NAME: ____ CLASS: ___________ INDEX: __________

CATHOLIC JUNIOR COLLEGE
JC2 Preliminary EXAMINATIONS
Higher 1

PHYSICS **8866/01**

Paper 1 **2014**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, tutorial group and index number on this cover page.

Write and/or shade your name, NRIC / FIN number and HT group on the Answer Sheet (OMR sheet), unless this has been done for you.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are a total of **30 Multiple Choice Questions (MCQs)** in 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 Answer Sheet (OMR sheet) provided.

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.
Calculators may be used.

PHYSICS DATA:

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

PHYSICS FORMULAE:

uniformly accelerated motion,
$$s = u t + \frac{1}{2} a t^2$$
$$v^2 = u^2 + 2 a s$$

work done on / by a gas, $W = p \Delta V$

hydrostatic pressure $p = \rho g h$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel,
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

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

1 Which of the following quantities are paired with the correct units?

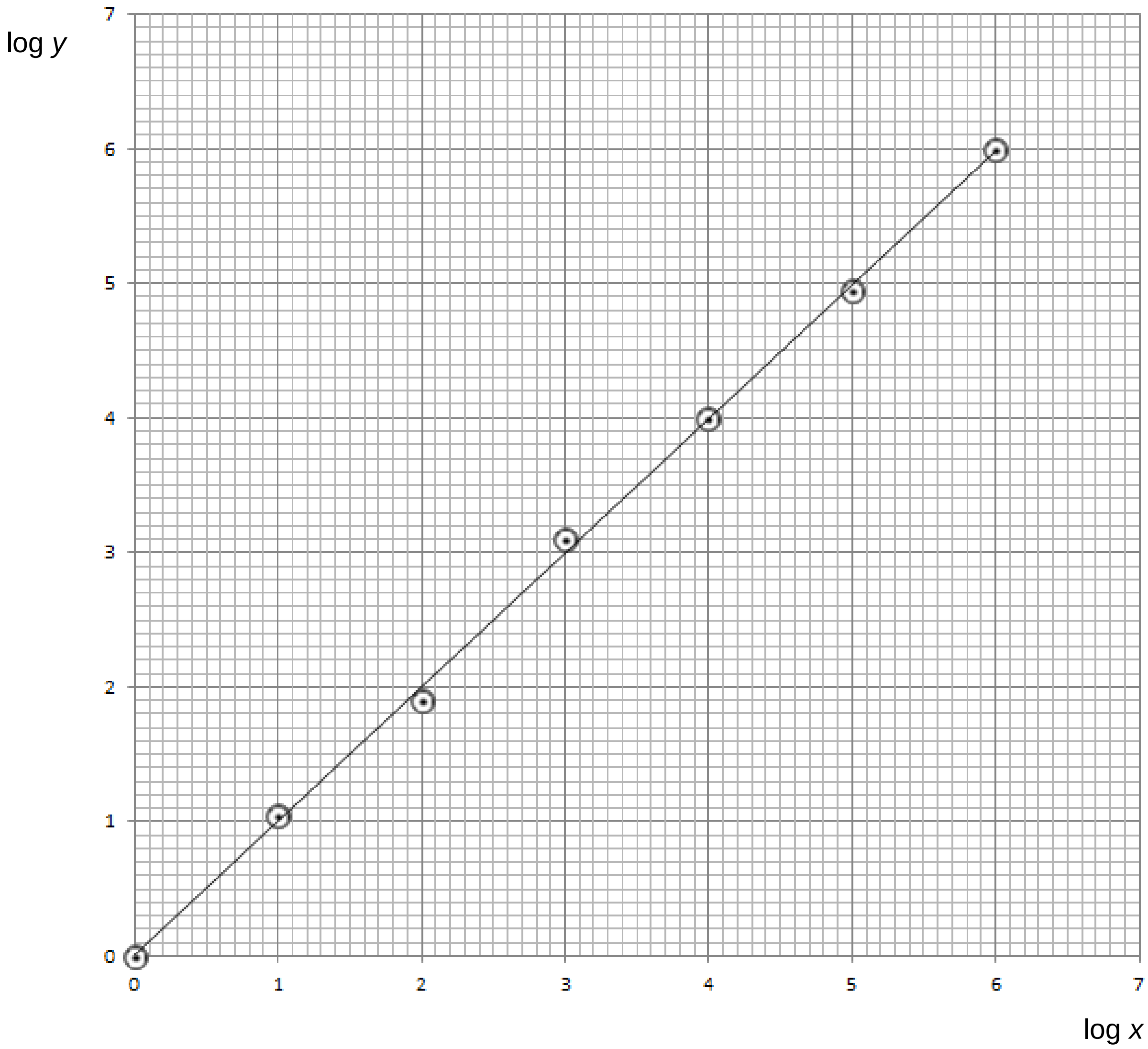
	quantity	units
A	work	newton (N)
B	e.m.f.	ampere (A)
C	current	coulomb (C)
D	pressure	pascal (Pa)

Answer: D

2 Two physical quantities, x and y, are related by the equation,

$$y = kx^n$$

where n and k are non-zero positive integers. A series of measurements of x and y were carried out by a student, and the graph of log y against log x is plotted as shown below.



Which of the following statements best describes the data acquired by the student?

A It is accurate and precise.

B It is inaccurate but precise.

C It is accurate but not precise.

D It is inaccurate and not precise.

Answer: B

Based on the equation, the graph is expected to have a non-zero y-intercept. However, the graph plotted shows a zero y-intercept. **Therefore, the data is inaccurate.**

However, the scatter of the data is small, and most of the points lie close to the best-fit line. **Therefore, the data is precise.**

3 A car initially moving at 40 m s^{-1} due west makes a turn at a junction, and is now travelling at a speed of 30 m s^{-1} due north.

What is the car's change in velocity?

A 10 m s^{-1} at a direction 53 ° east of north

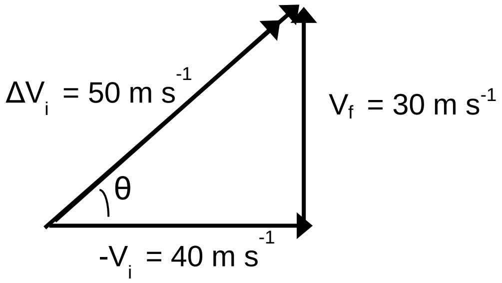
B 10 m s^{-1} at a direction 37 ° west of north

C 50 m s^{-1} at a direction 53 ° east of north

D 50 m s^{-1} at a direction 37 ° west of north

Answer: C

$$\Delta\vec{v} = \vec{v}_f - \vec{v}_i = \vec{v}_f + (-\vec{v}_i)$$

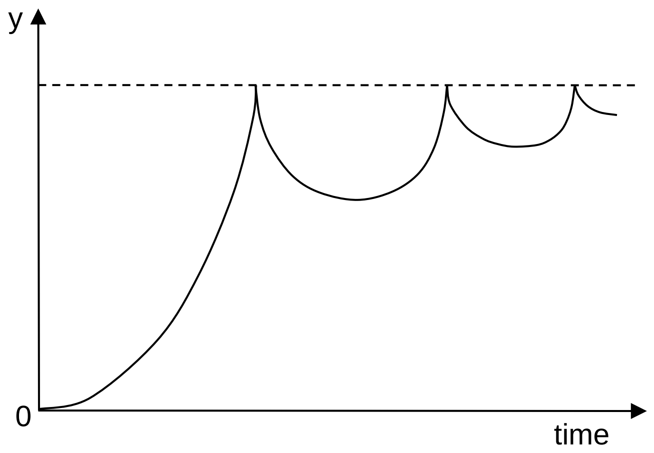


$$\Delta v = \sqrt{40^2 + 30^2} = 50 \text{ m s}^{-1}$$

$$\theta = \tan^{-1}\left(\frac{30}{40}\right) = 36.9°$$

Thus, the direction of the car's change in velocity is 37 ° north of east or 53 ° east of north.

