YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAM
Higher 2

CANDIDATE NAME			
CG		INDEX NO	

PHYSICS 9749/01

Paper 1 Multiple Choice **13 September 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.
Write your name, class and index number on the Answer Sheet in the spaces provided 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.

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 **16** 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	=	$\rho g h$
gravitational potential,	ϕ	=	$-\frac{Gm}{r}$
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	=	$x_o \sin \omega t$
velocity of particle in s.h.m.,	v	=	$v_o \cos \omega t$
		=	$\pm \omega \sqrt{(x_o^2 - x^2)}$
electric current,	I	=	$A n v q$
resistors in series,	R	=	$R_1 + R_2$+…….
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + ...$
electric potential,	V	=	$\frac{Q}{4\pi\varepsilon_o r}$
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,	λ	=	$\frac{ln\,2}{t_{\frac{1}{2}}}$

Answer **all** questions.

1 A hollow cylinder, which is open at both ends, has a radius of (3.0 ± 0.1) cm and a length of (15.0 ± 0.1) cm.

What is the value, with its absolute uncertainty, of the surface area of the cylinder?

A (280 ± 10) cm^2

B (282.7 ± 0.2) cm^2

C (420 ± 30) cm^2

D (424.1 ± 0.3) cm^2

2 A metal ball is dropped from rest over a bed of sand. It hits the sand bed one second later and makes an impression of maximum depth of 8.0 mm in the sand.

Assuming air resistance is negligible, what is the average deceleration of the ball on hitting the sand?

A 6.0×10^2 m s^{-2}

B 1.2×10^3 m s^{-2}

C 6.0×10^3 m s^{-2}

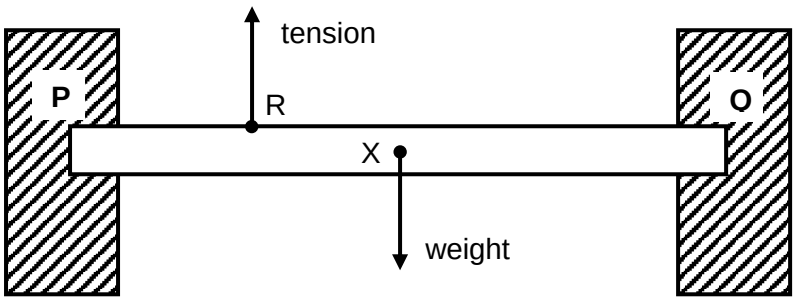
D 1.2×10^4 m s^{-2}

3 A car of mass 1500 kg has a driving force of 5600 N and it pulls a trailer of mass 500 kg. The resistive forces acting on the car and trailer are 1200 N and 400 N respectively.

What is the tension in the coupling between the car and trailer for this acceleration?

A 0 N **B** 1400 N **C** 1800 N **D** 2600 N

4 A horizontal beam has its centre of gravity at X. It is supported by a vertical wire attached to the beam at point R as indicated on the diagram. The tension in the wire is equal to the weight of the beam.

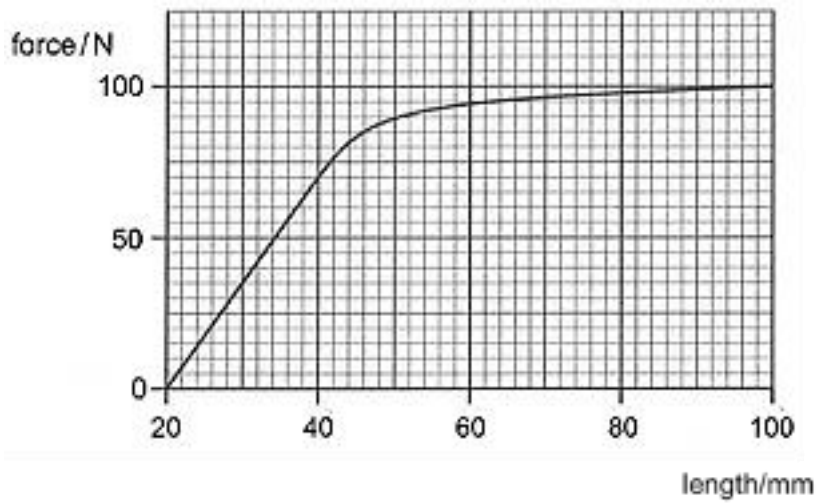


The ends of the beam fit into the sockets P and Q in two rigid vertical walls which keep the beam in equilibrium.

