



Catholic Junior College
JC2 Preliminary Examinations
Higher 2

CANDIDATE
NAME

MARK SCHEME

CLASS

2T

PHYSICS

Paper 1 Multiple Choice Questions

9749/01
September 2025
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.

Write in soft pencil.

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

Write and shade your name, NRIC / FIN number and HT group on the Answer Sheet (OMR sheet), 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 (OMR sheet).

Read the instructions on the Answer Sheet 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.

DATA

speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(1/(36\pi)) \times 10^{-9} \text{ F m}^{-1}$
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	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ mol}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$

FORMULAE

uniformly accelerated motion

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

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

$$W = p\Delta V$$

$$p = \rho gh$$

work done on / by a gas

hydrostatic pressure

gravitational potential

$$\phi = -\frac{Gm}{r}$$

temperature

$$T/K = T/^\circ\text{C} + 273.15$$

pressure of an ideal gas

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

mean translational kinetic energy of an ideal gas molecule

$$E = \frac{3}{2}kT$$

displacement of particle in s.h.m.

velocity of particle in s.h.m.

$$x = x_0 \sin \omega t$$

$$v = v_0 \cos \omega t$$

$$= \pm \omega \sqrt{x_0^2 - x^2}$$

electric current

$$I = Anvq$$

resistors in series

resistors in parallel

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

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

electric potential

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

alternating current / voltage

$$x = x_0 \sin \omega t$$

magnetic flux density due to a long straight wire

$$B = \frac{\mu_0 I}{2\pi d}$$

magnetic flux density due to a flat circular coil

$$B = \frac{\mu_0 NI}{2r}$$

magnetic flux density due to a long solenoid

$$B = \mu_0 nI$$

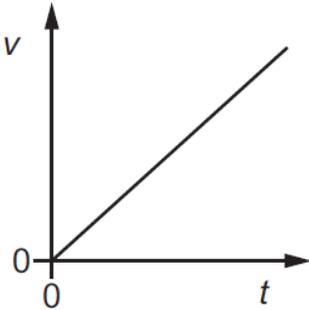
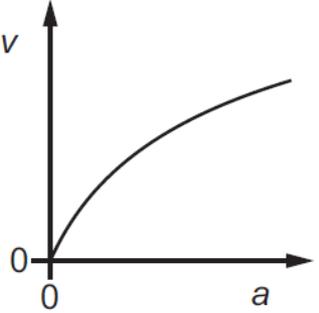
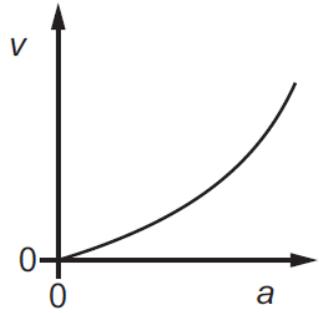
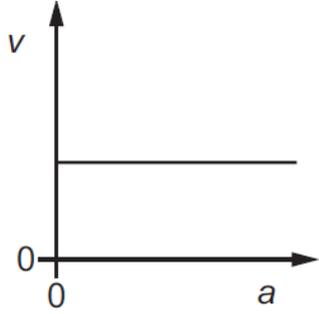
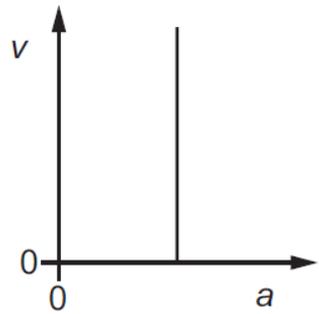
radioactive decay

$$x = x_0 \exp(-\lambda t)$$

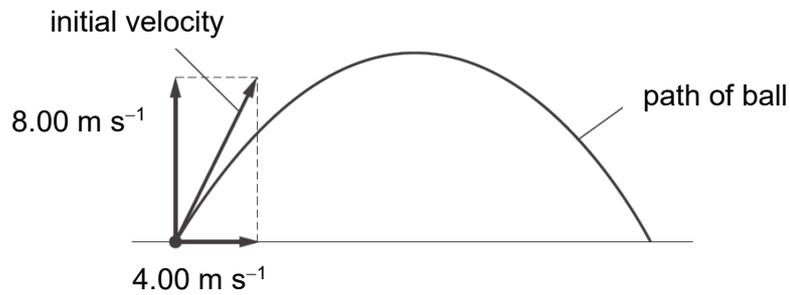
decay constant

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

1	Which length is equal to 1 dm?						
A	1×10^0 mm	B	1×10^1 mm	C	1×10^0 cm	D	1×10^1 cm
Answer: D $1 \text{ dm} = 1 \times 10^{-1} \text{ m} = 1 \times 10^2 \text{ mm} = 1 \times 10^1 \text{ cm}$							

2	A particle accelerates from rest. The graph shows the variation of the velocity v of the particle with time t .	
		
Which graph shows the variation of the velocity v with the acceleration a of the particle?		
A		B
		
C		D
		
Answer: D The gradient of the v - t graph is positive and constant. Hence, the acceleration is constant with respect to time. Hence, the v - a graph should be D such that the velocity is increasing at constant a .		

- 3 An astronaut on the Moon, where there is no air resistance, throws a ball. The ball's initial velocity has a vertical component of 8.00 m s^{-1} and a horizontal component of 4.00 m s^{-1} , as shown.



The acceleration of free fall on the Moon is 1.62 m s^{-2} .

What will be the speed of the ball 9.00 s after being thrown?

- | | | | | | | | |
|----------|-------------------------|----------|-------------------------|----------|-------------------------|----------|-------------------------|
| A | 6.60 m s^{-1} | B | 7.70 m s^{-1} | C | 10.6 m s^{-1} | D | 14.6 m s^{-1} |
|----------|-------------------------|----------|-------------------------|----------|-------------------------|----------|-------------------------|

Answer: B

Take upwards and rightwards as positive directions.

