H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

| | | | |
|---|---|---|---|
| CANDIDATE NAME | | | |
| CLASS | | TUTOR'S NAME | |
| CENTRE NUMBER | S | INDEX NUMBER | |

# PHYSICS 9749/01

Paper 1 Multiple Choice **24 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, class, Centre number and index number in the spaces at the top of this page.

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

This document consists of **13** printed pages.

**Data**

| | |
|---|---|
| speed of light in free space | $c = 3.00 \times 10^8$ m s$^{-1}$ |
| permeability of free space | $\mu_0 = 4\pi \times 10^{-7}$ H m$^{-1}$ |
| permittivity of free space | $\varepsilon_0 = 8.85 \times 10^{-12}$ F m$^{-1}$ |
| | $(1 / (36\pi)) \times 10^{-9}$ F m$^{-1}$ |
| elementary charge | $e = 1.60 \times 10^{-19}$ C |
| the Planck constant | $h = 6.63 \times 10^{-34}$ J s |
| unified atomic mass constant | $u = 1.66 \times 10^{-27}$ kg |
| rest mass of electron | $m_e = 9.11 \times 10^{-31}$ kg |
| rest mass of proton | $m_p = 1.67 \times 10^{-27}$ kg |
| molar gas constant | $R = 8.31$ J K$^{-1}$ mol$^{-1}$ |
| the Avogadro constant | $N_A = 6.02 \times 10^{23}$ mol$^{-1}$ |
| the Boltzmann constant | $k = 1.38 \times 10^{-23}$ J K$^{-1}$ |
| gravitational constant | $G = 6.67 \times 10^{-11}$ 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 | $T / \mathrm{K} = T / ^\circ\mathrm{C} + 273.15$ |
| pressure of an ideal gas | $p = \frac{1}{3}\frac{Nm}{V} < c^2 >$ |
| mean translational kinetic energy of an ideal 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 | $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ |

**1** A single sheet of aluminium foil is folded twice to produce a stack of four sheets. The total thickness of the stack of sheets is measured to be $(0.80 \pm 0.02)$ mm. This measurement is made using a digital calliper with zero error of $(-0.20 \pm 0.02)$ mm.

What is the percentage uncertainty in the calculated thickness of a single sheet?

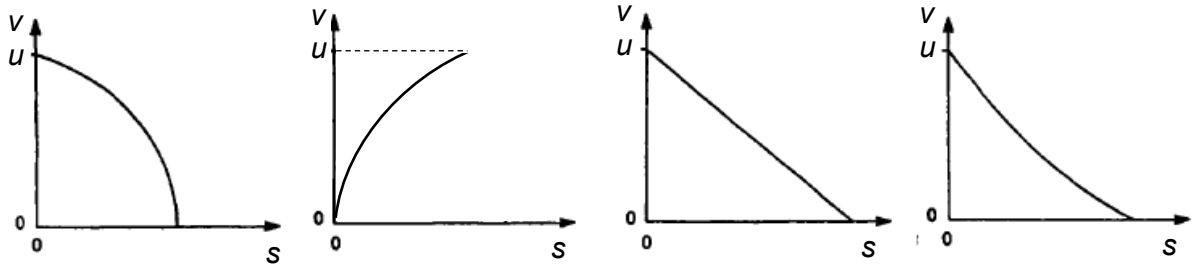
**A** 1.0% **B** 2.0% **C** 4.0% **D** 6.7%

**2** A voltmeter connected across a resistor in a circuit gives readings which have high precision but low accuracy.

Which of the following best describes the likely error in readings taken with this voltmeter?

| | random error | systematic error |
|---|---|---|
| **A** | high | high |
| **B** | high | low |
| **C** | low | high |
| **D** | low | low |

**3** A stone falls vertically and strikes soft ground with speed $u$. The stone experiences constant deceleration until it comes to rest. Which graph shows the variation of speed $v$ with distance $s$ below the ground surface?




