

Data

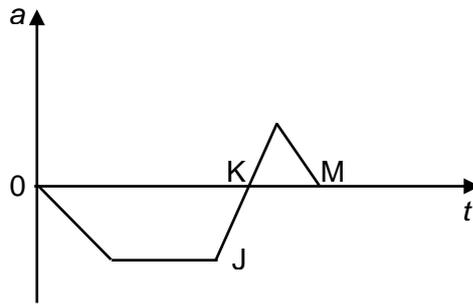
speed of light in free space,	c	=	$3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge,	e	=	$1.60 \times 10^{-19} \text{ C}$
the Planck constant,	h	=	$6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	u	=	$1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	m_e	=	$9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	m_p	=	$1.67 \times 10^{-27} \text{ kg}$
Acceleration of free fall	g	=	9.81 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,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \dots$

- 1 A boat changes its velocity from 16 m s^{-1} due north to 12 m s^{-1} due east.
What is its change in velocity?
- A 4 m s^{-1} at direction of 37° east of north
B 4 m s^{-1} at direction of 53° west of north
C 20 m s^{-1} at direction of 37° east of south
D 20 m s^{-1} at direction of 53° west of south
- 2 A student uses an analogue mass balance to measure mass. The mass balance is marked for every 0.2 kg but has a zero error of 0.4 kg . The student is not aware of this zero error and writes down a reading of 2.2 kg .
Is this reading accurate and precise?
- | | accurate | precise |
|---|----------|---------|
| A | no | no |
| B | no | yes |
| C | yes | no |
| D | yes | yes |
- 3 The e.m.f induced in a coil by a changing magnetic flux is equal to the rate of change of flux with time.
Which is a unit for magnetic flux?
- A $\text{kg m}^2 \text{ s}^{-2} \text{ A}^{-1}$
B $\text{kg m}^2 \text{ s}^{-2} \text{ A}$
C $\text{kg m}^2 \text{ s}^{-1} \text{ A}^{-1}$
D $\text{m s}^{-2} \text{ A}^{-1}$

- 4 A car starts from rest and travels along a straight road. The graph shows the variation with time t of its acceleration a , during part of the journey.

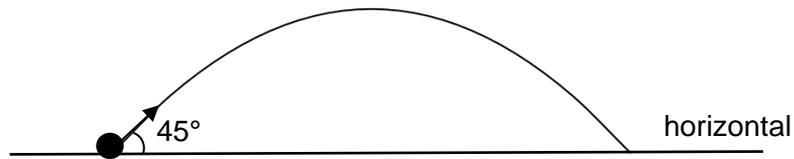


At which points on the graph does the car have its greatest speed and greatest displacement?

	greatest speed	greatest displacement
A	J	K
B	K	M
C	L	L
D	M	K

- 5 A motorist travelling at 13 m s^{-1} approaches a traffic light which turns red when he is 25 m away from the stop line. His reaction time (i.e. the interval between seeing the red line and applying the brakes) is 0.70 s and he brakes at a rate of 4.5 m s^{-2} . How far from the stop line will he stop, and on which side of it?
- A** 2.9 m behind the line
- B** 2.9 m beyond the line
- C** 4.0 m behind the line
- D** 4.0 m beyond the line

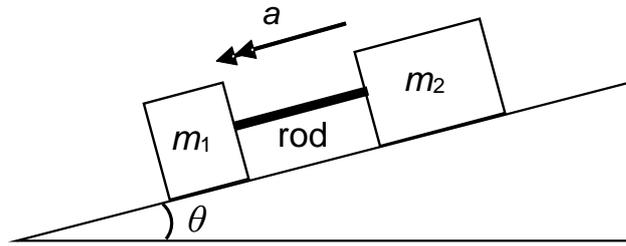
- 6 An object is projected with velocity of 60 m s^{-1} at 45° above the horizontal. Air resistance is negligible.



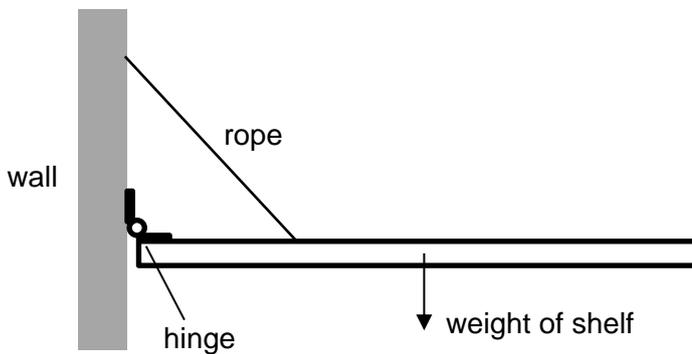
What is the speed of the object after 6.0 s ?