Vertical direction:

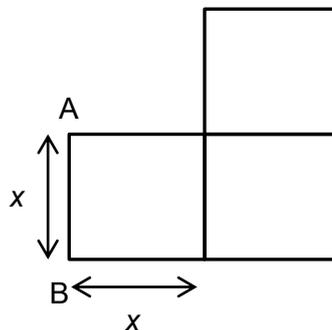
$$\begin{aligned} v_y &= u_y + a_y t \\ &= 8.00 + (-1.62)(9.00) \\ &= -6.58 \text{ m s}^{-1} \end{aligned}$$

Horizontal direction:

$$\begin{aligned} v_x &= u_x + a_x t \\ &= 4.00 + (0)(9.00) \\ &= 4.00 \text{ m s}^{-1} \end{aligned}$$

$$\begin{aligned} \text{speed after } 9.00 \text{ s} &= \sqrt{(-6.58)^2 + (4.00)^2} \\ &= 7.70 \text{ m s}^{-1} \end{aligned}$$

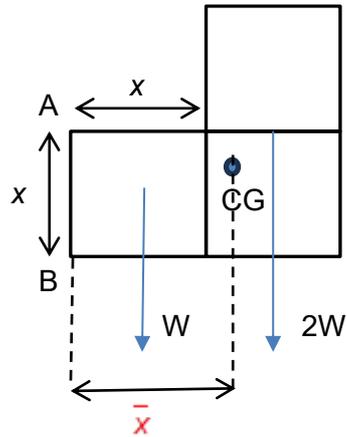
- 4 A uniform square metal sheet of length x is cut into an 'L' shape.



What is the distance of the centre of gravity of the sheet of metal from side AB?

- | | | | | | | | |
|----------|---------|----------|---------|----------|---------|----------|---------|
| A | $1.0 x$ | B | $1.2 x$ | C | $1.5 x$ | D | $1.8 x$ |
|----------|---------|----------|---------|----------|---------|----------|---------|

Answer: B



Let the weight of 1 square be W . Hence, the weight of 2 stacked squares on the right will be $2W$.

Let the horizontal distance of the CG of the 'L' shape be \bar{x} from B.

Hence, the equivalent weight of the combined L shape will be $3W$ acting downwards on this CG.

Taking moments about B,

Moment of the combined weight of the L shape about B = Sum of moments of the weight of the individual squares about B.

$$3W(\bar{x}) = W(0.5x) + 2W(1.5x)$$

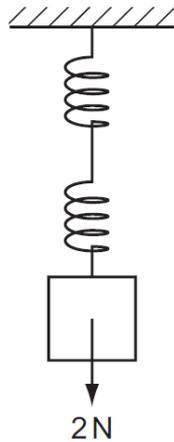
$$3\bar{x} = 3.5x$$

$$\bar{x} = 1.2x$$

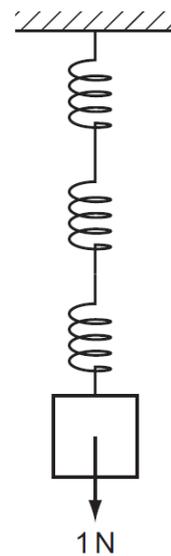
- 5 Several identical springs, each having the same spring constant, are joined in four arrangements. A different load is applied to each arrangement.

Which arrangement has the largest extension?

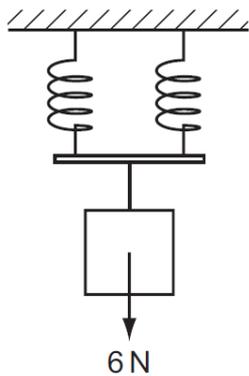
A



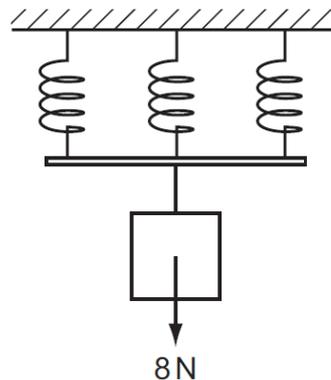
B



C



D



Answer: A

Let k be the spring constant of each of the identical springs.

For a spring system, $F_{\text{net}} = k_{\text{eff}} (e)$

where F_{net} is the load

k_{eff} is the effective spring constant

e is the extension of the arrangement

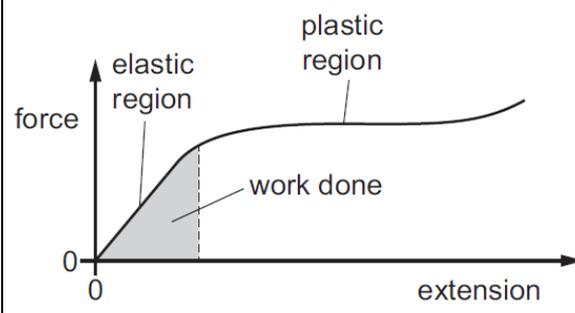
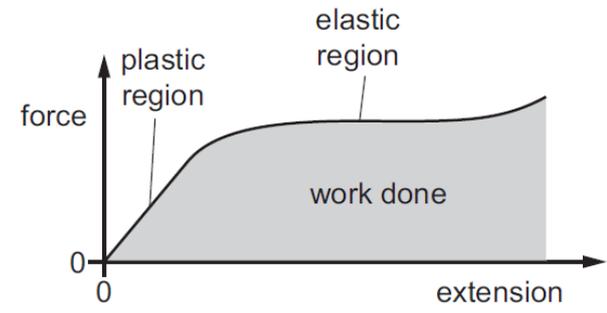
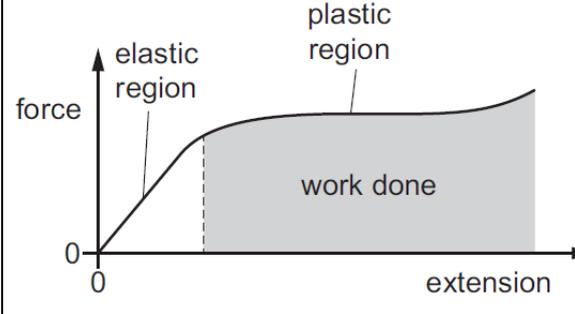
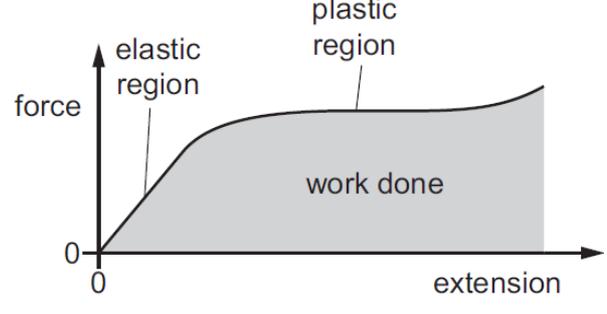
For A: $e = 2 / (0.5k) = 4 / k$ (largest)