**A** **B** **C** **D**

**4** A particle X with kinetic energy $E_k$ collides with a stationary particle Y. Both particles have the same mass.

After colliding, X and Y travel together as a single particle.

How much kinetic energy is lost in the collision?

**A** zero **B** $\frac{E_k}{4}$ **C** $\frac{E_k}{2}$ **D** $\frac{3E_k}{4}$

**5** A sphere of mass 3.0 kg travelling due North at 2.0 m $s^{-1}$ collides with another sphere of mass 4.0 kg travelling due East at 2.0 m $s^{-1}$.

The magnitude of their resultant momentum after the collision will be

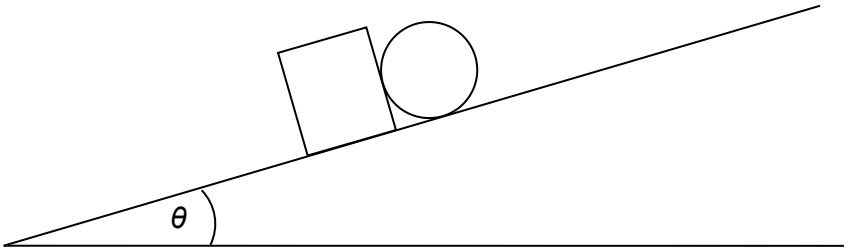
**A** 2.0 kg $ms^{-1}$.

**B** 10 kg m $s^{-1}$.

**C** 14 kg m $s^{-1}$.

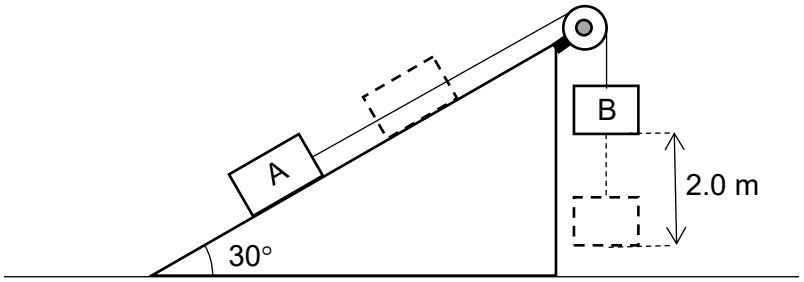
**D** dependent on whether the the collision is elastic or inelastic.

**6** A block and a sphere of equal mass *m* are placed on an inclined plane. If the maximum frictional force that can exist between the block and the plane is equal to the weight of the block, and there is no frictional force between the sphere and the plane, what is the maximum angle $\theta$ at which the plane can be inclined before the block starts to slip?




**A** 30° **B** 45° **C** 60° **D** 73°

**7** Blocks A and B, of masses 4.0 kg and 6.0 kg respectively, are connected by a light cord passing over a light, frictionless pulley. Block A is held at rest on a rough slope inclined at 30° to the horizontal as shown.




When A and B are released, block A experiences a constant frictional force of 3.0 N.

What is the total kinetic energy of A and B when B has travelled 2.0 m downwards?

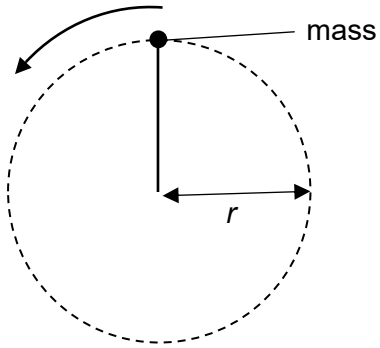
**A** 39 J **B** 72 J **C** 78 J **D** 118 J

**8** A wire is stretched elastically by a force of 200 N, causing an extension of 2.00 mm. The force is gradually increased to 250 N, and the wire remains within its elastic limit.

What is the work done in stretching the wire from 200 N to 250 N?

**A** 0.113 J **B** 0.225 J **C** 113 J **D** 225 J

**9** A small mass is attached to a light string and rotates in a vertical circle of radius *r*.




Taking *g* to be acceleration of free fall, what is the centripetal acceleration of the mass when it is at the lowest point of motion if the speed of the mass at the highest point just allow the mass to complete the circular motion?

