



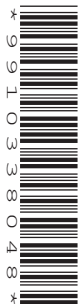
Oxford Cambridge and RSA

Friday 9 June 2023 – Morning

A Level Physics A

H556/02 Exploring physics

Time allowed: 2 hours 15 minutes



You must have:

- the Data, Formulae and Relationships booklet

You can use:

- a scientific or graphical calculator
- a ruler (cm/mm)



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

--	--	--	--	--

Candidate number

--	--	--	--

First name(s)

Last name

StemUp Model Solution

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **100**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE

- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **30 minutes** on this section.

Write your answer to each question in the box provided.

1 Which of these units is a base unit?

- A A
- B J
- C m^2
- D N

Your answer

A

[1]

2 The accepted value of g is 9.81 ms^{-2} . In an experiment to verify the value of g , students obtained a value of 10.20 ms^{-2} .

What is the percentage difference between the students' value and the accepted value of g ?

- A 1%
- B 2%
- C 4%
- D 8%

Your answer

C

[1]

3 Which of these statements is/are true?

- 1 Antiprotons are hadrons so are subject to the strong nuclear and weak nuclear forces.
- 2 Neutrons are subject to the weak nuclear force only.
- 3 The weak nuclear force is the only force that causes a change of quark type.

- A 1, 2 and 3
- B Only 1 and 2
- C Only 1 and 3
- D Only 3

Your answer

C

[1]

- 4 A 200 W heater is used for 90 minutes. The cost per kWh is 13 pence.

How much did it cost to use the heater?

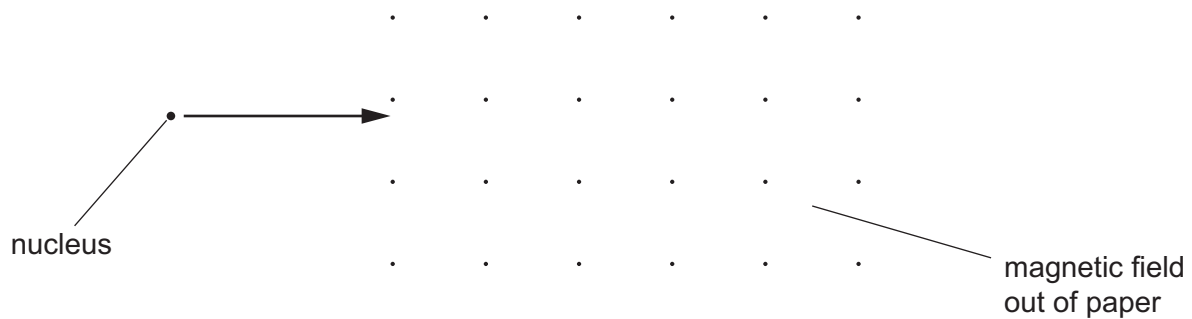
- A 3.9p
- B 39p
- C £2.34
- D £23.40

Your answer

A

[1]

- 5 The diagram shows the path of a nucleus entering a magnetic field.



In which direction does the force on the nucleus act as it enters the magnetic field?

- A down the page
- B into the page
- C out of the page
- D up the page

Your answer

A

[1]

- 6 Technetium-99m (Tc-99m) is a metastable isotope used in medical diagnosis.

Which ionising radiation does Tc-99m emit?

- A alpha
- B beta-minus
- C beta-plus
- D gamma

Your answer

D

[1]

- 7 The power dissipated across a $1\text{ k}\Omega$ resistor is 20 W .

What is the potential difference across the resistor?

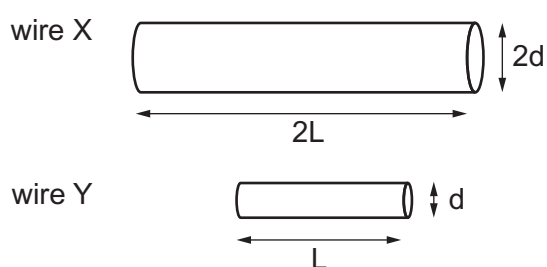
- A 0.02 V
- B 50 V
- C 140 V
- D $20\,000\text{ V}$

Your answer

C

[1]

- 8 The diagram shows the relative lengths and diameters of two copper wires, labelled wire X and wire Y.



What is the ratio of the resistivity of wire Y to wire X?

- A 1:1
- B 1:2
- C 1:4
- D 1:8

Your answer

A

[1]

- 9 The centres of a positron and a helium nucleus are separated by 2 mm.

What is the electrostatic force between them?

- A $1.15 \times 10^{-28} \text{ N}$
 B $2.30 \times 10^{-25} \text{ N}$
 C $5.75 \times 10^{-23} \text{ N}$
 D $1.15 \times 10^{-22} \text{ N}$

Your answer

D

[1]

- 10 A column of air in a tube of length L , closed at one end, is forced to vibrate at its fundamental frequency. A standing wave is set up inside the tube.

Which row in the table is correct for this standing wave?

