Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 1 June 2026

Morning (Time: 1 hour 45 minutes)

Paper reference **WPH14/01**

Physics

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

You must have:
Scientific calculator, ruler

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

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P:1/1/1/

P 7 9 3 5 0 A 0 1 3 2

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 Which of the following isotopes has the most neutrons in its nucleus?

☒ **A** $^{20}_{10}\text{Ne}$

☒ **B** $^{24}_{10}\text{Ne}$

☒ **C** $^{24}_{12}\text{Mg}$

☒ **D** $^{25}_{12}\text{Mg}$

(Total for Question 1 = 1 mark)

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2 An object moves in a circular path through an angle of 2.3 rad.

Which of the following gives this angle in degrees?

☒ **A** $\dfrac{2.3 \times 360}{2\pi}$

☒ **B** $\dfrac{2.3 \times 180}{2\pi}$

☒ **C** $\dfrac{2.3 \times 2\pi}{180}$

☒ **D** $\dfrac{2.3 \times 2\pi}{360}$

(Total for Question 2 = 1 mark)

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3 Which of the following is a possible unit of power?

☒ **A** kg m s^{-1}

☒ **B** GeV s^{-1}

☒ **C** N m

☒ **D** kW m^{-2}

(Total for Question 3 = 1 mark)

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4 Two particles collide. The collision is elastic.

Which row of the table describes what happens to momentum and kinetic energy in this collision?

	momentum	kinetic energy
☒ **A**	conserved	conserved
☒ **B**	conserved	not conserved
☒ **C**	not conserved	conserved
☒ **D**	not conserved	not conserved

(Total for Question 4 = 1 mark)

5 Which of the following quark combinations represents a meson?

☒ **A** $u\bar{d}\bar{d}$

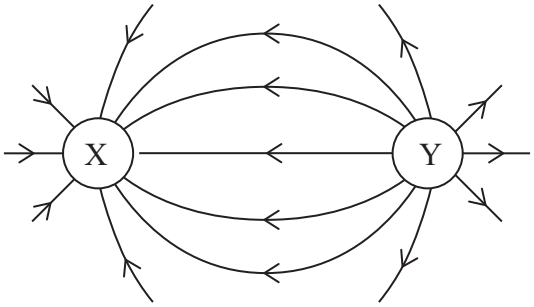
☒ **B** uuu

☒ **C** $d\bar{u}$

☒ **D** uu

(Total for Question 5 = 1 mark)

6 Two particles, X and Y, have an equal magnitude of charge. The diagram shows the electric field lines around the two particles.

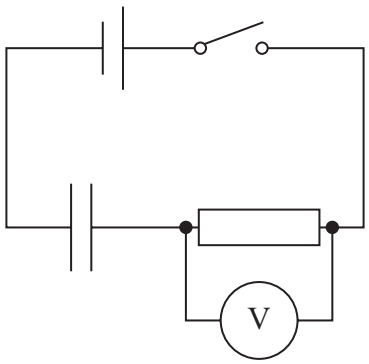


Which row of the table gives the sign of each charge?

		X	Y
☒	**A**	positive	positive
☒	**B**	positive	negative
☒	**C**	negative	positive
☒	**D**	negative	negative

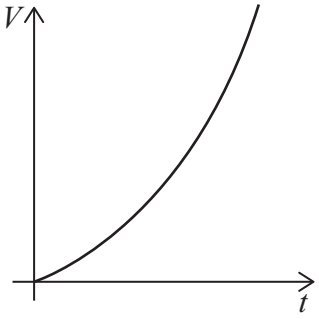
(Total for Question 6 = 1 mark)

7 A student investigated the charging of a capacitor using the circuit shown.

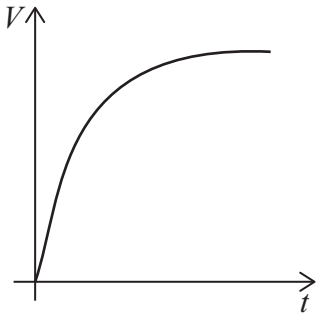


The capacitor was initially uncharged. The student closed the switch to charge the capacitor.