**A** $g$ **B** $2g$ **C** $4g$ **D** $5g$

**10** Two satellites P and Q orbit the Earth due to the gravitational field of the Earth. P and Q are at distances $R$ and $3R$ from the Earth's surface respectively, where $R$ is the radius of the earth. The speed of P is $v$.

What is the speed of Q?

**A** $\sqrt{\frac{1}{3}}\,v$ **B** $\sqrt{\frac{1}{2}}\,v$ **C** $\sqrt{2}\,v$ **D** $\sqrt{3}\,v$

**11** Mars has a diameter that is approximately 0.5 times the diameter of the Earth, and the mass of Mars is 0.1 times the mass of the Earth.

Given that the gravitational potential at the Earth's surface is –63 MJ kg$^{-1}$.

What is an approximate value for the gravitational potential at the surface of Mars?

**A** –13 MJ kg$^{-1}$ **B** –25 MJ kg$^{-1}$ **C** –95 MJ kg$^{-1}$ **D** –320 MJ kg$^{-1}$

**12** Container X contains neon and container Y contains argon. The two containers are identical, and the two gases are at the same temperature. The pressure in X is twice that in Y.

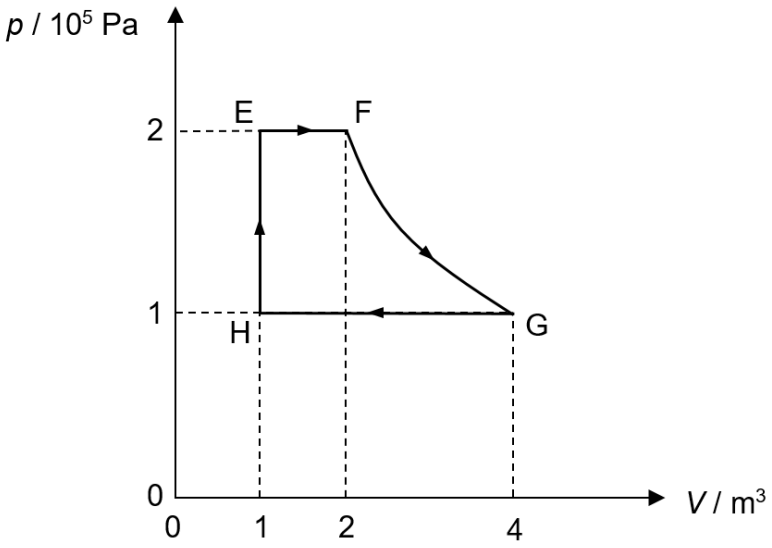
What is the ratio of the mean kinetic energy of a neon molecule to the mean kinetic energy of an argon molecule?
[The relative atomic masses of neon and argon are 20 and 40 respectively.]

**A** 0.5 **B** 1 **C** 2 **D** 4

**13** The density of helium at 150 kPa is 0.178 kg $m^{-3}$. What is the root-mean-square speed of its particles?

**A** 130 m $s^{-1}$ **B** 232 m $s^{-1}$ **C** 1300 m $s^{-1}$ **D** 1600 m $s^{-1}$

**14** An ideal gas goes through the thermodynamic cycle EFGHE as shown.




Which of the following statements is correct?

