RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749 / 01
PAPER 1
19 SEPTEMBER 2024

1 HOUR

CANDIDATE NAME									
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	3	J						

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

There are **thirty** questions in this section. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Optical Answer Sheet**.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on the Question Paper.

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

Hand in the Optical Answer Sheet.

This document consists of **20** printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_O	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_O	=	8.85×10^{-12} F m^{-1}
			$(1/(36\pi)) \times 10^{-9}$ F m^{-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
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-1}
gravitational constant,	G	=	6.67×10^{-11} N m^2 kg^{-2}
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	$p = \rho gh$
gravitational potential	$\phi = -Gm/r$
temperature	T / K = T / °C + 273.15
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$
	$= \pm\omega\sqrt{x_0^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
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	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

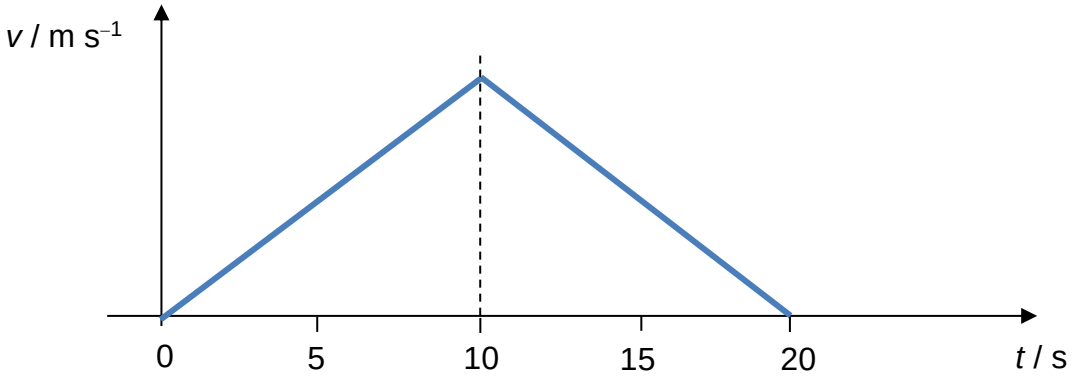
For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Answer Sheet**.

1 An alternative form of the unit of resistance, the ohm (Ω), is V A^{-1}.

Which of the following examples shows a similar correct alternative form of unit?

	Unit	Alternative form
A	Newton (N)	kg m s^{-1}
B	Hertz (Hz)	s^{-2}
C	Joule (J)	N m^{-1}
D	Tesla (T)	kg A^{-1} s^{-2}

2 A drone descends from a height for 20 s. The variation with time *t* of the vertical speed *v* of the drone is shown.



What is the ratio of $\frac{\text{distance travelled between 0 to 20 s}}{\text{distance travelled between 5 to 15 s}}$?

A 1.1 **B** 1.3

C 1.5 **D** 2.0

3 A ball is thrown upwards at an angle to the horizontal with an initial speed. Assuming that air resistance is not negligible, which of the following statement is incorrect?

A The path of the ball is asymmetrical about a vertical line passing through the highest point.

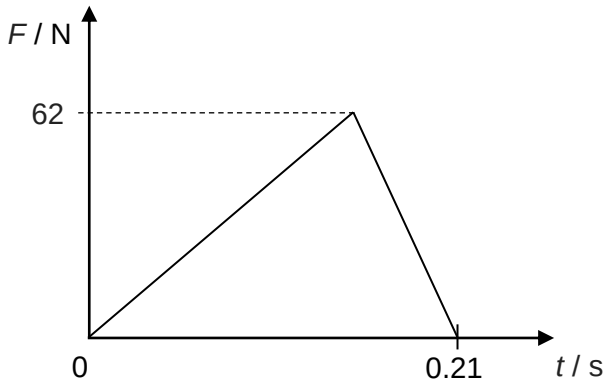
B Horizontal range of the ball is shorter than the case with negligible air resistance.

C The maximum height reached by the ball is smaller than the case with negligible air resistance.