- A 20.5 m s^{-1}
- B 35.5 m s^{-1}
- C 45.5 m s^{-1}
- D 50.5 m s^{-1}
- 7 A man of weight 590 N is standing on a weighing scale in a lift. The lift is accelerating upwards at 2.00 m s^{-2} . What is the reading on the weighing scale?
- A 470 N
- B 590 N
- C 710 N
- D 890 N
- 8 Newton's third law of motion concerns action and reaction forces. Which pair of forces is not a valid example?
- A The gravitation forces of attraction between the Earth and a satellite orbiting around the Earth.
- B The forces of repulsion between a horse magnet and a wire carrying current placed in between the horse magnet.
- C Tension from a string pulling the object upwards and pulling force by the object on the string.
- D Weight of a book placed on a floor and the normal force from the floor on the book.

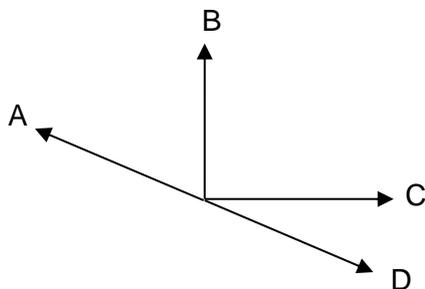
- 9 Two masses m_1 and m_2 are connected by a light rod as shown. The blocks are moving with acceleration a , down a smooth slope that is inclined at angle θ . What is the tension in the rod?



- A $m_1 a (\sin \theta)$ B $(m_1 - m_2) a$ C $(m_1 + m_2) a$ D zero
- 10 A man sitting in a train carriage observes that a pendulum hanging from the ceiling makes an angle of 30° to the vertical. What is the acceleration of the train?
- A 4.9 m s^{-2} B 5.7 m s^{-2} C 8.5 m s^{-2} D 9.8 m s^{-2}
- 11 A hinged shelf is held horizontally against a wall by a rope. The forces acting on the shelf are its weight, the force by the rope and the force by the hinge.



Which arrow could represent the direction of the force the hinge exerts on the shelf?



- 12 A constant force F is applied to a stationary object of mass m on a frictionless surface. Thus, the velocity of the object increases to some value v in a time t . It covers a distance s during this time.

Which expression represents the kinetic energy gained by the object?

- A $F s t$ B $F v$ C $F s$ D $\frac{m s}{2 t}$

- 13 The power delivered by an engine to a train travelling at a constant speed of 45 m s^{-1} is 2.0 MW . What is the resistive force it experiences?

- A 0 N B $9.9 \times 10^2 \text{ N}$ C $2.2 \times 10^4 \text{ N}$ D $4.4 \times 10^4 \text{ N}$

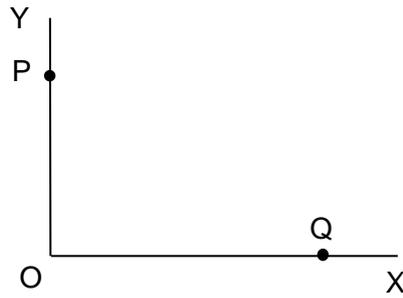
- 14 A bungee jumper has 27 kJ of gravitational potential energy at the top of his jump. He is attached to an elastic rope which starts to stretch after a short time of free fall. The table below shows values of the gravitational potential energy, elastic potential energy and kinetic energy at the top and bottom of the jump.

	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
top	27	0	0
bottom	0	27	0

What are the possible values of these three energies when the jumper is one third on the way down? Losses of energy due to air resistance is negligible.

	gravitational potential energy / kJ	elastic potential energy / kJ	kinetic energy / kJ
A	18	1	8
B	18	4	5
C	18	6	3
D	9	9	9

- 15 The diagram shows a flat surface with lines OX and OY at right angles to each other.