For B: $e = 1 / (k / 3) = 3 / k$

For C: $e = 6 / 2k = 3 / k$

For D: $e = 8 / 3k = 2.7 / k$ (smallest)

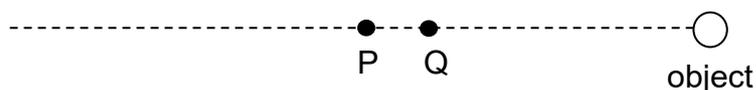
6	<p>The energy conversions inside a power station burning fossil fuel can be simplified as shown.</p> <p>chemical energy W \rightarrow thermal energy X \rightarrow electrical energy Y</p> <p>Which expression gives the efficiency of the power station?</p>						
A	$\frac{Y}{W}$	B	$\frac{Y}{(W + X)}$	C	$\frac{Y}{X}$	D	$\frac{Y}{(W + X + Y)}$
<p>Answer: A</p> <p>Efficiency = Useful power / Input power $= (Y/t) / (W/t)$ $= Y / W$</p>							

7	<p>A metal wire is stretched to breaking point and the force–extension graph is plotted.</p> <p>Which graph is correctly labelled with the elastic region, the plastic region and the area representing the work done to stretch the wire until it breaks?</p>			
A		B		
				
C		D		
				
<p>Answer: D</p>				
<p>The force is directly proportional to the extension in the elastic region. The work done is given by the area under the force extension graph. Breaking point is at the end of the graph. Only option D fits the description.</p>				

8	The Earth takes 24 hours to complete one rotation on its axis. What is the angular velocity of the Earth as it rotates on its axis?	
A	$1.75 \times 10^{-3} \text{ rad s}^{-1}$	
B	$1.99 \times 10^{-7} \text{ rad s}^{-1}$	
C	$4.36 \times 10^{-3} \text{ rad s}^{-1}$	
D	$7.27 \times 10^{-5} \text{ rad s}^{-1}$	
<p>Answer: D $\omega = 2\pi / T$ $= 2\pi / 24 \times 60 \times 60$ $= 7.27 \times 10^{-5} \text{ rad s}^{-1}$</p>		

9	A stone is attached to a string. The stone is then caused to swing in a vertical circular motion at a constant speed. Which of the following statements is <i>incorrect</i> ?	
A	The magnitude of resultant force acting on the stone is constant throughout the circular motion.	
B	The acceleration is always directed towards the centre of the circle throughout the circular motion.	
C	The kinetic energy of the stone is constant throughout the circular motion.	
D	The tension in the string when the stone is at the highest point of the circular motion is higher than that when the stone is at the lowest point.	
<p>Answer: D Centripetal force is constant in magnitude The centripetal acceleration is always acting towards the centre of circle K.E. is constant because speed is constant since $KE = \frac{1}{2} m v^2$</p> <p>At lowest point, tension – weight = centripetal force Tension = centripetal force + weight</p> <p>At highest point, tension + weight = centripetal force Tension = centripetal force - weight</p> <p>Tension at the highest point is lower than at the lowest point.</p>		

- 10** Two points P and Q are located a fixed distance apart on a straight line joining them to an object considered as a point mass.



The two points P and Q are moved closer to the point mass, while keeping the separation between them constant.

What happens to the magnitudes of their individual gravitational potentials and to the magnitude of the gravitational field strength between the two points?

	magnitudes of gravitational potentials	magnitudes of gravitational field strength difference	
A	both decrease	decreases	
B	both decrease	increases	
C	both increase	stays the same	
D	both increase	increases	

Answer: D

Gravitational potential at a point is given by:

$$\phi = \frac{-GM}{r}$$

As both P and Q move closer to the mass, their distances r decrease, and since ϕ becomes more negative, the magnitudes of the potentials $|\phi|$ increase.

Gravitational field strength is given by:

$$g = \frac{GM}{r^2}$$

As r decreases, g increases at both P and Q. Because g changes more rapidly with r nearer the mass (steeper gradient), the field strength difference between the two points also increases, even though their separation remains constant.

- 11** A gas molecule of mass m moves with velocity v and collides elastically with a wall perpendicular to that direction.

If the molecule makes N such collisions per second with the wall, what is the average force F exerted by the molecule on the wall?

A	$F = mvN$	B	$F = 2mvN$	C	$F = \frac{mv^2}{2}$	D	$F = \frac{mv}{N}$
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Answer: B

Each elastic collision with the wall causes a change in momentum:

$$\Delta p = -mv - (+mv) = -2mv$$

According to Newton's 3rd law of motion, the wall experiences a force equal in magnitude but opposite in direction. If the molecule hits the wall N times per second, the rate of change of momentum (i.e., force),

$$F = N \times \Delta p = N \times (2mv) \\ = 2mvN$$

- 12** A piece of metal of mass m , specific heat capacity c and temperature 20°C is placed into a liquid of temperature 100°C . The liquid, which is in a well-insulated container, has mass $3m$ and specific heat capacity $2.5c$.