D The time taken for the flight up to the highest point is longer than the time taken for the flight down.

4 The graph below shows the variation with time of the force exerted by a baseball pitching machine that throws baseballs of mass 150 g from rest.

What is the velocity of a ball immediately after leaving the machine?



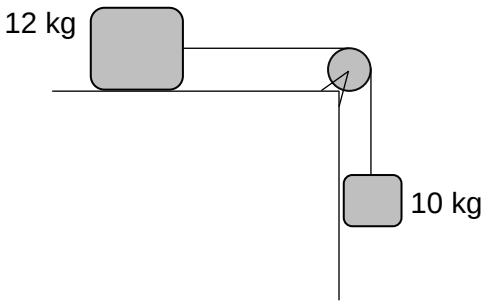
A 13 m s^{-1}

B 43 m s^{-1}

C 87 m s^{-1}

D 295 m s^{-1}

5 A block of mass 12 kg lies on a frictionless horizontal table. A rope connects the 12 kg block to another block of mass 10 kg that hangs freely via a frictionless pulley as shown in the diagram below. The system is then released from rest.



What is the tension in the rope?

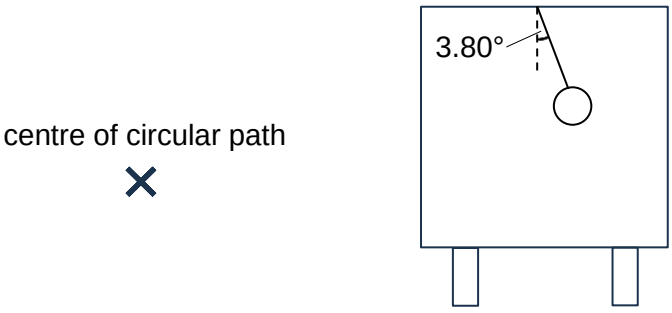
A 4.5 N

B 16 N

C 54 N

D 98 N

6 A train moving at 57.8 km h^{-1} travels around a circular curve at constant speed. An object hung from a string in the train makes an angle of 3.80° with the vertical. What is the radius of the circular path?



Rear view of train

A 24.6 m

B 34.0 m

C 396 m

D 5130 m

7 Given that the mass of Earth is 5.97×10^{24} kg, what is the speed of a satellite in a geostationary orbit about Earth?

A 1.66×10^{3} m s^{-1}

B 3.07×10^{3} m s^{-1}

C 2.00×10^{7} m s^{-1}

D 4.22×10^{7} m s^{-1}

8 A uniform spherical planet of mass 1.30×10^{22} kg has a diameter of 2380 km. A space probe of mass 5500 kg is launched from the surface to a height of 240 km.

What is the increase in gravitational potential energy of the space probe?

A 1.84×10^{8} J

B 6.73×10^{8} J

C 3.34×10^{9} J

D 4.01×10^{9} J

9 In the derivation of the relationship between the pressure, the number density of molecules and the mean square speed of the molecules of an ideal gas, which of the following is **NOT** an essential assumption?

A There are no intermolecular forces of attractions.

B The volume of the molecules are small when compared to the volume of the container.

C The molecules are in continuous random motion and all collisions are elastic.

D The average kinetic energy of a molecule is directly proportional to the temperature of the gas.

10 A polystyrene cup contains a mass of 130 g of water at 50 °C. A cube of ice of mass 20 g and temperature 0 °C is placed in the water. The water is stirred until the temperature is homogenous.

Assuming negligible heat loss to the cup and surroundings, what is the final temperature of the water?

specific heat capacity of water = 4.2×10^3 J kg^{-1} K^{-1}
specific latent heat of fusion of ice = 3.3×10^5 J kg^{-1}

A 3 °C

B 18 °C

C 33 °C

D 38 °C

11 In microwave ovens, water molecules in food are set into resonance when microwaves of a fixed frequency are incident on them. This causes the molecules to receive energy and hence warms up the food. In order to warm up the food faster, one can

A increase the frequency of the incident microwave while keeping its amplitude fixed.