What are the directions of the forces acting on the beam at sockets P and Q?

	socket P	**socket Q**
A	upwards	upwards
B	upwards	downwards
C	downwards	upwards
D	downwards	downwards

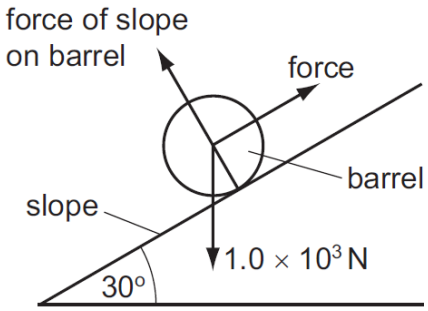
5 A rubber strip is stretched by a force. The graph of the applied force against its length is shown.



What is the work done in stretching the strip to the first point where it no longer obeys Hooke's law?

A 0.014 J **B** 0.70 J **C** 1.4 J **D** 700 J

6 The figure shows a barrel of weight 1.0×10^3 N on a frictionless slope inclined at 30° to the horizontal.



A force is applied to the barrel to move it up the slope at constant speed. The force is parallel to the slope.

What is the work done by the force in moving the barrel a distance of 5.0 m up the slope?

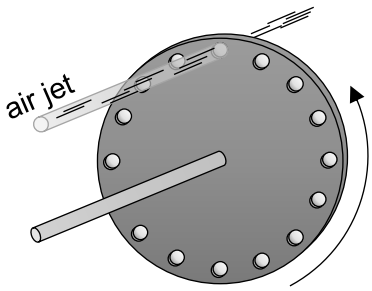
A 2.5×10^3 J **B** 4.3×10^3 J **C** 5.0×10^3 J **D** 1.0×10^4 J

7 A man lifts a weight of 480 N with a constant speed through a distance of 3.5 m using a rope and some pulleys. The man pulls on the rope with a force of 200 N and a length of 10.5 m passes through his hands.

What is the efficiency in percentage of the pulley system?

A 20% **B** 40% **C** 60% **D** 80%

8 The figure below shows a siren disk that has 16 holes near the edge which are equally spaced apart. When the disk is spun in front of a fast-moving jet of air, the holes modulate the air-jet to produce a sound of a particular frequency.



The time it takes for successive holes to move past the air jet is the period of the sound wave.

What is the angular speed of rotation if the frequency of the sound produced is 2200 Hz?

A 430 rad s^{-1} **B** 860 rad s^{-1} **C** 1730 rad s^{-1} **D** 3650 rad s^{-1}

9 Two satellites, X and Y, have circular orbits around Earth and have the same kinetic energy. Satellite X has a larger mass than Satellite Y.

Which of the following statements is **false**?

A Satellite X has a smaller total energy.

B Satellite X has a larger orbital radius.

C Satellite X has a larger period.

D Satellite X has a smaller angular velocity.

10 An external agent does 100 J of work in moving a 2.0 kg mass from point X to point Y in a gravitational field, and –120 J of work in moving the mass from point Y to point Z. Finally, the external agent does 2000 J of work in moving the mass from point Z to infinity.

What is the gravitational potential at point X?

A $-990\ \text{J kg}^{-1}$ **B** $-1010\ \text{J kg}^{-1}$ **C** $-1110\ \text{J kg}^{-1}$ **D** $-1980\ \text{J kg}^{-1}$

11 A 1.2 kW kettle is used to raise the temperature of 0.80 kg of water from 25°C to 100°C. The water then boils off totally.

The specific heat capacity and the latent heat of vaporisation is $4.2\ \text{kJ kg}^{-1}\ \text{K}^{-1}$ and $2300\ \text{kJ kg}^{-1}$ respectively.

If it took 30 mins for the whole process, what is the average rate of power loss to the surrounding?