What is the temperature of the liquid when thermal equilibrium is reached?

- A** 56°C **B** 60°C **C** 85°C **D** 91°C

Answer: D

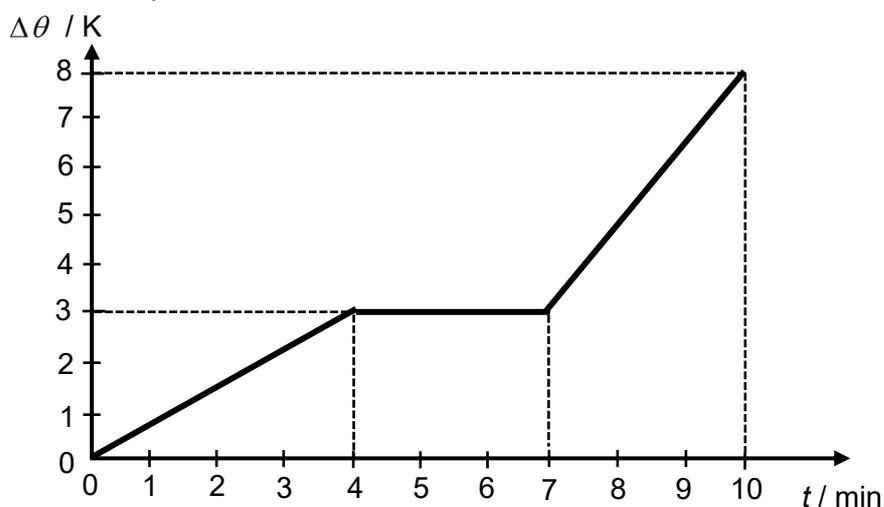
Using $Q = mc\Delta\theta$, heat gained by metal = heat lost by liquid;

$$mc(\theta_f - 20) = (3m)(2.5c)(100 - \theta_f)$$

$$\theta_f - 20 = 750 - 7.5\theta_f$$

$$\theta_f = 91^\circ\text{C}$$

- 13** The graph shows the variation with time t of temperature change $\Delta\theta$ for 1 kg of a substance, initially solid at room temperature. The substance receives heat at a uniform rate of 2000 J min^{-1} .



What can be deduced from this graph?

- A** The specific heat capacity of the substance is greater when liquid than when solid.
B The specific latent heat of fusion of the substance is 6000 J kg^{-1} .
C The substance melts at a temperature of 3 K.
D After 10 min, the substance is all gaseous.

Answer: B

Option A :

$$Q = Pt = mc\Delta\theta$$

$$P = \frac{mc\Delta\theta}{t}$$

From the graph, $\frac{\Delta\theta}{t}$ is bigger for liquid (7 – 10 min) than solid (1 – 4 min).

Since P and m are constant, therefore specific heat capacity c is smaller when liquid than when solid.

Option B:

$$Q = mL$$

$$2000 \times 3 = 1 \times L$$

$$L = 6000 \text{ J kg}^{-1}$$

Option C:

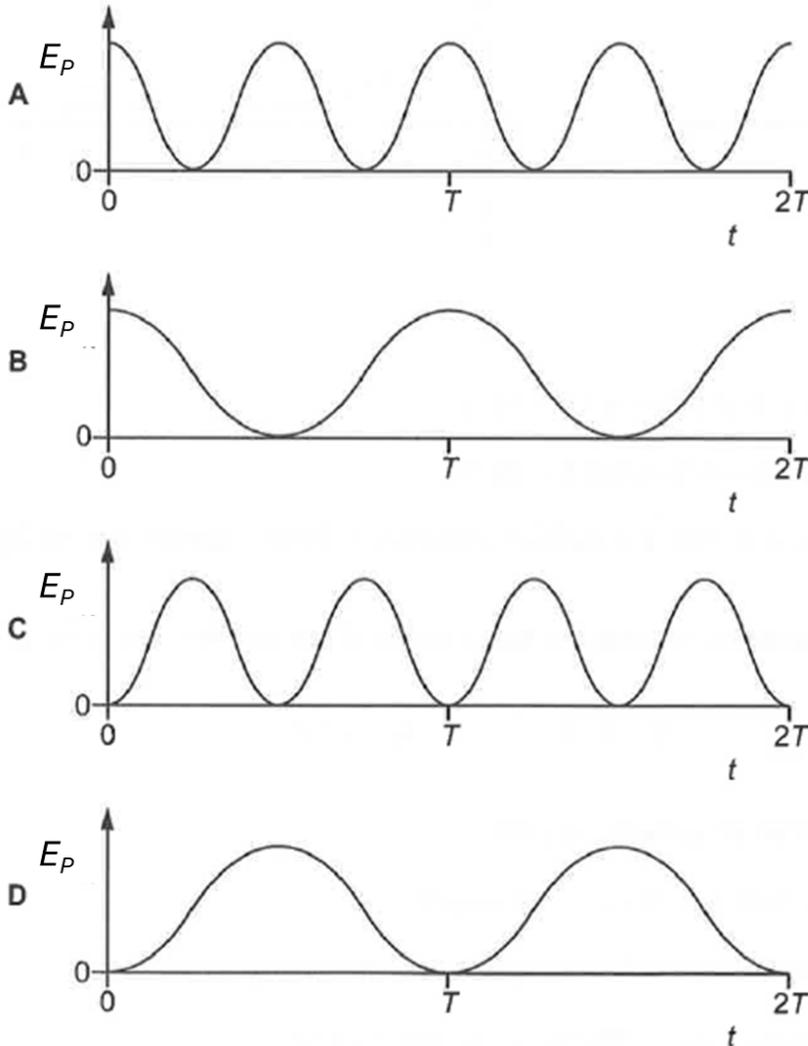
The substance melts after an increase in temperature of 3 K from room temperature. The melting temperature is not 3 K.

