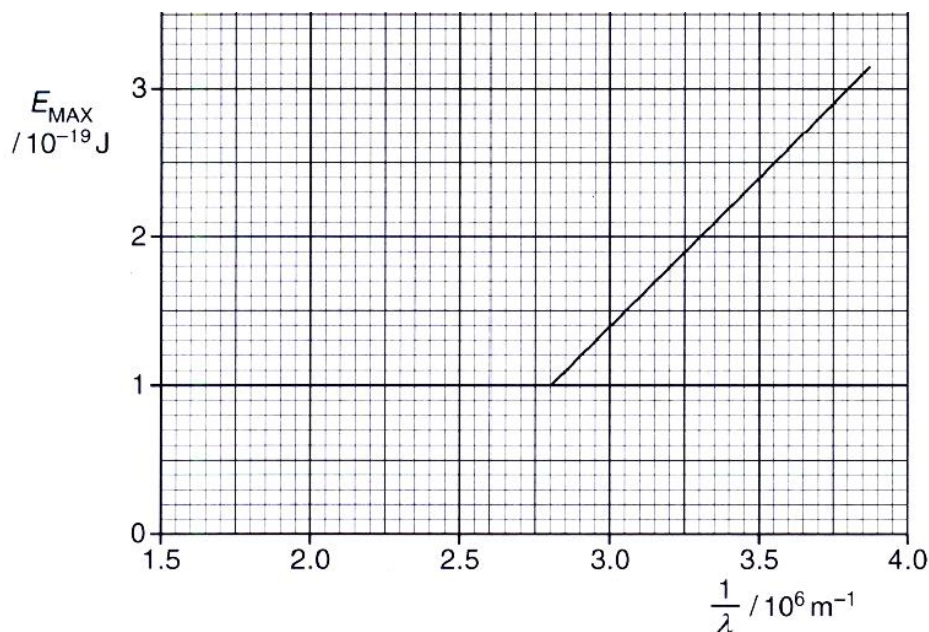


Fig. 5.1

- (a) Use Fig. 5.1 to
- (i) determine, without using a value for h , the maximum wavelength λ_0 at which emission of electron occurs, and

$$\lambda_0 = \dots\dots\dots \text{ m [3]}$$

(ii) show that the Planck constant is approximately 6.7×10^{-34} J s.

[2]

(b) The metal surface becomes oxidised but photoelectric emission is still observed. The work function energy of this new surface has been increased.

On Fig. 5.1, draw a line to show the variation with $\frac{1}{\lambda}$ of E_{MAX} for this oxidised surface.

[1]

Section B

Answer **two** of the questions in this section.

- 6 (a) State the principle of conservation of linear momentum.

.....

 [2]

- (b) A sphere of mass m travelling in a straight line with speed u collides head-on with another sphere of the same mass that has a speed u_2 . The speed u of the incoming sphere is greater than u_2 , as shown in Fig. 6.1. The collision is perfectly elastic.

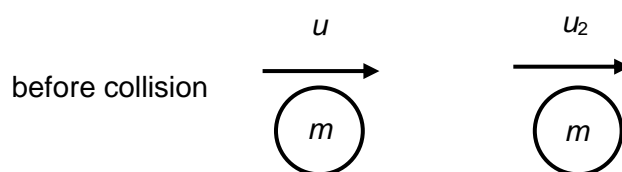


Fig. 6.1 (not to scale)

The incoming sphere of kinetic energy E may lose an amount of kinetic energy W .

The fractional energy lost by the incoming sphere, F is given to be

$$F = \frac{\text{energy lost by incoming sphere}}{\text{kinetic energy of incoming sphere}} = \frac{W}{E}$$

Fig. 6.2 shows how F , the fractional energy lost by the incoming sphere, depends on the ratio u_2/u .

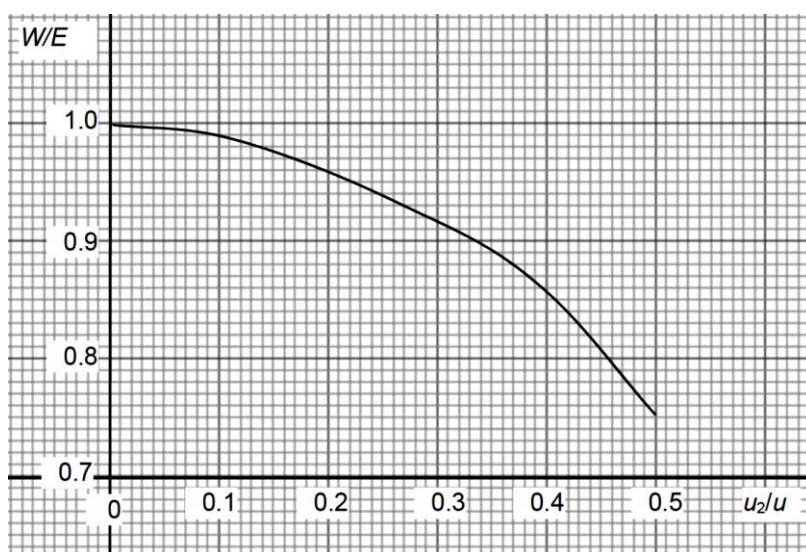


Fig. 6.2

(i) Explain what is meant by a *head-on* collision.
.....
.....
..... [1]

(ii) Explain what happens to the kinetic energy lost by the incoming sphere.
.....
.....
.....[2]

(iii) Given that the mass of the sphere is 1.67×10^{-27} kg and the speed of the incoming sphere is 1.40×10^7 m s⁻¹, calculate the energy lost by this incoming sphere in a perfectly elastic collision when $u_2 / u = 0.400$.

energy loss = J [3]

(iv) In another collision, the incoming sphere, moving with speed u collided with the second sphere that is initially at rest.