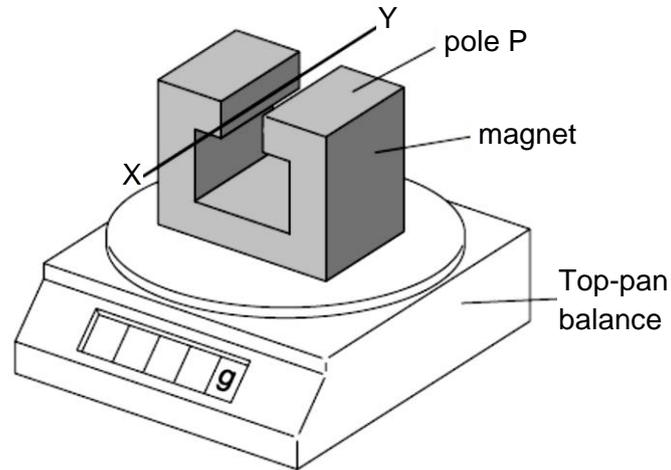


A straight current carrying conductor is placed at a position such that the magnetic field at O is found to be in the direction OX.

Which of the following correctly shows the position of the straight conductor and the direction of its current flow?

	position	direction of current flow
A	P	into the plane
B	P	out of the plane
C	Q	into the plane
D	Q	out of the plane

- 16 A large horseshoe magnet produces a uniform magnetic field of flux density B between its poles. The magnet is placed on a top-pan balance and a wire XY is situated between its poles, as shown in the figure below.



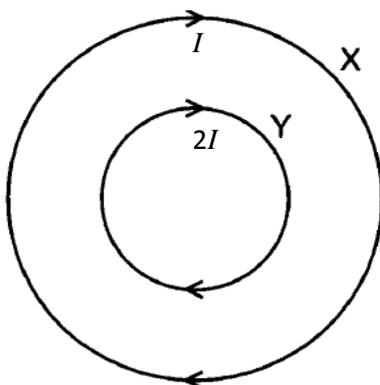
The wire XY is placed perpendicular to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y . The reading on the top-pan balance increases by 2.3 g.

What is the polarity of pole P of the magnet and the magnitude of the flux density between the poles?

	polarity of P	flux density / T
A	north	0.020
B	north	0.20
C	south	0.20
D	south	200

- 17 An electron is moving along the axis of a current-carrying solenoid. Which of the following is a correct statement about the electromagnetic force acting on the electron?
- A** The electromagnetic force acts radially outwards.
 - B** The electromagnetic force acts radially inwards.
 - C** The electromagnetic force acts in the direction of motion.
 - D** No electromagnetic force acts on the electron.

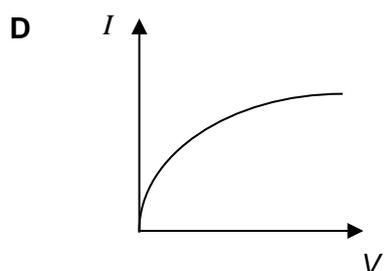
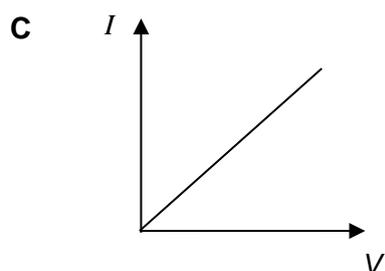
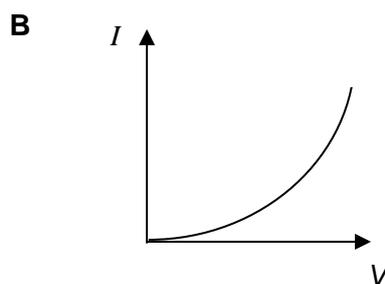
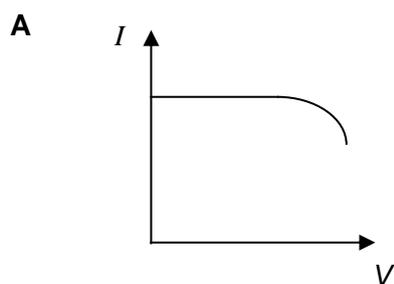
- 18 There are two concentric coils X and Y. Each coil carries a current in the same direction as shown below.



Which of the following statements is correct?

- A The force on coil X due to the current in coil Y is directed inwards towards the centre and it is twice the force on coil Y due to the current in coil X.
- B The force on coil X due to the current in coil Y is directed perpendicular to the plane of the coils and it is twice the force on coil Y due to the current in coil X.
- C The direction of the force acting on every point of Y is directed radially inwards, towards the centre of Y.
- D The direction of the force acting on every point of Y is directed radially outwards, away from the centre of Y.
- 19 Lamps in olden times used carbon filaments. The resistance of these filaments decreases as their temperature increases.