Option D:

Unless the graph becomes horizontal again, we are unable to determine when the substance starts to become gaseous.

- 14** A small pendulum bob is displaced to one side and released from rest at time $t = 0$. The bob then swings with simple harmonic motion with time period T .

Which graph represents the variation with time t of the gravitational potential energy E_P ?



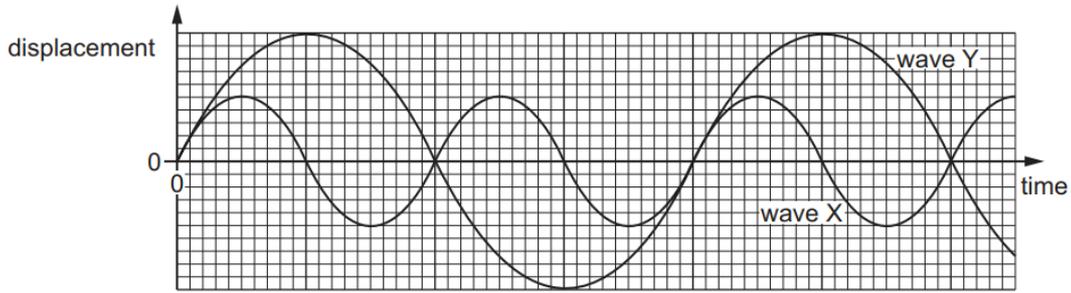
Answer: A

Explanation/Working:

At $t = 0$, the GPE is maximum since it is at the amplitude position.

The GPE is zero at the equilibrium position and in one cycle, the bob passes the equilibrium position twice, and therefore, it should have two minima per period.

15 The graph shows the variation with time of displacement for two transverse waves X and Y travelling through the same medium. For such mechanical waves, intensity is proportional to the square of frequency.



Wave X has frequency f and intensity I .

What is the frequency and intensity of wave Y?

	frequency	intensity	
A	$\frac{f}{2}$	$4I$	
B	$\frac{f}{2}$	I	
C	$2f$	I	
D	$2f$	$4I$	

Answer: B

Amplitude of Wave X is A
Wave Y has amplitude = $2A$

Using the relationship $I \propto A^2 f^2$,

$$\frac{I_Y}{I_X} = \left(\frac{2A}{A}\right)^2 \times \left(\frac{f}{2f}\right)^2 = 4 \times \frac{1}{4} = 1 \rightarrow I_Y = I_X = 1$$

16 Two polarising filters are placed next to each other so that their planes are parallel. The first polarising filter has its transmission axis at an angle of 50° to the vertical.

The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30° . □ □

A beam of vertically polarised light of intensity 8.0 W m^{-2} is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

A	zero	B	2.5 W m^{-2}	C	2.9 W m^{-2}	D	6.0 W m^{-2}
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	<p>Answer: B</p> <p>Light passes through the first polarising filter.</p> <p>Since the light is initially vertically polarised, the angle with the first filter's axis is 50°.</p> <p>Using Malus's Law: $I_1 = I_0 \cos^2(\theta) = 8.0 \times \cos^2(50^\circ) = 8.0 \times (0.6428)^2 = 8.0 \times 0.4132 = 3.31 \text{ W m}^{-2}$</p> <p>Light passes through the second polarising filter. The angle between the transmission axes of the two filters is 30°. Again using Malus's Law: $I_2 = I_1 \cos^2(30^\circ) = 3.31 \times (0.8660)^2 = 3.31 \times 0.75 = 2.5 \text{ W m}^{-2}$</p>
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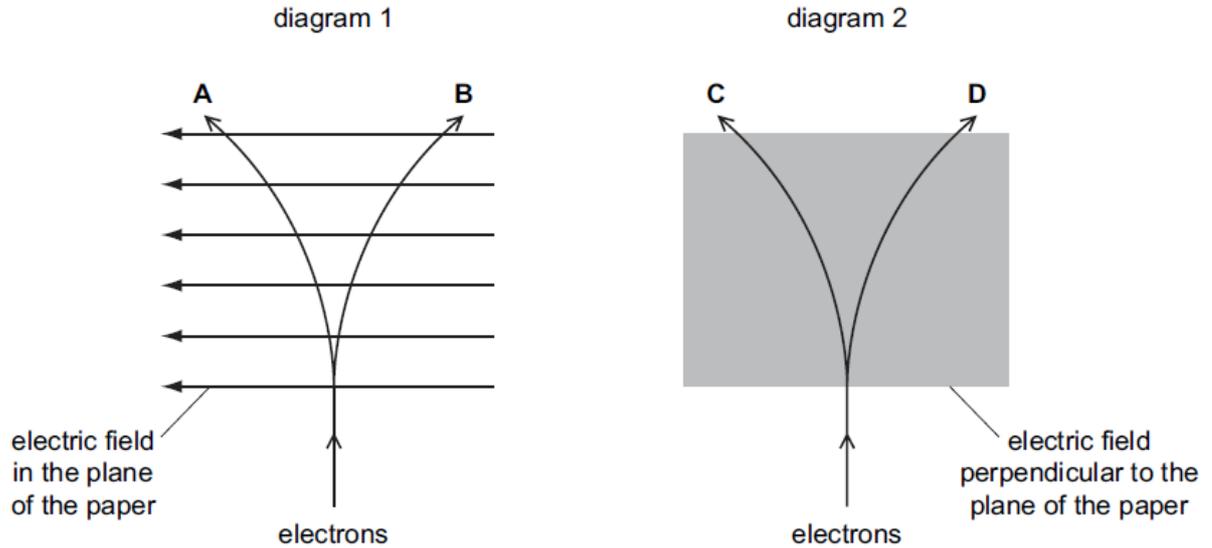
17	Which of the following is not an application of the Rayleigh criterion?
A	Assessing the resolving power of a telescope or microscope.
B	Calculating the minimum angular separation between two point sources to distinguish them.
C	Determining the angular position of the first minima in single slit diffraction.
D	Predicting whether two stars appear distinct in astronomical observations.
	<p>Answer: C</p> <p>Explanation/Working:</p> <p>Option C refers to diffraction pattern analysis, not resolution.</p> <p>Options A, B, and D are direct applications of the Rayleigh criterion, which concerns resolvability based on angular separation and diffraction limits.</p>