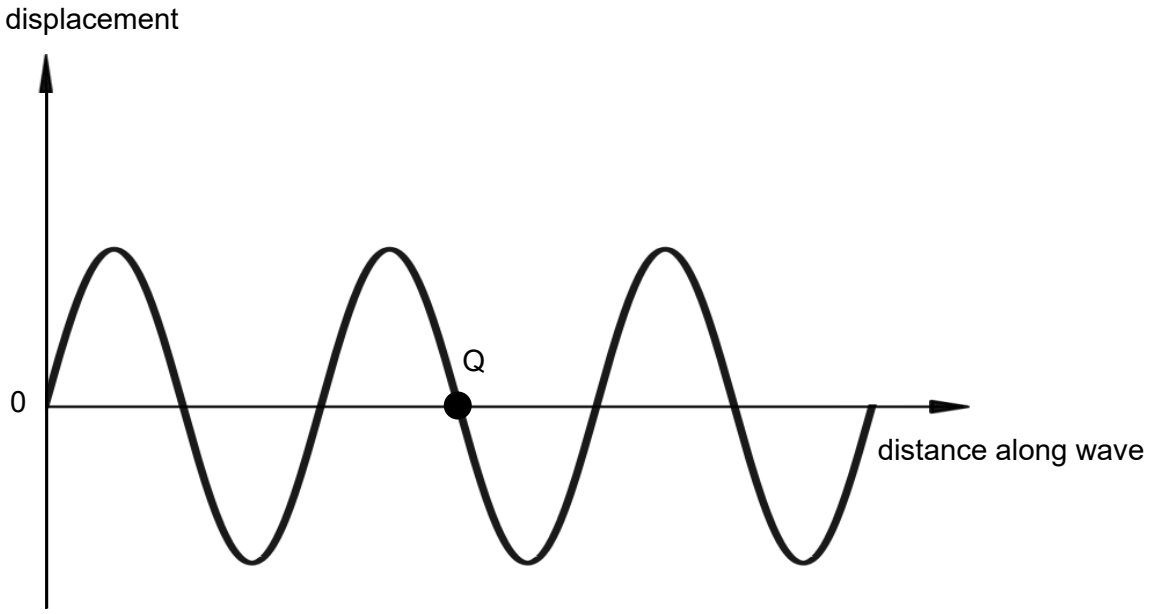
**A** After completing one cycle, there is net heat lost by the gas.

**B** During process FG, there is no change in the internal energy of the gas.

**C** During process HE, the gas loses heat.

**D** The work done by the gas during process EF is equal in magnitude to the work done on the gas during process GH.

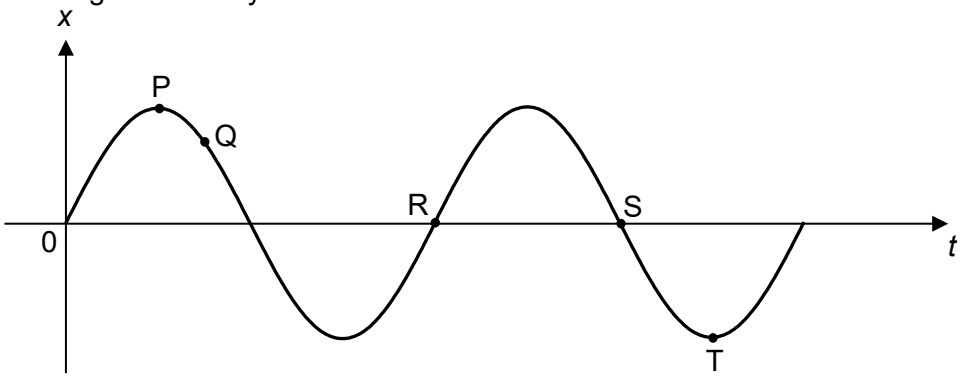
**15** This diagram shows the displacement-distance graph of a transverse wave at time, $t = 0$. Taking upwards as positive, point Q is a point on the wave and is travelling downwards at $t = 0$. Another point P is $\frac{7}{8}$ of a wavelength from point Q.




Which of the following descriptions shows a possible displacement and direction of velocity of point P?

| | displacement | direction of velocity |
|---|---|---|
| **A** | positive | positive |
| **B** | positive | 0 |
| **C** | 0 | negative |
| **D** | negative | negative |

**16** The graph below shows the variation with time *t* of the displacement *x* of a simple harmonic oscillator oscillating horizontally.




Which statement is correct?