1. Determine the fraction of energy lost.

fraction = [1]

2. Describe the motion of the two particles after the collision.
.....
.....
.....
..... [2]

- (v) Use the graph of Fig. 6.2 to suggest why paraffin wax, which has a high number density of protons, is a good absorber of high speed neutrons. (mass of neutrons = 1.67×10^{-27} kg)

.....

.....

.....

.....

..... [3]

- (c) The collision of particles is often not a head-on collision. In most cases, two particles A and B collide elastically, as illustrated in Fig. 6.3.

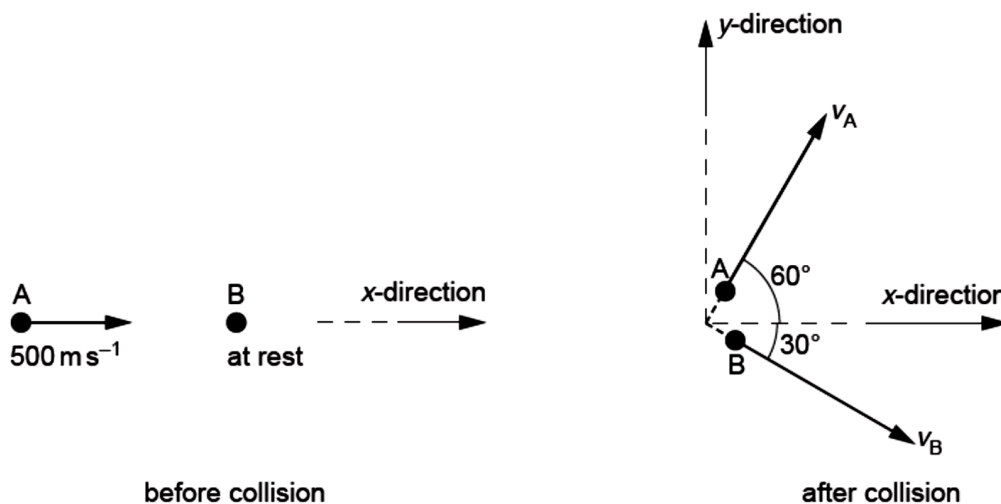


Fig. 6.3

The initial velocity of A is 500 m s^{-1} in the x-direction and B is at rest.

The velocity of A after collision is v_A at 60° to the x-direction. The velocity of B after the collision is v_B at 30° to the x-direction.

The mass m of each particle is 1.67×10^{-27} kg.

- (i) Calculate the total initial momentum of A and B.

momentum = N s [1]

(ii) State an expression in terms of m , v_A and v_B for the total momentum of A and B after the collision

1. in the x-direction,

.....

2. in the y-direction.

.....[2]

(iii) Calculate the magnitudes of the velocities of v_A and v_B after the collision.

$v_A = \dots\dots\dots \text{ m s}^{-1}$

$v_B = \dots\dots\dots \text{ m s}^{-1}$ [3]

- 7 (a) A tuning fork is knocked against a hard object such that it causes the neighbouring air molecules to vibrate with a frequency of 128 Hz. Fig. 7.1 shows the positions of the air molecules around the tuning fork at a particular instant.

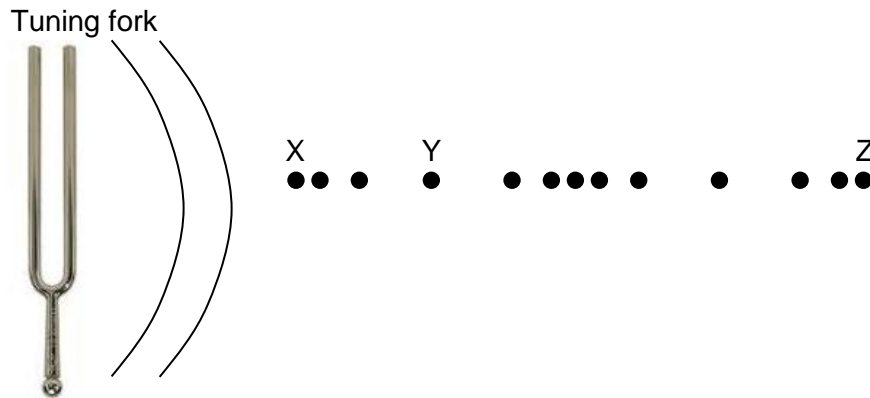


Fig. 7.1

- (i) Explain why the wave produced by the tuning fork cannot be polarised.

.....

 [1]

- (ii) Given that the distance between X and Z is 5.2 m, calculate the speed of the longitudinal wave between X and Z.

speed = m s⁻¹ [1]

- (iii) Determine the phase difference between X and Y.

phase difference = rad [1]

- (iv) The longitudinal waves created by tuning fork A can be assumed to have a power of 0.72 W and is equally generated in all directions. A microphone whose circular cross-section of radius 2.0 cm is placed 5.0 m away from the tuning fork as shown in Fig. 7.2.

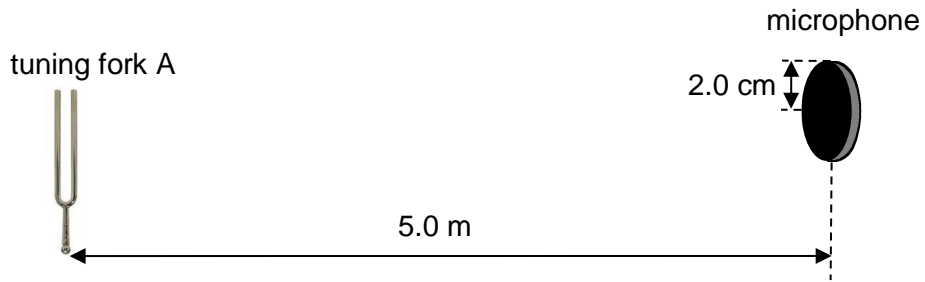


Fig. 7.2 (not to scale)

Determine the power received by the microphone.

power received = W [3]

- (b) In Fig. 7.3, S_1 and S_2 are two small loudspeakers, initially placed at position Y and Z, that emit sound waves of the same intensity and wavelength. A microphone for detecting sound intensity is placed at point P such that $YP = ZP$.

