



Anglo-Chinese Junior College

Physics Preliminary Examination

Higher 2



A Methodist Institution
(Founded 1886)

PHYSICS

Paper 1 Multiple Choice

9749/01

19 September 2025

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and index number on the Answer Sheet provided.

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

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

Read the instructions on the Answer Sheet very carefully.

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

Any rough working should be done in this Question Paper.

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

DATA AND FORMULAE

Data

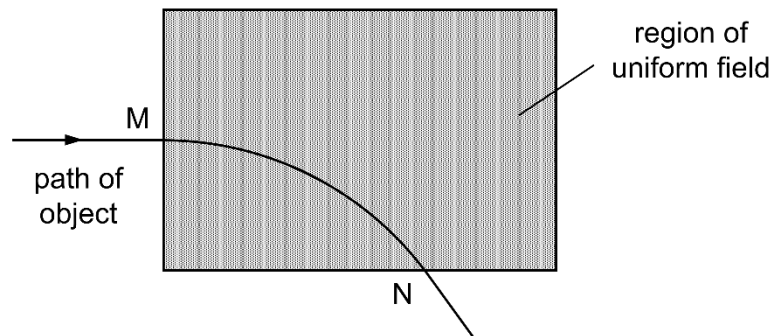
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(1/(36\pi)) \times 10^{-9} \text{ F m}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
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	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
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

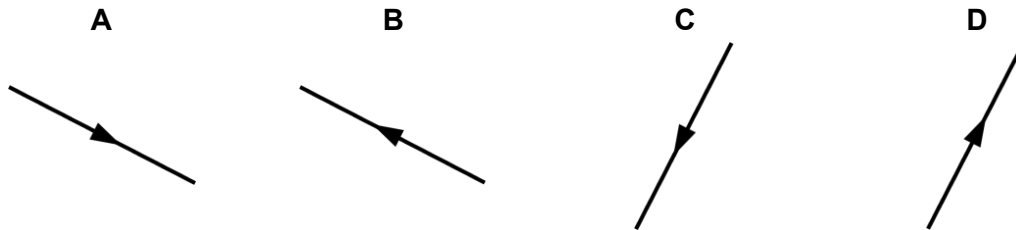
uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p \Delta V$
hydrostatic pressure	$p = \rho g h$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	$T/K = T/^{\circ}\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_o \sin \omega t$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$ $= \pm \omega \sqrt{x_o^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
electric potential	$V = \frac{Q}{4\pi\epsilon_o r}$
alternating current/voltage	$x = x_o \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_o nI$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

[Turn over]

- 1 A moving object enters a uniform field of force at M, travels at constant speed and exits the field at N as shown.



Which arrow best represents the direction of the change in velocity of the object from M to N?

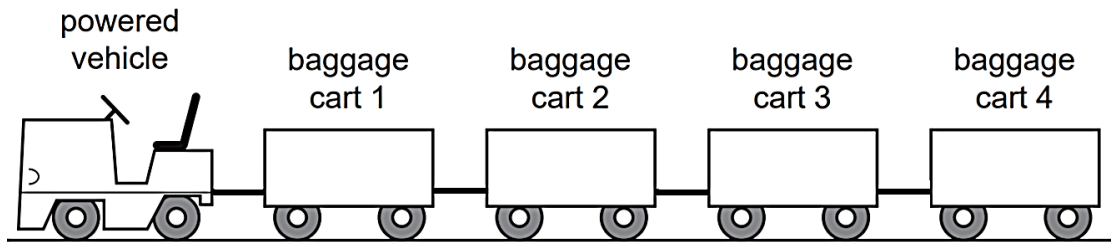


- 2 An object is thrown vertically upwards in air. The times for the upward motion t_u and the downward motion t_d to return to the same height are compared.

Which statement is correct?

- A** t_d is greater because at a given speed the resultant force when the object is moving downwards is smaller than the retarding force when it is moving upwards.
- B** t_d is greater because the object moves faster on its downward motion and therefore the air resistance is greater.
- C** t_u is greater because at a given speed, the resultant force when the object is moving downwards is greater than the retarding force when it is moving upwards.
- D** t_u is greater because the object moves faster on its downward motion due to gravitational force acting in the same direction as its motion.

- 3 A transport system used to move luggage from the airport terminal to the aircraft consists of a powered vehicle connected to four baggage carts by a series of connecting bars.