4 The graph below describes the motion of an object rebounding from a horizontal surface after being released from a point above the surface.



The quantity represented on the y-axis is the ball's

A acceleration **B** displacement **C** momentum **D** velocity

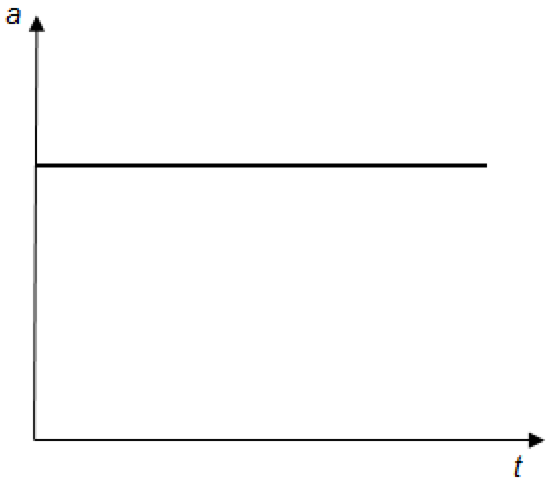
Answer: B

The point of release is taken to be y = 0 and the horizontal surface from which the ball rebounds from is represented by the dotted line on the graph. The displacement of the ball is observed to decrease with time for subsequent bounces.

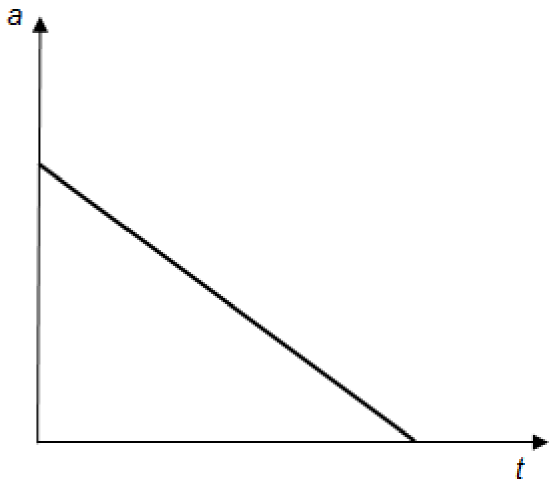
5 A metal sphere is held just below the surface of a deep tank of liquid and released.

Which of the following best illustrates how the acceleration *a* varies with time *t* after release?

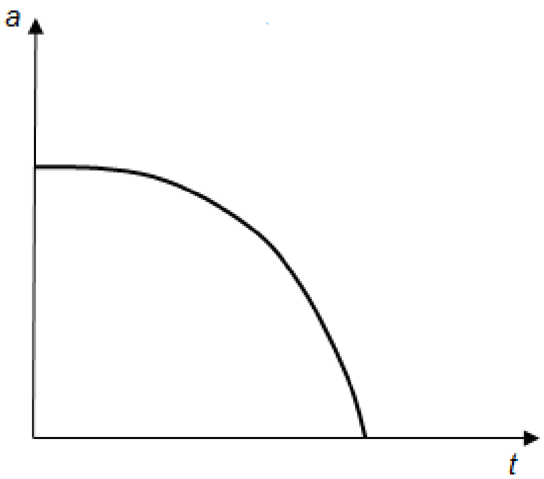
A



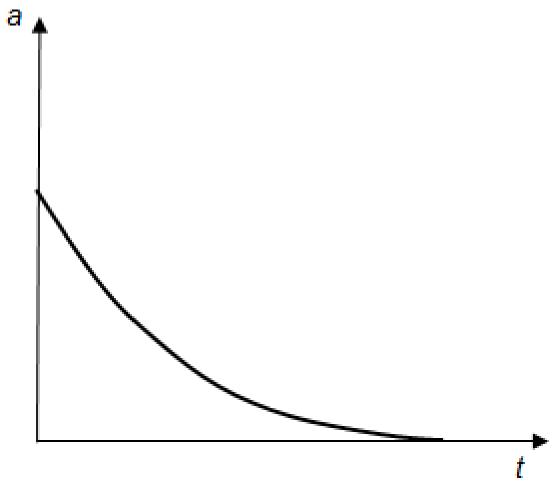
B



C



D



Answer: D

Assuming that drag is proportional to *v*

Net force acting on sphere is $F_{net} = mg - kv$

$ma = mg - kv$

$-kv = ma - mg$

Differentiating the above equation with respect to time t,

$$-k\frac{dv}{dt} = m\frac{da}{dt} \quad [\frac{dv}{dt} = a]$$

$$-ka = m\frac{da}{dt}$$

$$\frac{da}{dt} = -\frac{ka}{m}$$

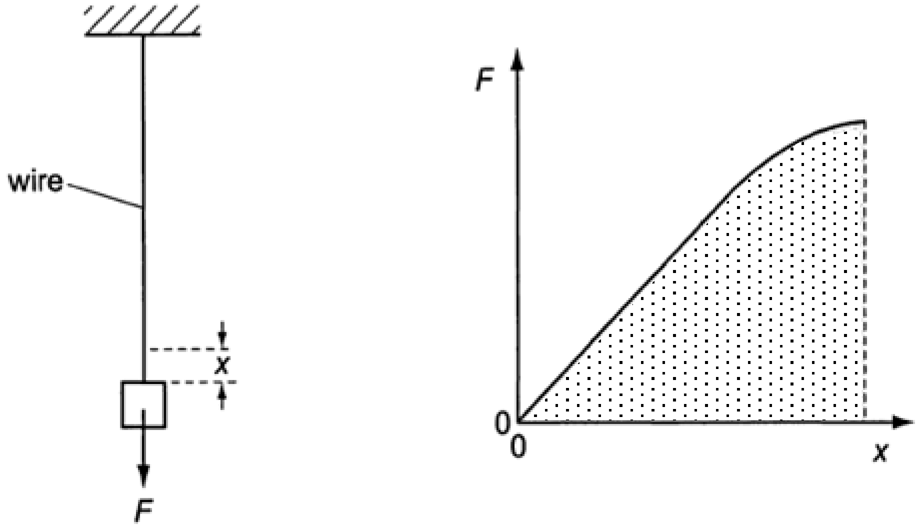
At time t = 0, sphere is just released from rest and $v = 0$, $a = g$.

$a = 0$, is when sphere reaches terminal velocity (where v is a maximum constant value).

Note that $\frac{da}{dt}$ represents the gradient of the *a*-*t* graph. The negative sign indicates that the graph is downward sloping. The value of gradient $\frac{da}{dt}$ decreases with time since a decreases from g to 0.

Hence *a*-*t* graph is a curve whose gradient is negative and decreases with time.

6 A wire, fixed at its upper end, is subjected to an increasing load *F* by increasing the mass attached to its lower end. A graph of *F* against the extension *x* of the wire is shown.



The wire is stretched beyond its elastic limit.