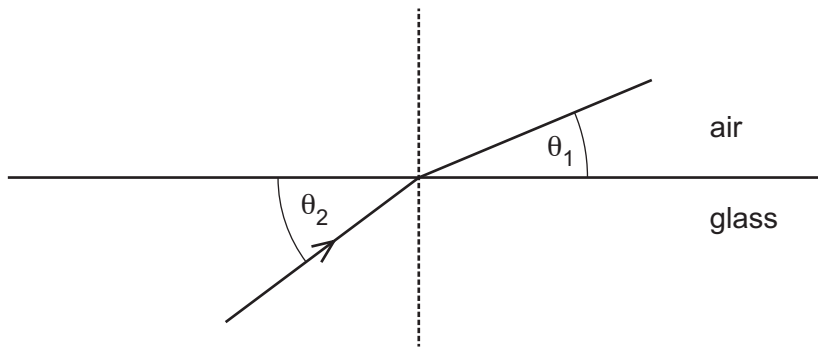
	Number of nodes inside the tube	Wavelength/m
A	1	L
B	1	$2L$
C	1	$4L$
D	2	$2L$

Your answer

C

[1]

- 11 A ray of light is travelling through glass with refractive index $n = 1.51$. The diagram (not to scale) shows light incident on a glass/air interface.



Which of these statements is/are true?

- 1 wavelength of light in glass < wavelength of light in air
- 2 $n_{\text{glass}} = 2n_{\text{air}}$
- 3 $\theta_2 > 48^\circ$

- A** 1 only
- B** 1 and 2
- C** 3 only
- D** 1 and 3

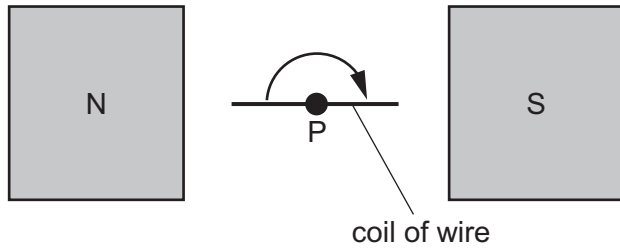
Your answer

D

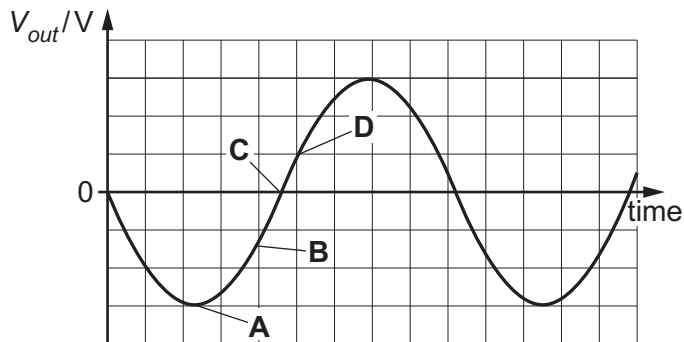
[1]

- 12 The diagram shows a coil of wire rotating between two permanent magnets in a model generator.

The coil is rotating clockwise about point P at constant angular velocity.



Which letter represents the output of the generator at the instant in the diagram?



Your answer

A

[1]

- 13 In the Rutherford scattering experiment alpha particles are directed at a gold foil.

Gold nuclei have 79 protons. The distance of closest approach is 47.0 fm.

Which is the best estimate of the work done on an alpha particle as it moves from 53.0 fm to the point of closest approach?

- A 10^{-18} J
- B 10^{-16} J
- C 10^{-15} J
- D 10^{-13} J

Your answer

D

[1]

- 14** A step-down transformer has an input potential difference of 200 V. There are 250 turns on the primary coil and 50 turns on the secondary coil. The secondary coil is connected to a $1.0\text{ k}\Omega$ resistor.

What is the current through the resistor?

- A** $2 \times 10^{-4}\text{ A}$
- B** 0.04 A
- C** 1 A
- D** 40 A

Your answer

B

[1]

- 15** Which statement is Faraday's law?

- A** The direction of electric current induced by a changing magnetic field is such that the magnetic field created by the induced current opposes changes in the initial magnetic field.
- B** The magnitude of the electrostatic force between two point charges is directly proportional to the product of the magnitudes of charges and inversely proportional to the square of the separation.
- C** The magnitude of induced EMF is proportional to the rate of change of the magnetic flux linkage.
- D** The total energy of an isolated system remains constant.

Your answer

C

[1]

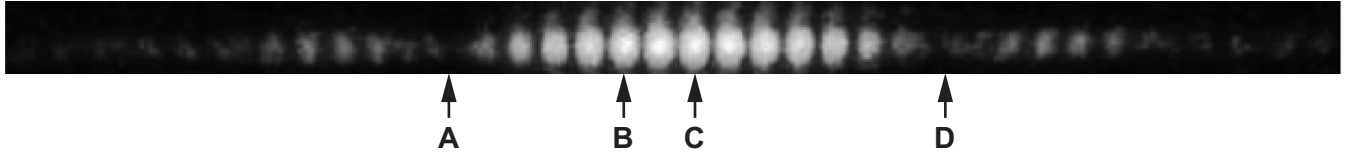
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Section B