The mass of each of the baggage carts is 400 kg and the system starts with an acceleration of 2.0 m s^{-2} .

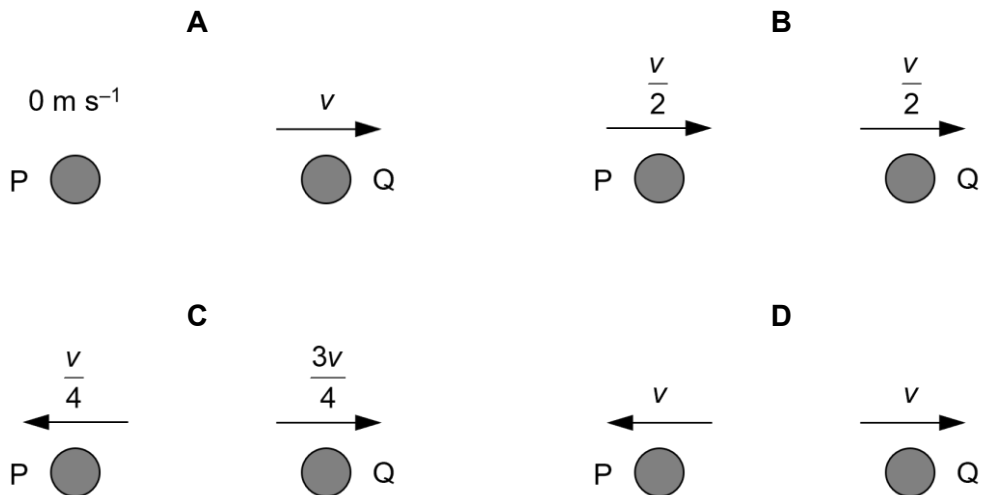
Ignore any frictional forces on the carts.

What is the tension in the connecting bar between baggage carts 2 and 3?

- A 400 N B 800 N C 1200 N D 1600 N
- 4 A small ball P moves with speed v towards another identical ball Q along a line joining the centres of the two balls. Ball Q is at rest initially and they collide elastically.

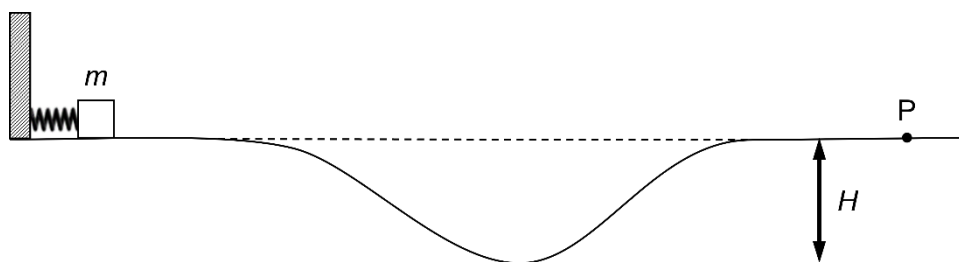


Which of the following shows the final velocities of the balls?



[Turn over]

- 5 A small object of mass m is launched by a spring and travels along a rough track to a point P as shown.



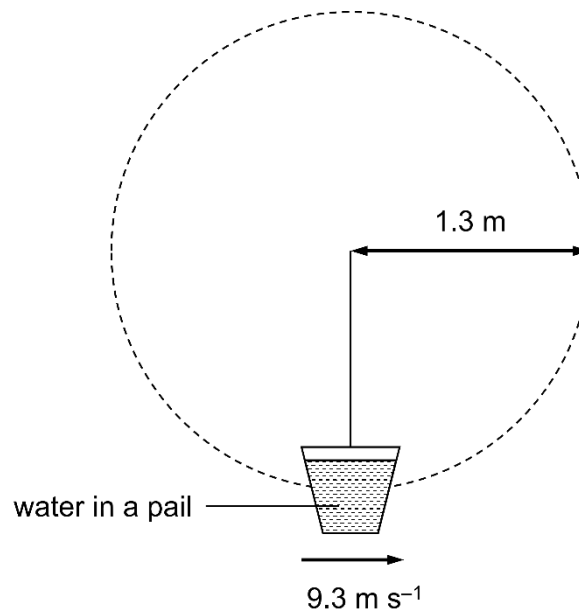
The spring constant of the spring is k and its initial compression is x .

