Pearson Edexcel International Advanced Level

Tuesday 21 October 2025

Morning (Time: 1 hour 45 minutes)

Paper reference **WPH14/01A**

Physics

International Advanced Level

UNIT 4: Further Mechanics, Fields and Particles

Question Paper

You must have:
Scientific Calculator and Answer book (sent separately).
Do not return this question paper with the answer book.

Information

- The list of data, formulae and relationships is printed at the end of this booklet.

Turn over ▶

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P 8 7 4 4 3 A

Pearson

SECTION A

Answer ALL questions.

1 The number of neutrons in a nucleus of $^{197}_{79}Au$ is

A 118

B 197

C 79

D 276

(Total for Question 1 = 1 mark)

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2 A particle moving in a circular path completes 7.5 revolutions in 9.0 s. Its angular velocity in rad s^{-1} is

A 0.83

B 5.2

C 68

D 420

(Total for Question 2 = 1 mark)

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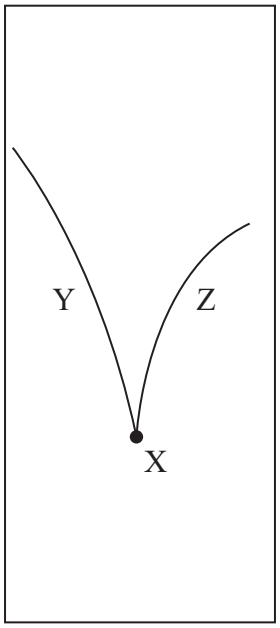
3 A moving pion decays into two particles, Y and Z. This decay occurs at point X in a particle detector and the tracks observed are shown.



Which of the following is a valid conclusion from these tracks?

A Momentum has not been conserved

B The pion is a neutral particle

C Y and Z have different masses

D Z is a negatively charged particle

(Total for Question 3 = 1 mark)

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4 A positron enters a particle accelerator. As it emerges from the accelerator, its mass is measured to be 3.8×10^{-29} kg.

It can be concluded that the positron

A is travelling at non-relativistic speeds

B has travelled in a circle

C has become a different particle

D is travelling at close to the speed of light

(Total for Question 4 = 1 mark)

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5 Which of the following is an equivalent unit to the tesla?

A NAm

B $\mathrm{NAm^{-1}}$

C $\mathrm{NA^{-1}m}$

D $\mathrm{NA^{-1}m^{-1}}$

(Total for Question 5 = 1 mark)

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6 Two capacitors of capacitance 1000 μF and 10 μF are charged so that they stored the same amount of energy. The potential difference (p.d.) across the 1000 μF capacitor is V_1 and the p.d. across the 10 μF capacitor is V_2.

The value of $\left(\frac{V_1}{V_2}\right)^2$ is

A 1×10^{-4}

B 1×10^{-2}

C 1×10^{2}

D 1×10^{4}

(Total for Question 6 = 1 mark)

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7 A student suggests that two colliding protons could undergo the interaction

$$p + p = p + n + \pi^+$$

Which of the following statements is true?

A The resulting particles must have a very high value of kinetic energy

B The interaction is not possible because charge is not conserved

C The colliding protons must have a very high value of kinetic energy

D The interaction is not possible because the number of particles is not conserved

(Total for Question 7 = 1 mark)

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8 A proton accelerates in an electric field and gains kinetic energy, giving it a change in momentum, Δp. An alpha particle accelerates in the same electric field and gains the same kinetic energy.