18 A beam of electrons is directed into an electric field and is deflected by it.

Diagram 1 represents an electric field in the plane of the paper. Diagram 2 represents an electric field directed perpendicular to the plane of the paper.

The lines A, B, C and D represent possible paths of the electron beam. All paths are in the plane of the paper.

Which line best represents the path of the electrons inside the field?



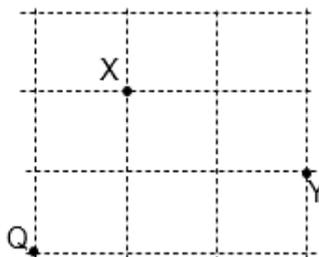
Answer: B

Electrons are negatively charged. In the left diagram, the field points to the left, so the force on electrons is to the right. An upward moving electron will curve towards the right → Path B.

For the diagram on the right, electric field is either in or out of the paper. This will cause electrons to deflect out of the plane of the paper, not along any of the shown paths which lie in the plane.

19 An isolated point charge is placed at point Q. The electric potential at point X is measured to be 720 V.

The relative positions of the three points Q, X, and Y are shown on the grid of squares below.



If the electric potential at X is 720 V, what is the electric potential at Y?

- | | | | | | | | |
|----------|-------|----------|-------|----------|-------|----------|-------|
| A | 509 V | B | 581 V | C | 720 V | D | 936 V |
|----------|-------|----------|-------|----------|-------|----------|-------|

Answer: A

Electric potential due to a point charge follows:

$$V \propto 1/r$$

Distance from Q to X:

$$r_x = \sqrt{1^2 + 2^2} = \sqrt{5} = 2.24$$

Distance from Q to Y:

$$r_y = \sqrt{3^2 + 1^2} = \sqrt{10} = 3.16$$

$$\frac{V_Y}{V_X} = \frac{r_x}{r_y} = \frac{2.24}{3.16} = 0.707$$

$$V_Y = 720 \times 0.707 = 509 \text{ V}$$

- 20** A cylindrical piece of wire has resistance R . It is stretched uniformly so that its length becomes three times longer, but its volume remains constant.

What is its new resistance in terms of R ?

A

$$\frac{R}{3}$$

B

R

C

$3R$

D

$9R$

Answer: D

Let original length = L , area = A .

Then original volume = $A \times L$

New length = $3L$

New area = $A' = \text{original volume} / \text{new length} = \frac{A \times L}{3L} = \frac{A}{3}$

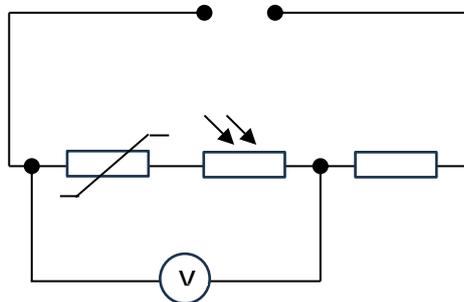
Original resistance:

$$R = \frac{\rho \times L}{A}$$

New resistance:

$$R' = \rho \times \frac{3L}{\frac{A}{3}} = \rho \times (3L \times \frac{3}{A}) = 9 \times (\rho \times \frac{L}{A}) = 9R$$

- 21** A negative temperature coefficient thermistor, an LDR and a fixed resistor are connected in series to a power supply. A voltmeter is placed across the thermistor-LDR combination.



Which conditions of brightness and temperature will produce the smallest reading on the voltmeter?

A

temperature
high

brightness
high

B

temperature
high

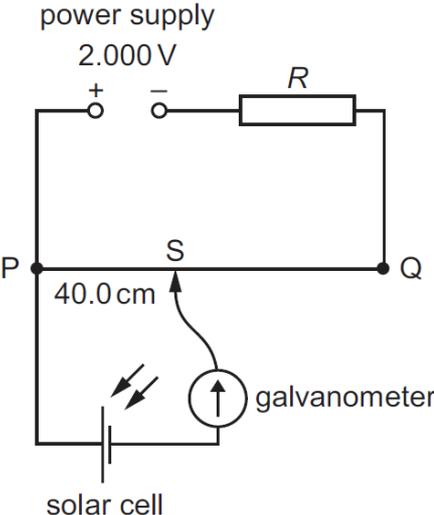
brightness
low

	C	low	high	
	D	low	low	

Answer: A

Smallest reading on the voltmeter, the total resistance of the thermistor and the LDR is the lowest.
 Lowest resistance of a NTC thermistor occurs when temperature is high
 Lowest resistance of LDR occurs when brightness is high

22 A power supply and a solar cell are compared using the potentiometer circuit shown.



The potentiometer wire PQ is 100.0 cm long and has a resistance of 5.00 Ω . The power supply has an e.m.f. of 2.000 V and the solar cell has an e.m.f. of 5.00 mV.

When the galvanometer shows zero deflection, the balance length PS is found to be 40.0 cm.

