RAFFLES INSTITUTION
PRELIMINARY EXAMINATION 2025
Higher 2

CANDIDATE NAME		CLASS INDEX NUMBER	

CLASS	2	5	S	0		

PHYSICS 9749/01

Paper 1 Multiple Choice **25 September 2025**

1 hour

You must answer on the multiple choice answer sheet

You will need: Multiple choice answer paper
Soft clean eraser
Soft pencil (type 2B is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, class and index number on the multiple choice answer sheet in the spaces provided.
- Do **not** use correction fluid or tape.
- You may use an approved calculator.

INFORMATION

- The total mark for this paper is 30.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	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}

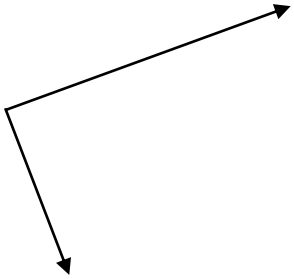
Formulae

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	=	ρgh
gravitational potential	ϕ	=	$-Gm/r$
temperature	T / K	=	T / °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	=	$x_0 \sin \omega t$
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	λ	=	$\ln 2 / t_{1/2}$

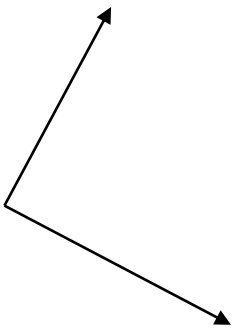
1 The arrow represents a vector R.

Which diagram does **not** represent R as two perpendicular components?

A



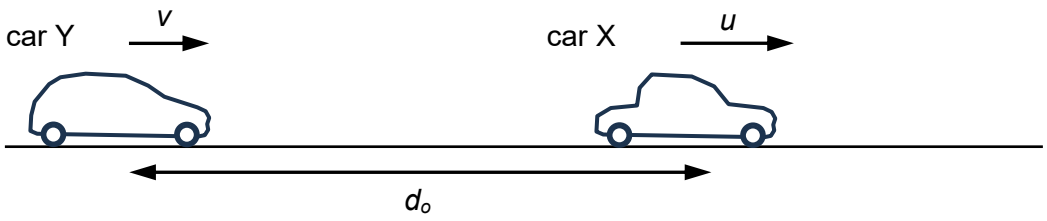
B



C

D

2 A car X travels at constant speed u along a straight road. At time $t = 0$, a second car Y is a distance d_0 behind car X and travels at a speed v in the same direction. Speed v is less than speed u.

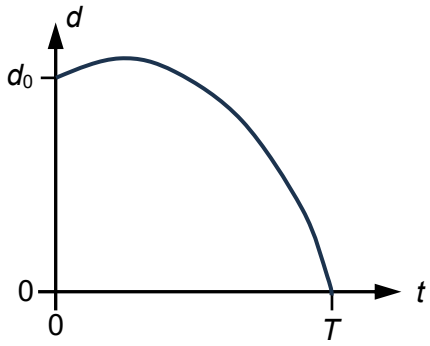


At time $t = 0$, car Y begins to accelerate with constant acceleration.

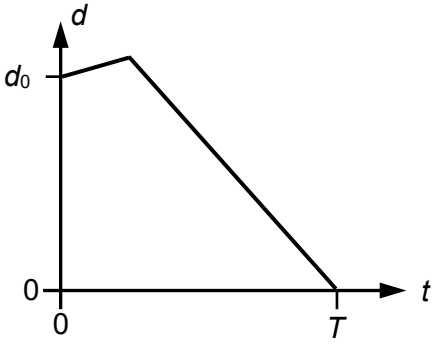
Car Y overtakes car X at time $t = T$.

Which graph best shows the variation with time t of the distance d between the cars?