Which graphs shows how the current I in the filament varies with the potential difference V across it?



- 20 A resistor of resistance R has power P when the current in the resistor is I . What is the resistance of a resistor that has power $2P$ when the current in it is $\frac{I}{2}$?

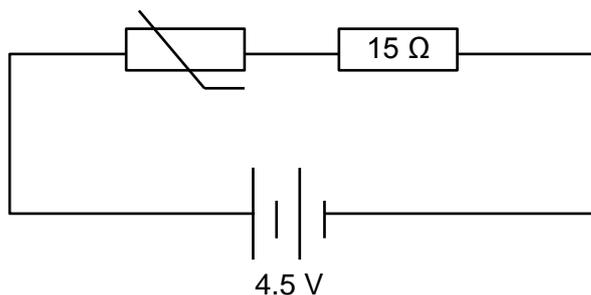
A $\frac{R}{8}$

B $\frac{R}{4}$

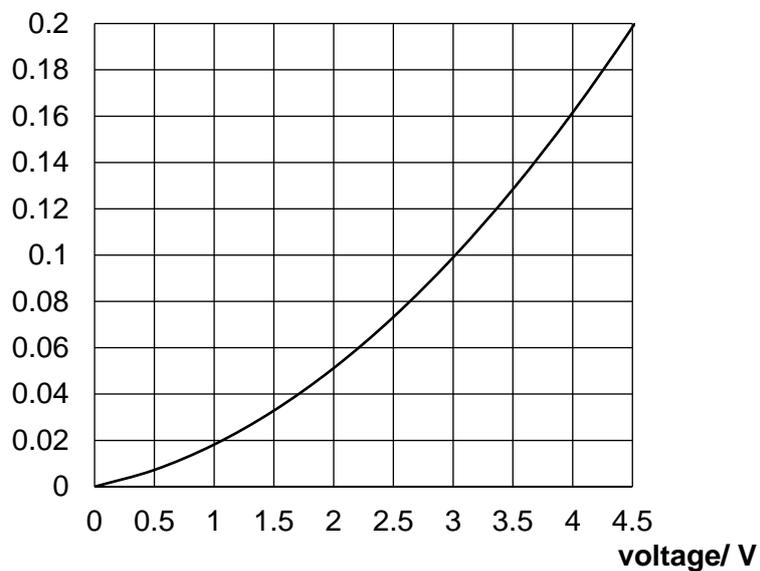
C $4R$

D $8R$

- 21 A $15\ \Omega$ resistor and a thermistor are connected in series to a battery of electromotive force $4.5\ \text{V}$ and negligible internal resistance.



current / A



The graph above shows the current – voltage characteristic of the thermistor. What is the current in the circuit?

A 0.05 A

B 0.10 A

C 0.15 A

D 0.20 A

- 22 When four identical lamps P, Q, R and S are connected as shown in diagram 1, they have normal brightness.

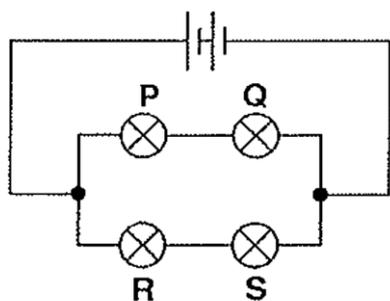


Diagram 1

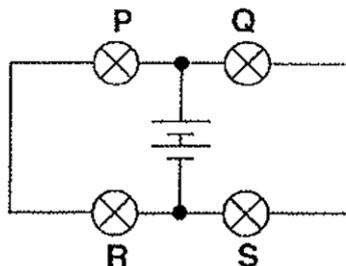
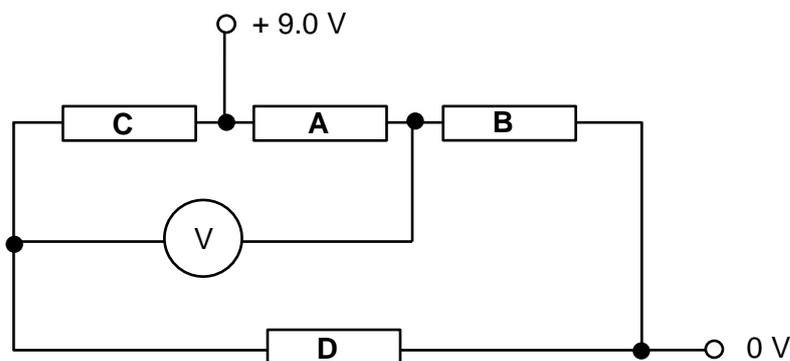


Diagram 2

When the four lamps are connected as shown in diagram 2, which statement is **correct**?