As it travels to P, it goes through a distance d and a dip of depth H . The object experiences a constant frictional force f for the entire motion.

What is the kinetic energy of the object at point P?

- A $\frac{1}{2}kx^2 - fd$
- B $\frac{1}{2}kx^2 - fd - mgH$
- C $\frac{1}{2}kx^2 + fd$
- D $\frac{1}{2}kx^2 + fd + mgH$

- 6 A pail of water is spun vertically in a circular motion with a radius of 1.3 m as shown.



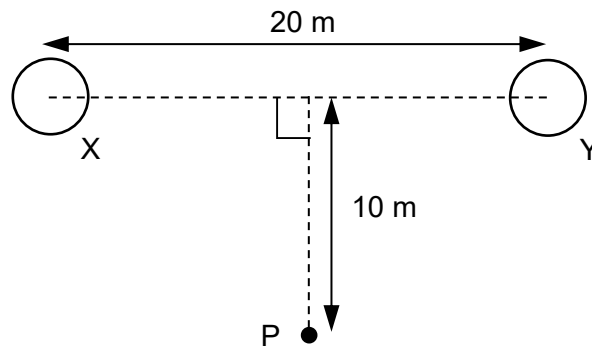
The mass of water is 0.52 kg and the speed of the pail at the bottom of the circle is 9.3 m s^{-1} .

What is the normal contact force acting on the water at the bottom of the circle?

- A** 5.1 N **B** 30 N **C** 35 N **D** 40 N

[Turn over]

- 7 Two identical 30 kg point masses X and Y are placed 20 m apart as shown.



P is a point 10 m perpendicular to the midpoint between X and Y.

What is the resultant gravitational field strength g and gravitational potential ϕ at P?

	$g / \text{N kg}^{-1}$	$\phi / \text{J kg}^{-1}$
A	1.4×10^{-11}	-2.8×10^{-10}
B	1.4×10^{-11}	0
C	2.0×10^{-11}	-2.8×10^{-10}
D	2.0×10^{-11}	0

- 8 A satellite orbits a planet at a distance r from its centre. Its kinetic energy is 3.2 MJ.

Another identical satellite orbits the planet at a distance $2r$ from its centre.

What is the gravitational potential energy of this second satellite?

- A** -0.80 MJ **B** -1.6 MJ **C** -3.2 MJ **D** -6.4 MJ

- 9 An isolated container is divided into two sections of equal volumes by a partition. The ideal gas in each section has the same pressure P .

What is the final pressure after the partition is removed?

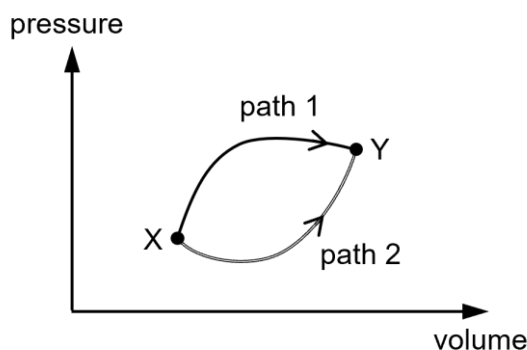
- A $\frac{1}{2}P$ B P C $\frac{3}{2}P$ D $2P$

- 10 A fixed volume container contains a mixture of two monatomic gases X and Y at the same temperature. The mass of the molecules of X is twice that of molecules of Y.

What is the ratio $\frac{\text{root mean square speed of molecules of X}}{\text{root mean square speed of molecules of Y}}$?

- A 0.50 B 0.71 C 1.4 D 2.0

- 11 A fixed mass of gas undergoes a change from state X to Y via two different paths as shown.



In path 1, 4.0 J of work is done by the gas and there is a thermal transfer of 10 J of energy into it.

In path 2, 2.0 J of work is done by the gas.

What is the thermal transfer of energy into the gas in path 2?