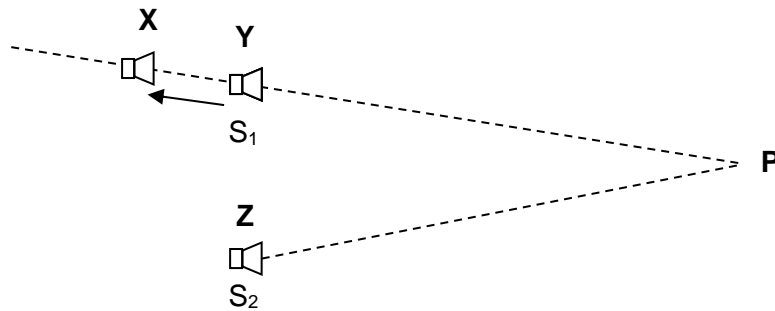


Fig. 7.3

- (i) Describe a method in which the period of the sound wave can be recorded.

.....

.....

.....

..... [2]

- (ii) One of the conditions required for the formation of a well-defined interference pattern is that the two sources are coherent.

State what is meant by coherent sources and suggest how *coherence* of S_1 and S_2 can be achieved.

.....

.....

.....

..... [2]

- (iii) Given that S_1 and S_2 are in phase, the speaker S_1 is moved slowly from Y to X along the line between these two points. As S_1 is moved, the sound detected at P fluctuates in intensity.

Explain this observation.

.....

.....

.....

.....

..... [3]

- (iv) In moving S_1 from point Y to point X as shown in Fig. 7.3, the intensity of the sound at P changes from a maximum to a minimum. The distance $YX = 0.082$ m.

Calculate the wavelength of the sound emitted by the sources.

wavelength = m [1]

- (v) S_1 remains at the point X and the frequency f of the sound emitted from both S_1 and S_2 is gradually increased until a maximum sound intensity is first detected at P. This occurs when $f = 4100$ Hz.

1. Estimate a value for the speed of sound.

speed = m s^{-1} [2]

2. Explain why the maximum sound intensity detected at P when S_1 is at point X differs from that detected at P if S_1 is at Y.

.....
.....
.....
..... [2]

(vi) Explain why for the maxima and minima to be observable, the amplitude of the two sound sources have to be approximately the same.

.....
.....
.....
..... [2]

- 8 (a) A battery of e.m.f. E and internal resistance r is connected to a variable resistor, as shown in Fig. 8.1.

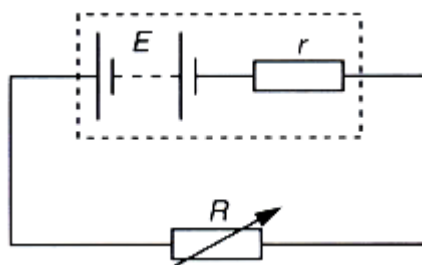


Fig. 8.1

The total power produced in the battery is P_T . The power dissipated in the variable resistor is P_R . The variation of P_T and P_R with resistance R of the variable resistor are shown in Fig. 8.2.

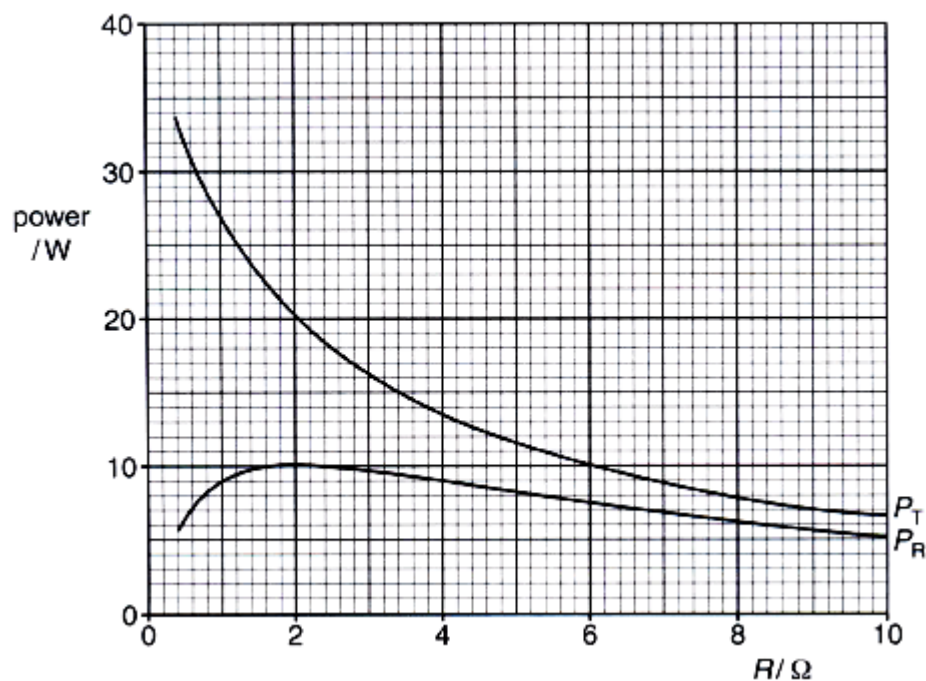


Fig. 8.2

- (i) For resistance $R = 1.0 \Omega$, use Fig. 8.2,
1. to show that the current in the circuit is 3.0 A. Explain your working.

2. to determine the e.m.f. E of the battery.

$$E = \dots\dots\dots \text{ V [2]}$$

- (ii) For any value of R , the value of P_T is greater than that of P_R .