- A The lamps do not light up.
 - B The lamps are less bright than normal.
 - C The lamps have normal brightness.
 - D The lamps are brighter than normal.
- 23 In the circuit shown, the resistance of resistors A and D is R while the resistance of resistors C and B is $2R$.

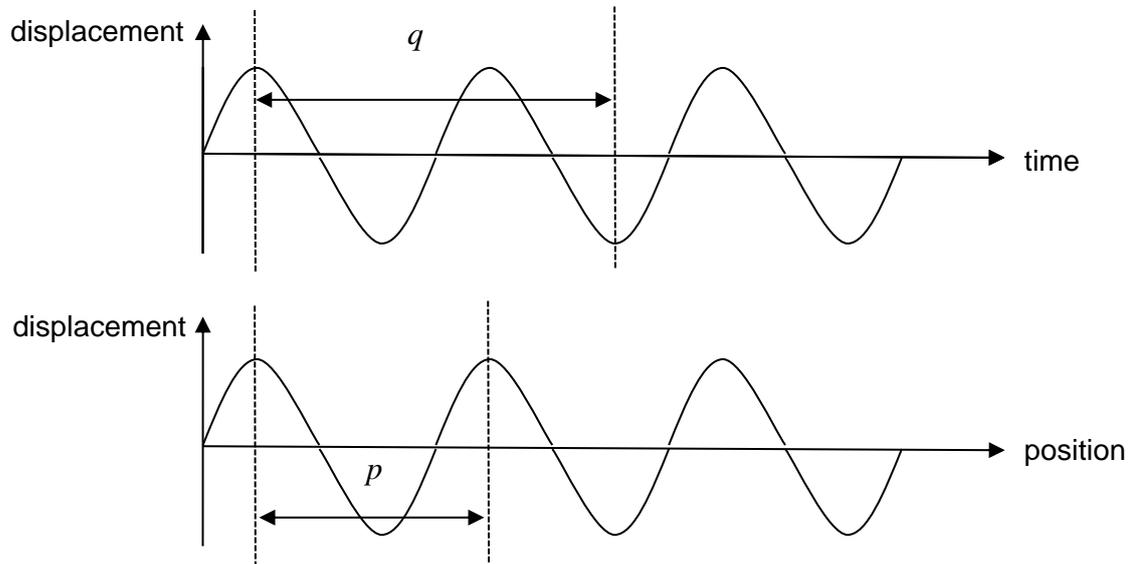


The potential difference between the input terminals is 9.0 V.

What is the reading on the voltmeter?

- A 0 V
- B 3.0 V
- C 6.0 V
- D 9.0 V

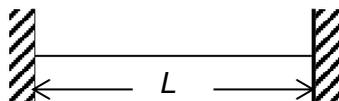
- 24 Which of the following statements is incorrect about progressive mechanical waves?
- A They propagate due to interaction between the particles of the medium.
 - B They can be transverse or longitudinal.
 - C They carry energy as they propagate.
 - D They can always be polarized.
- 25 A progressive wave can be represented by the following graphs.



Which of the following gives the speed of the wave?

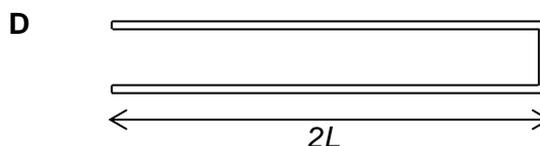
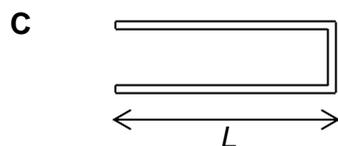
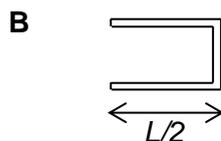
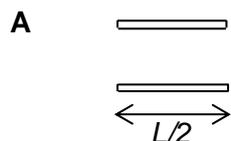
- A $\frac{q}{p}$
- B $\frac{p}{q}$
- C $\frac{2p}{3q}$
- D $\frac{3p}{2q}$

- 26 The figure below shows a stretched string of length L . The speed of waves on the string has the same speed as sound waves in the air. The fundamental mode of oscillation is then set up on the string.