The magnitude of the change in momentum of the alpha particle is

A $\sqrt{2}\,\Delta p$

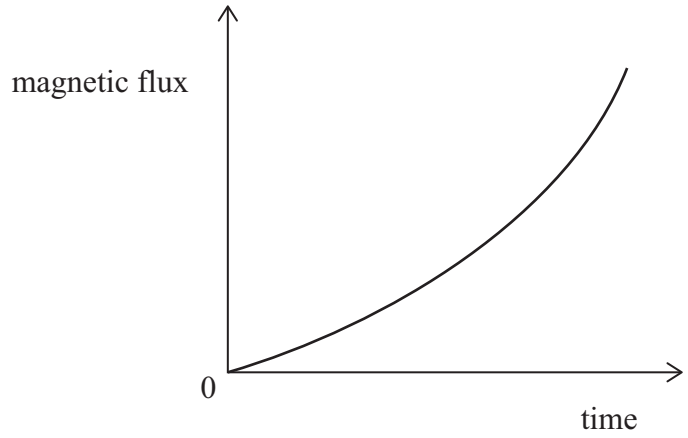
B $2\,\Delta p$

C $\sqrt{8}\,\Delta p$

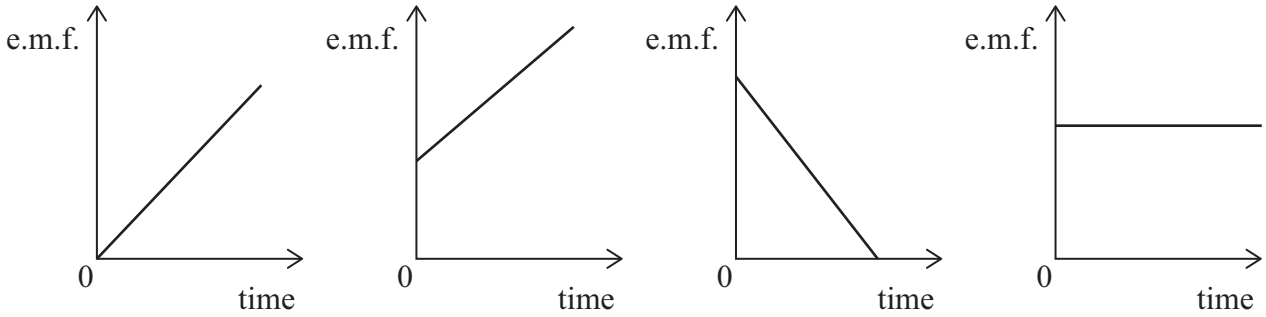
D $4\,\Delta p$

(Total for Question 8 = 1 mark)

9 The graph shows how the magnetic flux passing through a coil varies with time.



Which of the following graphs could show how the magnitude of the e.m.f. induced in the coil varies with time?



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

(Total for Question 9 = 1 mark)

10 Which of the following is **not** a valid conclusion from Rutherford's alpha scattering experiment?

A The nucleus contains most of the mass of the atom

B The nucleus contains protons

C The nucleus must be charged

D The nucleus is very small compared to the atom

(Total for Question 10 = 1 mark)

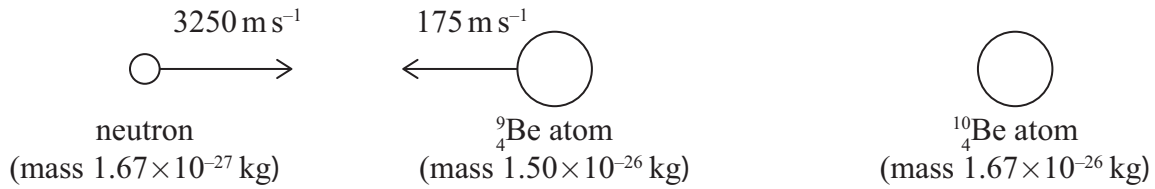
TOTAL FOR SECTION A = 10 MARKS

SECTION B

11 (a) State the principle of conservation of momentum.

(2)

(b) A head-on collision occurs between a neutron and a beryllium atom $^{9}_{4}\text{Be}$.
The nucleus of the beryllium atom absorbs the neutron to form the isotope $^{10}_{4}\text{Be}$.



(i) Calculate the velocity of the $^{10}_{4}\text{Be}$ atom, clearly stating its direction.

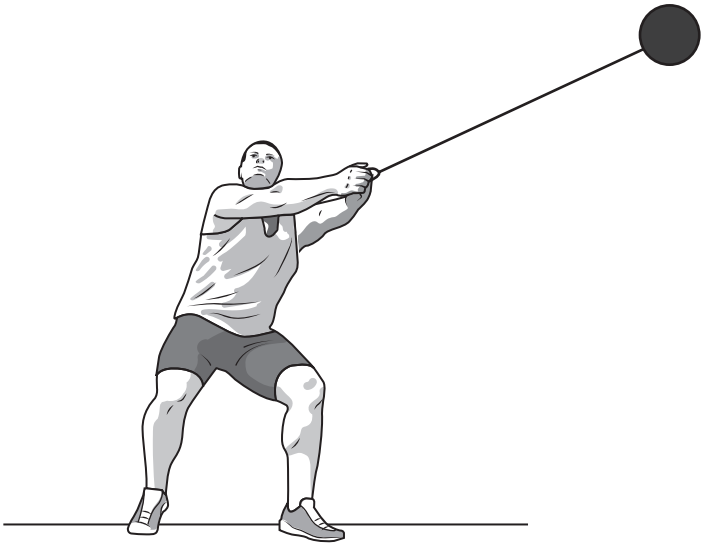
(4)

(ii) Using a suitable calculation, determine whether the collision was elastic or inelastic.

(2)

(Total for Question 11 = 8 marks)

12 Hammer throwing is an Olympic sport. The sport uses a metal sphere attached to a chain. The athlete holds the chain and spins around to give the sphere a large angular velocity.



When the sphere is released, it travels in a parabolic path through the air and lands on the ground.

(a) Explain why, at the instant of release, the sphere stops travelling in a circular path.

(2)

(b) The sphere has a mass of 7.3 kg. The athlete moves the sphere through a circle of radius 1.7 m. The speed of the sphere, at the instant of release, is $18\,m\,s^{-1}$.

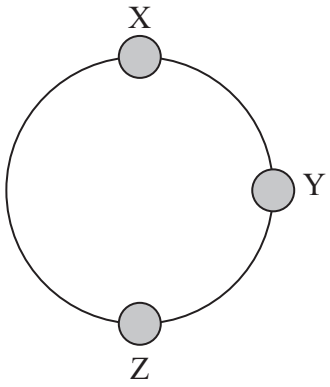
(i) Calculate the angular velocity of the sphere.