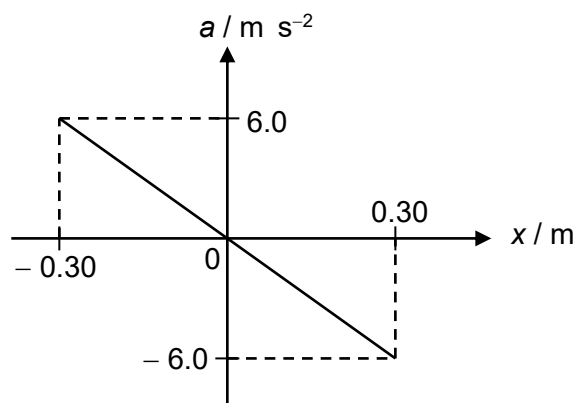
- A 4.0 J B 8.0 J C 12 J D 16 J

[Turn over]

- 12 An object is displaced from its equilibrium position and the oscillating system undergoes heavy damping.

Which of the following is true for the system?

- A** The object does not return to its equilibrium position for a very long time.
B The object oscillates with its amplitude decreasing exponentially with time.
C The object oscillates with its amplitude varying linearly with time.
D The object returns to its equilibrium position in the shortest possible time.
- 13 A particle moves such that its acceleration a is related to its displacement x from a fixed point as shown below.



What is its angular frequency?

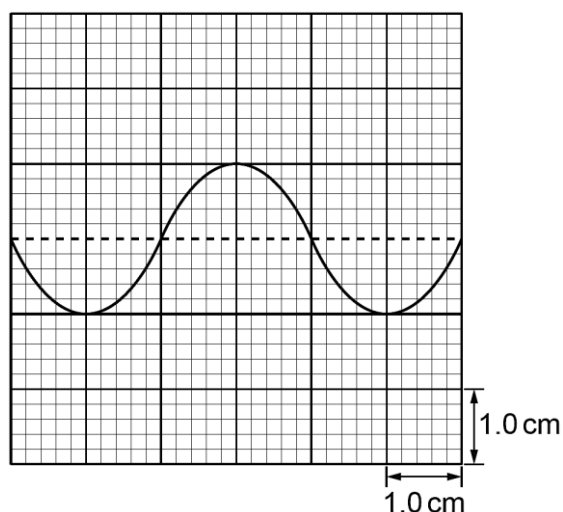
- A** 0.050 rad s^{-1}
B 1.8 rad s^{-1}
C 4.5 rad s^{-1}
D 20 rad s^{-1}
- 14 A progressive longitudinal sound wave moves through air. P, Q, R, S and T are the positions of the air particles along part of the wave at one instant.



Which pair of particles has a phase difference of π rad?

- A** P and S **B** P and T **C** Q and R **D** R and S

- 15** A microphone and a cathode-ray oscilloscope (CRO) are used to analyse a sound wave. The trace is displayed on the screen of the CRO as shown.



The speed of sound is 330 m s^{-1} and the CRO has a time-base setting of $4.0 \times 10^{-5} \text{ s cm}^{-1}$.