What does the shaded area on the graph represent?

A the amount of elastic potential energy stored in the wire

B the loss of gravitational potential energy of the mass

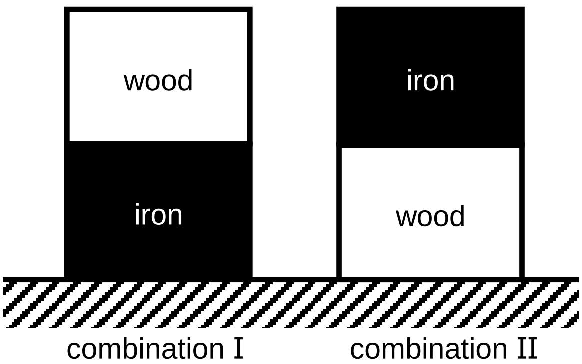
C the amount of heat produced in the wire

D the work done by *F* on the wire

Answer: D

Option A is not the answer as the wire has been stretched beyond its elastic limit which means that it will no longer store <u>all</u> of the energy from mechanical work performed on it in the form of elastic potential energy.

7 Two blocks, one made of wood and the other of iron, are arranged at rest on the ground as depicted in combination I and II below.



Which one of the following statements is correct?

A The force by the iron block on the wooden block in I is greater than that by the wooden block on the iron block in II.

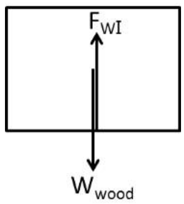
B The force by the wooden block on the iron block in I is the same as that by the iron block on the wooden block in II by virtue of Newton's 3rd law.

C The force by the wooden block on the iron block is equal to the weight of the wooden block in I while the force by the iron block on the wooden block is equal to the weight of the iron block in II.

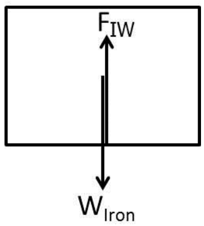
D The force by the ground on the iron block in I is greater than the force by the ground on the wooden block in II because the iron block, being denser than the wooden block, exerts more force on the ground.

Answer: C

Consider FBD of the wooden block in I. Since it is at equilibrium, its weight is equal to the normal contact force on the wooden block by the iron block for I. (Note: Both are not an action-reaction pair)



Consider FBD of the iron block in II, since it is at equilibrium, its weight is equal to the normal contact force on the iron block by the wooden block for II. (Note: Both are not an action-reaction pair)



Note: Weight of wooden block is LESSER than weight of iron block.

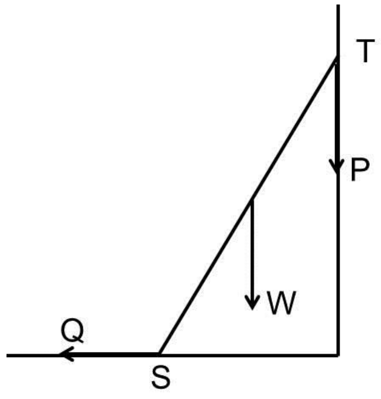
A is wrong as force by iron block on wooden block in I should be LESSER not greater.

B is wrong as force by wooden block on the iron block in I is LESSER than force by iron block on the wooden block in II.

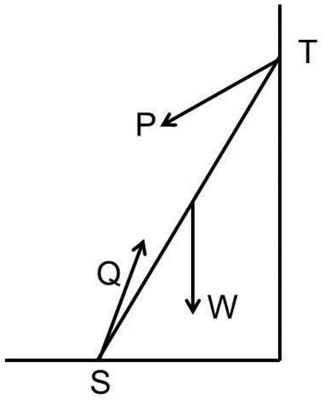
For D, treat the iron and wooden block as one object. At equilibrium, their combined weight is equal to the force by the ground on the iron block for I. At equilibrium, their combined weight is equal to the force by the ground on the wooden block for II. The statement should be the force by the ground on the iron block in I is the SAME as the force by the ground on the wooden block in II since their combined weights are the same for both scenarios.

8 A ladder ST, resting on a rough floor and learning against a rough wall, is on the point of slipping. It is of weight W and the contact forces exerted on the ladder by the wall and floor are P and Q respectively. Which one of the following diagrams correctly shows the directions of these forces?

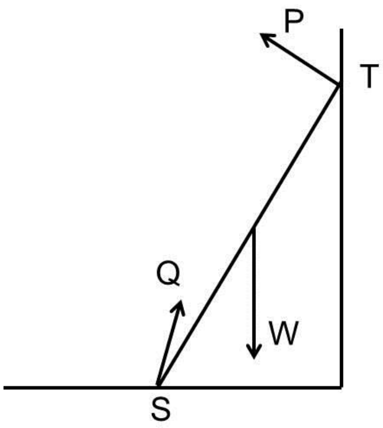
A



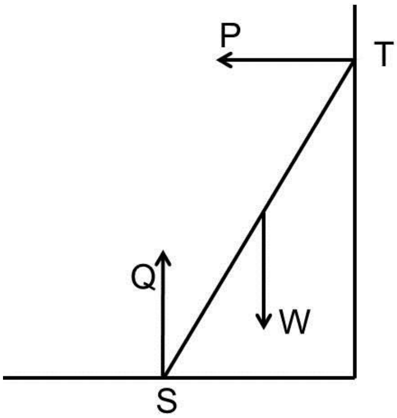
B



C

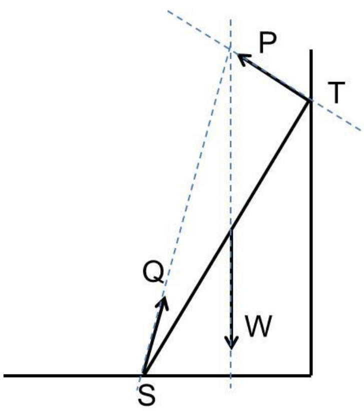


D



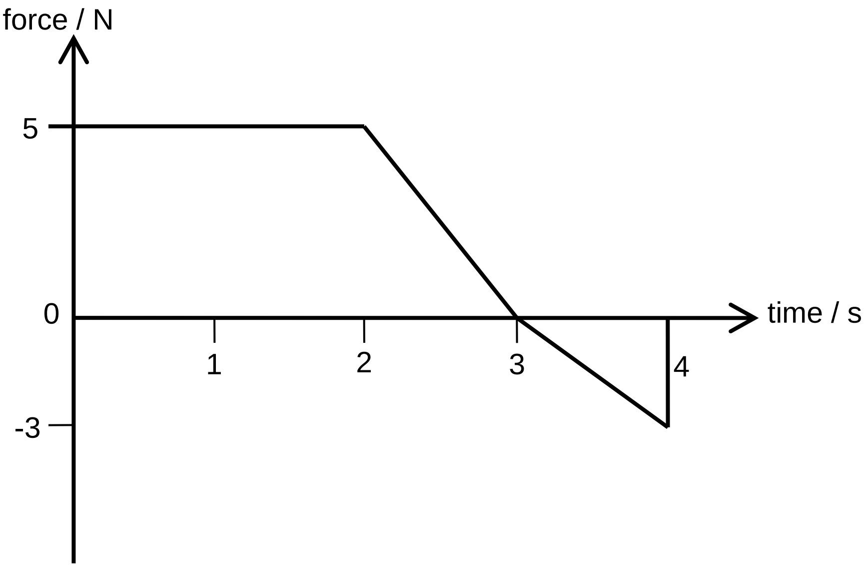
Answer: C

All the lines of action of forces acting on the ladder intersect at a single point when it is in equilibrium.