Pipes **A**, **B**, **C** and **D** below have lengths of $L/2$, $L/2$, L and $2L$ respectively.

In which pipe will the sound produced by the string cause resonance?



- 27 Electrons in a beam undergo diffraction when incident on a crystalline solid. Given that the order of magnitude of the separation of atoms in the solid is 0.1 nm , what is the estimated speed of an electron in the beam?

- A** $10^{-24} \text{ m s}^{-1}$ **B** $10^{-10} \text{ m s}^{-1}$ **C** 10^5 m s^{-1} **D** 10^6 m s^{-1}

- 28 Which of the following observations in the photoelectric effect does not require the use of quantum theory of electromagnetic radiation to explain?

- A** The existence of a threshold frequency
B The dependence of stopping voltage with frequency of incident radiation
C The relationship between photocurrent and intensity of incident radiation
D The almost instantaneous emission of electrons once radiation of high enough frequency is incident

- 29 The transition of electrons between three consecutive energy levels in a particular atom gives rise to three spectral lines. The shortest and longest wavelengths of those spectral lines are λ_1 and λ_2 respectively. The wavelength of the other spectral line is

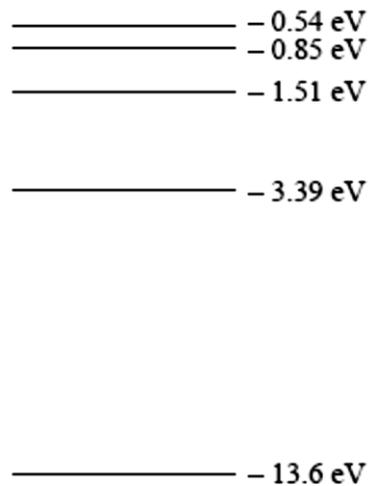
A $\frac{\lambda_1 + \lambda_2}{2}$

B $\lambda_1 - \lambda_2$

C $\frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

D $\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)^{-1}$

- 30 Some of the energy levels of the hydrogen atom are shown below.

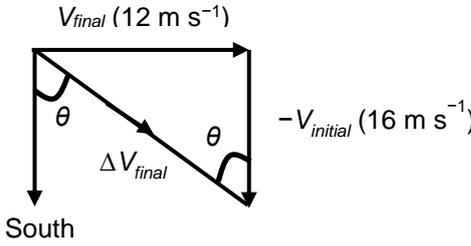


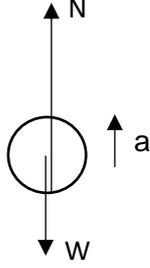
Electrons are excited to the -1.51 eV level. How many different photon frequencies will be detected when the electrons de-excite?

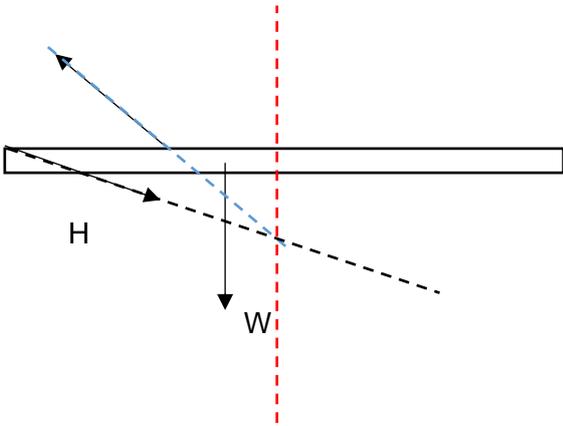
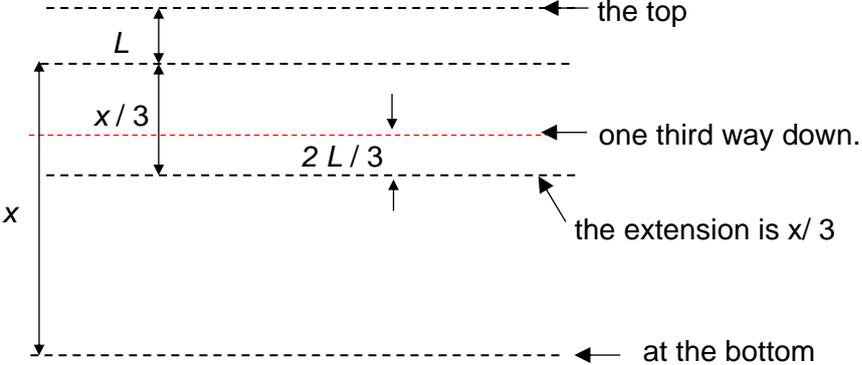
- A 2 B 3 C 4 D 5