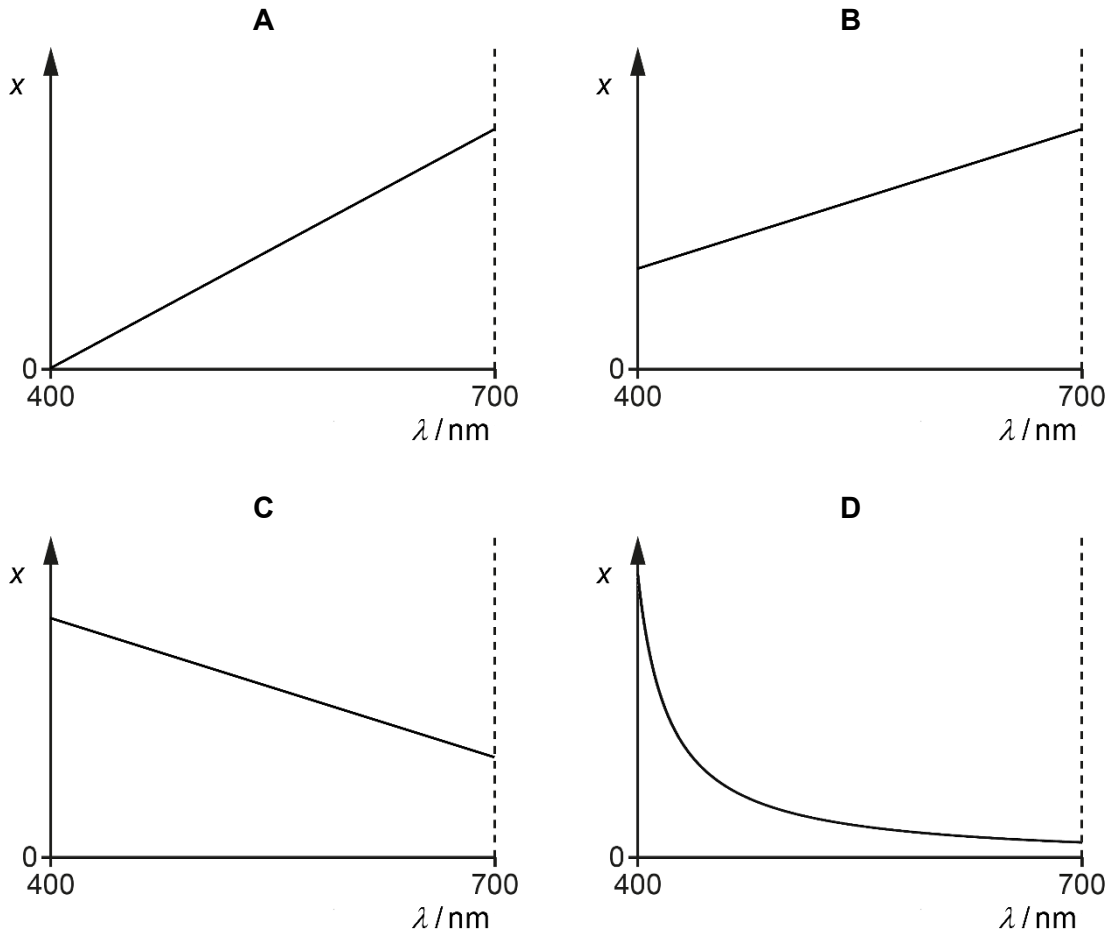
What is the wavelength of the sound wave?

- A** 1.3 cm **B** 2.6 cm **C** 4.0 cm **D** 5.3 cm

[Turn over]

- 16 The wavelength λ of light incident normally on a double slit is varied from 400 nm to 700 nm. This causes a variation in the distance x between the centres of two adjacent bright fringes on the screen.

Which graph shows the variation of x with λ ?

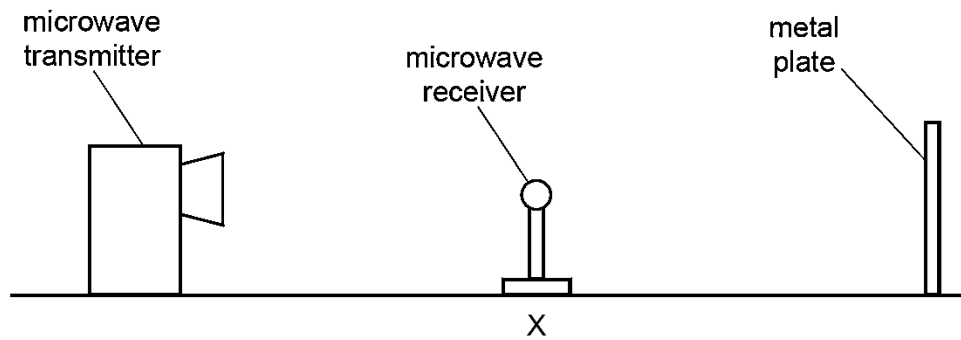


- 17 The diameter of the receiving dish of a telescope is 5.1 m. It receives light of wavelength $0.40 \mu\text{m}$ from two point sources at a distance of $2.8 \times 10^{25} \text{ m}$ away.

What is the minimum separation of the two points sources so that the light from them can be resolved?

- A $1.1 \times 10^{18} \text{ m}$
- B $2.2 \times 10^{18} \text{ m}$
- C $1.8 \times 10^{32} \text{ m}$
- D $3.6 \times 10^{32} \text{ m}$

- 18 A transmitter produces microwaves that travel in air towards a metal plate as shown.



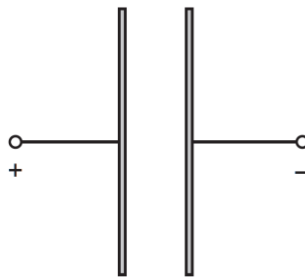
The microwaves have a wavelength of 12.0 cm.

A microwave receiver is initially placed at position X where it detects an intensity maximum. The receiver is then slowly moved away from X directly towards the plate.