(2)

(ii) Assuming that both the circle and chain are horizontal, calculate the force that the athlete exerts on the chain just before its release.

(2)

(c) The diagram below shows the sphere moving in a vertical circle.



(i) Draw arrows on the diagram in the answer book to show the direction of the centripetal force on the sphere at each of the positions X, Y and Z.

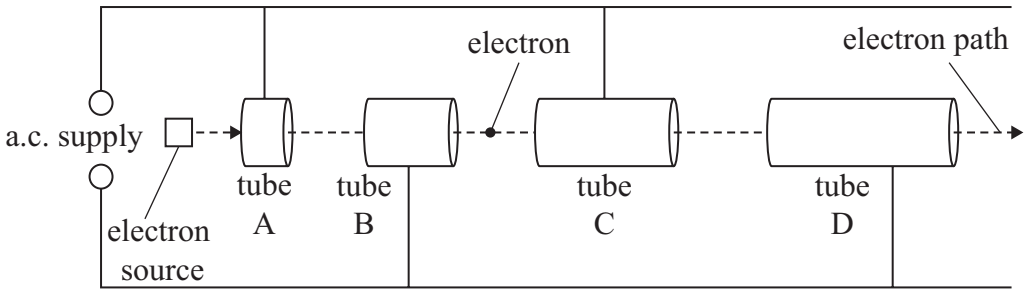
(1)

(ii) The tension in the chain varies as the sphere moves in a vertical circle. State the position X, Y or Z, at which the tension will be a maximum and the position X, Y or Z, at which the tension will be a minimum. Explain your answers.

(4)

(Total for Question 12 = 11 marks)

13 (a) High energy particles used to investigate the structure of matter are produced in particle accelerators. The diagram shows the main features of a linear accelerator (linac).



(i) An electron is shown between tubes B and C.

The circles in the diagram indicate the terminals of the a.c. supply. Indicate on the diagram their polarity when the electron is between tubes B and C.

Explain your answer.

(2)

(ii) Explain why it is necessary for the tubes to increase in length along the linac.

(1)

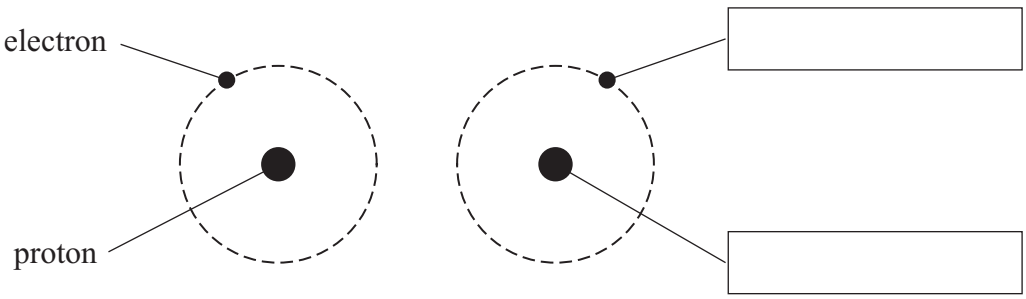
(iii) The peak voltage of the a.c. supply is 250 kV.

Calculate the increase in kinetic energy, in joules, as the electron moves from tube A to tube D.

(3)

(b) The Antiproton Decelerator at CERN slows down very high energy antiprotons to produce anti-atoms such as anti-hydrogen.

The diagram is a representation of a hydrogen atom and an anti-hydrogen atom.



(i) Use the boxes in the answer book to identify the particles in the anti-hydrogen atom.

(1)

(ii) State one difference and one similarity between the electron and its antiparticles in the anti-hydrogen atom.

(2)

(iii) State what would happen if a hydrogen atom collided with an anti-hydrogen atom.

(1)

(c) The proton and the electron are separated by an average distance of 0.053 nm.

(i) Calculate the magnitude of the electrostatic force acting on the electron at this distance.

(2)

(ii) Calculate the electrostatic potential energy of the electron at this distance.

(2)

(d) In the early 1960s Murray Gell-Mann proposed a quark model that consisted of three quarks. The table gives some of the properties of quarks.

Quark	Charge	Predicted mass in MeV/c^2
Up (u)	+2/3	4
Down (d)	–1/3	4
Strange (s)	–1/3	80

(i) Explain what is meant by a charge of +2/3.

(2)

(ii) State the predicted mass and charge of the $\bar{u}$ quark.

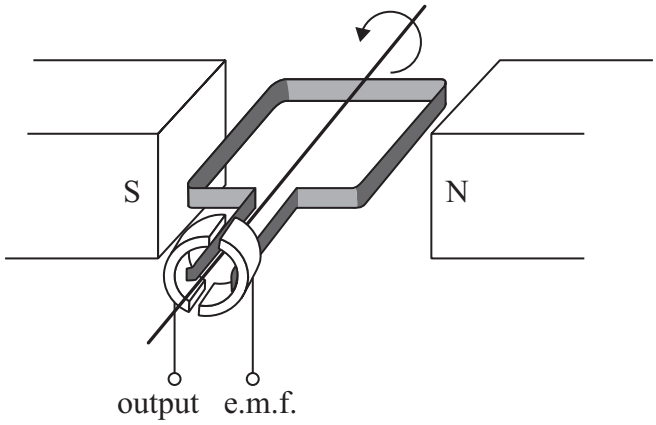
(2)

(iii) Calculate the mass of the $\bar{s}$ quark in kg.