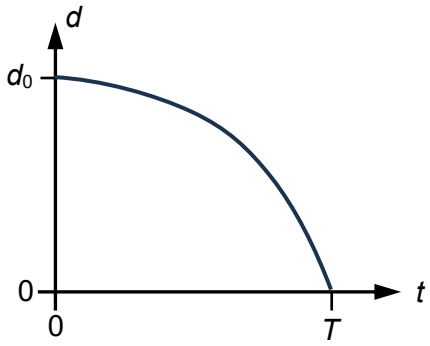
A



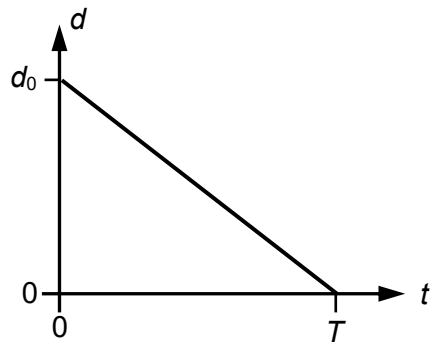
B



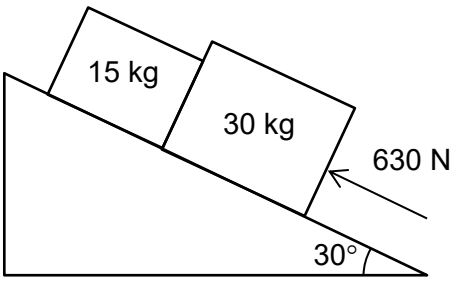
C



D



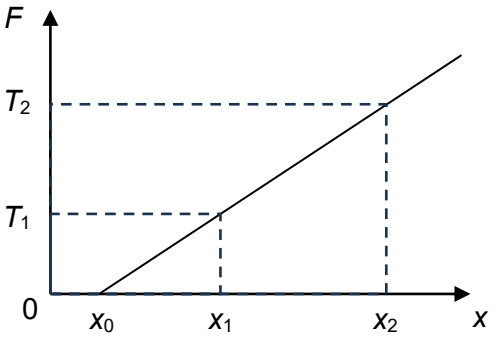
3 Two crates, of masses 15 kg and 30 kg, are in contact and placed on a frictionless incline that makes an angle of 30° to the horizontal. A constant force of 630 N parallel to the surface of the incline is applied to the 30 kg crate.



What is the force that each crate exerts on the other?

A 63 N **B** 140 N **C** 210 N **D** 420 N

4 The force F required to extend a spring of unstretched length x_0 to a length x is measured. When the tension in the spring is T_1, the length of the spring is x_1. When the tension in the spring is T_2, the length of the spring is x_2.



What is the work done to stretch the spring from length x_1 to length x_2?

A $\frac{1}{2}(T_2)(x_2 - x_0)$

B $\frac{1}{2}(T_1 + T_2)(x_2 - x_1)$

C $\frac{1}{2}(T_1 + T_2)(x_2 + x_1 - 2x_0)$

D $\frac{1}{2}(T_1 + T_2)(x_2 - x_1 - 2x_0)$

5 Which statement is correct?

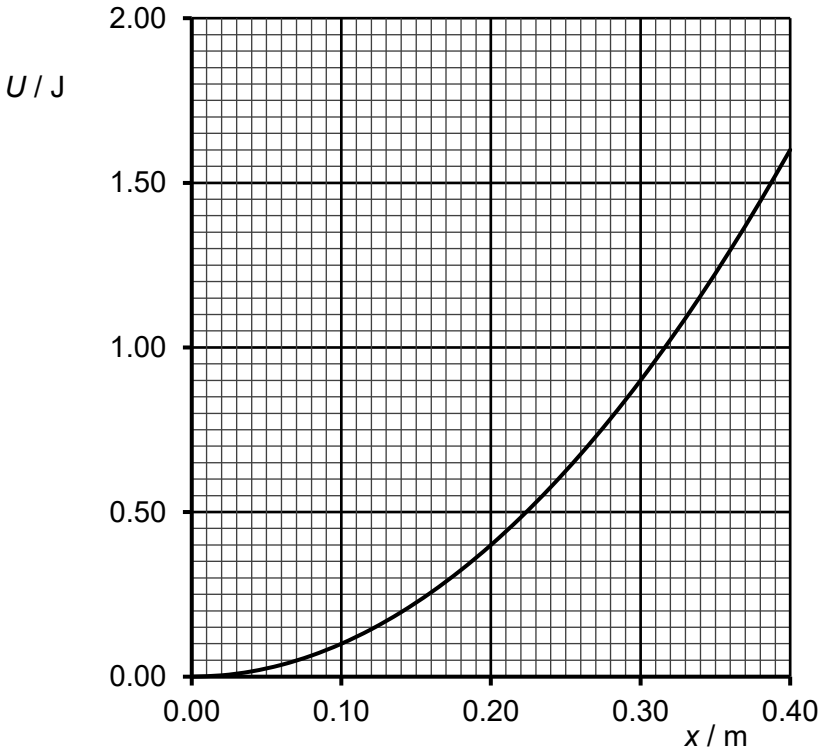
A An object with only a couple acting on it is in translational equilibrium.