1. Suggest what is represented by the quantity $(P_T - P_R)$.

.....
.....[1]

2. Use the values of P_T and P_R at $R = 1.0 \Omega$ and your answer to **(a)(i)1.** to determine the internal resistance r of the battery.

$$r = \dots\dots\dots \Omega [2]$$

- (iii) 1. Use Fig. 8.2 to state the value of R at which P_R is maximum.

$$R = \dots\dots\dots \Omega [1]$$

2. For the value of R stated in **(a)(iii)1.**, determine the efficiency of power transfer from the battery to the variable resistor.

$$\text{efficiency} = \dots\dots\dots \% [1]$$

3. State how the efficiency of power transfer changes for values of R between $4\ \Omega$ to $10\ \Omega$.

.....
..... [1]

(b) Fig 8.3 shows the variation with applied potential difference V of the current I in an electrical component C.

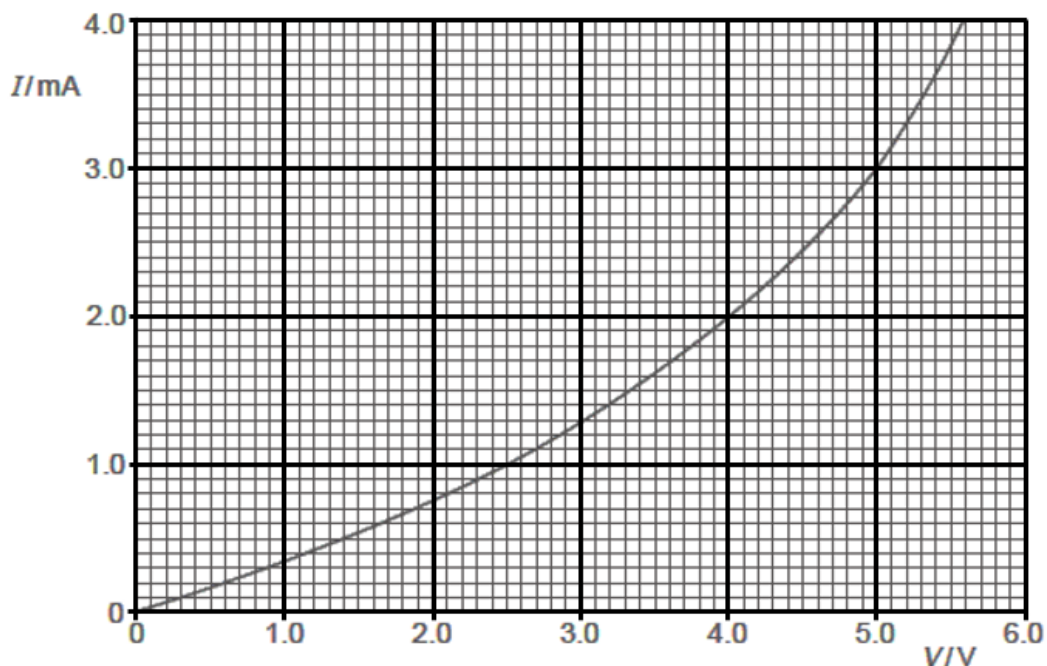


Fig. 8.3

(i) 1. Using Fig 8.3, explain why the resistance of component C decreases with increasing potential difference.

.....
.....
..... [1]

2. Determine the resistance of component C at a potential difference of 4.0 V.

resistance = Ω [2]

- (ii) Component C is connected in parallel with a resistor X of resistance $1500\ \Omega$ and a battery of e.m.f. F and negligible internal resistance, as shown in Fig. 8.4.

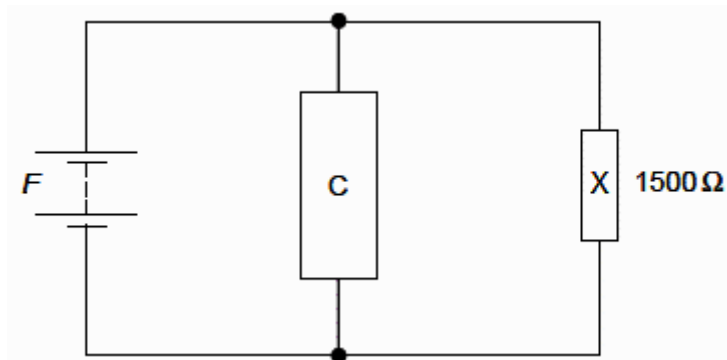


Fig. 8.4

1. On Fig. 8.3, draw a line to show the variation with potential difference V of the current I in resistor X. [2]
2. Hence, or otherwise, use Fig. 8.3 to determine the current in the battery for an e.m.f. of 2.0 V .

current = A [2]

- (iii) The resistor X of resistance $1500\ \Omega$ and the component C are now connected in series across a supply of e.m.f. 7.0 V and negligible internal resistance.

Using information from Fig. 8.3, state and explain which component, X or C will dissipate thermal energy at a greater rate.

.....

.....

.....

.....

.....

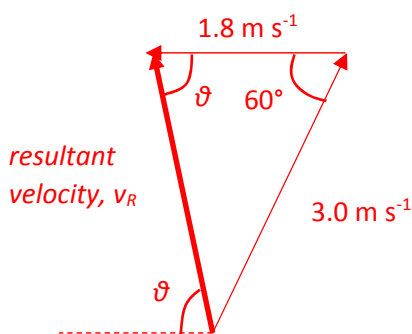
.....

..... [3]

END OF PAPER

SECTION A

1 (a)(i)



[B1] – Correct vector triangle (direction and magnitude)

1 (a)(ii)

Using cosine rule,

$$(v_R)^2 = (1.8)^2 + (3.0)^2 - 2(1.8)(3.0) \cos 60^\circ \quad [M1]$$

$$v_R = 2.6 \text{ m s}^{-1} \quad [A1]$$

$$(\sin \vartheta) / 3.0 = \sin 60^\circ / v_R \quad [M1]$$

$$\vartheta = 88^\circ$$

Direction is 88° anticlockwise from the river bank [A1]

Alternative marking: For students who use a scale diagram, workings need to be shown and accuracy mark to be awarded.