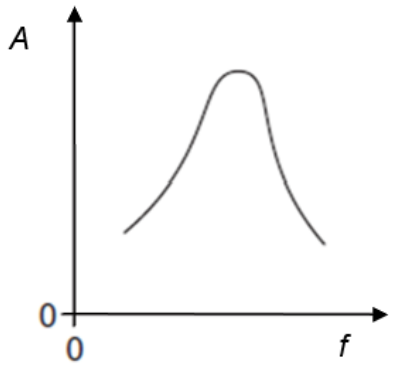
A 38 W **B** 180 W **C** 1100 W **D** 2300 W

12 The r.m.s. speed of the atoms of an ideal gas at 330 K is increased by 20%.

What is the new temperature of the gas?

A 230 K **B** 275 K **C** 396 K **D** 475 K

13 A periodic force is applied to a lightly-damped object, causing the object to oscillate. The graph shows how the amplitude *A* of the oscillations varies with the frequency *f* of the periodic force.



Which of the following statements best describes how the shape of the curve would differ if the damping were greater?

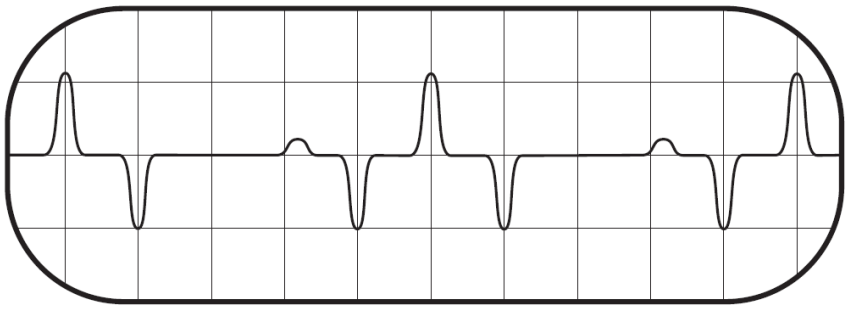
A The curve would be lower at all frequencies.

B The curve would be higher at all frequencies.

C The curve would be unchanged except at frequencies above the resonant frequency where it would be lower.

D The curve would be unchanged except at frequencies above the resonant frequency where it would be higher.

14 A signal that repeats periodically is displayed on the screen of a cathode-ray oscilloscope.



The screen has 1 cm squares and the time-base is set at 2.00 ms cm^{-1}.

What is the frequency of this periodic signal?

A 50 Hz **B** 100 Hz **C** 125 Hz **D** 200 Hz

15 A beam of plane-polarised light of intensity I is incident normally onto a polariser which has its polarising axis parallel to the incident beam.

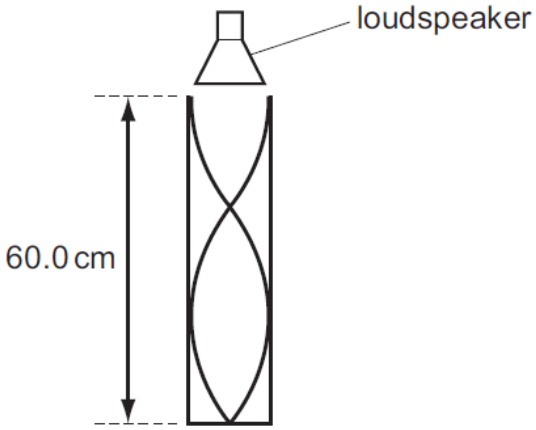
A second beam of plane-polarised light of intensity I is incident normally onto the same polariser but with its plane of polarisation perpendicular to the polarising axis of the polariser. Both beams of light arrived in phase to each other.

The angle of polarisation for the polariser is rotated to 45°.

What is the intensity of the emergent beam?

A 0.250 I **B** 0.500 I **C** I **D** 2 I

16 The sound from a loudspeaker placed above a tube causes resonance of the air in the tube. A stationary wave is formed with two nodes and two antinodes as shown.



The speed of sound in air is 330 m s^{-1}. The frequency of the sound from the loudspeaker is now increased to the next higher resonance of air in the tube.

What is the new frequency of the sound?