B An object with only a couple acting on it is in equilibrium.

C The direction of the torque of a couple depends on where the pivot is.

D A couple is an action-reaction pair of forces.

6 The variation with displacement x of the potential energy U of a body is shown.



What is the magnitude of the force acting on the body at x = 0.30 m?

A 0.090 N **B** 0.17 N **C** 3.0 N **D** 6.0 N

7 A driving force of 250 N is needed for a car of mass 900 kg to travel along a level road at a constant speed of 24 m s^{-1}.

What power is required to maintain the car at this speed when it is moving up a slope that rises 1.0 m for every 12 m of travel along the road?

A 6.8 kW **B** 12 kW **C** 18 kW **D** 24 kW

8 A ball of mass 0.10 kg is attached to a string and swung in a vertical circle of radius 0.50 m. The speed of the ball at the top of the circle is 6.0 m s^{-1}.

What is the tension in the string at this instant?

A 0.98 N **B** 6.2 N **C** 7.2 N **D** 8.2 N

9 A spherical body of radius r has uniform density ρ.

What is the gravitational potential on its surface?

A $-4\pi G\rho r^2$ **B** $-\frac{4}{3}\pi G\rho r^2$ **C** $-\frac{4}{3}\pi G\rho r$ **D** $\frac{4}{3}\pi G\rho r^2$

10 Two planets X and Y travel anticlockwise in circular orbits about a star. The radii of their orbits are in the ratio 3:1.

Diagram 1 shows the positions of X and Y at time $t = 0$. They are aligned such that they make a straight line with the star.

Diagram 2 shows the position of X at a later time $t = t_1$. The angular displacement of planet X is 90° from its initial position.

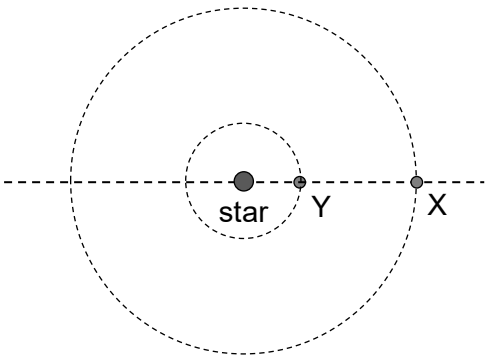


diagram 1

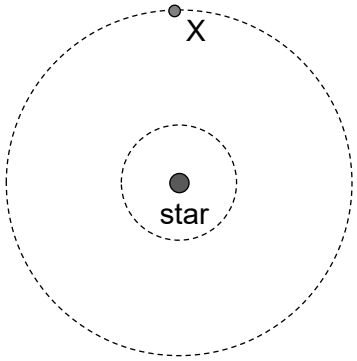
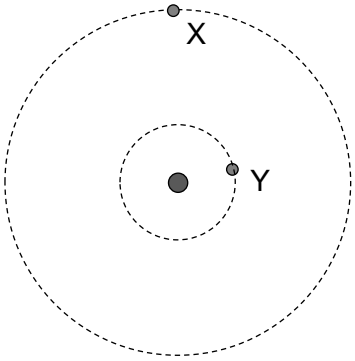


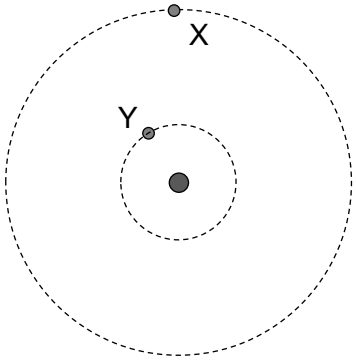
diagram 2

Which diagram shows the position of planet Y at time $t = t_1$?