**A** The phase difference between P and S is $\frac{\pi}{2}$ rad.

**B** The acceleration at T is zero.

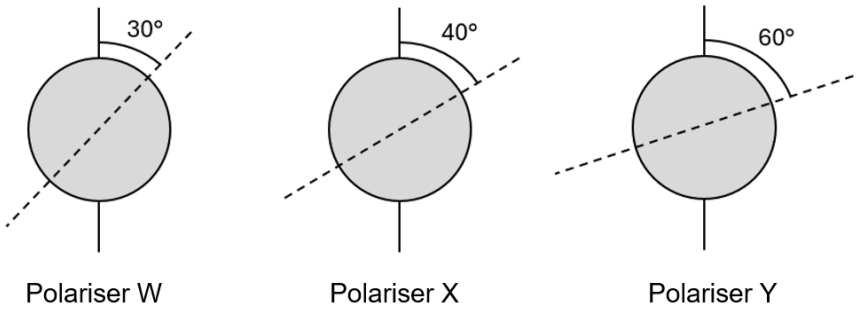
**C** The potential energy of the oscillator is larger at Q compared to T.

**D** The kinetic energy of the oscillator is larger at Q compared to R.

**17** The diagram below shows three polarisers W, X and Y.

A beam of unpolarised light of intensity $I_0$ is incident normally onto the surface of polariser W, which then passes through polariser X and eventually emerges from polariser Y.

The axis of polarisation of each polariser is indicated by a dashed line.




What is the intensity of the light that emerges from polariser Y?

**A** $0.11 I_0$ **B** $0.32 I_0$ **C** $0.43 I_0$ **D** $0.64 I_0$

**18** A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open and flared, as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The fundamental frequency of sound that the instrument can produce is 80 Hz.

Which different frequencies of sound can be produced by the instrument?

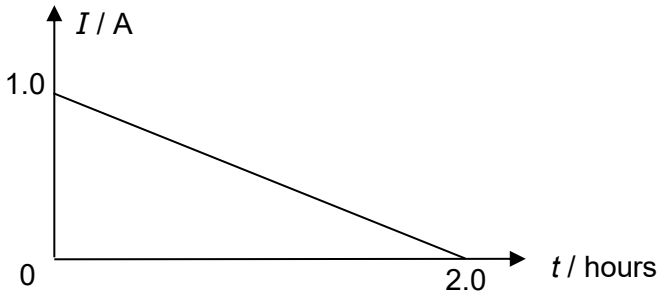
**A** 160 Hz, 240 Hz, 320 Hz

**B** 160 Hz, 320 Hz, 640 Hz

**C** 240 Hz, 400 Hz, 720 Hz

**D** 240 Hz, 320 Hz, 480 Hz

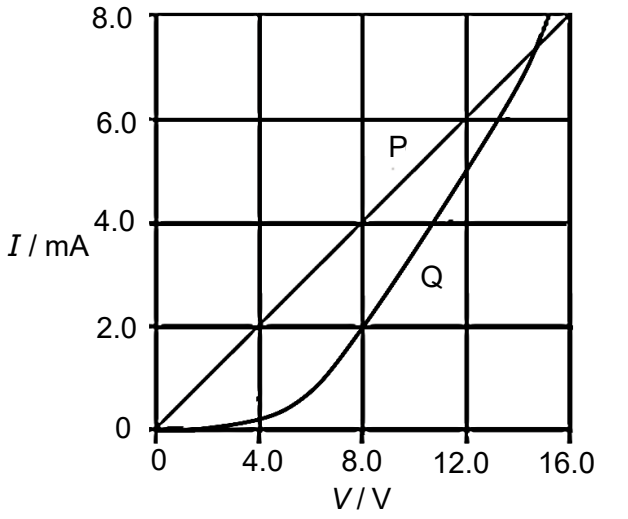
**19** A portable fan battery is charged by connecting it to a constant potential difference of 6.0 V. The variation with time $t$ of the current $I$ through the battery is as shown.




What is the energy transferred to the battery during the time of 2.0 hours shown in the graph?