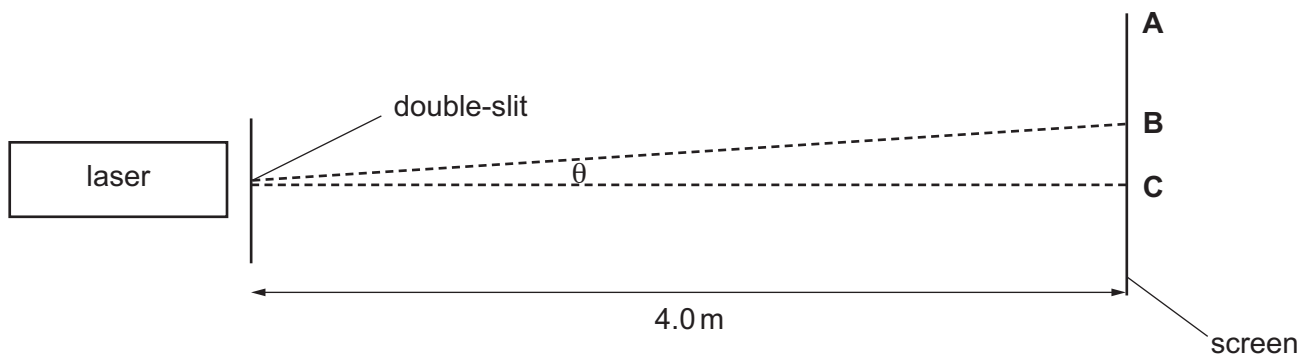
- 16 Fig. 16.1 shows the pattern obtained in a Young double-slit experiment. The pattern is **not** to scale. Three regions of the pattern are labelled **A**, **B** and **D**. The central maximum is labelled **C**.

Fig. 16.1



Red light of wavelength 640 nm was used in the experiment. The distance between the centres of the two slits was $1.00 \times 10^{-5} \text{ m}$. The distance from the double-slit to the screen was 4.0 m .

Fig. 16.2



- (a) Name the physical processes that cause the features labelled **A**, **D** and **B**, **C** in Fig. 16.1.

A and **D** *destructive interference (waves arrive in antiphase)*.....

B and **C** *constructive interference (waves arrive in phase)*.....

[2]

- (b) The Young double-slit experiment uses **coherent** waves. State what **coherent** means.

The waves have a constant (fixed) phase difference between them......

[1]

- (c) Explain how the part of the pattern labelled **B** is formed.

Waves from the two slits arrive at B in phase and interfere constructively. B is the second maximum from C, so the path difference is 2λ (phase difference 720°)......

[2]

- (d) Calculate the angle θ from the central maximum **C** to the maximum labelled **B** as shown in Fig. 16.2.

$$x = \lambda D / a = (640 \times 10^{-9} \times 4.0) / (1.00 \times 10^{-5}) = 0.256 \text{ m}$$

$$B \text{ is two fringe spacings from } C: BC = 2x = 2 \times 0.256 = 0.512 \text{ m}$$

$$\tan \theta = 0.512 / 4.0 = 0.128$$

$$\theta = \tan^{-1}(0.128) = 7.3^\circ$$

$$\theta = 7.3 \dots\dots\dots^\circ \text{ [3]}$$

17 Ultrasound B-scans can be used to image unborn babies.

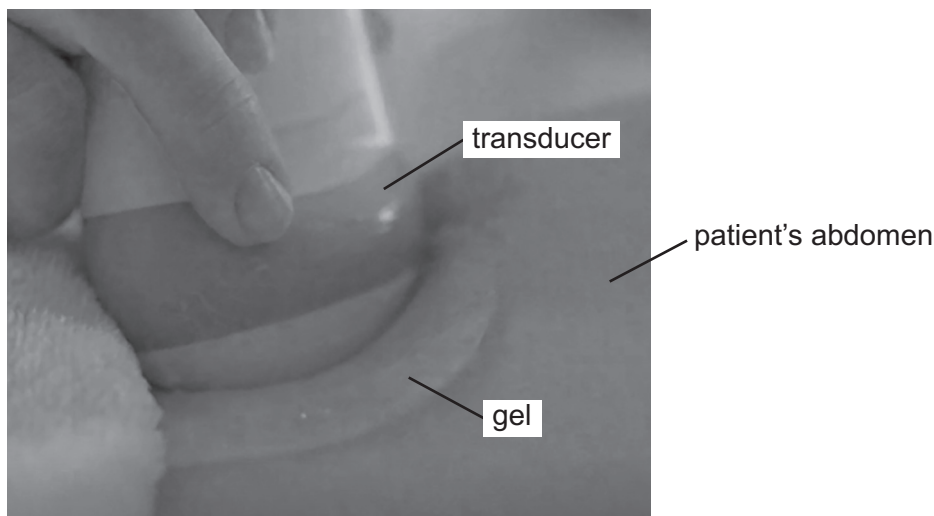
(a) Explain what is meant by ultrasound.

Ultrasound is a longitudinal (pressure) wave with a frequency greater than 20 kHz, above the upper limit of human hearing.

[2]

(b)* Fig. 17.1 is a labelled photograph of an ultrasound examination of a patient.

Fig. 17.1



Explain how the transducer both produces and receives ultrasound waves.

Explain the purpose of the gel.

[6]

Producing: a high frequency alternating p.d. is applied across the faces of a piezoelectric crystal in the transducer. This makes the crystal repeatedly expand and contract (oscillate, resonating) at the same high frequency, so it emits ultrasound waves into the body.