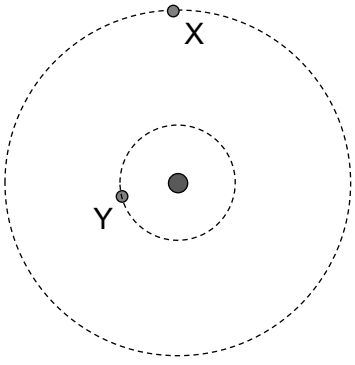
A



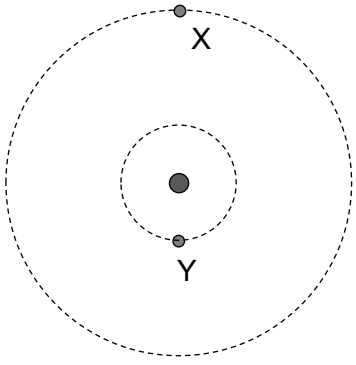
B



C



D



11 A particle oscillating horizontally with simple harmonic motion has a displacement given by the equation:

$$x = 3.0 \sin(20t),$$

where x is the displacement in metres and t is the time in seconds.

What is the displacement of the particle when the kinetic energy of the particle is equal to the potential energy?

A 0 m **B** 1.5 m **C** 2.1 m **D** 3.0 m

12 Which of the following is an example of resonance?

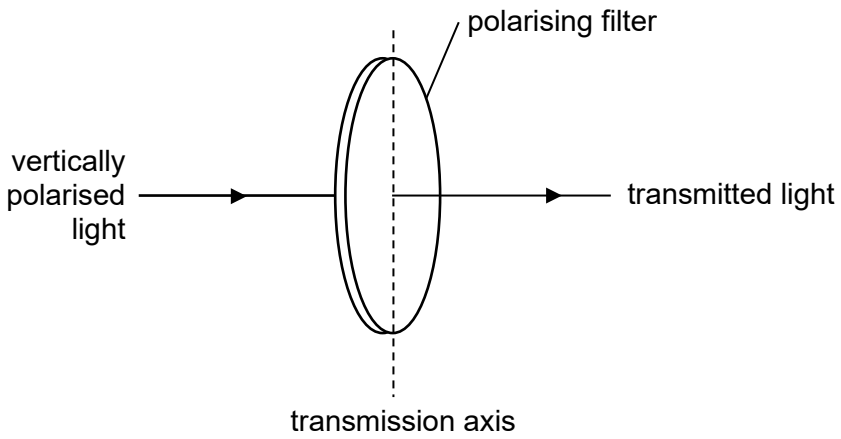
A A car oscillates with a large amplitude after going over a hump.

B A string that is fixed on both ends is plucked in the middle and it starts to vibrate.

C Increasing the initial displacement of a pendulum such that it oscillates at a larger amplitude.

D A child on a swing is given a push whenever he is about to move forward such that the amplitude of the swing increases.

13 A beam of vertically polarised light is incident normally on a polarising filter. The filter is rotated such that it is always in a plane perpendicular to the beam of light. The polarising axis of the filter is initially vertical as shown.



The filter is first rotated clockwise by an angle of 30° and the transmitted light waves have intensity I. The filter is then rotated anticlockwise by an angle of 45° from its current position.

What is the new intensity of the transmitted light waves?

A $0.089I$ **B** $0.67I$ **C** $1.2I$ **D** $24I$

14 A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 92 Hz.

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

A 92 Hz, 184 Hz, 276 Hz, 368 Hz

B 92 Hz, 184 Hz, 368 Hz, 736 Hz

C 92 Hz, 276 Hz, 460 Hz, 644 Hz

D 92 Hz, 276 Hz, 552 Hz, 828 Hz

15 A beam of monochromatic light falls on a diffraction grating at normal incidence. The third order diffracted beam occurs at an angle of 50.8° to the normal.

What is the highest order visible with this grating at this wavelength?

A 3 **B** 4 **C** 5 **D** 6

16 Which of the following is **not** a basic assumption of the kinetic theory of gases?

A All molecules are in random motion.

B All collisions between molecules are perfectly elastic.

C All molecules are point particles with negligible volume.

D All molecules move with the same speed at a certain temperature.