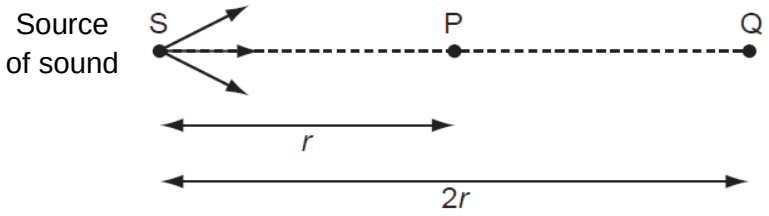
B increase the frequency and amplitude of the incident microwave.

C increase the amplitude of the incident microwave while keeping its frequency fixed.

D keep both frequency and amplitude of the microwave the same as before but increase the frequency of the water molecules.

12 Sound is emitted from a point source S. At point Q, air molecules oscillate with amplitude 6.0 μm.

What is the amplitude of oscillation of air molecules at P?



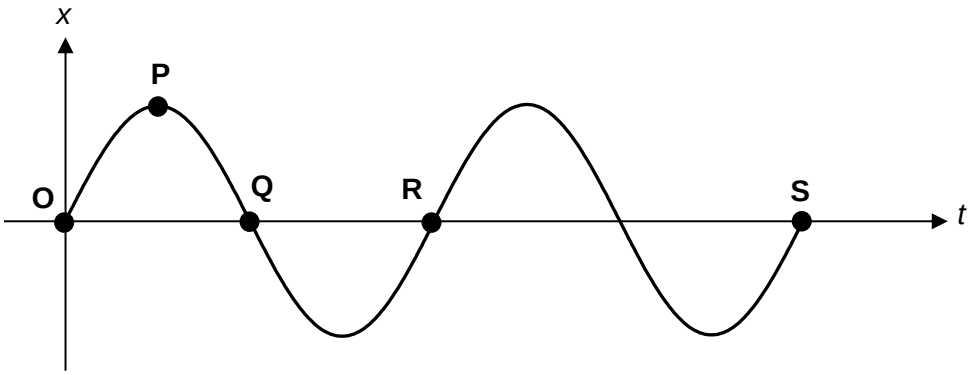
A 0.75 μm

B 1.5 μm

C 3.0 μm

D 12.0 μm

13 The graph below shows the variation with time *t* of the displacement *x* of a particle on a progressive wave.



Which statement below is true?

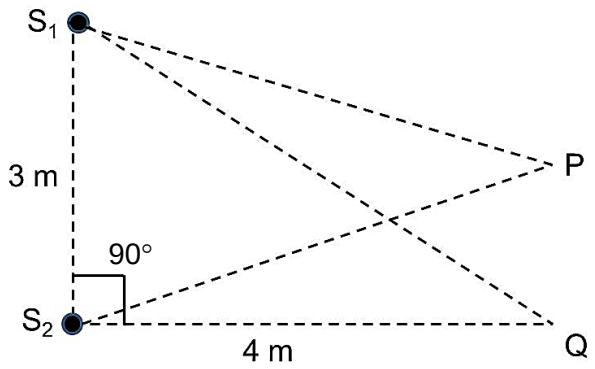
A OS represents two wavelengths.

B At P, the acceleration of the particle is zero.

C The phase difference between Q and R is 180°.

D The kinetic energy of the particle is higher when it is at Q than when it is at R.

14 Two sources of waves, S_1 and S_2, are situated as shown in the figure below. Individually, each source emits waves of intensity I.



Equidistant from S_1 and S_2, a detector at P registers a steady minimum wave intensity. The same detector registers the next steady minimum intensity when it moves to point Q. Which of the following statements is false about the two sources of waves?

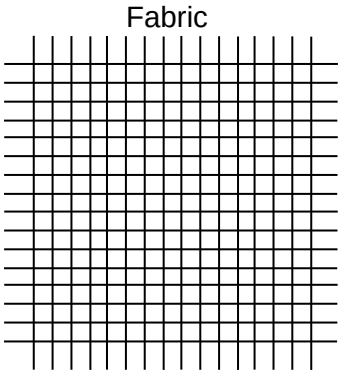
A The two sources of waves have the same amplitude.