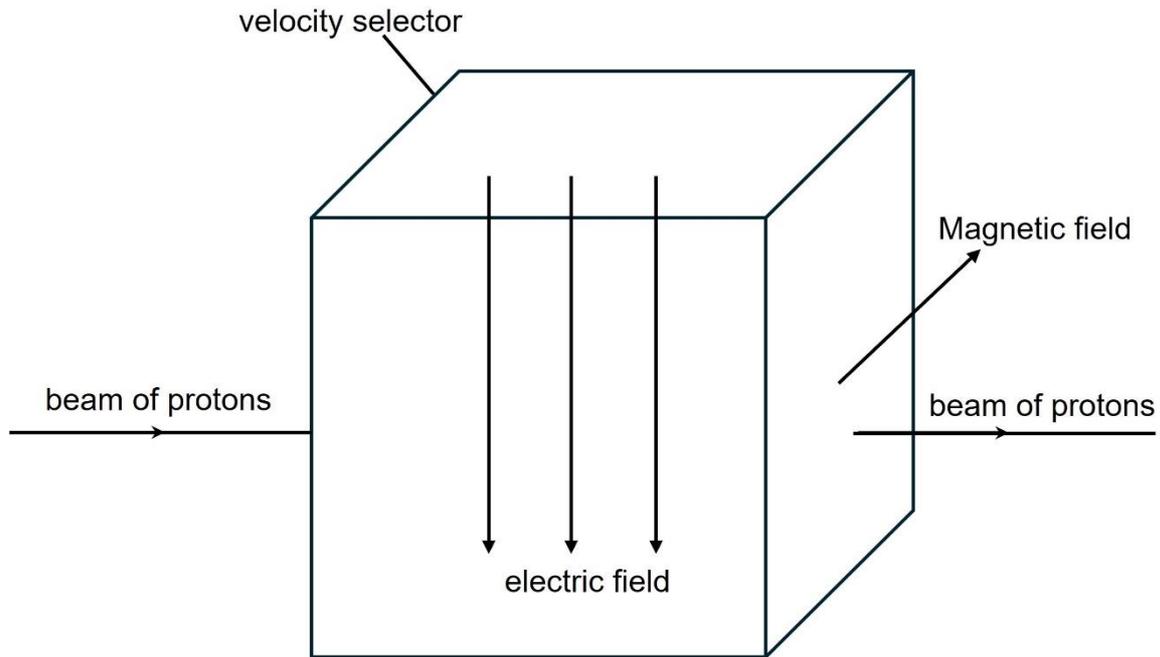
What is the resistance of R so that the galvanometer reads zero at this balance length?

A	395 Ω	B	795 Ω	C	995 Ω	D	1055 Ω
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Answer: B

At balance point, voltage across 40.0 cm $\rightarrow 5.00 \times 10^{-3}$ V
 Pd across PQ (100 cm) = $\frac{5.00 \times 10^{-3}}{40} \times 100 = 0.0125$
 Total voltage across R = 2.000 – 0.0125 V = 1.9875 V
 Total resistance = R + 5.00
 By potential divider principle: $1.9875 = 2 \frac{R}{R+5}$
 $0.99375(R+5) = R$
 $0.99375R + 4.96875 = R$
 $0.00625 R = 4.96875$
 $R = 795 \Omega$

- 23** A beam of protons enters a velocity selector as shown. The electric field E acts vertically downwards, and the magnetic field B is directed into the page.



If only protons with a particular speed emerge undeflected, which change would result in the protons being deflected downwards?

- | | |
|----------|--|
| A | Increasing the electric field strength only |
| B | Increasing the magnetic field strength only |
| C | Increasing both E and B by the same factor |
| D | Increasing the proton's speed |

Answer: A

For no deflection, $E = vB$. Increasing E only makes the electric force greater compared to the magnetic force, causing downward deflection.

- 24** A rectangular coil of wire lies in a uniform magnetic field of 0.30 T. The field is perpendicular to the plane of the coil. The coil is stretched from dimensions 0.20 m \times 0.50 m to 0.20 m \times 0.80 m in 2.0 seconds.

What is the average emf induced in the coil during this time?

- | | | | | | | | |
|----------|---------|----------|---------|----------|---------|----------|---------|
| A | 0.009 V | B | 0.018 V | C | 0.027 V | D | 0.036 V |
|----------|---------|----------|---------|----------|---------|----------|---------|

Answer: A

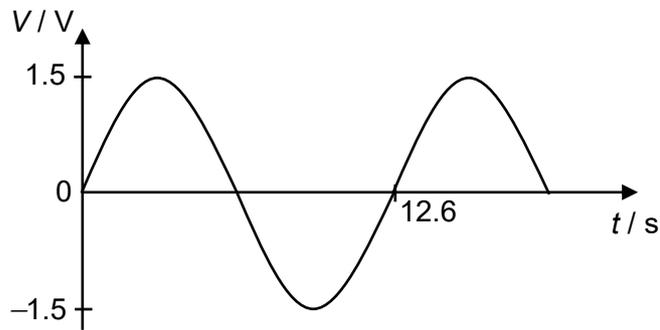
Initial area = $0.20 \times 0.50 = 0.10 \text{ m}^2$

Final area = $0.20 \times 0.80 = 0.16 \text{ m}^2$

Change in flux, $\Delta\Phi = B \times \Delta A = 0.30 \times (0.16 - 0.10) = 0.018 \text{ Wb}$

Average emf = $\Delta\Phi / \Delta t = 0.018 / 2.0 = 0.009 \text{ V}$

25 The variation of an alternating voltage V with time t is shown in the graph below.



Which expression best represents V in terms of t ?