17 Which of the following statements regarding internal energy is correct?

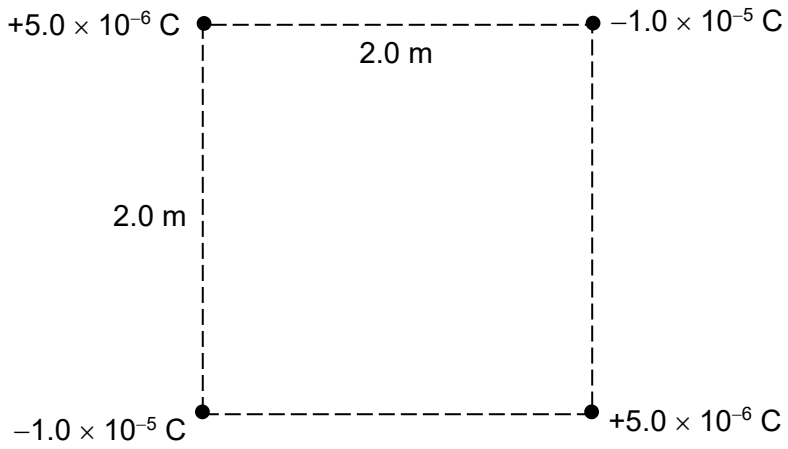
A Shaking a bottle of water will increase its internal energy.

B An expanding gas with an increase in temperature leads to a fall in internal energy.

C The internal energy of a gas always increases when heat is supplied to the gas.

D Compressing a gas will always increase its internal energy.

18 Two point charges of $+5.0 \times 10^{-6}$ C and two point charges of -1.0×10^{-5} C are fixed at the corners of a rigid square as shown. The length of each side of the square is 2.0 m.



What is the total electric potential energy of the system?

A -0.90 J **B** -0.50 J **C** -0.45 J **D** 1.1 J

19 Which statement is **not** correct?

A The electric potential at a point can be zero even though the electric field at that point is not zero.

B The electric field at a point can be zero even though the electric potential at that point is not zero

C As the distance from a positive point charge increases, the electric potential gradient decreases.

D A charged particle under the action of an electric force will always move from a region of higher electric potential to a region of lower electric potential.

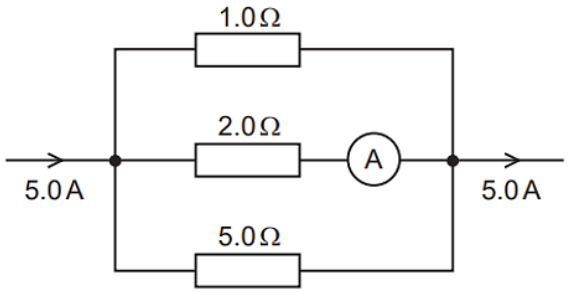
20 A metal wire of length 20 cm and uniform cross-sectional area contains 4.8×10^{22} free electrons.

When a potential difference is applied across the ends of the wire, the free electrons move with an average drift speed of 3.2×10^{-5} m s^{-1}.

What is the current in the wire?

A 0.0098 A **B** 0.050 A **C** 1.2 A **D** 6.1 A

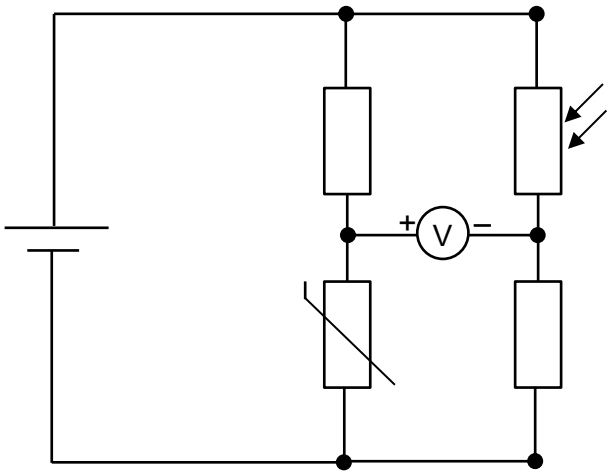
21 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.



What is the reading on the ammeter?