For option B, though the line of actions of the forces act at a single point, the force P is made up of both the normal and frictional forces and the frictional force should act upwards.

9 A body of mass 3.0 kg is acted on by a force which varies with time *t* as shown below.



If the force acts along the same axis as its motion and its initial velocity is 2.0 m s^{-1}, what is its velocity at time *t* = 4.0 s?

A 5.7 m s^{-1} **B** 6.7 m s^{-1} **C** 11 m s^{-1} **D** 33 m s^{-1}

Answer: A

Area under graph represents, $F\Delta t$, which is also the change in momentum, Δp (it is a vector quantity)

$$= \frac{1}{2} \times 5 \times (2+3) + (-\frac{1}{2} \times 1 \times 3) = 11$$

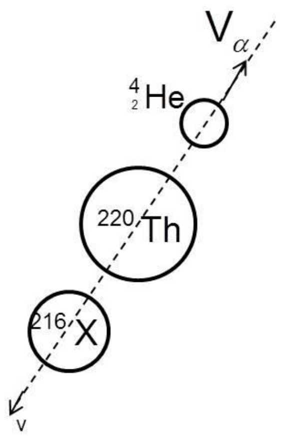
$$11 = \Delta p = m\Delta v$$
$$11 = 3\,(V_f - 2)$$
$$V_f = 5.7\ \text{m s}^{-1}$$

10 A stationary thorium nucleus of mass 220u splits into an α particle of mass 4u and a lighter nucleus of mass 216u. The α particle has kinetic energy E_α. What is the kinetic energy of the lighter nucleus?

A $\frac{E_\alpha}{110}$ **B** $\frac{E_\alpha}{108}$ **C** $\frac{E_\alpha}{55}$ **D** $\frac{E_\alpha}{54}$

Answer: D

Let *x* be the recoiling nucleus.



By conservation of momentum:
total initial momentum = total final momentum

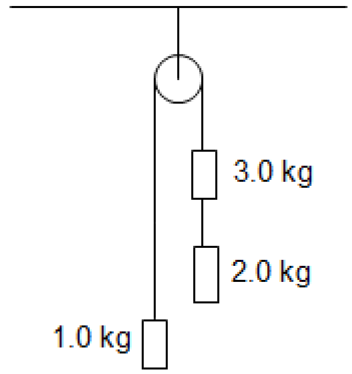
$$M.0 = m_x v + m_\alpha V_\alpha$$

$$v = -\frac{m_\alpha V_\alpha}{m_x}$$

KE of X = $\frac{1}{2} m_x v^2 = \frac{1}{2} m_x \left(-\frac{m_\alpha V_\alpha}{m_x}\right)^2$

$$= \frac{1}{2} m_\alpha V_\alpha^2 \left(\frac{m_\alpha m_x}{m_x^2}\right) = E_\alpha \left(\frac{4u}{216u}\right) = \frac{E_\alpha}{54}$$

11 A light inextensible string is wound, as shown, over a frictionless, light pulley. What is the tension in the string between the 2.0 kg and the 3.0 kg masses when the system is released?

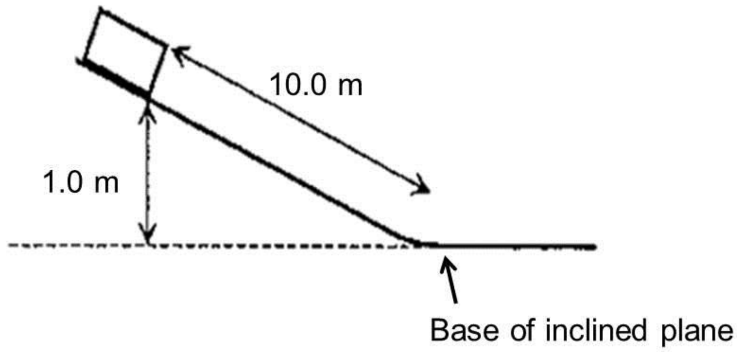


A 6.5 N　　**B** 16 N　　**C** 20 N　　**D** 39 N

Answer: A

Let T be the tension in between the 3.0 kg and 1.0 kg masses and a be the acceleration of the system (The direction of a is assumed to be in the downward direction of the 2 kg and 3 kg masses).
Consider the 3.0 kg and 2.0 kg masses as one system, taking downwards as positive
$5.0g - T = 5.0a$　　　(1)
Consider the FBD of the 1.0 kg mass, taking upwards as positive
$T - 1.0g = 1.0a$　　　(2)
Solving simultaneously, $a = (2/3)g$
Consider the FBD of the 2.0 kg mass,
Let T' be the tension between the 3.0 kg and 2.0 kg masses,
$2.0g - T' = 2.0a$
$T' = 6.5$ N

12 A body of mass 1.0 kg initially at rest slides down an inclined plane that is 1.0 m high and 10.0 m long as shown in the figure below.



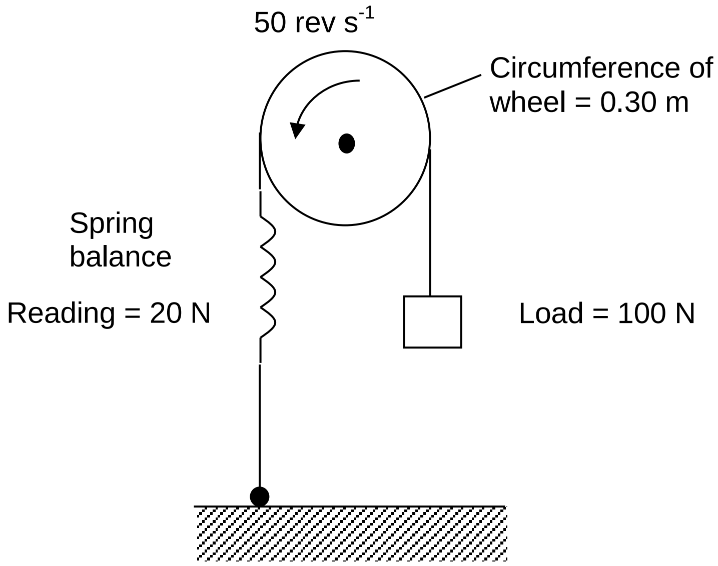
If the body experiences a constant resistive force of 0.5 N while travelling on the slope, what is the kinetic energy of the body at the base of the plane?

A 4.8 J　　**B** 9.3 J　　**C** 10 J　　**D** 15 J

Answer: A

Lost in G.P.E = Gain in K.E + Work against friction
1(1)(9.81) = K.E + 0.5(10)
K.E = 4.8 J

13 The figure shows a wheel which is driven by an electric motor. A rope is fastened at one end to a spring balance. The rope passes over the wheel and supports a freely hanging load. When the wheel is turning anticlockwise at a steady speed, the balance reading is constant.



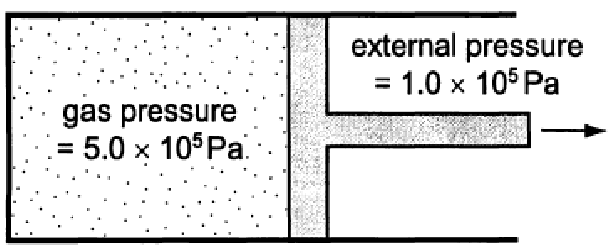
What is the output power of the motor?