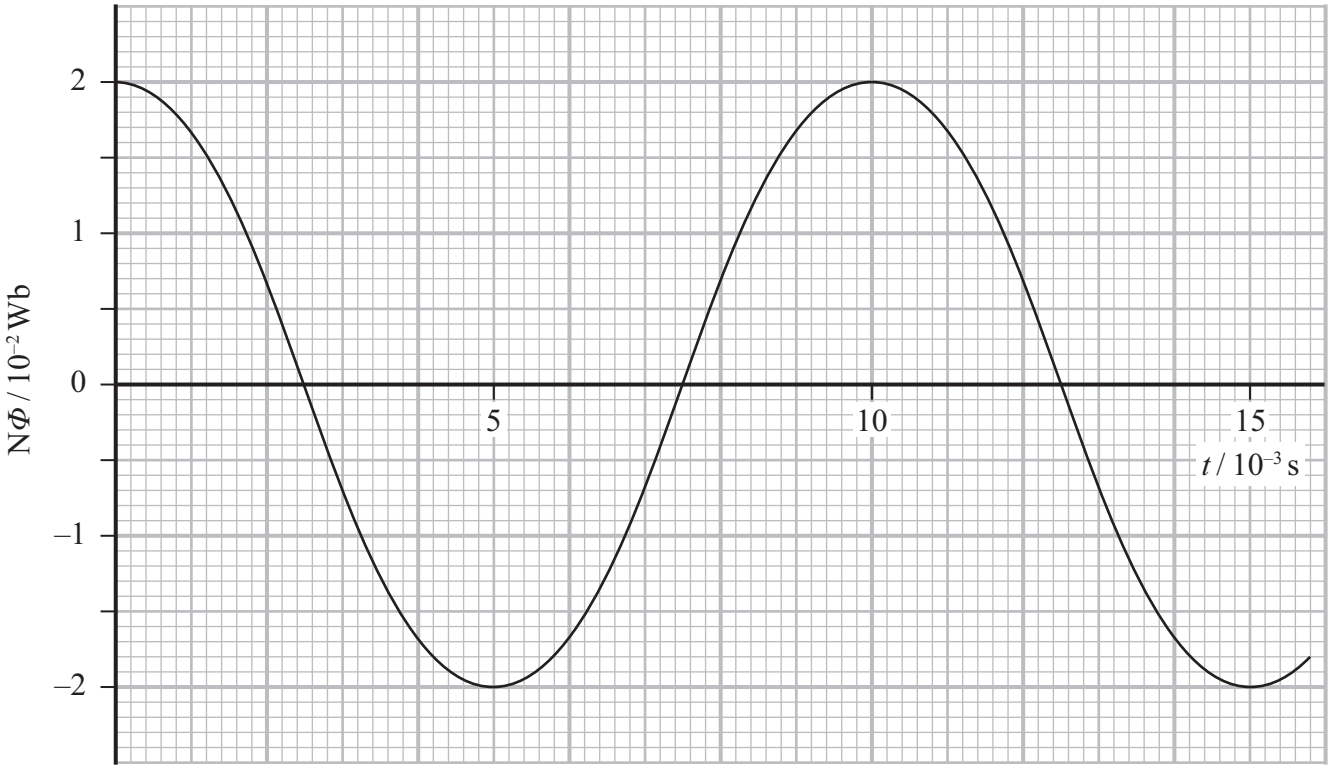
(3)

(Total for Question 13 = 21 marks)

14 The diagram shows a simple generator. It has a flat coil of negligible resistance which can be rotated in a magnetic field. The coil has 500 turns and an area of 2.5×10^{-3} m^2.



The graph shows the variation of the magnetic flux linkage $N\Phi$ with time t as the coil is rotated at a steady frequency in a uniform magnetic field.



(a) Determine the frequency of rotation of the coil.

(2)

(b) Determine the magnetic flux density of the field.

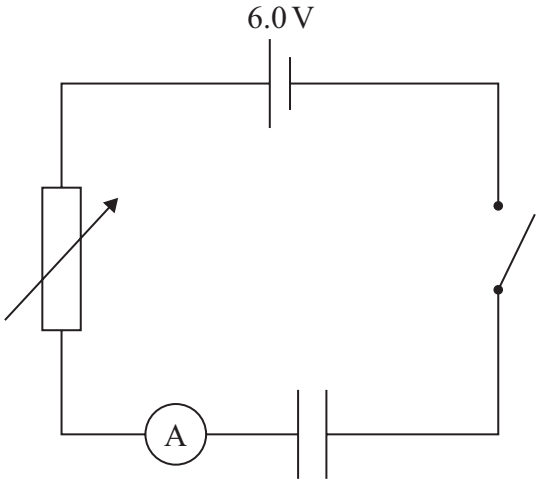
(2)

(c) Determine the maximum e.m.f. induced in the coil.