B The two sources of waves are coherent.

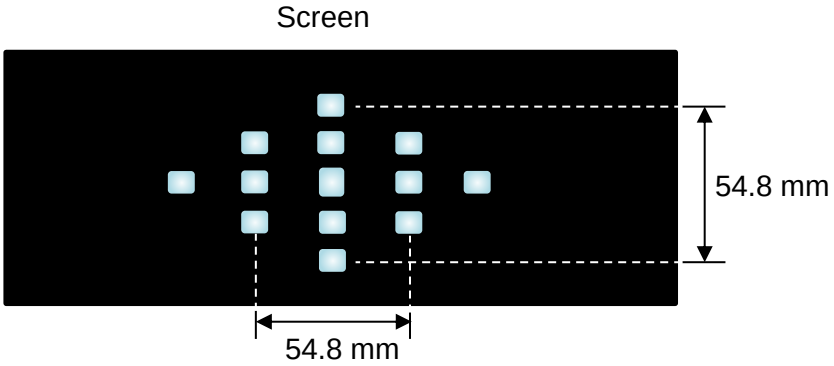
C The two sources of waves have a phase difference of π radians.

D The waves from the two sources have a wavelength of 2 m.

15 A fabric consists of closely-spaced horizontal and vertical threads as shown.



When a laser with a wavelength of 685 nm is incident on the fabric, a diffraction pattern is observed on a screen placed at a distance of 2.00 m away, as shown below.



The separation between the **horizontal** threads of the fabric is

A 2.50×10^{-5} m

B 5.00×10^{-5} m

C 1.00×10^{-4} m

D 9.48×10^{-4} m

16 A charged oil droplet of mass m is falling, initially freely, in a vacuum between two horizontal metal plates that are separated by a distance x.

A potential difference (p.d.) V is then applied across the plates. This results in the oil droplet continuing to accelerate downwards but with a reduced acceleration a.

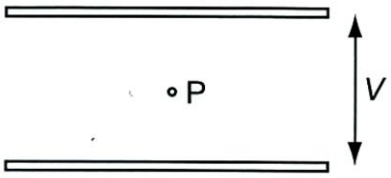
The polarity of the applied p.d. is then reversed so that the direction of the electric force on the droplet is reversed. This results in the downwards acceleration of the oil droplet increasing to $7a$.

What is the magnitude of the charge on the oil droplet?

A $\frac{max}{V}$ **B** $\frac{3max}{V}$

C $\frac{6max}{V}$ **D** $\frac{7max}{V}$

17 A small positively charged particle P is balanced halfway between two horizontal plates when a potential difference V is applied between the plates.



When V is increased, P rises towards the upper plate.

When V is decreased, P falls towards the lower plate.

Which statement is correct?

A Decreasing V increases the electric potential energy and decreases the gravitational potential energy of the particle.

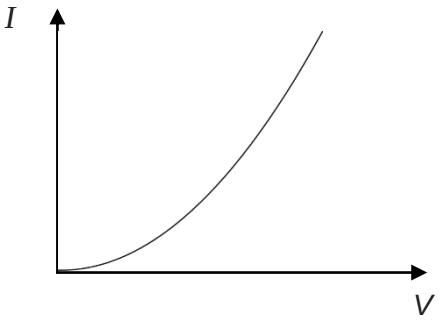
B Decreasing V increases both the electric and the gravitational potential energy of the particle.

C Increasing V increases both the electric and the gravitational potential energy of the particle.

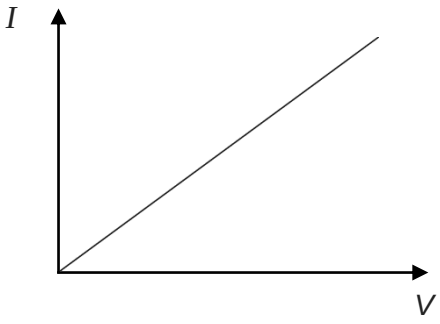
D The change of electric potential energy of the particle must equal the change of gravitational potential energy of the particle.