A 0.3 kW **B** 1.2 kW **C** 1.5 kW **D** 1.8 kW

Answer: B

Treat the load and rope attached to load as one system, (assume massless rope)
To keep the load at a steady speed
tension due to spring balance + additional force due to wheel on the rope connected to load = mg
additional force due to wheel = 100 – 20 = 80 N
Velocity of rim of wheel = distance / time = circumference x 50 rev s^{-1}
= 0.30 x 50 = 15 m s^{-1}
Output power = Force x velocity = 80 N x 15 = 1200 W = 1.2 kW

14 A gas at a pressure of 5.0 x 10^5 Pa is enclosed in a cylinder fitted with a piston.



The gas expands by 4.0 m^3 against a constant external pressure of 1.0 x 10^5 Pa.

How much work does the gas do against the external pressure?

A 4.0 x 10^5 J **B** 12 x 10^5 J **C** 16 x 10^5 J **D** 20 x 10^5 J

Answer: A

Work done by gas = external pressure x ΔV
= 1 x 10^5 x 4 = 4.0 x 10^5 J

15 A stationary sound wave is set up in a 4.0 m column, with both ends open, using a sound generator producing waves of frequency 400 Hz. The speed of the sound is 320 m s^{-1}.

If the sound generator doubles the frequency of the sound wave produced, how many more antinodes will be present in the stationary wave?

A 5 **B** 10 **C** 11 **D** 21

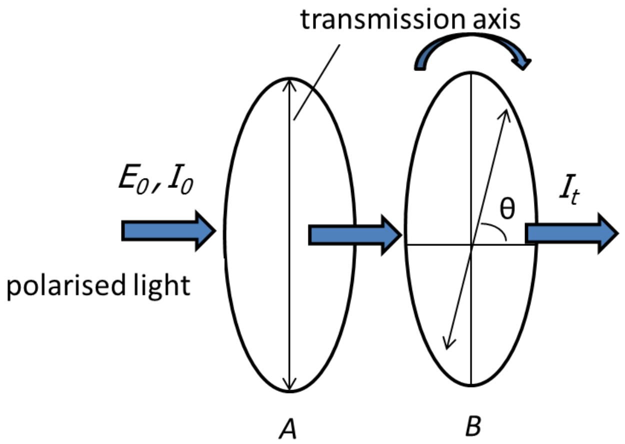
Answer: B

Using v = fλ,
λ = 320 / 400 = 0.80 m
No. of wavelengths in tube = 4.0 / 0.80 = 5
No. of antinodes in 5 wavelengths = 11

If frequency is doubled,
λ = 320 / 800 = 0.40 m
No. of wavelengths in tube = 4.0 / 0.40 = 10
No. of antinodes in 10 wavelengths = 21

Thus, there are 10 more antinodes in the stationary wave.

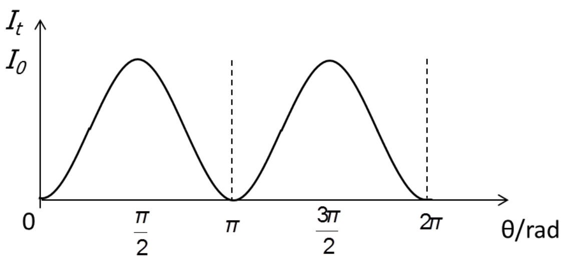
16 The figure below shows two ideal polarisers A and B where their transmission axes are parallel to each other.



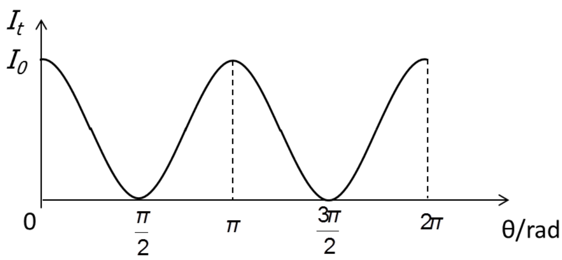
Polarised light of amplitude E_0 and intensity I_0 is incident on A with its electric field vector parallel to the transmission axis. Polariser B is then rotated so that its transmission axis makes an angle θ, as shown in the figure above.

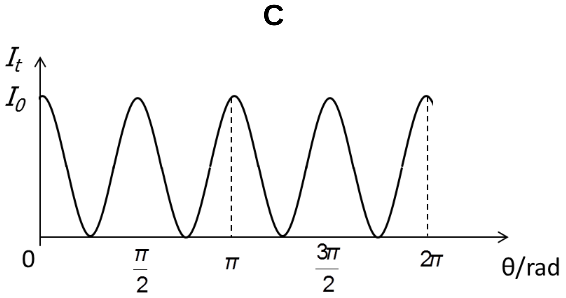
Which of the following graphs shows how the intensity of the transmitted light I_t varies with the angle θ?

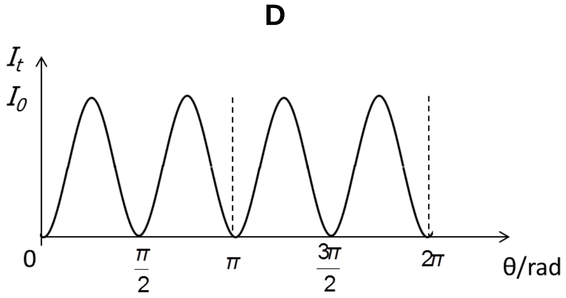
A



B



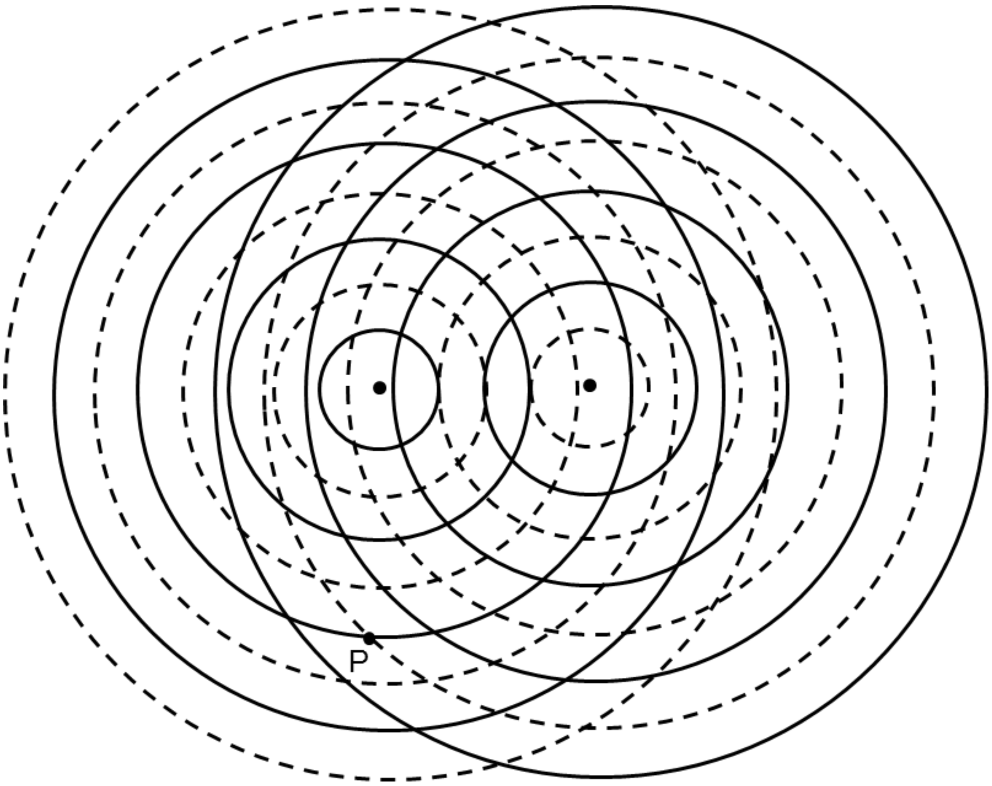




Answer: A

Option A is the answer as when θ is 0°, the transmission axes are perpendicular to one another and hence no light passes through.
When θ is 90°, the axes are parallel to one another and maximum intensity of light passes through.
In between these two angles, the intensity transmitted increases.