Marking points: - correct direction and vector length drawn to chosen scale for boat and water velocity. [B2]

accuracy for $v_R (\pm 0.2 \text{ m s}^{-1})$ [B1]

accuracy for $\vartheta (\pm 2.0^\circ)$ [B1]

1 (b)(i)

$$\frac{V}{t} = \frac{\pi P r^4}{8 B l}$$

$$B = \frac{\pi P r^4}{8 \left(\frac{V}{t}\right) l}$$

$$B = \frac{\pi (2.50 \times 10^3) (0.75 \times 10^{-3})^4}{8 (1.20 \times 10^{-6}) (0.250)} \quad [M1]$$

$$B = 1.04 \times 10^{-3} \text{ N s m}^{-2} \quad [A0]$$

1 (b)(ii)

$$\frac{\Delta B}{B} = \frac{\Delta P}{P} + 4 \left(\frac{\Delta r}{r}\right) + \left(\frac{\Delta(V/t)}{(V/t)}\right) + \frac{\Delta l}{l}$$

[C1] – Correct application of multiplication law

Comments

Students need to be careful to label the vector diagram with BOTH the correct direction (arrow direction) and magnitude (value of velocity). Otherwise, it is not considered a vector diagram.

Comments

Those who chose the calculation method could obtain the magnitude of the resultant velocity correctly. However, most failed to calculate the direction correctly. Note, that calculating an angle is not considered having described the direction correctly. The angle must be described with reference to a reference direction which should not be respect to NSEW direction as no where in the question was stated where the N is! Reference should easily be made with respect to the river bank.

Those who chose to use the scale diagram option must draw angles accurately with a protractor.

Comments

Comments

Many students failed to make B the subject BEFORE applying the multiplication law. In fractional uncertainty, it is not necessary to convert the numerator and denominator to SI base units. Many

JC2 H1 Physics Prelim Exam Solution (Paper 2)

$$\frac{\Delta B}{B} = \frac{0.05}{2.50} + 4\left(\frac{0.01}{0.75}\right) + \left(\frac{0.01}{1.20}\right) + \frac{0.001}{0.250}$$

[M1] – Correct substitution

$$\frac{\Delta B}{(1.04 \times 10^{-3})} = 0.085667$$

$$\Delta B = 8.91 \times 10^{-5} \text{ OR}$$

$$= 0.09 \times 10^{-3} \text{ N s m}^{-2}$$

[A1] – Correct answer (rounded to 1 sf)

1 (b)(iii)

$$B = (1.04 \pm 0.09) \times 10^{-3} \text{ N s m}^{-2}$$

[A1]

2 (a)

- The velocity increases from rest at a constant rate from $t = 0$ to $t = 8$ s.
- The velocity decreases to 0 m s^{-1} at a constant rate from $t = 8$ to $t = 10$ s.
- The velocity increases from 0 m s^{-1} at a constant rate in the opposite direction from $t = 10$ to $t = 16$ s.

[B1] – First 2 bullet points

[B1] - Last bullet point

2 (b)(i)

Displacement is given by the area under the graph

$$\text{displacement} = \frac{1}{2} (10)(5) \quad [M1]$$

$$= 25 \text{ m} \quad [A1]$$

2 (b)(ii)

Acceleration is given by the gradient of the graph at $t = 10$ s

$$\text{acceleration} = -5/2 \quad [M1]$$

$$= -2.5 \text{ m s}^{-2} \quad [A1]$$

If no negative sign, minus 1 mark

2 (b)(iii)

Maximum speed of the ball occurs at $t = 16$ s

$$\text{Maximum speed} = 15 \text{ m s}^{-1}$$

[M1]

$$\text{Maximum kinetic energy} = \frac{1}{2} m v_{\max}^2$$

$$= \frac{1}{2} (0.4)(15)^2$$

$$= 45 \text{ J}$$

[A1]

who chose to do so, made conversion errors.

Absolute uncertainty of B must already be stated to 1 sf here.

Comments

Many could not write the value to B to the correct format. 1sf for uncertainty and B to the correct dp as the uncertainty.

Comments

Many students could not describe the third point correctly, failing to recognize that the object is now travelling in the opposite direction with increasing velocity at a constant rate.

Comments

Quite well done.

Comments

Quite a handful did not state acceleration here as negative value. (Object is decelerating here)

Comments

Quite well done.

JC2 H1 Physics Prelim Exam Solution (Paper 2)

2 (c)

The maximum displacement of the ball from P = 25 m

The ball starts to return to P from $t = 10$ s travelling in the opposite direction.

Let t be the time for the ball to travel a distance of 25 m from then.

Using, $s = ut + \frac{1}{2}at^2$

$$25 = 0 + \frac{1}{2}(2.5)(t)^2 \quad [M1]$$

$$t = 4.5 \text{ s}$$

Hence time from $t = 0$ for the ball to return to

$$P = 10 + 4.5 = 14.5 \text{ s} \quad [A1]$$

Comments

Many student was caught unaware by the requirement of calculating the elapsed time from $t = 0$ s!

3 (a)

Resultant force in any direction is zero [B1]

Resultant moment/ torque about any point is zero [B1]

Comments

Students need to explicitly state the term "in any direction" and "about any point" for the conditions to hold. Most students lose a mark because of this reason.

3 (b)(i)

$$\text{Force} = 33 \sin 52^\circ = 26 \text{ N} \quad [A1]$$

Comments

Generally well done. Students are able to resolve the force into two components.

3 (b)(ii)

$$26 \times 0.30 = (W \times 0.20) + (12 \times 0.40) \quad [C1]$$

$$W = 15 \text{ N} \quad [A1]$$

Comments

Some students were careless with finding the moment and did not determine the perpendicular distance.