The ultrasound is sent out in short pulses. Receiving: between pulses the reflected ultrasound returning from boundaries inside the body is incident on the same crystal, making it change shape (vibrate). This induces an alternating p.d. across the crystal, which is processed to form the image.

Gel: the acoustic impedance of air is very different from that of skin (the body), so without gel almost all the ultrasound would be reflected at the air

to skin boundary, since $I_r/I_0 = (Z_2 - Z_1)^2 / (Z_2 + Z_1)^2$ is close to 1.

The gel removes the air gap and has an acoustic impedance similar to that of skin, so there is very little reflection at the body boundary. This allows most of the ultrasound to be transmitted into the patient's body and the reflected

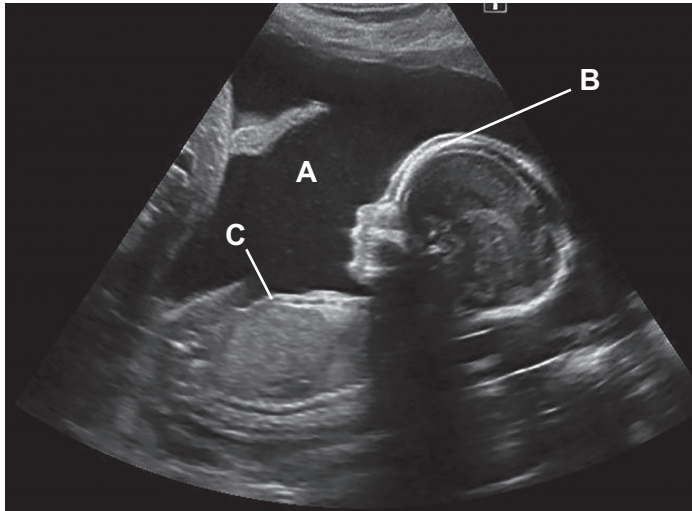
Additional answer space if required

waves to be transmitted back out to the transducer.

Question 17 continues on page 14

- (c) Fig. 17.2 shows a B-scan of an unborn baby.

Fig. 17.2



- (i) Explain why no signal is received back from **A**.

A is a single uniform medium (fluid) with no boundary, so there is no change in acoustic impedance and nothing to reflect the ultrasound. [1]

- (ii) Explain why a greater signal is received back from **B** than **C**.

Acoustic impedance of B (skull bone) is different from C (soft tissue). The change in acoustic impedance at B (relative to fluid A) is greater than at C, so more intensity is reflected. [2]

- (d) Doppler ultrasound can be used to measure the speed of blood flow through blood vessels.

The speed of ultrasound in blood is 1600 ms^{-1} .

A transducer emitting ultrasound of frequency 10.0000 MHz is placed at 50° to the blood vessel.

The reflected ultrasound has a frequency of 9.9987 MHz .

Calculate the speed v of the blood flow.

$$\Delta f = 10.0000 \text{ MHz} - 9.9987 \text{ MHz} = 1300 \text{ Hz}$$

$$\Delta f / f = 2v \cos \theta / c \text{ so } v = \Delta f c / (2f \cos \theta)$$

$$v = (1300 \times 1600) / (2 \times 10.0000 \times 10^6 \times \cos 50^\circ)$$

$$v = 0.162 \text{ m s}^{-1}$$

$$v = 0.16 \text{ ms}^{-1} \text{ [2]}$$

18 Fig. 18 represents a tube open at both ends.

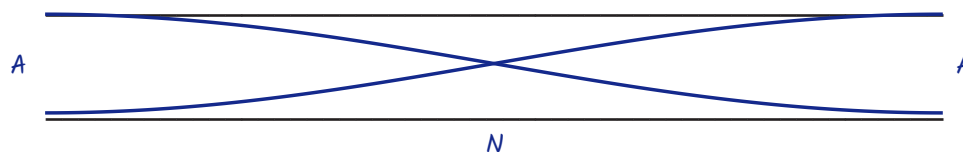
Air inside the tube is forced to oscillate by a speaker and produces a standing wave.

The length of the tube is 30.0 cm.

The wave speed inside the tube is 340 ms^{-1} .

(a) On Fig. 18 sketch the standing wave for the fundamental mode of vibration.

Fig. 18



[1]

(b) Calculate the frequency f_0 of the speaker that is producing the standing wave inside the tube.

$$\lambda = 2L = 2 \times 0.300 = 0.600 \text{ m}$$

$$f_0 = v / \lambda = 340 / 0.600$$

$$f_0 = .567 \dots \text{ Hz [1]}$$

(c) The frequency of the speaker is increased.