What is the number of intensity minima that are detected by the receiver as it moves from X to a position that is 33.5 cm away from X?

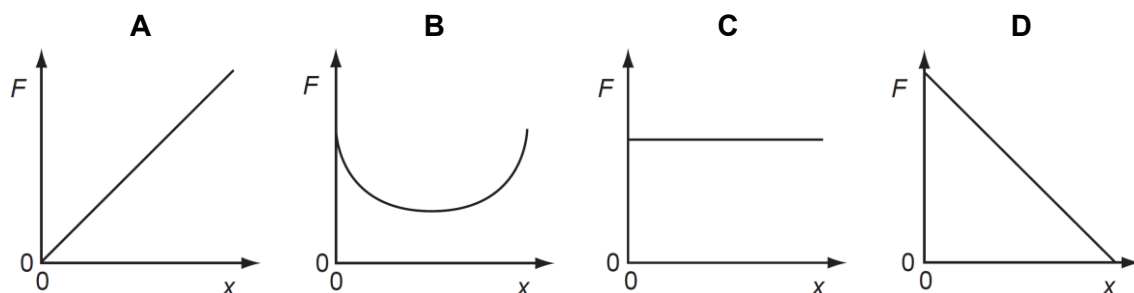
- A** 2 **B** 3 **C** 5 **D** 6

- 19 Two oppositely-charged parallel plates are arranged as shown.



An α -particle is released from rest from the surface of the positively-charged plate.

Which graph shows how the force F on the α -particle varies with its distance x from the positive plate?



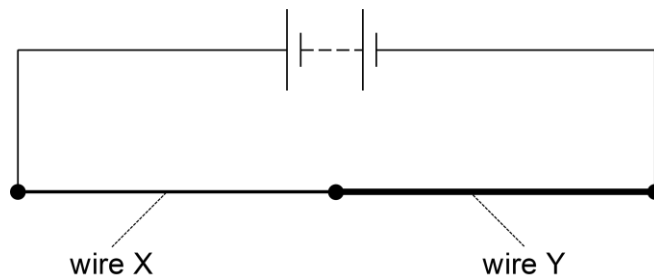
[Turn over]

- 20** A charged object sets up an electric and gravitational field.

What is a similarity between the electric potential and the gravitational potential produced by the object?

- A** Both potentials are equal to the work done by an external force.
 - B** Both potentials are inversely proportional to the square of the distance from the centre of the object.
 - C** Both potentials are negative.
 - D** Both potentials change when moving along a field line.
- 21** Two wires, X and Y, are made from the same metal. The diameter of wire Y is twice that of wire X.

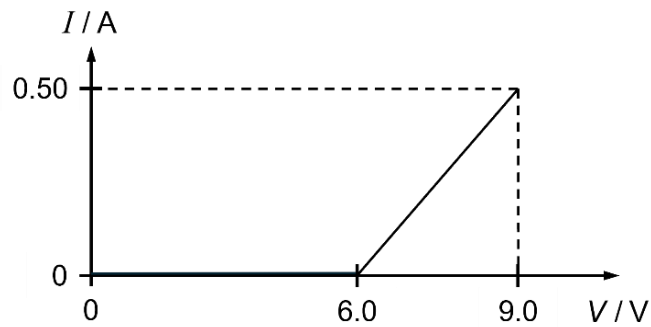
Both wires are connected in series to a battery as shown.



What is the ratio $\frac{\text{average drift speed of free electrons in wire Y}}{\text{average drift speed of free electrons in wire X}}$?

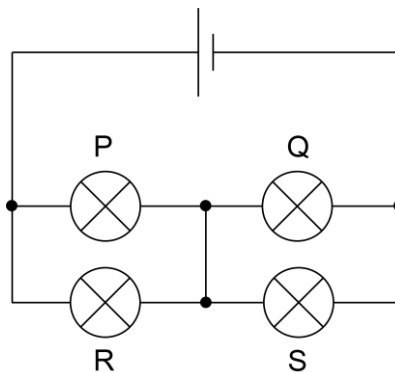
- A** 0.25
- B** 0.50
- C** 2.0
- D** 4.0

- 22 The graph shows the variation with potential difference V of the current I in an electrical component.



Which statement about the electrical component is correct?