3 (b)(iii)

When bucket is filled with water, there is larger downward force that leads to an increase in the clockwise moment of the weight of the bucket about the pivot A. (no change in perpendicular distance) [B1]

Since the moment due to the weight of the beam at point A remains the same. [B1]

Force in the bar has to increase to provide a greater counter-clockwise moment to balance the increased clockwise moment for the same perpendicular distance of the force about the pivot. [A1]

Comments

Students need to explain that the moment of weight of beam remains the same. Also, students should state clearly that the perpendicular distance of the force in the bar remains the same too. Students who explained the increase in the force using summation of force is not accepted. This explanation does not take into account the force acting at the pivot.

4 (a)

Magnetic force on wire $F = BIL$

$$\text{Force per unit length } F/L = BI = (5.2 \times 10^{-2})(7.5) \quad [M1]$$

$$= 0.39 \text{ N m}^{-1} \quad [A1]$$

Using FLHR, direction of magnetic force on wire is downwards.

Comments

Well done.

[B1]

4 (b)

force on wire is equal to the total force on the free electrons,
 $BIL = N$ (Force on 1 electron)

(Number of electrons = number per unit volume \times cross sectional area \times length)

$$BIL = (N/V)(AL)(\text{Force on 1 electron})$$

$$BI = (7.8 \times 10^{28})(1.5 \times 10^{-9})(\text{force on 1 electron})$$

$$= 1.17 \times 10^{23}(\text{force on 1 electron})$$

[M1]

$$\text{Force on 1 electron} = 0.39/1.17 \times 10^{23}$$

$$= 3.3 \times 10^{-24} \text{ N}$$

[M1]

[A1]

5 (a)(i)

When $E_{\text{max}} = 0$,

$$hc \left(\frac{1}{\lambda} - \frac{1}{\lambda_0} \right) = 0$$

$$\lambda = \lambda_0$$

From Fig 5.1, when $E_{\text{max}} = 0$,

$$\frac{1}{\lambda} = 2.30 \times 10^6$$

[M1]

$$\lambda = 4.34 \times 10^{-7} \text{ m}$$

[A1]

$$\text{i.e. } \lambda_0 = 4.34 \times 10^{-7} \text{ m}$$

5 (a)(ii)

Using points $(3.80 \times 10^6, 3.0 \times 10^{-19})$ and $(2.30 \times 10^6, 0)$ to find gradient of graph

Gradient of graph = hc

[M1]

$$\frac{(3.0 \times 10^{-19} - 0)}{(3.8 \times 10^6 - 2.3 \times 10^6)} = hc$$

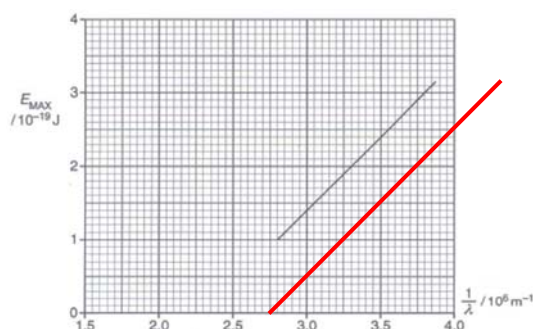
$$3.0 \times 10^{-19} = h \times 3.0 \times 10^8 (3.80 \times 10^6 - 2.30 \times 10^6)$$

[M1]

$$h = 6.7 \times 10^{-34} \text{ J s}$$

[A0]

5 (b)



The new line should be a straight line having the same gradient but a larger x-intercept.

[A1]

Comments

Poorly done with a lot of students not careful with the units conversion or not aware that unit conversion is required.

Comments

Poorly attempted. Only a handful was able to use the correct approach for this question. However many read off the corresponding x-intercept for $E_{\text{max}} = 0$ wrongly as they did not realise that the graph did not intersect the x-axis.

Comments

Fairly well done by those who attempted this question. Most could recognise that the gradient of the graph gives hc .

Comments

Fairly well done. Only a handful did not realise that the new graph will have the same gradient since gradient gives hc , which is a constant.

SECTION B

6 (a)

The total momentum of a system (of colliding particles) remains constant [M1]

Provided there is no resultant external force acting on the system/ isolated or closed system [A1]

Comments

Students should note that the conservation law does not only apply to collisions. The law can be applied when a system undergoes decay or explosion. Students should spend time to memorise the law.

6 (b)(i)

A head-on collision is when the particles move along the same linear direction after the collision. [B1]

Comments

Most students were not aware of the meaning of "head-on".

6 (b)(ii)

As the collision is elastic, the total kinetic energy of the spheres must be conserved. [B1]

Hence, the loss of kinetic energy of the incoming sphere goes to the gain of kinetic energy of the bombarded sphere. [B1]

Comments

Several students did not realise that since the collision is elastic, there is no loss of energy to other forms of energy. The total KE remains constant and the loss of KE of the incident sphere is transferred to the other sphere.

6 (b)(iii)

Kinetic energy of sphere = $\frac{1}{2}mv^2 = 1.64 \times 10^{-13} \text{ J}$ [M1]

From graph, for $\frac{u_2}{u} = 0.400$,

$$\frac{W}{E} = 0.855 \quad [M1]$$

$$\frac{W}{1.64 \times 10^{-13}} = 0.855$$

energy loss, $W = 1.40 \times 10^{-13} \text{ J}$ (to 3 s.f) [A1]

Comments

Students need to read the graph to half a small square. One mark is penalised for reading the value to be 0.85 or 0.86.

Generally poorly done.

6 (b)(iv)1.

Since the second sphere is at rest $u_2 = 0$,

$u_2/u = 0$,

From graph, $W/E = 1$ [A1]

Comments

This part is poorly done. Students need to understand the question and how to use the graph to help them solve a problem.