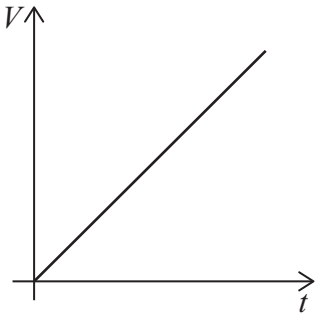
Which of the following graphs shows how the potential difference V across the resistor varied with time t?



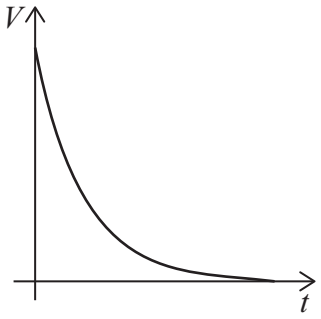
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(Total for Question 7 = 1 mark)

8 A cyclist is travelling at $9\,m\,s^{-1}$.
She uses the brakes to reduce her speed to $0\,m\,s^{-1}$ in a time of 3 s.

The total mass of the bicycle and cyclist is 80 kg.

Which of the following gives the magnitude of the impulse applied by the brakes, in N s?

☒ **A** $80 \times (9 - 0)$

☒ **B** $80 \times 9.81 \times (9 - 0)$

☒ **C** $80 \times (9 - 0) \times 3$

☒ **D** $\dfrac{80 \times (9 - 0)}{3}$

(Total for Question 8 = 1 mark)

9 An electron, a neutral pion, a neutron and a proton each move at the same speed through a uniform magnetic field. Each particle is travelling perpendicular to the magnetic field.

Which particle would be deflected into a circular path with the smallest radius?

☒ **A** electron

☒ **B** neutral pion

☒ **C** neutron

☒ **D** proton

(Total for Question 9 = 1 mark)

10 Two identical point charges are separated by a distance x. The charges exert a force F on each other.

The separation of the charges is increased to $2x$.

Which of the following is the magnitude of the force at a separation of $2x$?

☒ **A** F

☒ **B** $2F$

☒ **C** $\dfrac{F}{2}$

☒ **D** $\dfrac{F}{4}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 A teacher uses a sensor to measure the electric field strength around a charged sphere.

(a) State what is meant by an electric field.

(1)

.....

.....

(b) The sphere has a charge of 1.4×10^{-8} C.

Calculate the electric field strength 45 cm from the centre of the sphere.

(2)

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.....

.....

.....

Electric field strength = ...

(Total for Question 11 = 3 marks)

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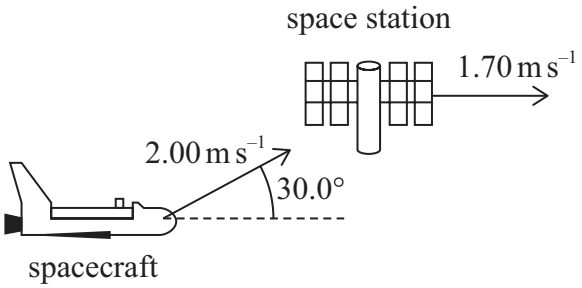
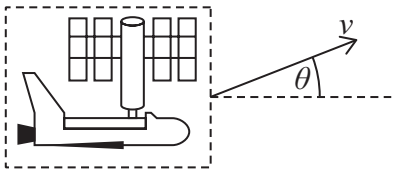
12 A space station travels through space. A spacecraft moves towards the space station, as shown.



The spacecraft joins with the space station, and they move off together, as shown below.



combined spacecraft and space station

Calculate the speed v and angle θ of the combined spacecraft and space station.

mass of spacecraft = 5.20×10^4 kg
mass of space station = 4.50×10^5 kg

v = ...

θ = ...

(Total for Question 12 = 6 marks)

13 In the Proton-Antiproton Collider, protons and antiprotons are accelerated. The protons collide with the antiprotons and new particles are produced.

Physicists suggest that a possible interaction is

$$p + \bar{p} \rightarrow \pi^- + \pi^+ + \pi^0$$

(a) Deduce whether baryon number and charge are conserved in this interaction.