A 1.3 A **B** 1.5 A **C** 3.8 A **D** 4.3 A

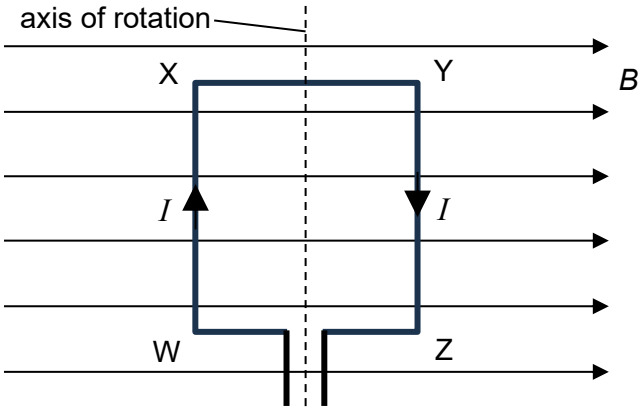
22 A student conducts an experiment by setting up a circuit as shown in the diagram. The diagram shows how the positive and negative terminals of a voltmeter are connected to the circuit. The initial reading on the voltmeter is positive.



Which changes, if any, in temperature and light intensity would cause the voltmeter reading to decrease?

	temperature	light intensity
A	increase	increase
B	no change	decrease
C	decrease	no change
D	decrease	decrease

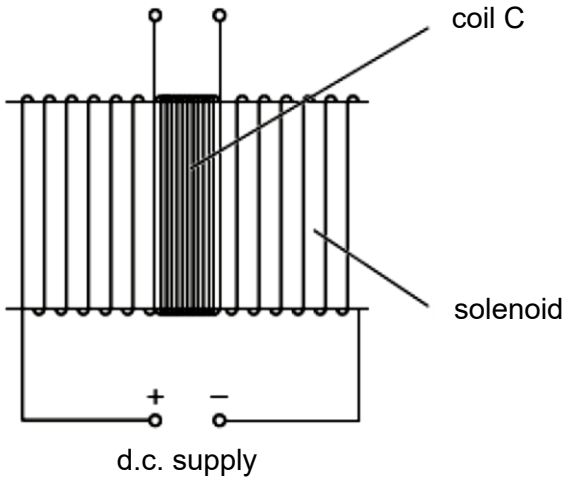
23 A rectangular loop WXYZ carries a current I and rotates in a magnetic field of flux density B. The axis of rotation is perpendicular to the magnetic field.



Which row correctly describes the variation of the magnitude of the magnetic force acting on WX and torque on the loop?

	magnetic force	torque
A	constant	constant
B	constant	not constant
C	not constant	constant
D	not constant	not constant

24 A solenoid has a coil C of wire wound tightly about its centre as shown.

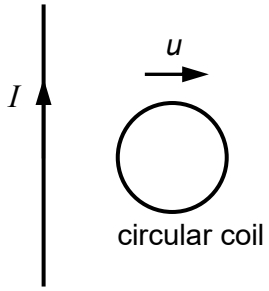


The coil C has 96 turns of area 1.6×10^{-3} m^2. The solenoid has 950 turns in 80 cm and carries a current of 2.0 A. The current is reversed in a duration of 0.24 s.

What is the average induced e.m.f. in coil C when the current is reversed?

A 0 V **B** 1.9 mV **C** 3.1 mV **D** 3.8 mV

25 A fixed long straight wire carrying current I is placed close to a circular conducting coil. The circular coil is moving away from the wire with an initial speed u.



wire with steady current

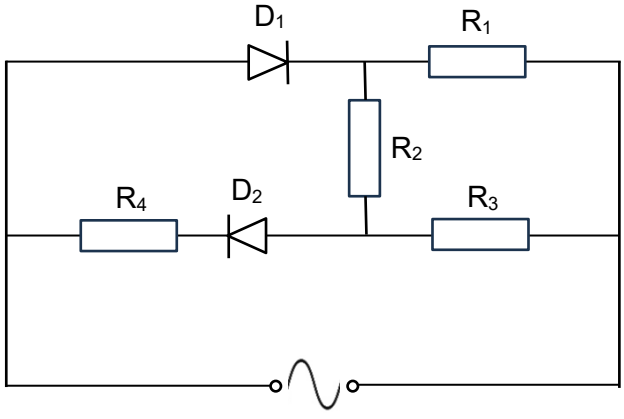
Which row correctly describes the direction of the induced current and the speed of the circular coil as the coil moves away from the wire?

	direction of induced current	speed
A	clockwise	no change
B	clockwise	decrease
C	anticlockwise	no change
D	anticlockwise	decrease

26 In the circuit shown, D_1 and D_2 are ideal diodes. Resistor R_1 has a resistance of $2R$. Resistors R_2, R_3 and R_4 are identical and have the same resistance R.