A 138 Hz **B** 413 Hz **C** 688 Hz **D** 963 Hz

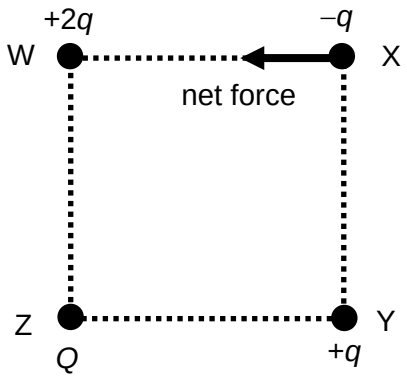
17 A light source emits light which is a mixture of two wavelengths, λ_1 and λ_2.

When the light is incident on a diffraction grating it is found that the fifth order of light of wavelength λ_1 occurs at the same angle as the fourth order for light of wavelength λ_2.

If λ_1 is 480 nm, what is λ_2?

A 400 nm **B** 480 nm **C** 600 nm **D** 750 nm

18 The figure below shows three charges $+2q$, $-q$ and $+q$ placed at the corners W, X and Y of a square WXYZ respectively. A fourth charge Q is placed at Z, after which the charge at X experiences a net electric force indicated by the arrow.



What is the value of Q?

A $-2.8q$ **B** $-1.4q$ **C** $1.4q$ **D** $2.8q$

19 A point charge $-q$ is brought from a point P_1 in space to another point P_2 by an external agent. The electric potentials at points P_1 and P_2 are V_1 and V_2 respectively.

What is the work done on the charge?

A $q(V_2 + V_1)$ **B** $q(-V_2 - V_1)$ **C** $q(V_2 - V_1)$ **D** $q(V_1 - V_2)$

20 The table shows the properties of two different wires, P and Q.

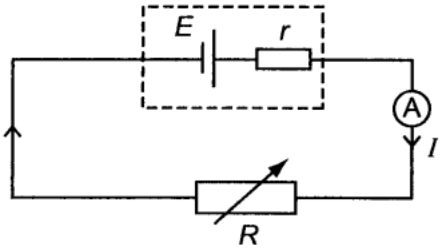
	length	resistance	resistivity of material
Wire P	l	R	ρ
Wire Q	$2\,l$	$\frac{1}{4}R$	$\frac{1}{3}\rho$

Wire P has a cross-section of diameter d.

What is the diameter of the cross-section of wire Q?

A $0.41d$ **B** $1.6d$ **C** $2.7d$ **D** $7.1d$

21 A battery of e.m.f. *E* and internal resistance *r* delivers a current I through a variable resistor *R*.



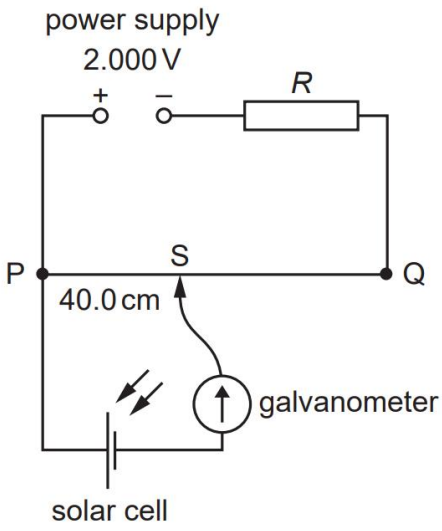
R is set at two different values and the corresponding currents I are measured using an ammeter of negligible resistance.

R / Ω	I / A
1.0	3.0
2.0	2.0

What is the value of the e.m.f. *E*?

A 3.0 V **B** 3.5 V **C** 4.0 V **D** 6.0 V

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



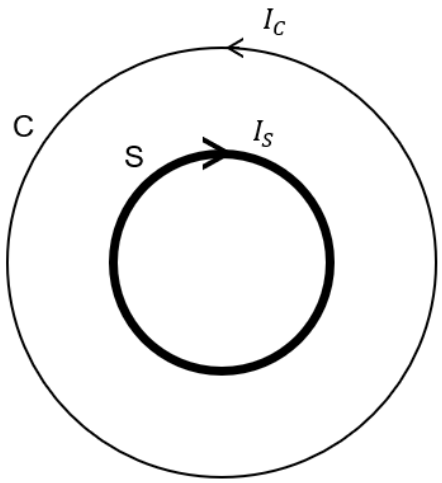
The e.m.f. produced by the solar cell is measured on the potentiometer.