(2)

(b) The π^- decays to produce a muon and another particle X, as shown.

$$\pi^- \rightarrow \mu^- + X$$

(i) Muons are leptons.

Determine the identity of particle X. You should use conservation laws.

(3)

(ii) Muons at rest have a very short lifetime.

Muons are created in the upper atmosphere and travel towards the surface of the Earth.

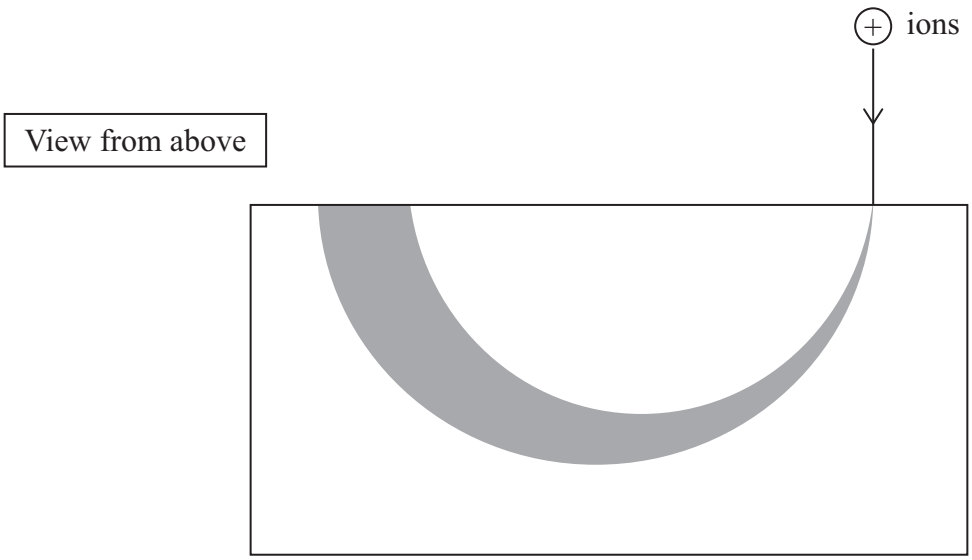
The muons would be expected to decay before they reach the surface of the Earth. However, most of these muons do reach the surface of the Earth.

Explain why.

(2)

(Total for Question 13 = 7 marks)

14 A mass spectrometer is used to identify ions of unknown substances.
A beam of positively charged ions is directed into a region of uniform magnetic field.
The ions are deflected into a circular path, as shown.



(a) State the direction of the magnetic field.

(1)

.....

(b) An ion with momentum p and charge Q enters the region of uniform magnetic field.

(i) Show that the radius r of the circular path of this ion is given by

$$r = \frac{p}{BQ}$$

where B is the magnetic flux density of the uniform magnetic field.

(2)

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(ii) Ions with mass m are deflected into a circular path of radius 1.52 m.

Show that the value of $\frac{m}{Q}$ is about $2.4 \times 10^{-7}\,\text{kg}\,\text{C}^{-1}$.

$B = 40.0\,\text{mT}$
speed of ions $= 2.50 \times 10^{5}\,\text{m}\,\text{s}^{-1}$

(3)

(iii) These ions form when an atom loses an electron.

A physicist suggests that these ions have 23 nucleons in the nucleus.

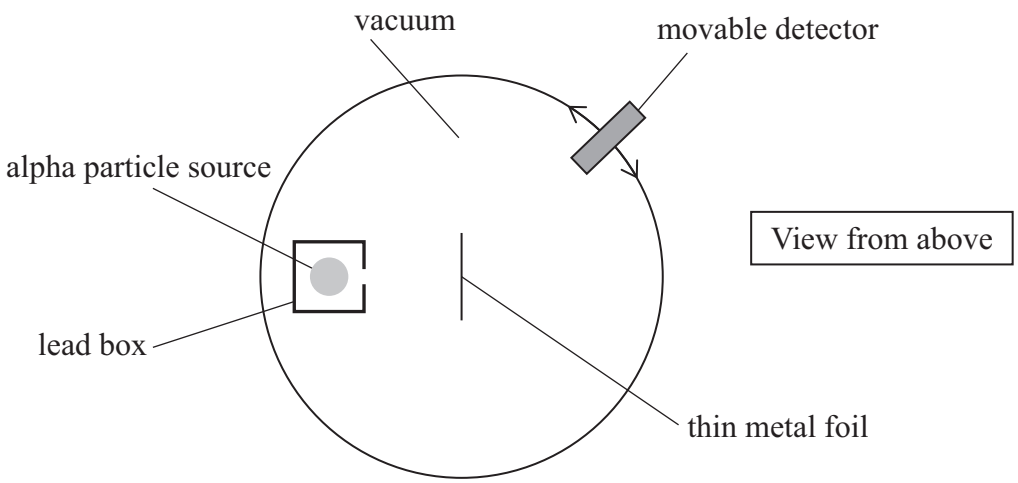
Deduce whether this suggestion is correct.