END OF PAPER

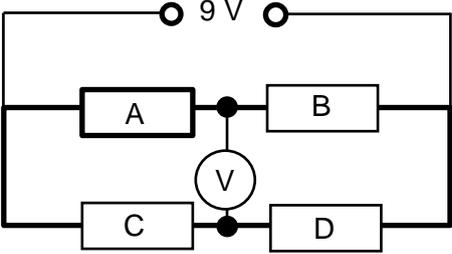
Paper 1 MCQs Solution:

S/N	Answer	Explanation
1	C	 $\Delta V_{final}^2 = 12^2 + 16^2$ $\Delta V_{final} = 20 \text{ m s}^{-1}$ $\tan \theta = 12 / 16$ $\theta = 37^\circ$
2	B	The smallest division on the mass balance is 0.2 kg. Absolute uncertainty is 0.1 kg for 1 reading. (1 measurement takes 2 readings so absolute uncertainty for 1 measurement is 0.2 kg.) The student has recorded his reading to the right precision. Hence, the reading is precise. However, it is not accurate as there is zero error which is unaccounted for.
3	A	ϕ is the flux linkage $e.m.f = \frac{d\phi}{dt}$ $[\phi] = [e.m.f][t]$ $= [p.d][t]$ $= \left[\frac{P}{I} \right][t]$ $= \left(\frac{\text{kg m}^2 \text{s}^{-3}}{\text{A}} \right) (\text{s})$ $= \text{kg m}^2 \text{s}^{-2} \text{A}^{-1}$
4	B	<p>Car accelerates (gain in speed) until point K.</p> <p>Since area under triangle between K and M is smaller than area under trapezium from 0 to K, the car maintains motion in the same direction.</p> <p>Therefore, car is gaining displacement until point M.</p>
5	B	<p>Distance traveled before brakes are applied = $13 \times 0.7 = 9.1 \text{ m}$</p> <p>Using $v^2 = u^2 + 2as$, $s = 18.8 \text{ m}$</p> <p>Total distance travelled = $9.1 + 18.8 = 27.9 \text{ m}$.</p> <p>Distance beyond the stop line = $27.9 - 25 = 2.9 \text{ m}$</p>
6	C	$v_y = u_y - a_y t$ $= 60 \sin 45^\circ - 9.81 \times 6$ $= -16.4 \text{ m s}^{-1}$ $v_x = u_x$ $= 60 \cos 45^\circ$ $= 42.4 \text{ m s}^{-1}$ $v^2 = v_x^2 + v_y^2$ $v^2 = (-16.4)^2 + (42.4)^2$ $v = 45.5 \text{ m s}^{-1}$

7	C	$F_{net} = m a$ $N - W = m a$ $N - 590 = (590 / 9.81) (2.00)$ $N = 710 \text{ N}$ 
8	D	<p>The gravitation force of attraction between satellite and earth is a pair of action and reaction force.</p> <p>Wire with current flowing will generate magnetic field around it. Hence, the wire acts a magnet which interacts with the horse magnet. Hence the magnetic forces of repulsion is a pair of action and reaction force.</p> <p>The upthrust is a force exerted by the water on the block. Hence upthrust and force by the block on the water is a pair of action and reaction force.</p> <p>The normal force is exerted by the floor on the floor. Weight of the book is exerted by the earth on the book. These two forces are of different type of forces and hence they cannot be a pair of action and reaction force.</p>
9	D	<p>m_1 and m_2 have the same acceleration.</p> <p>Considering rod, m_1 and m_2 as a system,</p> $(m_1 + m_2)g \sin \theta = (m_1 + m_2) a$ $a = g \sin \theta$ <p>considering m_1 as a system, $m_1 g \sin \theta - T = m_1 a$,</p> $m_1 a - T = m_1 a, T = 0$
10	B	<p>Since object is in translational equilibrium,</p> <p>(leftwards forces = rightward forces)</p> <p>Mass of ball x Acceleration of ball = horizontal component of Tension in string.</p> $ma = T \sin 30 - (1)$ <p>(upward forces = downward forces)</p> <p>Weight of ball = vertical component of Tension in string.</p> $mg = T \cos 30 - (2)$ <p>(1)/(2): $a/g = \tan 30$</p> $a = g \tan 30 = 5.7$