A $V = 1.5 \sin(0.499t)$

B $V = 1.5 \sin(2.01t)$

C $V = 3.0 \sin(0.249t)$

D $V = 1.5 \sin(12.6t)$

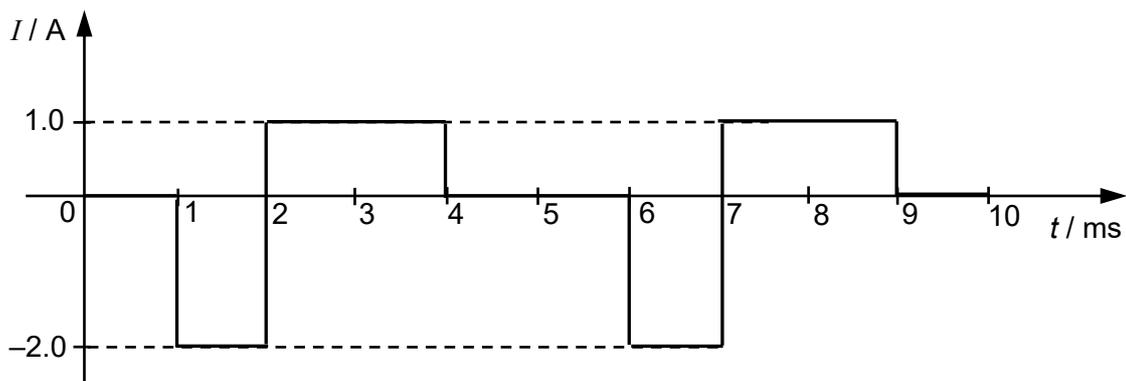
Answer: A

$$x = x_0 \sin(\omega t)$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{12.6} = 0.499 \text{ rads}^{-1}; x_0 = 1.5 \text{ V}$$

Therefore, $V = 1.5 \sin(0.499t)$.

26 An alternating current with a rectangular waveform as shown in the diagram below flows through a 10Ω resistor.



What is the average power dissipated by the resistor?

A 0 W

B 8 W

C 12 W

D 28 W

Answer: C

To find I_{rms} ; Firstly, you square the graph, then you find the total area over 1 period. Next, find the average area over 1 period, and then you will obtain the answer by taking the square root.

$$I_{\text{r.m.s.}} = \sqrt{\frac{(-2.0^2 \times 1) + (1.0^2 \times 2)}{5}}$$

$$= 1.09545 \text{ A}$$

$$\text{Average power} = I_{\text{r.m.s.}}^2 \times R$$

$$= 1.09545^2 \times 10$$

$$= 12 \text{ W}$$

- 27** A photon of light has frequency f , momentum p , and speed c . The Planck constant is h .
Which expressions for the momentum and the energy of the photon are correct?

	momentum	energy	
A	hf	pc	
B	hf	$\frac{pc}{2}$	
C	$\frac{hf}{c}$	pc	
D	$\frac{hf}{c}$	$\frac{pc}{2}$	

Answer: C

Explanation/Working:

de Broglie equation: $\lambda = \frac{h}{p}$

$$\frac{c}{f} = \frac{h}{p}$$

$$p = \frac{hf}{c}$$

Since $E = hf$

$$p = \frac{E}{c}$$

$$E = pc$$

- 28** An electron in an atom transitions from -25.0 eV to -80.0 eV . A photon is emitted in the process.
What is the wavelength of the emitted photon?

A	15.5 nm	B	22.6 nm	C	49.7 nm	D	300 nm
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Answer: B

Explanation/Working:

Energy difference

$= -80.0 - (-25.0) \text{ eV} = -55.0 \text{ eV}$ $= -55.0 \times 1.60 \times 10^{-19} \text{ J}$ $= 8.81 \times 10^{-18} \text{ J}$ $\lambda = \frac{hc}{\Delta E} = \frac{(6.63 \times 10^{-34})(3.00 \times 10^8)}{8.81 \times 10^{-18}} = 2.26 \times 10^{-8} \text{ m}$ $\lambda = 22.6 \text{ nm}$
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29	Which of the following best describes the Heisenberg's uncertainty principle?			
A	The uncertainty principle applies only to microscopic particles like electrons.			
B	The uncertainty principle only applies to particles moving close to the speed of light.			
C	The product of the uncertainties in position and momentum of a particle has a minimum value.			
D	It is possible to reduce the uncertainty in both position and momentum of a particle to zero with advanced measuring techniques.			
<p>Answer: C</p> <p>Explanation/Working:</p> <p>The HUP applies to all particles, not just electrons (Option A) or objects moving at high speeds (Option B). It is also a limitation of knowledge of the value of the quantities, and not just a technological issue (Option D).</p> <p>Option C is correct because this is the statement of the inequality $\Delta x \Delta p \geq h$</p>				

30	Thorium-232 undergoes the following fission reaction:						
${}_{90}^{232}\text{Th} \rightarrow {}_{54}^{140}\text{Xe} + {}_{36}^{90}\text{Kr} + 2{}_0^1\text{n}$							
The binding energy per nucleon for the nuclei involved are:							
Thorium-232: 7.6 MeV							
Xenon-140: 8.3 MeV							
Krypton-90: 8.5 MeV							
What is the energy released by this fission reaction?							
A	1.64 x 10 ⁸ J	B	2.63 x 10 ⁻¹¹ J	C	1.47 x 10 ⁻¹² J	D	2.63 x 10 ⁻¹⁷ J
<p>Answer: B</p> <p>Explanation/Working:</p> <p>Thorium-232 has 232 nucleons.</p> <p>Binding energy = 232 × 7.6 = 1763.2 MeV</p> <p>Xenon-140: 140 × 8.3 = 1162.0 MeV</p> <p>Krypton-90: 90 × 8.5 = 765.0 MeV</p>							

$$\begin{aligned} \text{Energy released} &= \text{Binding energy of products} - \text{Binding energy of reactants} \\ &= 1927.0 - 1763.2 = 163.8 \text{ MeV} \end{aligned}$$

$$1 \text{ MeV} = 1.602 \times 10^{-13} \text{ J}$$

$$\text{Energy in joules} = 163.8 \times 1.602 \times 10^{-13} = 2.63 \times 10^{-11} \text{ J}$$

END OF PAPER