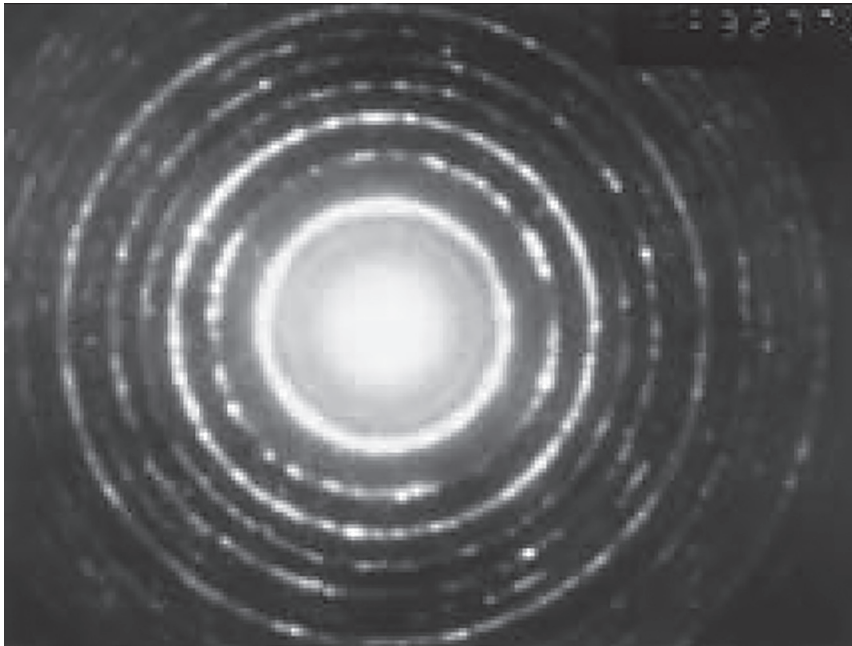
Calculate the next frequency f_1 that will produce a standing wave in this tube.

$$\text{Next standing wave (second harmonic): } \lambda = L = 0.300 \text{ m}$$

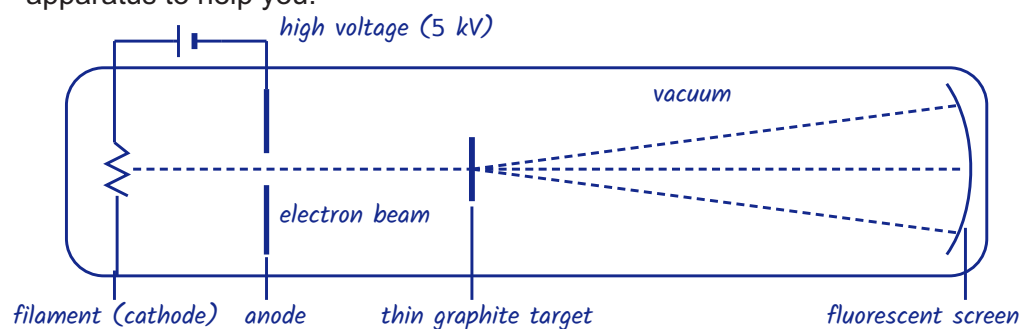
$$f_1 = v / \lambda = 340 / 0.300 = 1133 \text{ Hz}$$

$$f_1 = .113 \times 10^3 \dots \text{ Hz [2]}$$

- 19 The picture shows an electron diffraction pattern produced by graphite in a cathode-ray tube.



- (a) Describe the experiment that produces this pattern. Draw a labelled diagram of the apparatus to help you.



The tube is evacuated so electrons are not scattered by air. A low voltage supply heats the filament (cathode), which releases electrons by thermionic emission. The electrons are accelerated towards the anode through a high p.d. (5 kV). The beam passes through a thin graphite target, is diffracted, and hits the fluorescent screen, which glows to show rings. [4]

- (b) Explain why light and dark circles as shown in the picture are produced, stating what this evidence provides about electron behaviour.

This is evidence of the wave nature of electrons; the electrons are diffracted by the gaps between the graphite atoms and the diffracted waves interfere. Light circles: waves arrive in phase, giving constructive interference. Dark circles: waves arrive in antiphase (phase difference 180°), giving destructive interference. [3]

(c) A potential difference (p.d.) 5 kV is used to accelerate the electrons.

(i) Calculate the work done W on the electrons.

$$W = eV = 1.60 \times 10^{-19} \times 5.0 \times 10^3$$

$$W = 8.0 \times 10^{-16} \text{ J [1]}$$

(ii) Calculate the de Broglie wavelength λ of the accelerated electrons.

$$\frac{1}{2}mv^2 = W: v = \sqrt{2 \times 8.0 \times 10^{-16} / 9.11 \times 10^{-31}}$$

$$v = 4.19 \times 10^7 \text{ m s}^{-1}$$

$$p = mv = 9.11 \times 10^{-31} \times 4.19 \times 10^7 = 3.82 \times 10^{-23} \text{ kg m s}^{-1}$$

$$\lambda = h / p = 6.63 \times 10^{-34} / 3.82 \times 10^{-23}$$

$$\lambda = 1.74 \times 10^{-11} \text{ m}$$

$$\lambda = 1.74 \times 10^{-11} \text{ m [2]}$$

(iii) Suggest a value for the spacing between the graphite atoms.
Justify your answer.

About $1.7 \times 10^{-11} \text{ m}$ (same order as λ), because for electrons to be diffracted the gap between atoms must be approximately the same size as the de Broglie wavelength. [1]

- 20 In an experiment a circuit is set up so that a capacitor with a resistor in series can be charged and at some later time discharged through the same resistor without changing the positions of the components. This process can be repeated.