11	D	<p>By <u>extending the lines of three forces</u>, they should meet at a point only. This to ensure the net moment (torque) due to all the three forces will be zero so that the shelf will be rotational equilibrium. The horizontal component of H is acting to the right to balance the leftward horizontal component of T so that the net horizontal force is zero.</p> 
12	C	<p>Work done by the net external force = change in K.E $F s = K.E_{final} - K.E_{initial} = K.E_{final}$</p>
13	D	<p>$P_{eng} = F_{eng} v \Rightarrow F_{eng} = 2 \times 10^6 / 45 = 4.4 \times 10^4 \text{ N}$ Since velocity is constant, $F_{resist} = F_{eng}$</p>
14	A	<p>Let the natural length of the rope be L. Let the total extension of rope be x when it is at the bottom of the jump.</p>  <p>When it is one third way down: Extension = $(L + x) / 3 - L = x / 3 - 2 L / 3$ which less than $x / 3$. Hence E.P.E cannot exceed 3 kJ which is the E.P.E when the extension is $x / 3$.</p> <p>Hence the possible answer is only A.</p>
15	B	<p>Using right hand grip rule, a current coming out of the plane at P will result in a magnetic field that is anticlockwise. (in the direction OX)</p>

16	B	<p>force on magnet / balance is downwards => by Newton's third law force on wire is upwards => pole P is a north pole</p> $F = BIL = mg$ $B \times 2.6 \times 4.4 \times 10^{-2} = 2.3 \times 10^{-3} \times 9.81$ $B = 0.20 \text{ T}$
17	D	B field and electron motion are parallel to each other. No force is acting on electron.
18	D	The setup has two currents flowing in the same direction. Thus, they will attract each other with the same magnitude of force that are opposite in direction-an action reaction pair.
19	B	<p>As the voltage increases:</p> <ul style="list-style-type: none"> • the current will increase, the heating power dissipated across the lamp increase. • the temperature increases. • resistance decreases. • ratio of I / V should increase since $I / V = 1 / R$ • The graph should be steeper.
20	D	$P = I^2 R \quad \dots\dots\dots (1)$ $2P = (I / 2)^2 R_{new} \quad \dots\dots\dots (2)$ <p>(2) / (1):</p> $R_{new} = 8R$
21	B	<p>current / A</p> <p>voltage / V</p> $4.5 = 15 \times I + V_{thermistor}$ $I = (4.5 - V_{thermistor}) / 15$ <p>Plot a line of $I = (4.5 - V_{thermistor}) / 15$ on the same graph. When both lines meet, the Y co-ordinate of the point gives current flowing in circuit.</p>
22	C	Both circuits are identical.

23	B	 <p>p.d across voltmeter = p.d across C – p.d across A $= (2R/3R) \times 9 - (R/3R) \times 9$ $= 3 \text{ V}$</p>
24	D	<p>Only transverse waves can be polarized. Longitudinal waves is a progressive mechanical wave as well but it cannot be polarized.</p>

25	D	$q = \frac{3T}{2}; p = \lambda;$ $v = \frac{\text{distance}}{\text{time}} = \frac{\lambda}{T} = \frac{3p}{2q}$
26	B	For string, $L = \frac{\lambda}{2}$ For L/2 closed pipe, $L/2 = \frac{\lambda}{4}$. Therefore, $L = \frac{\lambda}{2}$, same wavelength as that of string.
27	D	For significant diffraction, $\lambda \sim d$ (atomic separation) According to de Broglie, $\lambda = h / (mv)$ $\Rightarrow v = 6.63 \times 10^{-34} \div (9.11 \times 10^{-31} \times 10^{-10}) = 7.3 \times 10^6 \text{ m/s}$
28	C	This observation can be explained by wave theory
29	D	For the shortest spectral line, the energy difference between involved levels = $\frac{hc}{\lambda_1}$ For the longest spectral line, the energy difference between involved levels = $\frac{hc}{\lambda_2}$ Thus, the energy difference between levels for the third spectral line = $\frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$ Let the wavelength of this third spectral line be λ_3 . Thus, the energy difference can also be expressed as $\frac{hc}{\lambda_3}$. We then have $\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$
30	B	– 1.51 eV to – 3.39 eV – 3.39 eV to – 13.6 eV – 1.51 eV to – 13.6 eV