The input voltage to the circuit is a sinusoidal alternating voltage of peak value V_0.

What is the average power delivered to the circuit?



A $0.25\frac{V_0^2}{R}$ **B** $0.36\frac{V_0^2}{R}$ **C** $0.39\frac{V_0^2}{R}$ **D** $0.79\frac{V_0^2}{R}$

27 According to Bohr's model for the hydrogen atom, the electron at the ground state moves in an orbit of specific radius r with specific tangential velocity v around a positively charged nucleus.

Which of the following statements correctly explains why the Bohr's model is wrong?

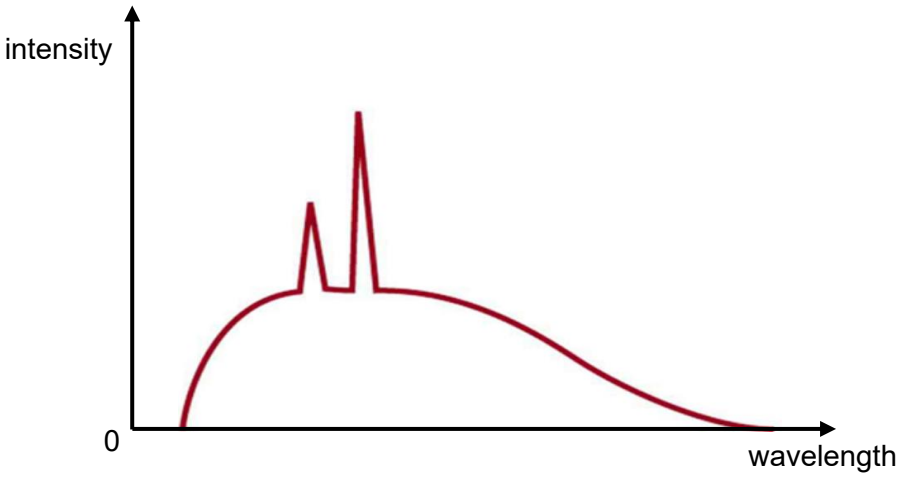
A Bohr's model implies that the uncertainties in r and v are both zero simultaneously and thus violating the Heisenberg uncertainty principle.

B Bohr's model implies that the uncertainty in r and the uncertainty in the momentum of the electron in the radial direction are both zero simultaneously and thus violating the Heisenberg uncertainty principle.

C Based on the Heisenberg uncertainty principle, an electron confined to such a small space will be moving faster than the speed of light.

D Based on the Heisenberg uncertainty principle, the electron will eventually escape, and the atom will not be stable.

28 An X-ray spectrum is shown in the figure below.



Which of the following best explains the origin of the sharp peaks in the X-ray spectrum?

A They are caused by transitions of electrons between energy levels in the atoms of the target.

B They are produced when high-energy electrons slow down in the electric fields of nuclei.

C They result from scattering of X-rays off electrons in the target.

D They are due to diffraction of X-rays by atoms in the crystal lattice of the target.

29 A positron and an electron, each of mass 9.11×10^{-31} kg moving with negligible kinetic energy, meet and annihilate each other, producing two gamma photons of the same frequency.

What is the energy of each of the two gamma photons produced?

A 5.5×10^{-22} J **B** 4.1×10^{-14} J **C** 8.2×10^{-14} J **D** 1.6×10^{-13} J

30 During a particular fission process, a uranium-235 nucleus absorbs a slow-moving neutron. This initiates the fission reaction, creating a xenon-144 nucleus, a strontium-90 nucleus and two neutrons.

The binding energies per nucleon are:

Uranium-235	7.6 MeV
Xenon-144	8.4 MeV
Strontium-90	8.5 MeV

What is the energy released or absorbed in the reaction?

A 1.5×10^{-12} J of energy is absorbed

B 1.5×10^{-12} J of energy is released

C 3.0×10^{-11} J of energy is absorbed

D 3.0×10^{-11} J of energy is released