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.

What is the value of resistance *R* so that the galvanometer reads zero when PS = 40.0 cm?

A 395 Ω **B** 795 Ω **C** 995 Ω **D** 1055 Ω

23 A long solenoid S has 15 turns per unit length. A circular loop of wire C is placed over S as shown in the diagram below. S and C are coaxial. A current I_S of 0.20 A is passed through S and a current I_C of 0.90 A is passed through C in the directions shown.

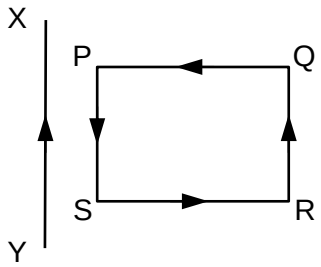


The radius of S is 0.80 m and the radius of C is 1.6 m.

What is the magnitude of the resultant magnetic flux density at the centre of C?

A 0 T **B** 1.0×10^{-6} T **C** 3.4×10^{-6} T **D** 4.1×10^{-6} T

24 A long straight wire XY lies in the same plane as a square loop of wire PQRS which is free to move. The sides PS and QR are initially parallel to XY.



When currents start to flow in the wire and loop in the direction as shown in the diagram, what is the effect on the loop?

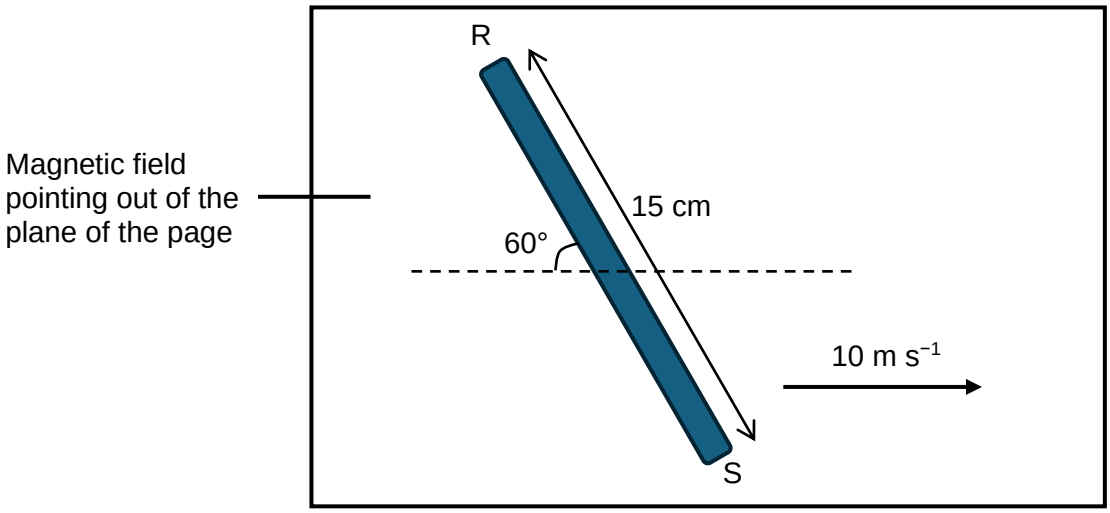
A it moves towards the long wire

B it moves away from the long wire

C it rotates about an axis parallel to XY

D it remains stationary

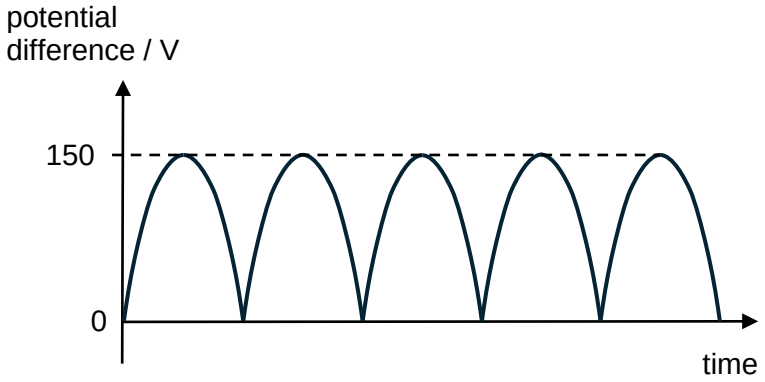
25 A straight conductor of length 15 cm is moved through a magnetic field at 10 m s^{-1}. It is oriented 60° from the horizontal as shown in the diagram. The magnetic flux density is 2.8 mT.