mass of nucleon $= 1.67 \times 10^{-27}\,\text{kg}$

(3)

(Total for Question 14 = 9 marks)

***15** Alpha particles are directed towards a thin metal foil. The number of alpha particles in different directions is measured using the apparatus shown.



Describe the observations from this experiment and the conclusions that can be made about the structure of the atom.

(Total for Question 15 = 6 marks)

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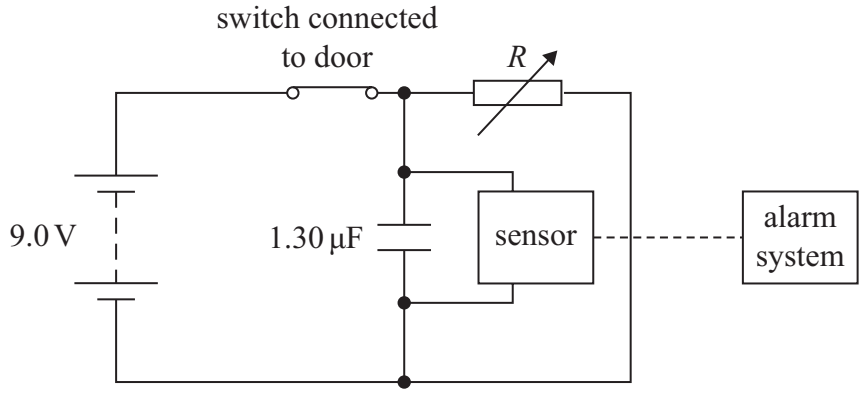
16 An alarm system is controlled using the circuit shown.



The capacitor is used to produce a time delay between the door opening and the alarm being activated.

As the door opens, the switch opens and the capacitor begins to discharge. When the charge on the capacitor decreases below a certain value, the sensor activates the alarm system.

(a) The time constant of a resistor capacitor circuit is given by *RC*.

State what is meant by the term 'time constant'.

(1)

.....

.....

(b) The door is opened and the capacitor discharges.

Sketch a graph to show how the potential difference across the capacitor varies with time.

(2)

(c) The alarm system should be activated exactly 25 s after the door is opened.

The alarm system is activated when the potential difference across the capacitor decreases to a value of 2.3 V.

The variable resistor is adjusted so that R is 12 MΩ.

Deduce whether this value of R will produce a time delay of exactly 25 s.

(3)

(Total for Question 16 = 6 marks)

17 Under certain circumstances, a high energy photon can create a particle-antiparticle pair.

One example of this is when a single photon creates a proton and an antiproton.

(a) A photon has a frequency of 4.6×10^{23} Hz.

Deduce whether this photon has sufficient energy to create a proton and an antiproton.

(5)

(b) A single photon creates a proton and an antiproton. The photon energy is greater than the minimum energy required to create the proton and antiproton. The excess energy provides kinetic energy to the proton-antiproton pair.

Calculate the speed of the proton.

excess energy = 28 MeV

(4)

Speed of proton = ...