18 Which of the following graphs correctly shows the variation with the potential difference V across a negative temperature coefficient (NTC) thermistor of the current I through it?

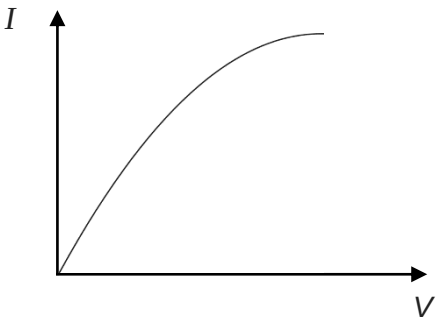
A



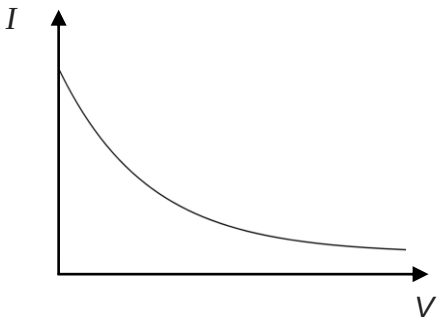
B



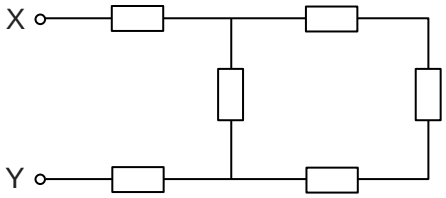
C



D



19 6 identical resistors of resistance R are set up across points X and Y as shown in the diagram below. What is the effective resistance across X and Y in terms of R?



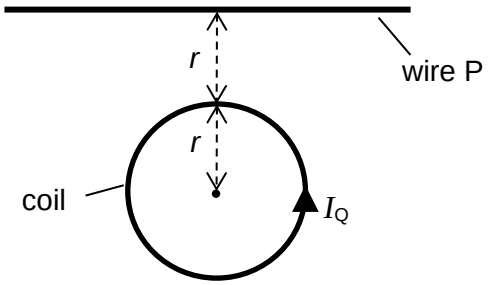
A 1.50 R

B 2.75 R

C 3.33 R

D 5.00 R

20 A coil Q of a single turn and radius *r*, carries an anti-clockwise current I_Q and lies flat on the table. A long straight wire P carrying current I_P is placed on the same table such that its perpendicular distance from the centre of coil Q is 2*r*.



Which of the following will cause the resultant magnetic field at the centre of coil Q to be zero?