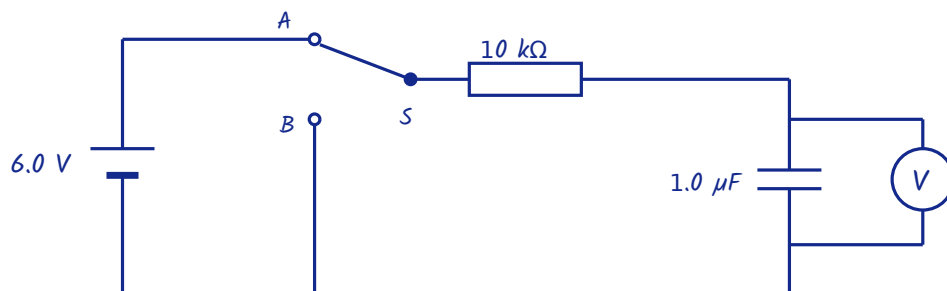
The supply has a potential difference (p.d.) 6.0 V d.c.

The capacitor has capacitance $1.0 \mu\text{F}$.

The resistor has resistance $10 \text{ k}\Omega$.

A voltmeter is used to measure the p.d. across the capacitor.

- (a) Draw a circuit diagram for this experiment.



[2]

- (b) Calculate the charge Q stored on the capacitor when it is fully charged.

$$Q = CV = 1.0 \times 10^{-6} \times 6.0$$

$$Q = 6.0 \times 10^{-6} \text{ C [1]}$$

- (c) Use a calculation to explain why it will not be possible to measure the variation of p.d. across the capacitor with time, using a stop watch.

$$\text{Time constant } \tau = CR = 1.0 \times 10^{-6} \times 10 \times 10^3 = 0.010 \text{ s}$$

τ is the time for the p.d. to fall to $1/e$ (37%) of its initial value.

$$V = V_0 e^{-t/CR}; \text{ to fall to } 0.6 \text{ V (10\% of } 6.0 \text{ V),}$$

$$t = CR \ln(6.0 / 0.6) = 0.010 \times \ln 10 = 0.023 \text{ s}$$

This is far less than human reaction time (about 0.2 s), so the p.d. changes too quickly to record with a stop watch. [4]

- (d) State how this experiment can be modified to measure the variation of p.d. across the capacitor with time as the capacitor charges.

Connect the voltmeter (voltage sensor) to a data logger, or use an oscilloscope, to record the p.d. at very short time intervals. [1]

- (e) The capacitor was completely charged and then discharged to 4.12 V.

- (i) Calculate the time t required for the p.d. across the capacitor to reach 4.12 V when discharging.

$$V = V_0 e^{-t/CR} \quad \text{so} \quad 4.12 = 6.0 e^{-t/0.010}$$

$$t = 0.010 \times \ln(6.0 / 4.12) = 0.010 \times 0.376$$

$$t = 3.76 \times 10^{-3} \text{ s}$$

$$t = 3.76 \times 10^{-3} \text{ s} \quad [2]$$

- (ii) Calculate the average rate at which energy is lost by the capacitor as it discharges from 6.0 V to 4.12 V.

$$\Delta E = \frac{1}{2} C V_1^2 - \frac{1}{2} C V_2^2$$

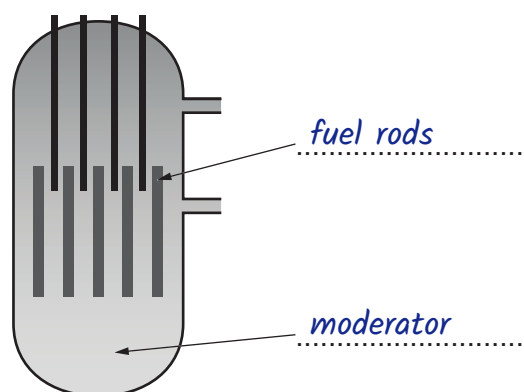
$$\Delta E = \frac{1}{2} \times 1.0 \times 10^{-6} \times (6.0^2 - 4.12^2) = 9.51 \times 10^{-6} \text{ J}$$

$$\text{rate} = \Delta E / t = 9.51 \times 10^{-6} / 3.76 \times 10^{-3}$$

$$\text{rate} = 2.53 \times 10^{-3} \text{ J s}^{-1}$$

$$\text{average rate at which energy is lost} = 2.53 \times 10^{-3} \text{ J s}^{-1} \quad [3]$$

- 21 The diagram shows a simplified layout of a nuclear fission reactor used in a nuclear power station.



- (a) Complete the labels on the diagram [2]

- (b)* Describe how fission of nuclei is induced and controlled in the nuclear reactor.

Show how fission leads to the release of large amounts of energy.

The following masses may be useful.

Particle	Mass / u
U-235 nucleus	235.04395
Ba-141 nucleus	140.91440
Kr-92 nucleus	91.92617
${}^1_0\text{n}$ neutron	1.00867

[6]

A slow (thermal) neutron is absorbed by a U-235 nucleus, which becomes an unstable U-236 nucleus. This undergoes fission into two smaller daughter nuclei and 2 or 3 fast neutrons, e.g. $n + \text{U-235} \rightarrow \text{Ba-141} + \text{Kr-92} + 3n$. The moderator (e.g. graphite or water) slows the fast neutrons down by collisions so that they can be absorbed by other U-235 nuclei, causing further fissions: a chain reaction. Control rods (e.g. boron) are raised or lowered to absorb excess neutrons, so that on average one neutron from each fission causes another fission and the rate of fission stays constant. Mass before = $235.04395 + 1.00867 = 236.05262 \text{ u}$

$$\text{Mass after} = 140.91440 + 91.92617 + (3 \times 1.00867) = 235.86658 \text{ u}$$

$$\text{Mass defect} = 0.18604 \text{ u} = 0.18604 \times 1.661 \times 10^{-27} = 3.090 \times 10^{-28} \text{ kg}$$

$$E = \Delta mc^2 = 3.090 \times 10^{-28} \times (3.00 \times 10^8)^2 = 2.78 \times 10^{-11} \text{ J (about 174 MeV) per fission.}$$

Additional answer space if required

This energy is released as kinetic energy of the products. 1 kg of U-235 contains about 2.6×10^{24} nuclei, so a very large amount of energy (about 7×10^{13} J) is released.