**A** 360 J **B** 720 J **C** 22 000 J **D** 43 000 J

**20** The $I$-$V$ characteristics of two electrical components P and Q are shown below.




Which of the following statements is correct?

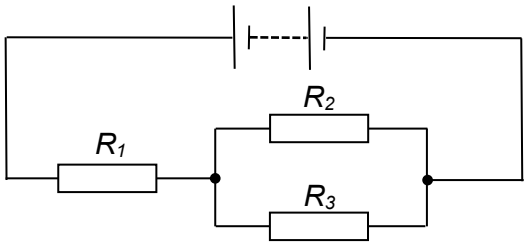
**A** P is an ohmic conductor and Q is a filament.

**B** Resistance of Q is always larger than resistance of P.

**C** At 2.0 mA, the power dissipated through Q is twice that of P.

**D** At the point where the two lines intersect the resistance of Q is approximately twice that of P.

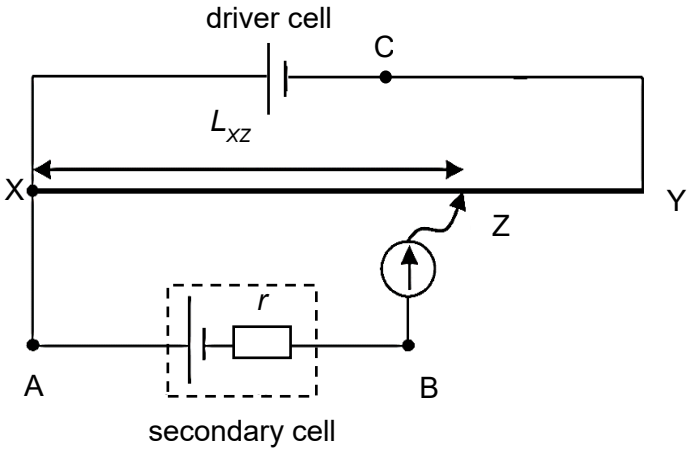
**21** The diagram shows a network of three identical resistors connected to a battery of negligible internal resistance.




What is the ratio of $\frac{\text{power dissipated in } R_1}{\text{power dissipated in } R_2}$ ?

**A** 1 **B** 2 **C** 4 **D** 9

**22** A typical potentiometer circuit is shown.




Which of the following does **not** increase the balance length $L_{XZ}$?

**A** decreasing the e.m.f. of the driver cell.

**B** increasing the e.m.f. of the secondary cell.

**C** adding a fixed resistor in series with the driver cell at point C.

**D** decreasing the internal resistance of the secondary cell.

**23** In the direction opposite of an electric field line, which of the following must be true?

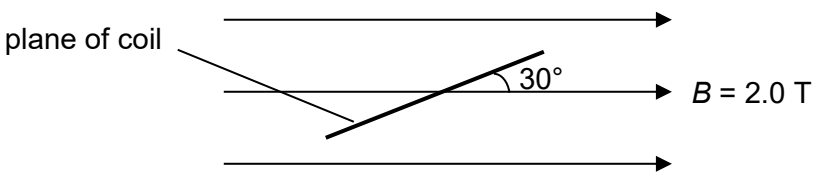
**A** The potential must decrease.

**B** The potential must increase.

**C** The electric field strength must decrease.

**D** The electric field strength must increase.

**24** A square coil of 10 turns with sides of 5.0 cm is placed so that the plane of the coil makes an angle of 30° with the direction of a uniform magnetic field $B$ of flux density 2.0 T. A current of 15 A is passed through the coil.




What is the magnitude of the torque acting on the square coil?