17 The diagram below shows the wavefronts of two periodic circular waves in a portion of a ripple tank. The bold lines represent the crests while the dotted lines represent the troughs of the wave.



From the diagram, which of the following statements is false?

A The two sources are coherent.

B The two sources are out of phase with one another.

C The two sources are about four wavelengths apart.

D At point P, destructive interference occurs as the two sources meet with a path difference of one wavelength.

Answer: C

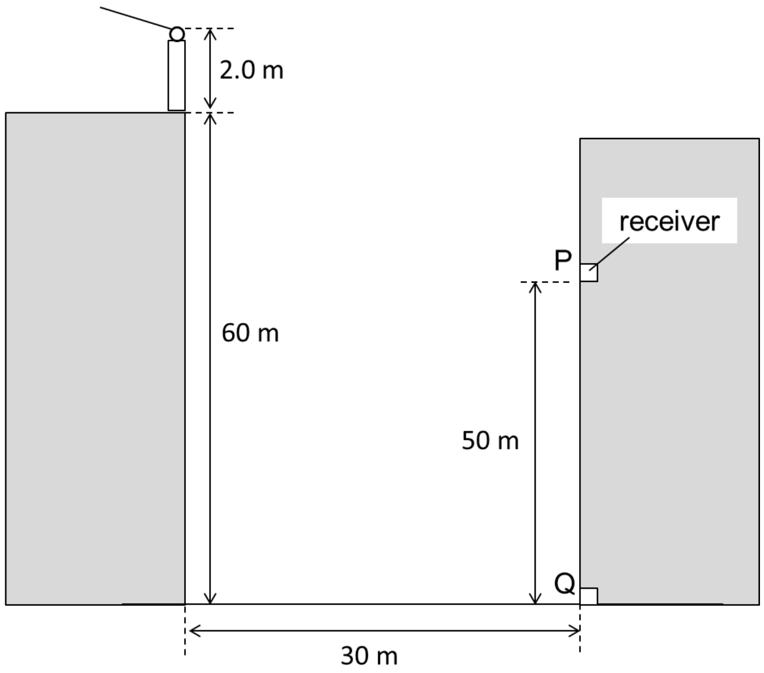
Option A is true since the distance between one bold line (crest) to another (or one dotted line (trough) to another) is the same for both waves, they have the same frequency and hence are coherent.

Option B is true but to be more precise, the two sources are in antiphase or 180° out of phase with one another.

Option C is false as the sources are 2 wavelengths apart.

Option D is true because at point P, source on the left travels 3 wavelengths and source on the right travels 4 wavelengths. The path difference travelled is 1 wavelength. The crest wavefront meets the trough wavefront, hence destructive interference occurs.

18 A public announcement system, placed 2.0 m on top of a building as shown in the diagram below (not drawn to scale), gives out a signal to the neighbouring area. A person at P, in a building 30 m away and 50 m high from the ground, receives the signal with a receiver of area 0.010 m^2.



What will be the area of the receiver required by a person at Q, at the bottom of the building, if he needs to receive the signal with the same power?

A 0.045 m^2 **B** 0.052 m^2 **C** 1.2 m^2 **D** 4.5 m^2

Answer: A

The intensity at P and Q varies with distance from the source,

$$I \propto \frac{1}{d^2}$$

$$\frac{I_P}{I_Q} = \frac{d_2^2}{d_1^2}$$

$$\frac{I_P}{I_Q} = \frac{(\sqrt{62^2 + 30^2})^2}{(\sqrt{12^2 + 30^2})^2} = \frac{62^2 + 30^2}{12^2 + 30^2} = \frac{4744}{1044}$$

For both signals to receive the same power at P and Q,

$$I_P A_P = I_Q A_Q$$

$$\frac{I_P}{I_Q} = \frac{A_Q}{A_P}$$

$$\frac{4744}{1044} = \frac{A_Q}{0.010}$$

$$A_Q = 0.045$$

19 A blue laser light is used in a Young's double-slit experiment.

Which of the following will be observed when a change is made to the experiment?

	Change to experiment	Observation
A	Covering one of the slits completely.	No fringe pattern is seen.
B	Moving the source of light nearer to the double slits.	Fringe separation will increase.
C	Covering one of the slits with a polaroid.	No change in position of central bright fringe.
D	Replacing the blue laser light with a red laser light.	Central bright fringe will shift upwards.

Answer: C

Option C is true as the maximum intensity point will not shift although the maximum intensity will decrease.

Option A is wrong because a single-slit diffraction pattern will be seen.
Option B is wrong because the fringe separation is not dependent on the distance between light source and slit.
Option D is wrong because replacing the laser light with one of higher wavelength will cause the fringe separation to increase but will not shift the points of maximum intensity.

20 A high potential difference is applied between the electrodes of a zinc-bromine battery when it is recharged. Negative bromide ions then move towards the positive electrode and positive zinc ions move towards the negative electrode.

In each second, twice the number of bromide ions compared to zinc ions arrive at their respective electrodes. Each bromide ion has a charge of -1.60 x 10^{-19} C, while each zinc ion has a charge of +3.20 x 10^{-19} C. The steady current through the circuit is 128 mA.

What is the number of bromide ions arriving in each second at the positive electrode?

A 2.0 x 10^{17} **B** 4.0 x 10^{17} **C** 2.0 x 10^{20} **D** 4.0 x 10^{20}

Answer: B
steady current: rate of flow of charge = total charge per unit time.
both bromide ions and zinc ions contribute to the total current, i.e.