(Total for Question 17 = 9 marks)

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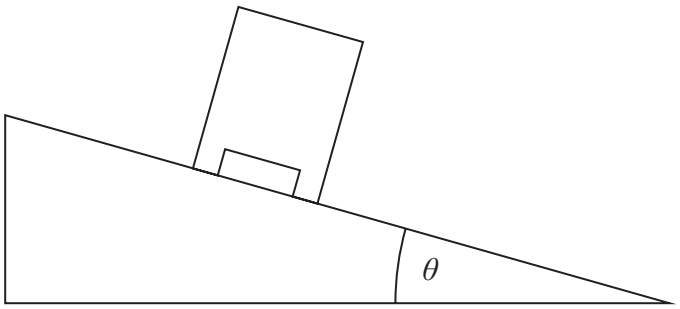
18 The stability of a lorry is tested by driving the lorry around a circular track. The track is inclined at an angle θ to the horizontal, as shown.

(Source: © dpa picture alliance/Alamy)



(a) A frictional force F acts on the lorry, along the slope as shown below. The black dot represents the lorry.

Complete the free-body force diagram to show all the forces acting on the lorry.

(2)

(b) The mass of the lorry is 2.6×10^4 kg and the radius of the track is 55 m.

(i) The lorry is driven around the track at a speed of 19 m s^{-1}.

Calculate the centripetal force acting on the lorry at this speed.

(2)

Centripetal force = ...

(ii) At a particular speed v, the frictional force F is zero.

Calculate a value for v.

angle of the track to horizontal, $\theta = 22°$

(4)

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$v =$ .....

(Total for Question 18 = 8 marks)

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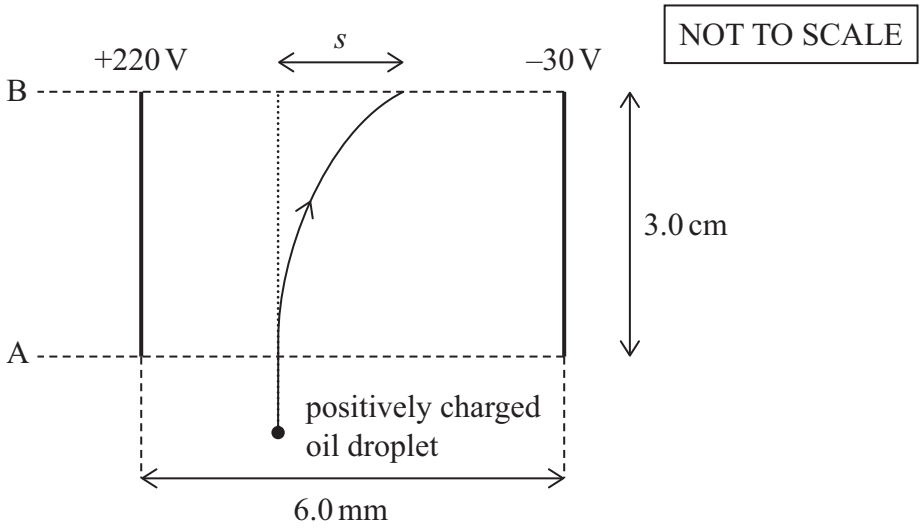
19 A uniform field is produced when a potential difference is applied between two parallel plates. The electric field can be used to deflect a beam of charged particles.

(a) A potential difference is applied between two parallel plates, as shown.

Add to the diagram to show the electric field lines between the plates.

(2)

(b) A positively charged oil droplet enters the field, as shown.



(i) Show that the electric field strength between the plates is about $4 \times 10^4\,V\,m^{-1}$.

(2)

.....

.....

.....

.....

(ii) The oil droplet is moving at $44\,m\,s^{-1}$ as it passes line A. When the droplet reaches line B it has a displacement s.

Calculate the displacement s of the droplet.

length of plates = 3.0 cm
mass of droplet = 2.9×10^{-11} kg
charge on droplet = 5.0×10^{-12} C

(5)

s = ...

(iii) The oil droplet continues moving beyond line B.

Explain the path of the oil droplet beyond line B.