(3)

(Total for Question 14 = 7 marks)

15 A student is investigating capacitance. She sets up the circuit shown.

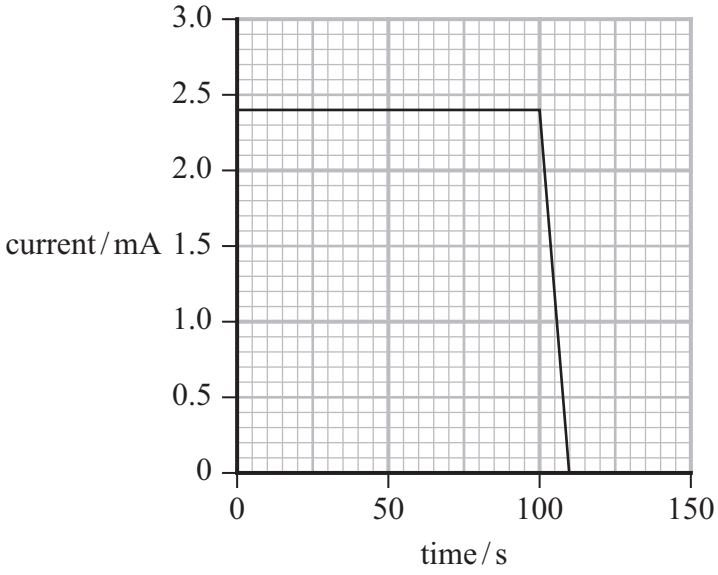


(a) When the switch is closed there is a maximum current, which decreases to zero over a period of time as the capacitor changes. Explain why.

(3)

(b) The student discharged the capacitor. She set the variable resistor to a maximum resistance and closed the switch. As the capacitor charged, the student decreased the resistance of the variable resistor so that the current remained constant until the capacitor was fully charged.

A graph of current against time is shown.



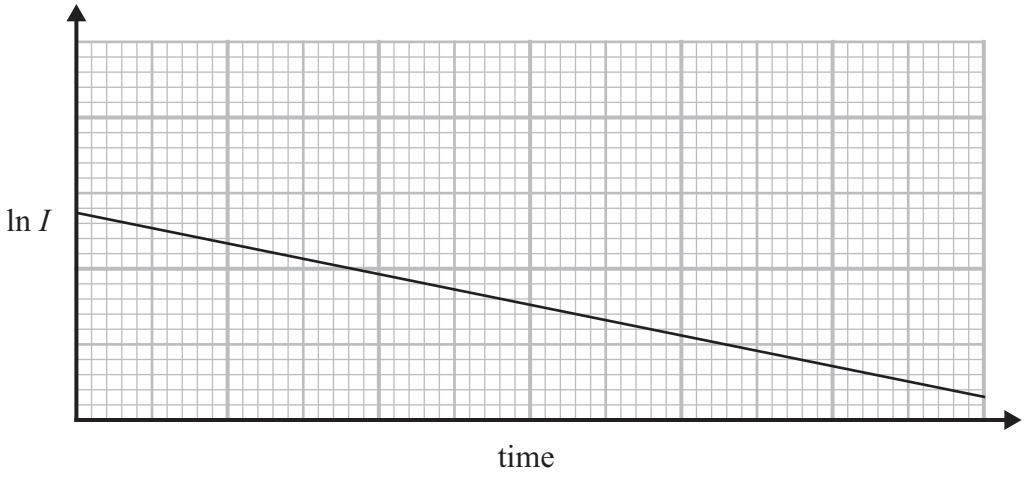
(i) Determine the capacitance of the capacitor.

(3)

(ii) Hence determine the energy stored by the capacitor when it is fully charged.

(2)

(c) Capacitance can also be determined by measuring the current I at regular time intervals, as a capacitor discharges through a resistor, and plotting a graph of ln I against time.



(i) Explain how capacitance can be determined using this graph.

(3)

(ii) A capacitor was discharged through a 390 Ω resistor. The capacitance of the capacitor was calculated at 2200 μF.

Explain why the data from the graph for this circuit would be difficult to obtain using an ammeter. Your answer should include a calculation.