6 (b)(iv)2.

The first sphere will come to rest [B1] and the second sphere will move off speed u . [B1]

Comments

This part is poorly done, primarily because students faced difficulties in (iv)2.

6 (b)(v)

The graph can be used on the ground that the proton and neutron have the same mass.

The protons in the paraffin wax have very low initial velocities compared to the fast-moving neutrons, hence the ratio $\frac{u_2}{u}$ is small. [B1]

From the graph, the $\frac{W}{E}$ ratio will be high, meaning the neutrons would lose most or all of its kinetic energy during collision. [B1]

Comments

Students do not understand the meaning of "high number density" which simply means that there is a large number of protons per unit volume in paraffin wax. Also, student failed to recognise that given the masses of protons and neutrons to be the same, they could use the graphs

JC2 H1 Physics Prelim Exam Solution (Paper 2)

The incoming neutrons will be absorbed or stopped at its tracks by the paraffin wax. [B1]

6 (c)(i)

$$\begin{aligned} \text{Total momentum} &= p_A + p_B \\ &= 1.67 \times 10^{-27} \times 500 + 0 \\ &= 8.35 \times 10^{-25} \text{ N s} \end{aligned}$$

[A1]

6 (c)(ii)

$$\begin{aligned} 1. &mv_A \cos 60^\circ + mv_B \cos 30^\circ \\ 2. &mv_A \sin 60^\circ + mv_B \sin 30^\circ \end{aligned}$$

[A1]

[A1]

6 (c)(iii)

$$500m = mv_A \cos 60^\circ + mv_B \cos 30^\circ$$

And

$$0 = mv_A \sin 60^\circ + mv_B \sin 30^\circ$$

[C1]

[C1]

Or using a vector triangle

$$v_A = 250 \text{ m s}^{-1}$$

$$v_B = 430 \text{ m s}^{-1}$$

[A1]

7 (a)(i)

Given that it is a sound wave, its particle vibrates in the direction as the wave propagation, thus it cannot be polarised

[B1]

7 (a)(ii)

2 full cycles are found between X and Z

This means that the wavelength $\lambda = 5.2 / 2 = 2.6 \text{ m}$

$$\text{Since } v = f \lambda = 128 \times 2.6 = 333 \text{ m s}^{-1}$$

[A1]

7 (a)(iii)

Between a rarefaction and compression, half a wave is found.

$$\text{Hence, phase difference} = \phi = 2\pi \frac{0.5\lambda}{\lambda} = \pi \text{ rad}$$

[A1]

7 (a)(iv)

Intensity of wave at position of microphone

$$= P / 4\pi x^2$$

$$= 0.72 / [4\pi(5.0)^2]$$

$$= 2.29 \times 10^{-3} \text{ W m}^{-2}$$

[M1]

Power picked up by microphone

$$= I \times A = (2.29 \times 10^{-3}) \times [\pi(0.02)^2]$$

$$= 2.9 \times 10^{-6} \text{ W}$$

[M1]

[A1]

7 (b)(i)

Connect the microphone to a C.R.O

[B1]

and part (iv) to respond to this question.

Comments

Mostly well done. Several students showed clearly that the momentum of particle B is zero.

Comments

Students showed understanding that they need to resolve the momentum into two components.

Comments

Not well done. Only a few students could make sense of the conservation of linear momentum in the x and y-directions.

Comments

Well done.

Comments

Some students were not mindful about when determining the wavelength.

Comments

Well done.

Comments

Poorly done with several students not knowing how to link the quantities involved.

Comments

Poorly done. For those student who noticed the use of C.R.O, the description of how to capture the period was not elaborated.

JC2 H1 Physics Prelim Exam Solution (Paper 2)

Set the time base of the C.R.O such that a full wave can be registered and the period will be the time taken for one full wave form. [B1]

7 (b)(ii)

The waves generated by the sources have a phase difference that remains constant with time. [B1]

This can be achieved by connecting the two loudspeakers to the same sound source/ signal generator, producing waves that are in phase.

OR

two constant sound sources of the same frequencies. [B1]

7 (b)(iii)

The sound waves from the two sources undergo interference. The path difference ($S_1P - S_2P$) and the phase difference at P is altering as S_1 moves. [B1]

Since the two sources are in phase, the waves meet in phase at P when the path difference between the sources is an integral multiple of wavelengths; constructive interference at P results in maximum intensity. [B1]

The waves meet in anti-phase at P when the path difference is an odd integral multiple of half wavelengths; destructive interference at P results in minimum intensity. [B1]

7 (b)(iv)

path difference = $S_1X = \lambda/2$
 $\lambda = 0.164 \text{ m}$; [A1]

7 (b)(v)1.

$S_1X = \text{one wavelength} = 0.082 \text{ m}$;
 $v = f\lambda = 4100 \times 0.082$ [M1]
 $= 336 \text{ m s}^{-1}$ OR 340 m s^{-1} ; [A1]

7 (b)(v)2.

As S_1 is moved further away, the intensity at P due to S_1 decreases as intensity is inversely proportional to the square of the distance from the source. The wave amplitude at P due to S_1 also decreases since intensity is proportional to (amplitude)². [B1]

During constructive interference at P, the resultant amplitude, and thus the resultant maximum intensity when S_1 is at point X is smaller than that when S_1 is at its original position. [B1]

7 (b)(vi)

During maxima, the resultant amplitude will be the maximum vector sum of the amplitude of the 2 waves, while during

Comments

Students were able to state correctly what is coherent. But not many were able to obtain the second mark.

Comments

Most students can bring in the idea of path difference but not able to further explain using the concept.

Comments

well done.

Comments

Many students were not able to identify the magnitude of wavelength.

Comments

Many students argue that the one is CI while the other is a DI, without understanding the question.