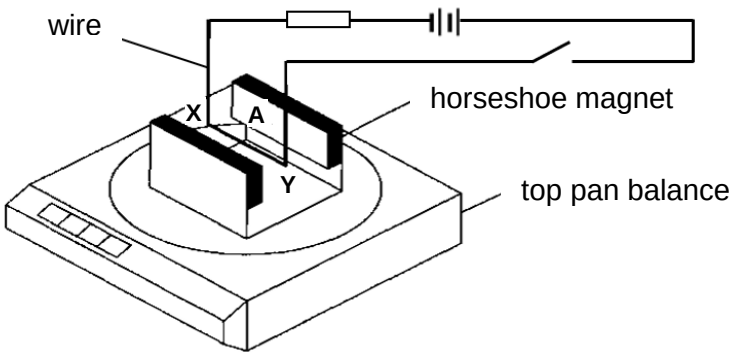
A I_P to the right, $I_P = 2\pi I_Q$

B I_P to the left, $I_P = 2\pi I_Q$

C I_P to the right, $I_Q = 2\pi I_P$

D I_P to the left, $I_Q = 2\pi I_P$

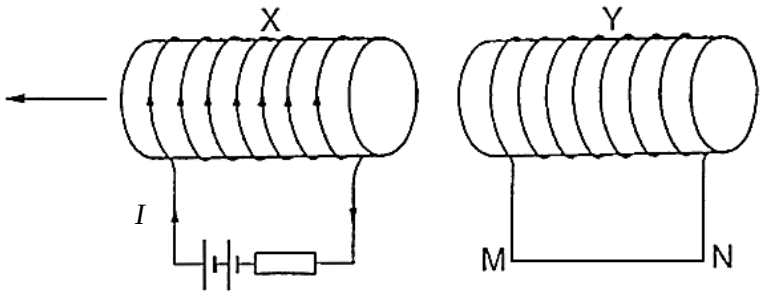
21 A horseshoe magnet rests on a top-pan balance with a wire XY suspended between the poles of the magnet. The wire is not in contact with the horseshoe magnet and is a part of the circuit as shown. When the switch is closed, the reading on the balance increases.



Which one of the following correctly gives the direction of the magnetic force on wire XY and the magnetic pole of face **A** of the horseshoe magnet?

	direction of magnetic force on wire XY	magnetic pole of face **A** of the horseshoe magnet
A	upwards	North pole
B	upwards	South pole
C	downwards	North pole
D	downwards	South pole

22 X and Y are solenoids wound on cardboard tubes, X carries constant current I as shown below and moves with constant speed away from Y among the common axis of the two tubes.

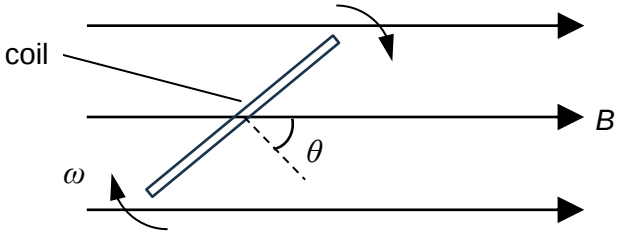


As a result of electromagnetic induction, a current will flow in the straight wire MN and there will be a force between X and Y.

Which one of the following correctly describes both the current and the force?

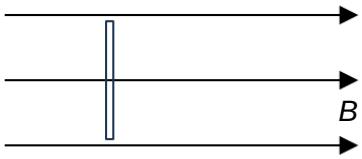
	nature and direction of current in straight wire MN	nature of force
A	diminishing, N to M	attraction
B	diminishing, M to N	repulsion
C	constant, N to M	repulsion
D	constant, M to N	attraction

23 A circular coil rotates with a constant angular velocity about a diametrical axis perpendicular to a uniform magnetic field. At which of the following orientations of the coil is the induced e.m.f. in the coil a maximum?

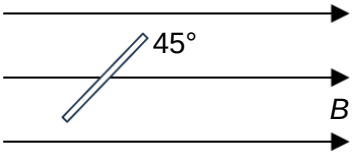


A

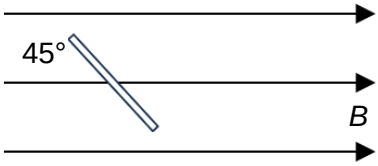
B



C



D



24 A power plant sends an average of 120 kW of electric power to a town by electrical cables. The cables have a total resistance of 3.0 Ω.

What is the power lost in the cables if the power was transmitted at a voltage of 6.0 kV?

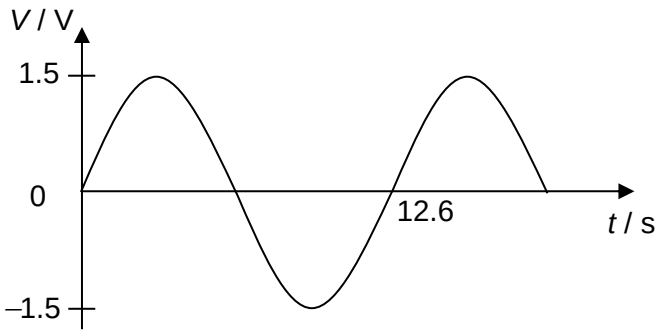
A 20 W

B 130 W

C 1200 W

D 1.2×10^7 W

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 $V = 1.5\sin(12.6t)$

26 Which of the following statements about the photoelectric effect is true?

A Photoelectrons are not emitted as long as intensity of illumination is low.