(3)

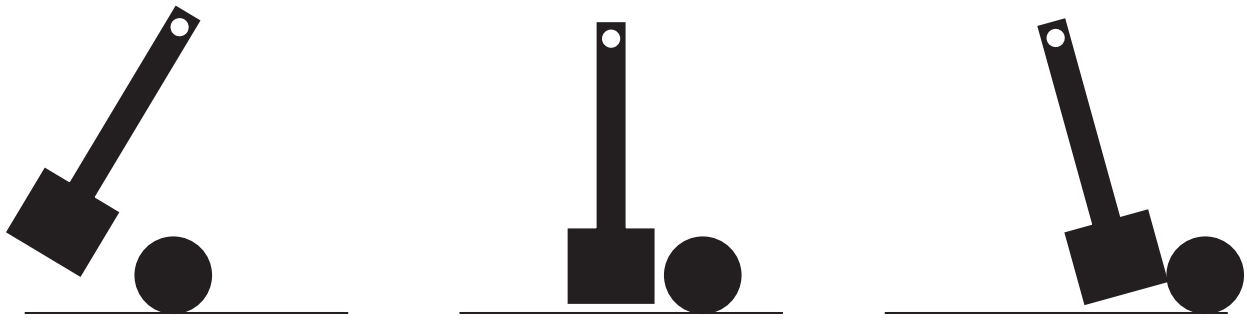
(Total for Question 15 = 14 marks)

16 A student performs two experiments where a heavy, swinging object attached to a pivot is raised to a constant height and released (A) before striking a stationary ball. The student measures the distance the ball travels across a rough surface before stopping. In the first experiment, the swinging object immediately comes to a stop after striking the ball (B). In the second experiment, the swinging object can swing freely past the lowest point (C).

Discuss the expected results of both experiments, with reference to both the momentum of the ball and the distance the ball travels before stopping.

Assume that the same average force is applied while the object and ball are in contact and that the same ball is used each time.

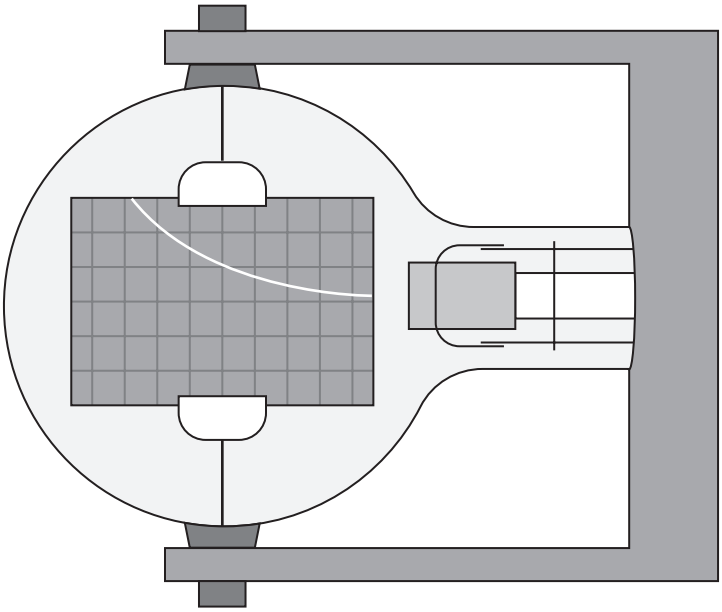
(6)



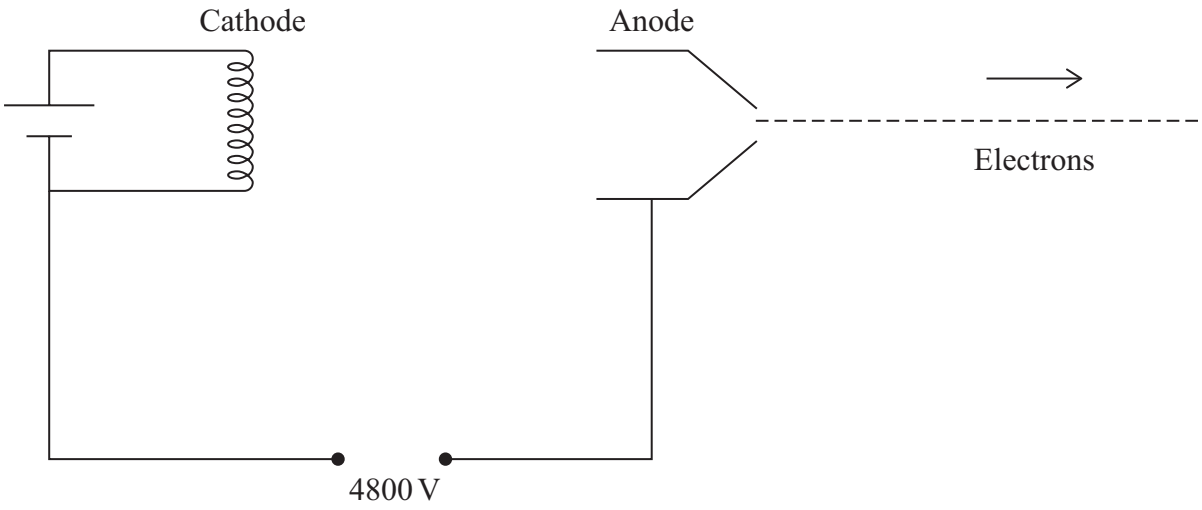
A B C

(Total for Question 16 = 6 marks)

17 A teacher is using an electron beam tube to demonstrate the deflection of electrons in a uniform electric field.



A potential difference (p.d.) of 4800 V is applied between the cathode and anode of the tube. The cathode is heated and electrons are emitted from the surface. These electrons are then accelerated from rest and pass through a hole in the anode.