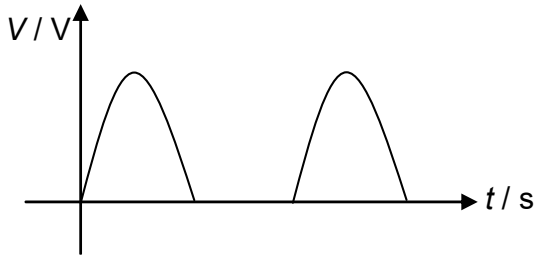
**A** 0.19 N m **B** 0.33 N m **C** 0.38 N m **D** 0.65 N m

**25** A flat circular coil of 120 turns, each of area 0.070 $m^2$, is placed with its axis parallel to a uniform magnetic field. The flux density of the field is changed steadily from 80 mT to 20 mT over a period of 4.0 s.

What is the e.m.f. induced in the coil during this time?

**A** 0 mV **B** 1.1 mV **C** 130 mV **D** 500 mV

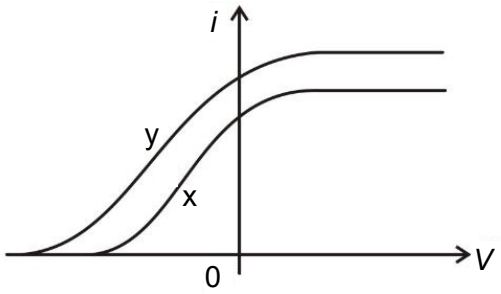
**26** The figure belows shows a varying voltage.




The r.m.s. value of this rectified voltage is 100 V. The peak voltage is

**A** 50 V **B** 71 V **C** 141 V **D** 200 V

**27** The figure shows the variation of the photoelectric current $i$ with voltage $V$ between the electrodes in a photocell for two different radiations, x and y.




The intensity and the frequency of radiation x are $I_x$ and $f_x$ while the intensity and the frequency of radiation y are $I_y$ and $f_y$. Which of the following shows the relationship between the intensities and frequencies of x and y?

**A** $I_x > I_y$ , $f_x > f_y$ **B** $I_x > I_y$ , $f_x < f_y$

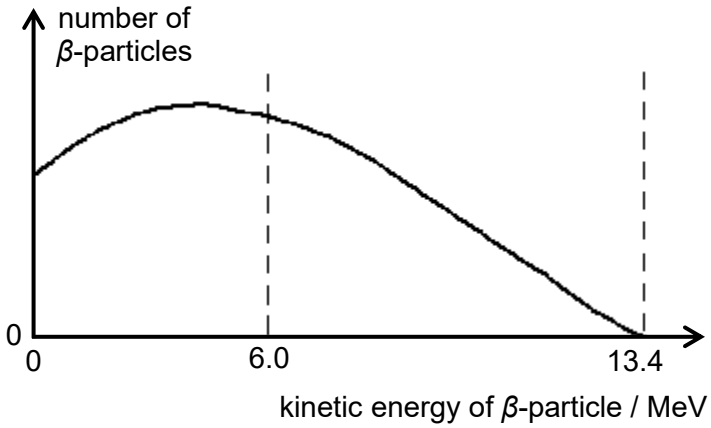
**C** $I_x < I_y$ , $f_x > f_y$ **D** $I_x < I_y$ , $f_x < f_y$

**28** An electron of mass $m$ and charge $e$ is accelerated from rest through an electric field of potential difference $V$.

What is the frequency of a photon whose wavelength is equal to the de Broglie wavelength of this electron?

**A** $\frac{c\sqrt{2meV}}{h}$ **B** $\frac{h}{\sqrt{2meV}}$ **C** $\frac{hc}{eV}$ **D** $\frac{eV}{h}$

**29** The beta spectrum for $^{12}B$ decay is as shown below.




The kinetic energy of an emitted $\beta$-particle is 6.0 MeV. What is the approximate energy of the associated neutrino?

**A** 4.0 MeV **B** 6.0 MeV **C** 7.4 MeV **D** 13.4 MeV

**30** A radioactive source in the laboratory has a half-life of 10 days. The count rate was measured to be 100 Bq initially. 20 days later, the count rate was found to be 34 Bq. What is the count rate in the laboratory without the source?

**A** 9 **B** 12 **C** 17 **D** 22

**End of Paper**