- (c) The energy released from the fusion of 1 kg of hydrogen is more than seven times the energy released by the fission of 1 kg of uranium.

Compare the practicalities of using nuclear fusion of hydrogen with using nuclear fission of uranium to meet our energy needs.

Fission technology is established; fusion reactors are not yet established. A

fission chain reaction is self-sustaining once started, but fusion needs

extremely high temperatures and pressures and the plasma is hard to contain.

Uranium is finite and must be enriched; hydrogen fuel is effectively unlimited

(from sea water). Fission produces long half-life radioactive waste and risks

meltdown; fusion produces effectively no radioactive waste. [4]

- 22 Radiographers commonly use molecules containing fluorine F-18 as tracers in positron emission tomography (PET) scanning.

Fluorine has a proton number of 9.

F-18 decays to oxygen (O) by β^+ decay.

- (a) Write the equation for the decay of a nucleus of F-18 using nuclear notation.



[2]

- (b) The β^+ particle (positron) produced travels only a short distance in the patient before it meets an electron and is annihilated.

Calculate the wavelength λ of gamma photons produced.

Each photon has energy $m_e c^2$ (annihilation gives two photons):

$$E = mc^2 = 9.11 \times 10^{-31} \times (3.00 \times 10^8)^2 = 8.20 \times 10^{-14} \text{ J}$$

$$E = hc / \lambda \text{ so } \lambda = hc / E = 6.63 \times 10^{-34} \times 3.00 \times 10^8 / 8.20 \times 10^{-14}$$

$$\lambda = 2.43 \times 10^{-12} \text{ m}$$

$$\lambda = 2.4 \times 10^{-12} \text{ m} \quad [3]$$

- (c) X-rays and gamma-rays are produced by different physical processes.

Briefly describe both processes.

X-rays: produced when fast-moving electrons hit a metal target and decelerate rapidly, losing kinetic energy.

Gamma rays: emitted from unstable nuclei as they decay (de-excite). [2]

- (d) F-18 has a half-life of 109.7 minutes.

Explain the advantage that this has for the patient but the disadvantage that this has for the radiographers.

The half-life is short, so the activity is high and F-18 decays quickly.

Advantage: the patient's exposure to ionising radiation is kept as low as possible.

Disadvantage: radiographers have only a short time to scan and diagnose the patient, and F-18 must be made on site just before use. [3]

23
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

23 As light passes through a substance its intensity decreases exponentially with distance.

$$I_x = I_0 e^{-\mu x}$$

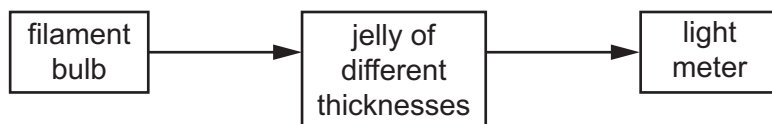
I_x is the intensity of light at a given thickness of jelly

I_0 is the intensity of light immediately before it enters the jelly

μ is the constant of proportionality

x is the thickness of the jelly that the light has passed through.

Some students are studying the absorption of visible light by red jelly. They set up the experiment below.