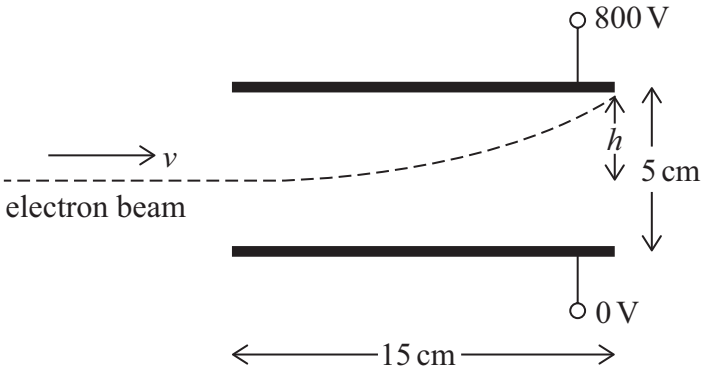
(a) State the name of the process by which electrons are emitted from the cathode.

(1)

(b) Show that the speed v of the electrons as they leave the anode is about $4 \times 10^7 \text{ m s}^{-1}$.

(3)

(c) After leaving the anode, the electrons follow a parabolic path as they pass between a pair of parallel plates with a p.d. of 800 V between them. There is a uniform electric field between the plates.



(i) Calculate the force due to the electric field that acts on an electron while it is between the plates.

(3)

(ii) An electron experiences an upward acceleration a as it passes between the plates. Its vertical displacement h after time t is given by

$$h = \frac{1}{2}at^2$$

Calculate the value of h as the electron leaves the plates.

(4)

(d) (i) Keeping the p.d. between the cathode and anode at 4800 V, the p.d. between the parallel plates is decreased.

Draw the new path of the electrons on the diagram in the answer book (c). Label this path A.

(1)

(ii) Keeping the p.d. between the parallel plates at 800 V, the p.d. between the cathode and anode is decreased.

Draw the new path of the electrons on the diagram in the answer book (c). Label this path B.

(1)

(Total for Question 17 = 13 marks)

TOTAL FOR SECTION B = 80 MARKS
TOTAL FOR PAPER = 90 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \text{kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}\ \text{kg}$	

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density $\rho = \frac{m}{V}$

Stokes' law $F = 6\pi\eta rv$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \frac{1}{2} F\Delta x$

Young modulus $E = \frac{\sigma}{\varepsilon}$ where

Stress $\sigma = \frac{F}{A}$

Strain $\varepsilon = \frac{\Delta x}{x}$

Unit 2

Waves

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\frac{T}{\mu}}$
Intensity of radiation	$I = \frac{P}{A}$
Refractive index	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
	$n = \frac{c}{v}$
Critical angle	$\sin C = \frac{1}{n}$
Diffraction grating	$n\lambda = d \sin\theta$

Electricity

Potential difference	$V = \frac{W}{Q}$
Resistance	$R = \frac{V}{I}$
Electrical power, energy	$P = VI$
	$P = I^2R$
	$P = \frac{V^2}{R}$
	$W = VIt$
Resistivity	$R = \frac{\rho l}{A}$
Current	$I = \frac{\Delta Q}{\Delta t}$
	$I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Particle nature of light

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2} mv^2_{max}$
de Broglie wavelength	$\lambda = \frac{h}{p}$

Unit 4

Further Mechanics

Impulse	$F\Delta t = \Delta p$
Kinetic energy of a non-relativistic particle	$E_k = \frac{p^2}{2m}$
motion in a circle	$v = \omega r$
	$T = \frac{2\pi}{\omega}$
	$a = \frac{v^2}{r}$
	$a = r\omega^2$
Centripetal force	$F = ma = \frac{mv^2}{r}$
	$F = mr\omega^2$

Electric and magnetic fields

Electric field	$E = \frac{F}{Q}$
Coulomb's law	$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$
	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$
	$E = \frac{V}{d}$
Electrical potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
Capacitance	$C = \frac{Q}{V}$
Energy stored in capacitor	$W = \frac{1}{2}QV$
	$W = \frac{1}{2}CV^2$
	$W = \frac{1}{2}\frac{Q^2}{C}$
Capacitor discharge	$Q = Q_0 e^{-t/RC}$

Resistor-capacitor discharge $I = I_0 e^{-t/RC}$

$V = V_0 e^{-t/RC}$

$\ln Q = \ln Q_0 - \frac{t}{RC}$

$\ln I = \ln I_0 - \frac{t}{RC}$

$\ln V = \ln V_0 - \frac{t}{RC}$

In a magnetic field $F = Bqv \sin \theta$

$F = BIl \sin \theta$

Faraday's and Lenz's laws $\mathscr{E} = \frac{-\mathrm{d}(N\phi)}{\mathrm{d}t}$

Nuclear and particle physics

In a magnetic field $r = \frac{p}{BQ}$

Mass-energy $\Delta E = c^2 \Delta m$

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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Tuesday 21 October 2025

Morning (Time: 1 hour 45 minutes)

Paper reference **WPH14/01A**

Physics

International Advanced Level
UNIT 4: Further Mechanics, Fields and Particles
Answer Book

You must have:
Scientific Calculator and Question book (sent separately).