- A The resistance decreases at voltages from 6.0 V to 9.0 V.
 - B The resistance is $0.056 \, \Omega$ at a voltage of 9.0 V.
 - C The resistance is $6.0 \, \Omega$ at a voltage of 9.0 V.
 - D The resistance is zero at voltages between 0 and 6.0 V.
- 23 A cell is connected to four identical lamps as shown.

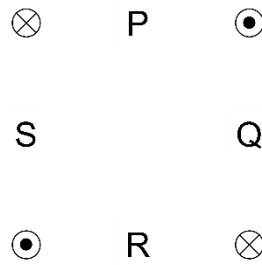


What happens when lamp Q is blown out?

- A Lamp P becomes brighter than before.
- B Lamp S becomes brighter than before.
- C Lamp S does not light up.
- D Lamps P and R remain as bright as before.

[Turn over]

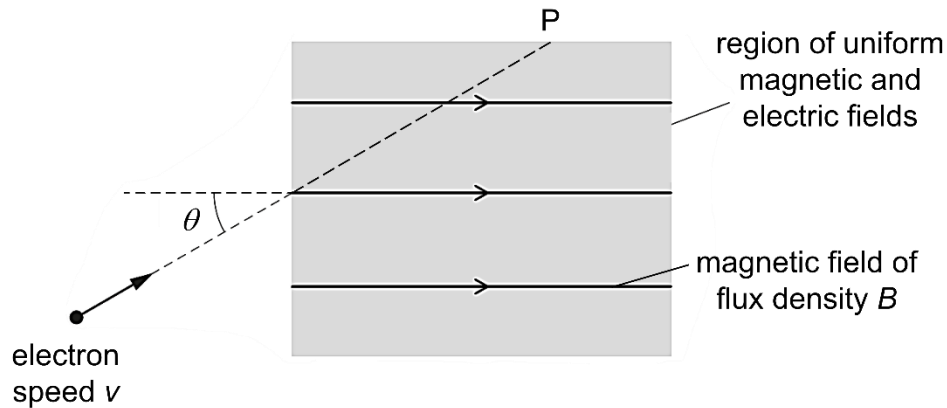
- 24** Four long, straight wires carrying equal current with directions as shown, are placed at the corners of a square. The positions P, Q, R and S are the mid-points of the lines joining the wires.



Which statement correctly describes the directions of the resultant magnetic field at the positions P, Q, R and S?

- A** Different at all four positions.
- B** P is the same as at Q, R is the same as at S but opposite to the directions at P and at Q.
- C** P is the same as at R, Q is the same as at S but opposite to the directions at P and at R.
- D** The same at all four positions.

- 25** An electron is travelling in a vacuum at speed v . The electron enters a region of uniform magnetic field of flux density B . A uniform electric field also exists in the region so that the electron remains undeflected and exits the region at point P as shown.

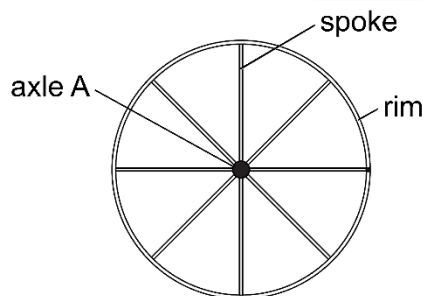


The initial direction of the electron is at an angle of θ to the direction of the magnetic field.

What is the magnitude and direction of the electric field?

	magnitude	direction
A	$B \sin \theta$	into the page
B	$B \sin \theta$	out of the page
C	$Bv \sin \theta$	into the page
D	$Bv \sin \theta$	out of the page

- 26** A metal wheel consists of an axle A, eight spokes and a rim as shown.



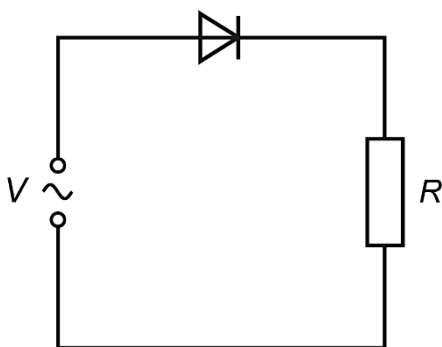
The rim has a radius of 0.65 m and the wheel rotates with an angular speed of 120 rad s^{-1} . There is a uniform magnetic field of flux density 0.23 T perpendicular to the plane of the page.

What is the magnitude of the e.m.f. induced across each spoke?