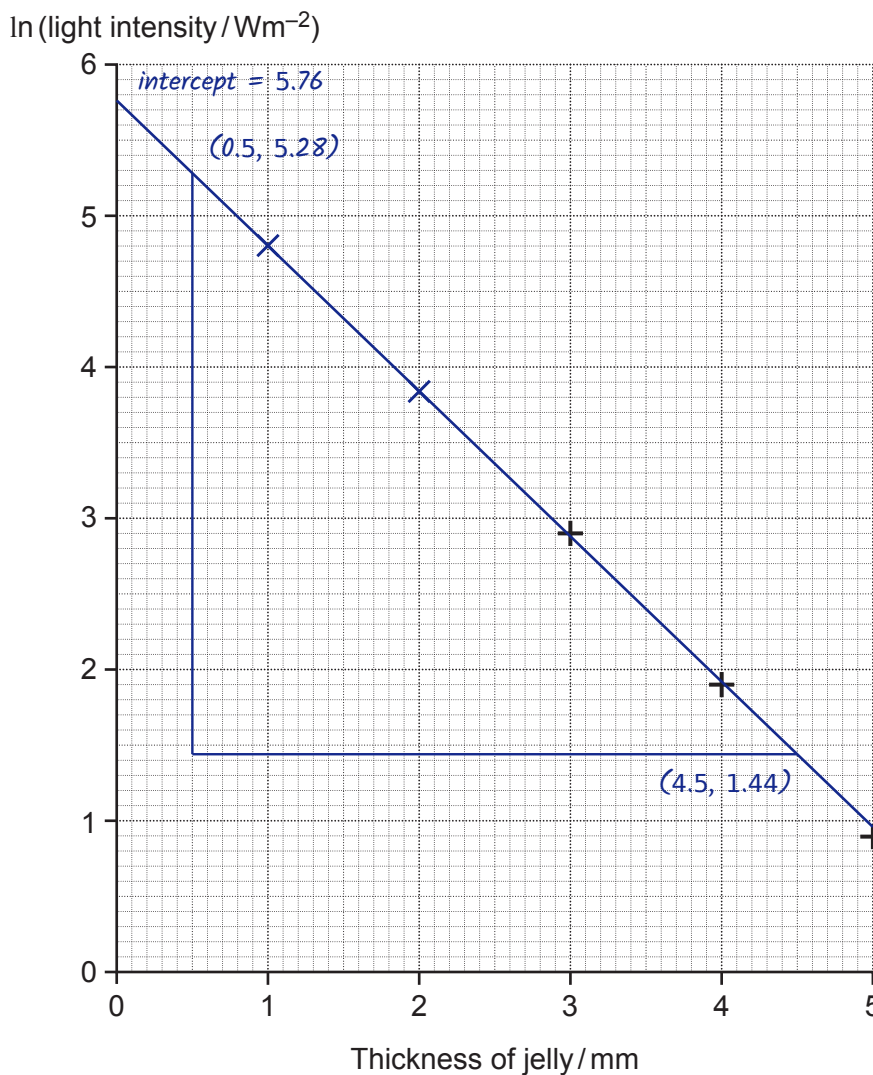


- The power to the bulb is kept constant.
- The distance between the bulb and the light meter is kept constant.
- Blocks of jelly of different thickness are used.
- They measure the intensity of light using a light meter.

(a) The table below shows their results and the natural log of the light intensity.

Thickness of jelly/mm	Light intensity/Wm ⁻²	ln (light intensity/Wm ⁻²)
1	122	4.804
2	46.5	3.839
3	17.8	2.88
4	6.82	1.92
5	2.62	0.960

- (i) Complete the last column of the results table for the 1 mm and 2 mm thicknesses of jelly. [1]
- (ii) Plot the results from the table on the graph. Three points have already been plotted. [1]



(iii) Draw a best-fit straight line through your data points. [1]

(b) (i) Show how the equation for exponential absorption of light can give a straight line graph with a negative gradient.

$$I_x = I_0 e^{-\mu x} \text{ so taking natural logs: } \ln I_x = \ln I_0 - \mu x$$

$$\ln I_x = -\mu x + \ln I_0 \text{ compare with } y = mx + c$$

$$y = \ln I_x, \text{ gradient } m = -\mu \text{ (negative), } y\text{-intercept } c = \ln I_0$$

[2]

(ii) Use your graph to determine the intensity of the light I_0 before it enters the jelly.

$$y\text{-intercept} = 5.76 = \ln I_0 \text{ so } I_0 = e^{5.76} = 317$$

$$I_0 = 320 \dots\dots\dots \text{ Wm}^{-2} \quad [2]$$

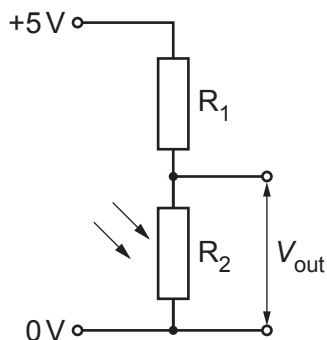
- (iii) Use your graph to determine the constant of proportionality μ in units of mm^{-1} .

$$\text{gradient} = (1.44 - 5.28) / (4.5 - 0.5) = -3.84 / 4.0 = -0.96 \text{ mm}^{-1}$$

$$\mu = -\text{gradient} = 0.96$$

$$\mu = 0.96 \dots \text{mm}^{-1} \quad [2]$$

- (c) The students decide to make their own light meter using this circuit.



The value of R_1 is $5 \text{ k}\Omega$. The value of R_2 was 100Ω when 1 mm jelly was used and $8 \text{ k}\Omega$ when 5 mm jelly was used.

- (i) Calculate the output voltage range obtained in this experiment.

$$V_{\text{out}} = 5 \times R_2 / (R_1 + R_2)$$

$$1 \text{ mm: } 5 \times 100 / 5100 = 0.098 \text{ V} \quad 5 \text{ mm: } 5 \times 8000 / 13000 = 3.08 \text{ V}$$

$$\text{range} = 0.098 \text{ to } 3.08 (2.98) \dots \text{V} \quad [2]$$

- (ii) Describe **two** ways the output voltage range could be increased.

1 Increase the input (supply) e.m.f. above 5 V.

2 Decrease the resistance of the fixed resistor R_1 .

[2]

- (iii) Explain how the circuit responds to a change in light intensity.

As the light intensity increases, the resistance of the LDR (R_2) decreases, so the p.d. across R_2 (V_{out}) decreases, and vice versa.

[1]

END OF QUESTION PAPER

[illegible]

Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of Cambridge University Press & Assessment, which is itself a department of the University of Cambridge.

© OCR 2023