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In the question marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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M:1/1/1/1/

P 8 7 4 8 0 A 0 1 2 0

Pearson

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 1 = 1 mark)

2

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 2 = 1 mark)

3

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 3 = 1 mark)

4

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 4 = 1 mark)

5

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 5 = 1 mark)

6

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 6 = 1 mark)

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7

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 7 = 1 mark)

8

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 8 = 1 mark)

9

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 9 = 1 mark)

10

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11

(a)

(2)

(b)

(i)

(4)

(ii)

(2)

(Total for Question 11 = 8 marks)

12

(a)

(2)

(b)

(i)

(2)

(ii)

(2)

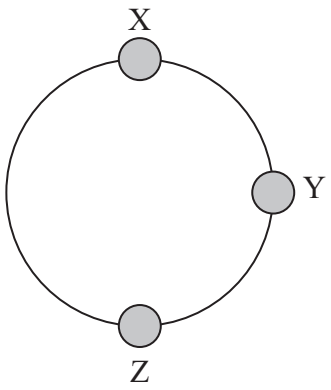
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c)

(i)



(1)

(ii)

(4)

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.....

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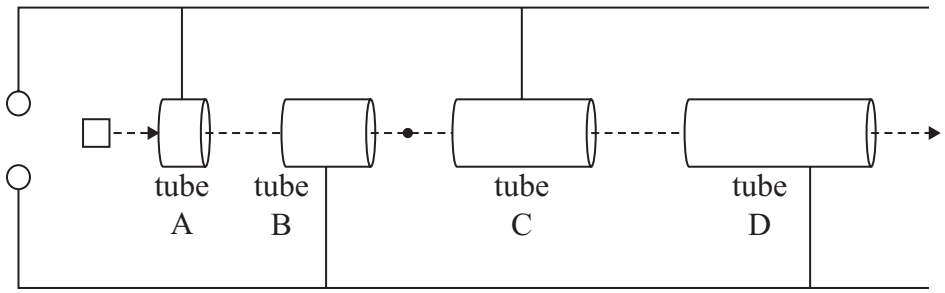
.....

.....

(Total for Question 12 = 11 marks)

13 (a)



(i)

(2)

(ii)

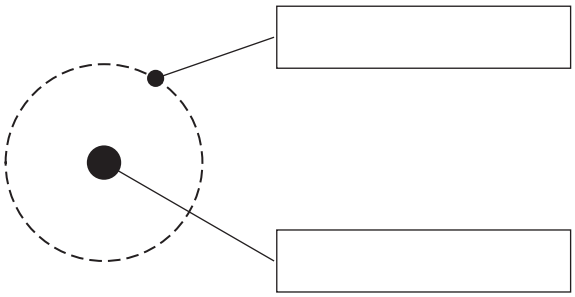
(1)

(iii)

(3)

(b)

(i)



(1)

(ii)

(2)

.....

.....

.....

.....

(iii)

(1)

.....

.....

.....

(c)

(i)

(2)

(ii)

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(d)

(i)

(2)

(ii)

(2)

(iii)

(3)

(Total for Question 13 = 21 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

14

(a)

(2)

(b)

(2)

(c)

(3)

(Total for Question 14 = 7 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

15

(a)

(3)

(b)

(i)

(3)

(ii)

(2)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c)

(i)

(3)

(ii)

(3)

(Total for Question 15 = 14 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

***16**

(6)

(Total for Question 16 = 6 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

17

(a)

(1)

(b)

(3)

(c) (i)

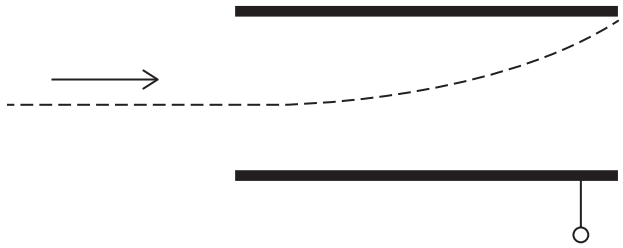
(3)

(ii)

(4)

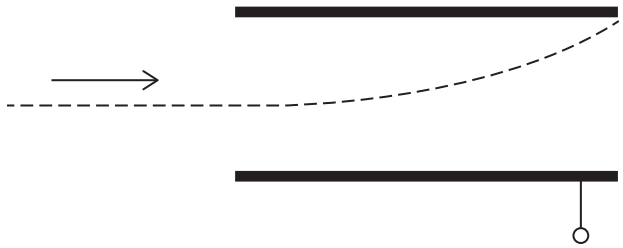
(d) (i)

(1)



(ii)

(1)



(Total for Question 17 = 13 marks)

TOTAL FOR SECTION B = 80 MARKS
TOTAL FOR PAPER = 90 MARKS

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