B Doubling the frequency radiation will double the stopping potential.

C For a particular clean metal surface, there will be a minimum wavelength below which no emission of photoelectrons will occur.

D Increasing the intensity of incident monochromatic light increases the photo-current.

27 In an atom, an electron is moving with a speed of 2.0×10^6 m s^{-1} with an uncertainty of 0.005%.

What is the minimum uncertainty with which the location of the electron can be located?

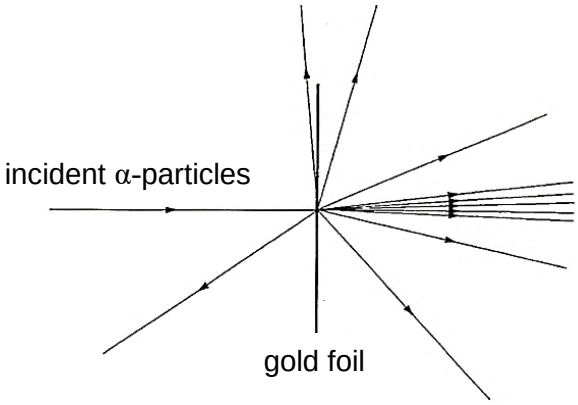
A 2.7×10^{-23} m

B 3.6×10^{-10} m

C 7.3×10^{-6} m

D 0.15 m

28 A thin gold foil is bombarded with α-particles as shown.

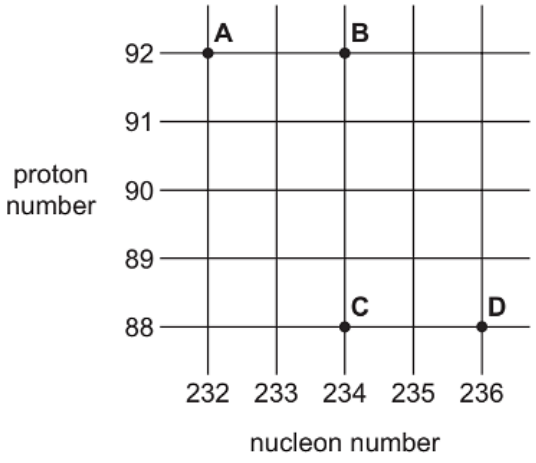


Which explanation best explains the corresponding observation?

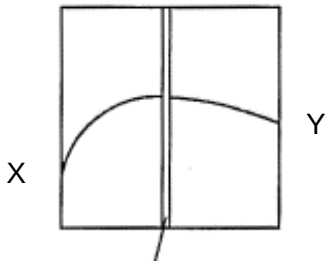
	Observation	Explanation
A	Most of the particles undergo little to no deflection.	The electrostatic repulsion acting on them is only along the direction of initial velocity.
B	Most of the particles undergo little to no deflection.	The mass of the nucleus is too little.
C	A tiny fraction of the particles is scattered at large angles.	The nucleus is mostly empty space.
D	A tiny fraction of the particles is scattered at large angles.	Bulk of the mass of the atom is concentrated in a very small positively charged region.

29 $^{234}_{90}Th$ decays by β^- emission into a daughter product which in turn decays by a β^- emission into a granddaughter product.

Which letter in the diagram represents the granddaughter product?



30 Radiation from a radioactive source enters an evacuated region in which there is a uniform magnetic field perpendicular to the plane of the diagram. This region is divided into two by a sheet of aluminium about 1 mm thick. The curved horizontal path followed by the radiation is shown in the diagram below.



Which of the following correctly describes the type of radiation and its point of entry?

	type of radiation	point of entry
A	alpha	X
B	alpha	Y
C	beta	X
D	beta	Y

END OF PAPER