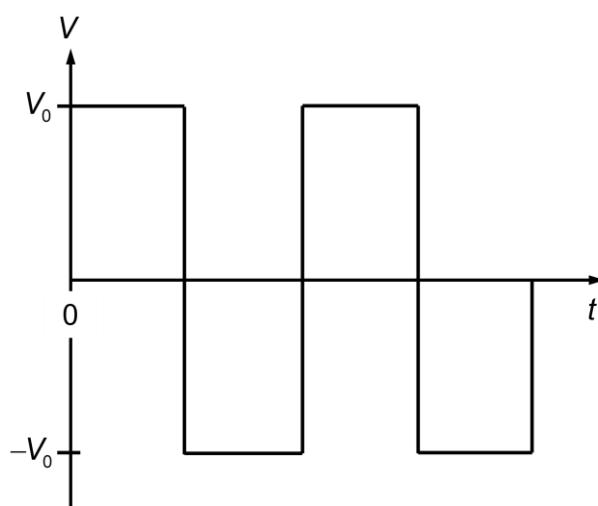
- A** 2.9 V **B** 5.8 V **C** 12 V **D** 18 V

[Turn over]

- 27** An alternating square wave power supply V is connected to a resistor of resistance R and a diode in the circuit as shown.



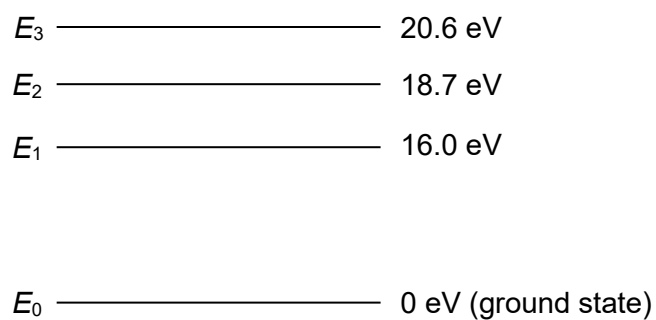
The variation of V with time t is shown in the graph.



What is the mean power dissipated in the resistor?

- A** $\frac{V_0^2}{4R}$ **B** $\frac{V_0^2}{2R}$ **C** $\frac{V_0^2}{\sqrt{2}R}$ **D** $\frac{V_0^2}{R}$

28 Some electron energy levels for a mixture of gas are shown in the diagram.

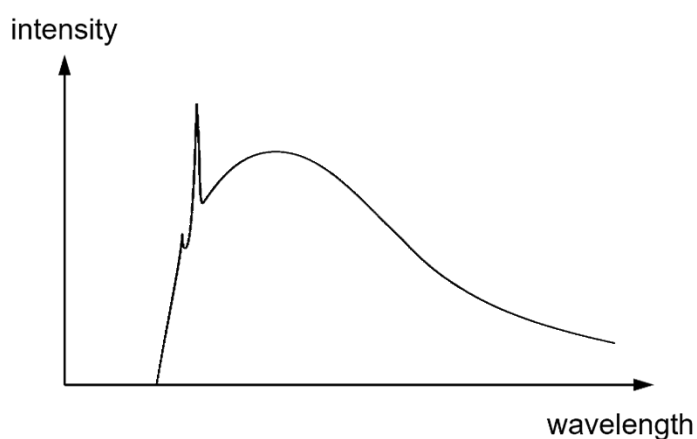


Which transition will result in the emission of light of wavelength 650 nm?

- A $E_2 \rightarrow E_1$
- B $E_3 \rightarrow E_0$
- C $E_3 \rightarrow E_1$
- D $E_3 \rightarrow E_2$

[Turn over]

- 29 The diagram shows an X-ray spectrum produced when electrons strike a heavy metal target.



The potential difference through which electrons are accelerated from rest is now increased.

Which row describes the change in the spectrum?

	minimum X-ray wavelength	wavelengths of characteristic spectra
A	decreases	decreases
B	decreases	no change
C	increases	decreases
D	increases	no change

- 30 Which observation shows that a radioactive source emits **only** α -radiation?

- A** The count rate reduces significantly 1 cm away from the source in air.
- B** The count rate reduces significantly when the source is surrounded by a lead block.
- C** The radiation beam is deflected by an electric field perpendicular to it.
- D** The radiation beam remains undeflected by a magnetic field parallel to it.

End of Paper