Which point is at a higher potential and what is the potential difference, p.d., measured across the conductor RS?

	higher potential at	p.d./mV
A	R	3.6
B	R	4.2
C	S	3.6
D	S	4.2

26 An alternating current is supplied to a full wave rectifier. The output from the rectifier has the shape shown in the diagram, with a maximum value of 150 V.



A 20 Ω resistor is placed in series with this output.

What are the r.m.s. value of the current and the average power to the resistor?

	r.m.s. current / A	power / W
A	5.3	560
B	7.5	560
C	5.3	1100
D	7.5	1100

27 In the photoelectric effect, light incident on a metal surface causes electrons to be ejected from the surface.

Which statement is correct?

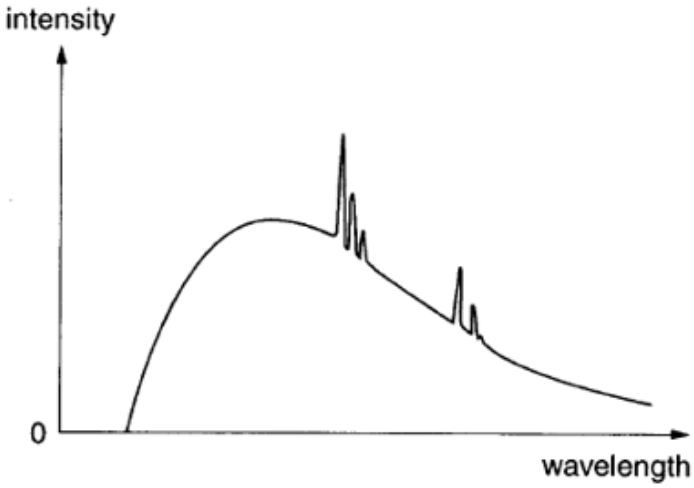
A Electrons are ejected only if the wavelength of the incident light is greater than some minimum value.

B The de Broglie wavelength of the ejected electrons is the same as the wavelength of the incident light.

C The maximum energy of the electrons is independent of the intensity of the incident light.

D The maximum energy of the electrons is independent of the type of metal.

28 The diagram shows a sketch of the X-ray spectrum produced when electrons strike a metal target.



The potential difference *V* applied to the electrons incident on the metal is now increased.

Which of the following statements is correct?

A All the energy of the electrons is converted into X-rays.

B The wavelengths of the characteristic X-ray spectral lines are independent of the potential difference applied to accelerate the electrons.

C The maximum X-ray wavelength obtained is $\frac{hc}{eV}$.

D There is no change to the overall intensity of the X-ray spectrum.

29 When α-particles are directed at gold leaf:

1. almost all α-particles pass through without deflection
2. a few α-particles are deviated through large angles.

What are the reasons for these effects?

	1	2
A	most α-particles have enough energy to pass right through the gold leaf	gold is very dense, so a few low energy α-particles bounce back from the gold surface
B	most α-particles miss all gold atoms	a few α-particles bounce off gold atoms
C	the gold nucleus is very small so most α-particles miss all nuclei	occasionally the path of an α-particle is close to a nucleus
D	the positive charge in an atom is not concentrated enough to deflect an α-particle	occasionally an α-particle experiences many small deflections in the same direction

30 The nuclide $^{238}_{92}U$ emits an α-particle. The resulting nuclide decays by emitting a β-particle to form a new nuclide.

What are the neutron number and the proton number of the new nuclide?

	neutron number	proton number
A	234	91
B	234	90
C	143	91
D	143	90