$$Q = n_{Br}q_{Br} + n_{Zn}q_{Zn} = It$$

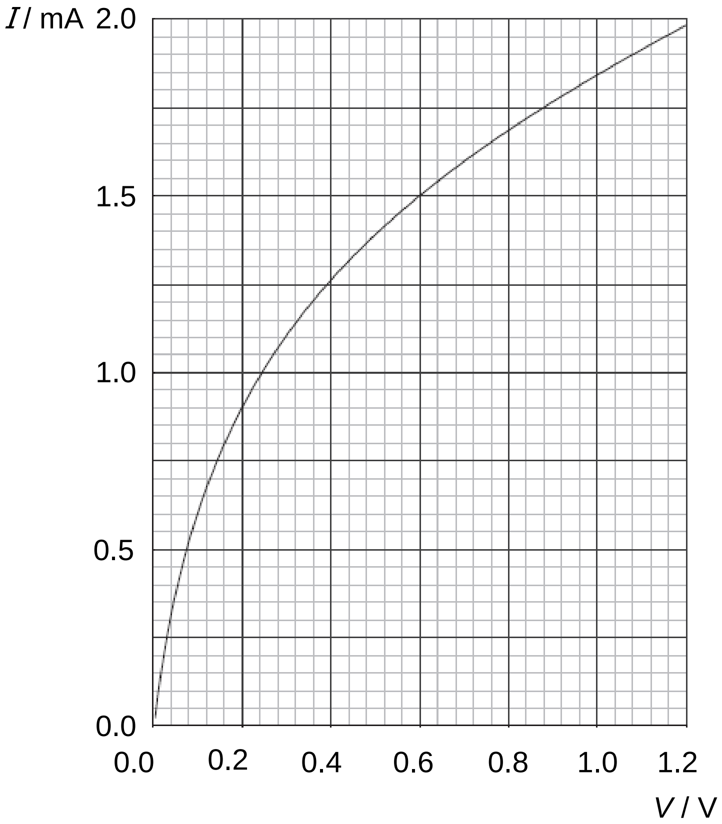
$$Q = n_{Br}q_{Br} + \frac{1}{2}n_{Br}q_{Zn} = It, \text{ since } n_{Br} = 2n_{Zn}$$

$$n_{Br}\left(1.6\times10^{-19}\right) + \frac{1}{2}n_{Br}\left(3.2\times10^{-19}\right) = It$$

$$\frac{n_{Br}}{t}\left(3.2\times10^{-19}\right)=128\times10^{-3}$$

$$\frac{n_{Br}}{t}=4.0\times10^{17}$$

21 The graph below shows the variation with current I of the potential difference V across an electronic component.



Which of the following statement is correct?

A The electric component is a diode.

B The resistance is increasing with increasing potential difference.

C The resistance of the component is 950 Ω when the potential difference is 0.60 V.

D When the potential difference is 0.60 V, the power dissipated at the component is 0.90 W.

Answer: B
The resistance is increasing with increasing p.d. Hence, it cannot be a diode.

The resistance of the component is 400 Ω when the potential difference is 0.60 V. (R = ratio of V to I.)

When the p.d. is 0.60 V, the power dissipated is 0.90 mW.

22 A strain gauge consists of a length of wire with uniform cross-sectional area. Its resistance is 4.000 kΩ. It is attached to a gas container. When the container expands, the strain gauge changes its dimensions. Its length increases by 2.0% and diameter reduces by 1.0 %. What is the new resistance of the strain gauge?

A 3.842 kΩ **B** 4.121 kΩ **C** 4.163 kΩ **D** 4.897 kΩ

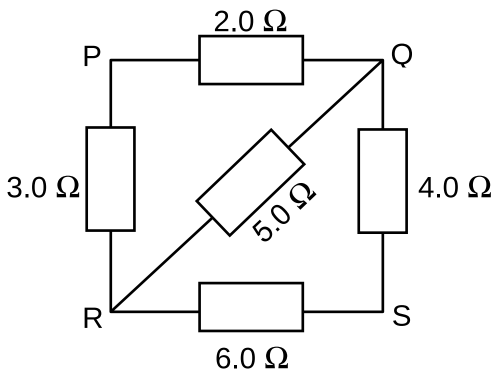
Answer: C

$R \propto \frac{L}{A} \propto \frac{L}{d^2}$, $L_2 = 1.02\, L_1$, and $d_2 = 0.99\, d_1$

$\frac{R_2}{R_1} = \frac{L_2}{L_1}\left(\frac{d_1}{d_2}\right)^2 = 1.02 \times \left(\frac{1}{0.99}\right)^2 = 1.0407$

R_2 = 4.163 kΩ.

23 The diagram shows a network of five resistors.



What is the effective resistance between P and S?

A 1.9 Ω **B** 2.1 Ω **C** 2.5 Ω **D** 3.6 Ω

Answer: D

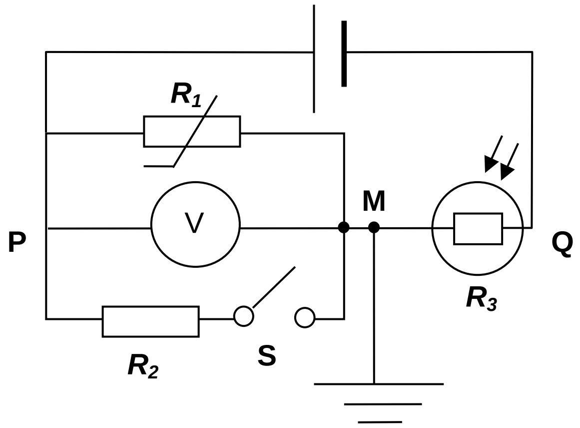
When a p.d. is applied across PS, the potential at Q = potential at R. Therefore, there is no potential difference across the 5.0 Ω resistor and it should not be considered when determining the effective resistance.

Hence,

$\frac{1}{R_{eff}} = \frac{1}{2.0 + 4.0} + \frac{1}{3.0 + 6.0}$

R_{eff} = 3.6 Ω.

24 A thermistor R_1 is connected to a battery of constant e.m.f. with negligible internal resistance as shown in the figure.



Which of the following actions will cause an increase in the potential difference V measured by the voltmeter? Assume that the voltmeter has infinite resistance.

A Close switch S

B Increase the light intensity at R_3 with S open

C Remove the earth connection at M with S open

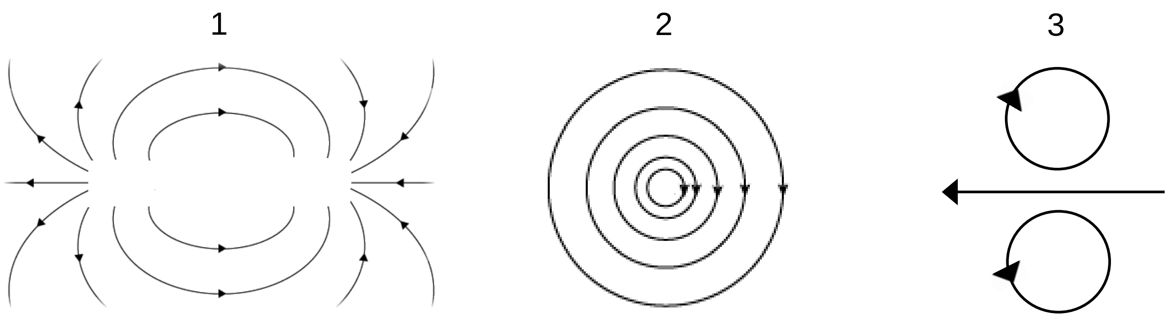
D Increase the temperature of the thermistor with S open

Answer: B

By potential divider principle, voltmeter reading increase when effective resistance across thermistor is increased or resistance R_3 is reduced. Greater light intensity reduces the resistance of the LDR.

Option A is wrong as closing switch S will decrease the p.d. across the thermistor.
Option C has no effect on the circuit.
Option D will decrease the resistance of the thermistor, thereby decreasing p.d. across it.

25 Three magnetic fields are shown.



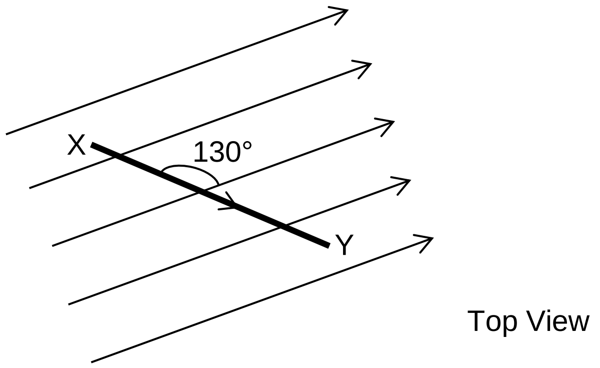
Which objects correctly match the fields 1, 2 and 3 respectively?