(3)

(Total for Question 19 = 12 marks)

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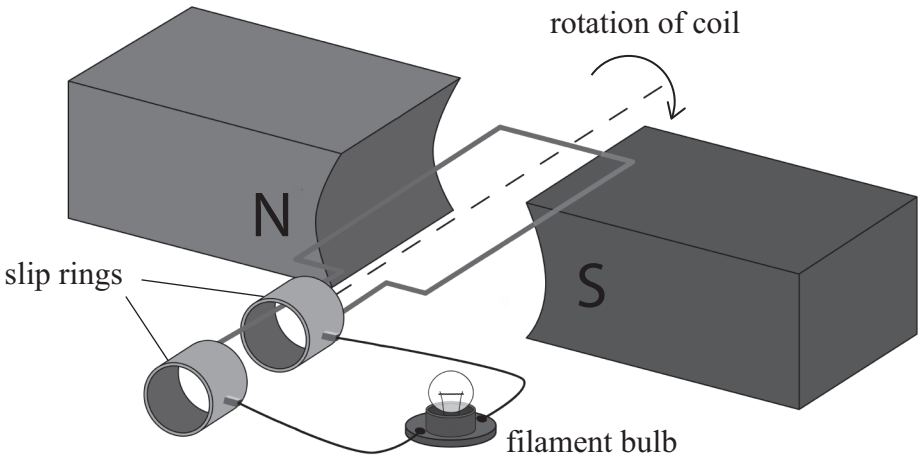
20 The diagram shows a coil rotating in the magnetic field between the north pole N and the south pole S of a magnet.

The slip rings connect the coil to a filament bulb. There is a current in the filament bulb when the coil rotates.

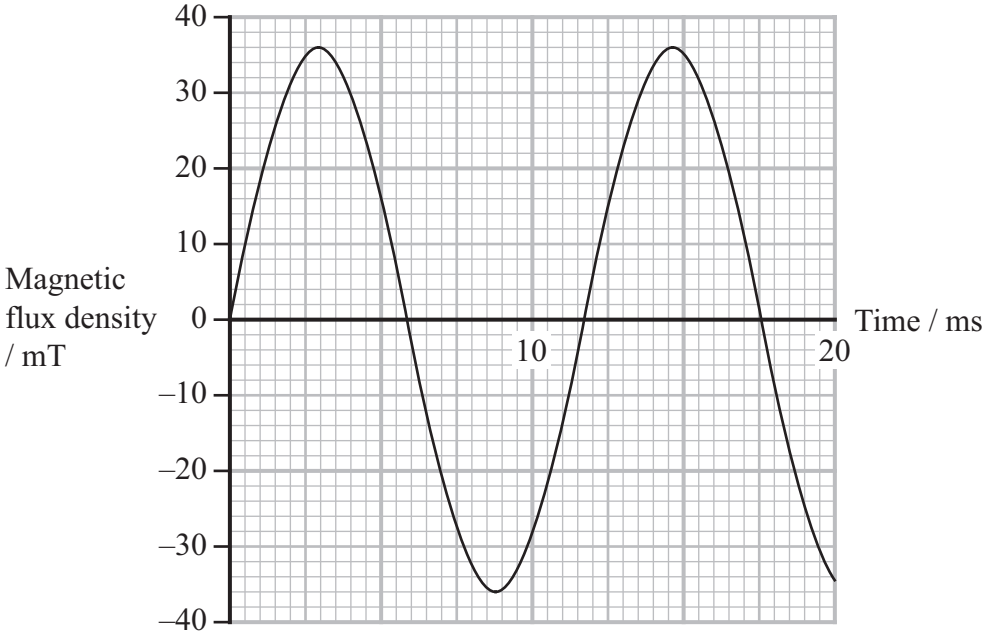


(Source: © Steve Cymro/Shutterstock)

(a) Explain why there is a current in the filament bulb when the coil rotates.

(2)

(b) The graph shows how the magnetic flux density, perpendicular to the plane of the coil, varies with time.



(i) Determine the angular velocity of the coil.

(3)

.....

.....

.....

.....

Angular velocity = ...

(ii) The coil has 250 turns and an area of $2.56 \times 10^{-4}\,m^2$.

Determine the maximum current through the filament bulb.

resistance of filament bulb = 35 Ω

(6)

Current = ...

(c) A student suggests that doubling the frequency of rotation of the coil will double the power dissipated in the filament bulb.

Deduce whether this suggestion is correct.

No further calculations are required.
Assume that the resistance of the filament bulb does not change.

(3)

(Total for Question 20 = 14 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	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electron volt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
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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