Comments

Some students were able to identify the change in the amplitude but not

minima, the resultant amplitude will be the minimum vector sum of the two amplitude. [B1]

Thus in order to have the biggest contrast between these two vector sums, their amplitude have to be approximately the same. [B1]

the significant and the contrast between the two amplitudes.

8 (a)(i)1.

When $R = 1.0 \Omega$, $P_R = 9.0 \text{ W}$.

$$P_R = I_R^2 R$$

$$9.0 = I_R^2 \times 1.0 \quad [C1]$$

$$I_R = 3.0 \text{ A}$$

Since R is connected in series with battery, the current I_E in the circuit is the same as that in the resistor [M1]

i.e. $I_{\text{circuit}} = 3.0 \text{ A}$ [A0]

Comments

Most did not realise the question is asking for current in the circuit, rather than current in the resistor. An explicit relationship between the two variables is expected to be stated.

8 (a)(i)2.

When $R = 1.0 \Omega$, $P_T = 27.0 \text{ W}$

$$P_T = I_E E$$

$$27.0 = 3.0 \times E \quad [C1]$$

$$E = 9.00 \text{ V} \quad [A1]$$

Comments

Some wrongly use 1.0Ω as the total resistance of the circuit while others have no idea how (a)(i)1. is linked to 2. Those who manage to solve it may have forgotten about the s.f rule.

8 (a)(ii)1.

$(P_T - P_R)$ represents the power dissipated in the internal resistance of the battery. [B1]

Comments

About half got it correct. But students should be explicit in stating both the object (internal resistance of battery).

8 (a)(ii)2.

Since the internal resistance is connected in series with the battery, the current flowing through it is the same as that of the battery.

$$(P_T - P_R) = I_r^2 r$$

$$27.0 - 9.0 = 3.0^2 \times r \quad [C1]$$

$$r = 2.00 \Omega \quad [A1]$$

Comments

For those who did not know the significance of $(P_T - P_R)$, they usually do not know how to solve the next part. Those who manage to solve it may have forgotten about the s.f rule.

8 (a)(iii)1.

When P_R is maximum, $R = 2.00 \Omega$. [B1]

Comments

Generally well done.

8 (a)(iii)2.

$$\text{Efficiency} = \frac{\text{Power Output}}{\text{Power Input}} \times 100\%$$

$$\text{Efficiency} = \frac{10.0}{20.0} \times 100\% = 50\% \quad [B1]$$

Comments

Generally well done.

8 (a)(iii)3.

The increase in resistance from 4Ω to 10Ω increases the efficiency of the power transfer. [B1]

Comments

There are some amount of guessing in this question.

8 (b)(i)1.

Comments

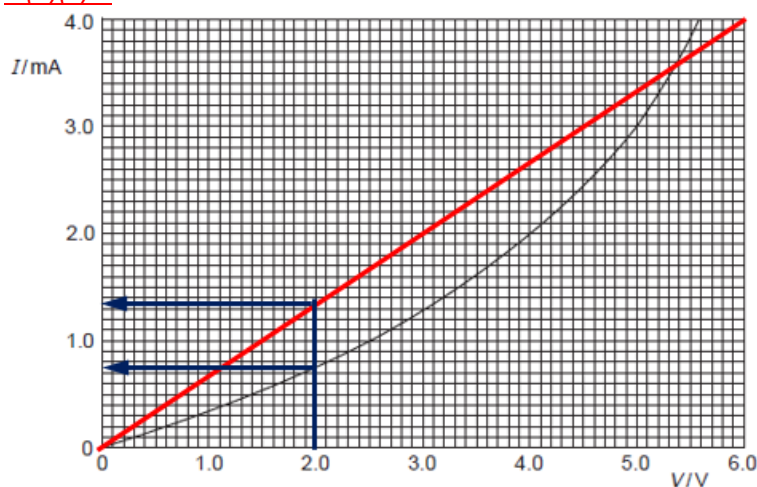
Resistance is the ratio of voltage to current. Since the increase in current is proportionally greater than the increase in voltage [M1], the resistance of component C decreases with increasing potential difference [A0].

8 (b)(i)2.

$$R = \frac{V}{I} = \frac{4.0}{2.00 \times 10^{-3}} \quad [C1]$$

$$= 2000 \Omega \quad [A1]$$

8 (b)(ii)1.



*Straight line from origin [M1]
and passing through (6.0 V, 4.0 mA) [A1]*

8 (b)(ii)2.

*From Fig. 8.3, when e.m.f. $\mathcal{E} = 2.0 \text{ V}$,
 $I_c = 0.75 \text{ mA}$ and $I_x = 1.35 \text{ mA}$ [C1]
Since component C and resistor X is connected in parallel to battery,
 $I_{\text{battery}} = I_c + I_x$
 $I_{\text{battery}} = 0.75 + 1.35 = 2.1 \text{ mA}$ [A1]
(Allow argument in terms of $P = I^2 R$ or IV)*

8 (b)(iii)

*Since resistor X and component C are connected in series, the current in X and C is the same. [B1]
From Fig. 8.4, the p.d. across C is larger than that across X when the e.m.f. is 7.0 V. [M1]
Since $P = IV$, component C dissipate thermal energy at a greater rate. [A1]*

Student needs to understand that resistance is not related to the gradient of the I-V graph. Explanation needs to be highlighted the extent of increase in both current and voltage.

Comments

Most common error is that the unit of current is mA not A.

Comments

Surprisingly, a significant majority did not draw the I-V graph of a fixed resistor. For those who draw a straight line through origin needs to be more careful how to depict a resistance of 1500Ω .

Comments

Many did not fully understand that the current of the circuit consists of both the current in C and X in a parallel circuit. Potential divider should not be used in this solution. Students need to be careful in the reading of coordinates.

Comments

Comparison of the rate of thermal dissipation requires comparison of the voltage, current and resistance of the component. Such information should be obtained from the graph, especially understanding that X and C are connected in series.