	1	2	3
A	long straight wire	bar magnet	flat circular coil
B	bar magnet	long straight wire	flat circular coil

C	flat circular coil	long straight wire	bar magnet
D	bar magnet	flat circular coil	long straight wire

Answer: **B**

26 A 45 cm segment of a straight conducting wire is placed in a magnetic field of flux density 0.035 T, with a current of 3.8 A flowing from X to Y as shown in the figure below.



What are the magnitude and the direction of the magnetic force acting on the wire?

	Magnitude / N	Direction
A	0.038	into the page
B	0.038	out of the page
C	0.046	into the page
D	0.046	out of the page

Answer: D

Magnitude of magnetic force,

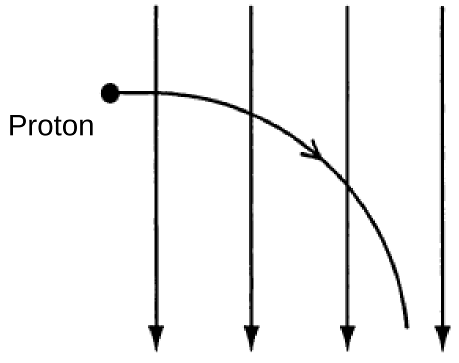
$$F = BIL\sin\theta$$
$$F = 0.035 \times 3.8 \times 0.45 \sin 130°$$
$$F = 0.046 \text{ N}$$

Using Fleming's Left Hand Rule, the force on the wire is directed out of page.

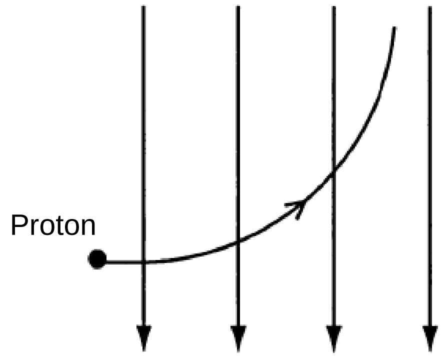
27 A charged particle enters a uniform magnetic field.

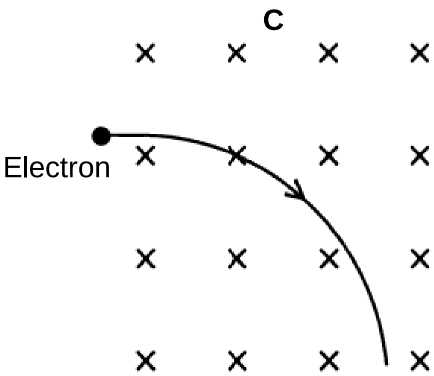
Which of the following diagram represents the path of the particle in the magnetic field?

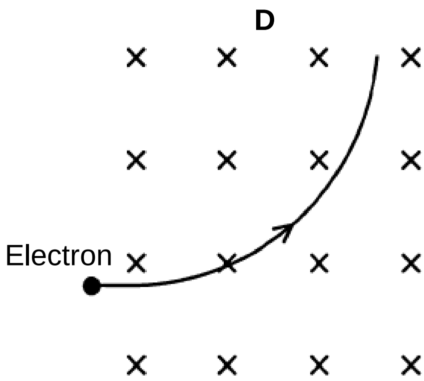
A



B







Answer: C

Using Fleming's Left Hand Rule, force on electron is downwards.
A and B is incorrect as the magnetic force will be directed into the page and will not move in that circular path.

28 Light of frequency f falls on a metal surface of work function energy ϕ and ejects electrons of maximum kinetic energy K.

If the wavelength of this light is doubled and its intensity halved, what will be the maximum kinetic energy of the emitted electrons?

A K

B $2K$

C $2\,hf - \phi$

D $\frac{1}{2}hf - \phi$

Answer: D

For original set up,

$$hf = \frac{hc}{\lambda} = \phi + K$$

When the wavelength is doubled the energy of each photon is halved

The change in intensity (keeping the frequency constant) will change the rate of photon incident on the plate. Since the question only requires the final maximum KE of the photoelectrons, the rate of photon incidence is not important here.

Therefore,

$$hf = \frac{hc}{\lambda_{new}} = \phi + K_{new}$$

$$K_{new} = \frac{hc}{\lambda_{new}} - \phi$$

$$= \frac{hc}{2\lambda} - \phi$$

$$= \frac{1}{2}hf - \phi$$

29 When electrons are accelerated towards a crystal with an appropriate speed, an electron diffraction pattern may be observed.

What is the potential difference through which the electron must be accelerated from rest for it to have a wavelength of 3.2×10^{-10} m?

A 9.51 V **B** 14.7 V **C** 39.3 V **D** 9.51×10^{24} V

Answer: B

Using the conservation of energy,

$$\text{Gain of KE of electron} = \text{Loss of EPE of electron}$$

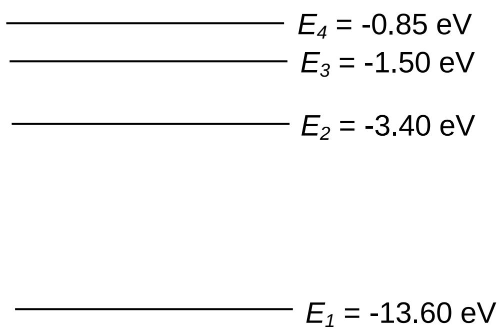
$$\frac{p^2}{2m} = q_e V$$

$$\frac{\left(h/\lambda\right)^2}{2m} = q_e V$$

$$V = \frac{\left(h/\lambda\right)^2}{2mq_e}$$

$$V = \frac{\left(6.63\times10^{-34}\right)^2}{2\left(3.2\times10^{-10}\right)^2\left(9.11\times10^{-31}\right)\left(1.6\times10^{-19}\right)} = 14.7 \text{ V}$$

30 In an experiment, students are required to observe the results from an absorption spectrum and infer the respective transitions that were involved. They were given the figure below showing four energy levels E_1, E_2, E_3 and E_4 of the atom used in the experiment.



Which of the following statements written by the student is false?

A There are distinct dark lines seen in the spectrum.

B One of the photons absorbed is in the red-orange region of the visible spectrum.

C One of the absorption lines observed corresponds to a transition from the E_2 to E_3 state.

D There are four dark lines which indicate that there are four discrete energy levels in the atoms.

Answer: D

Option A: Characteristics of an absorption spectrum.

Option C:

$$\text{Energy of absorbed photon} = \text{Energy difference between transition states}$$

$$\frac{hc}{\lambda}=\Delta E$$

$$\lambda=\frac{hc}{\Delta E}$$

$$\lambda=\frac{\left(6.63\times10^{-34}\right)\left(3.0\times10^{8}\right)}{[-1.50-(-3.40)]\left(1.6\times10^{-19}\right)}=654 \text{ nm}$$

This transition is caused by an absorption of a visible photon (red).

Option B: Same reason as C.

Option D: The number of dark lines indicates the number of transitions between the energy levels and not the number of energy levels.