Oxford Cambridge and RSA

Practice paper – Set 1

AS Level Physics A
H556/02 Exploring Physics

MARK SCHEME

Duration: 2 hour 15 minutes

MAXIMUM MARK 100

Final

MARKING INSTRUCTIONS

Generic version as supplied by OCR Sciences

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

SECTION A

Question	Answer	Marks	Guidance
1	C	1	
2	D	1	
3	B	1	
4	B	1	
5	A	1	
6	C	1	
7	D	1	
8	A	1	
9	A	1	
10	C	1	
11	C	1	
12	D	1	
13	B	1	
14	A	1	
15	D	1	
	Total	15	

SECTION B

Question			Answer	Marks	Guidance
16	a		current = $\frac{0.060}{2.4}$ or current = 0.025 (A) $R = \frac{6.0-2.4}{0.025}$ R = 140 (Ω)	C1 C1 A1	**Note** answer to 3 sf is 144 Ω
	b		$I = Anev$ and $A = 2.0 \times 10^{-6}$ (m^2) $0.025 = 2.0 \times 10^{-6} \times 1.4 \times 10^{25} \times 1.60 \times 10^{-19} \times v$ $v = 5.6 \times 10^{-3}$ (m s^{-1})	C1 C1 A1	**Allow** any subject Possible ecf
	c		The current is constant, therefore $v \propto n^{-1}$. The mean drift velocity is therefore smaller.	M1 A1	
	d	i	With the variable resistor set at zero / close to zero, the p.d. across the resistor is zero / small, so p.d. across lamp is 2.4 V / large. With the variable resistor set at its maximum value, there is a p.d. across the variable resistor, so p.d. across the lamp is not small.	B1 B1	
	d	ii	The lamp is connected to the slider contact of a potentiometer arrangement. Ammeter and voltmeter connected correctly.	B1 B1	
			Total	**12**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>17</td><td>a</td><td></td><td>Level 3 (5–6 marks)
Clearly labelled diagram.
Procedure is correct including appropriate measurements
Analysis is correct and includes A5.
(6 marks)
Any point omitted or incorrect (5 marks).
There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)
Good diagram.
Most measurements made
Some analysis.
(4 marks)
Any point omitted or incorrect (3 marks).
There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.

Level 1 (1–2 marks)
Basic diagram with incomplete labels.
Some measurements.
Limited analysis.
(Maximum 2 marks)
The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.

0 marks
No response or no response worthy of credit.</td><td>B1 × 6</td><td>Diagram
1. Labelled diagram of glass block & ray box
2. Incident and refracted rays shown
3. Normal shown and correct i and r

Procedure
1. Block placed on paper
2. Incident and refracted rays marked
3. Angles measured using a protractor

Analysis
1. sin i and sin r calculated
2. sin i against sin r graph plotted
3. Straight line of best fit drawn
4. gradient = refractive index (n)
5. Error bars drawn to find the gradient</td></tr>
</table>

Question			Answer	Marks	Guidance
	b		The ray is refracted away from the normal, therefore the refractive index of water is less than the refractive index of glass or speed of light in water is greater than the speed of light in glass. The frequency remains constant. $v = f\lambda$ and therefore the wavelength of light increases as it travels from glass to water.	B1 B1 B1	
			Total	**9**	

Question			Answer	Marks	Guidance
18	a		Waves / sources with constant phase difference.	B1	
	b	i	Place a microphone close to loudspeaker and connect it to the oscilloscope. Measure the number of divisions between neighbouring peaks of the signal. (AW) The separation between the neighbouring peaks should be 3.6 divisions.	B1 B1 B1	**Allow** 'connect oscilloscope to the signal generator (which is connected to the loudspeaker)'
		ii	The sound is diffracted at each slit. The diffracted waves interfere in the space beyond the slits. There is loud sound / maxima / constructive interference when phase difference is zero or when path difference $n\lambda$. There is quiet sound / minima / destructive interference when phase difference is 180° or when path difference is $(n + ½)\lambda$.	B1 B1 B1 B1	
		iii	$x = 2 \times 0.75$ (= 1.5 m) $\lambda = \frac{0.40 \times 1.5}{5.0}$ $\lambda = 0.12$ (m)	C1 C1 C1	
		iv	$v = 2800 \times 0.12$ $v = 340$ (m s^{-1})	B1	Possible ecf from **(iii)**
		v	Position does not depend on intensity, hence no change. Intensity decreases by a factor of 4.	B1 M1 A1	
			Total	**15**	

Question			Answer	Marks	Guidance
19	a		$Q = It$ and $e = 1.6 \times 10^{-19}$ (C) number of electrons = $0.24 \times 10^{-6} \times 5.0/1.6 \times 10^{-19}$ number of electrons = 7.5×10^{12}	C1 C1 A1	
	b		$\frac{hc}{\lambda} = \phi + KE_{\max}$ and $\phi = 2.3 \times 1.6 \times 10^{-19}$ $\frac{6.63\times10^{-34}\times3.00\times10^{8}}{5.1\times10^{-7}} = 2.3\times1.6\times10^{-19} + KE_{\max}$ $KE_{\max} = 2.2 \times 10^{-20}$ (J)	C1 C1 A1	**Allow** 3 marks for an answer of 2.0×10^{-20} J; value of h to 2 s.f. is used.
	c		The rate of photons incident on **M** is doubled. The rate of emission of photoelectrons / current is doubled.	B1 B1	
			Total	**8**	

Question			Answer	Marks	Guidance
20	a		The decay constant is the probability of decay of a nucleus per unit time.	B1	**Allow**: The decay constant is the fraction of nuclei decaying per unit time. **Allow**: decay constant = activity ÷ number of nuclei left in a sample
	b		number decaying in 1st second = 2000 × 0.10 = 200 number decaying in the 2nd second = 1800 × 0.10 = 180 number left = 1800 – 180 = 1620	C1 A1	
	c		**Level 3 (5–6 marks)** Correct explanation Correct determination of λ and half-life Correct determination of uncertainty (Maximum 6 marks) Any point omitted or incorrect (5 marks). *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Mostly correct explanation Mostly correct determination of λ and half-life Some attempt of determining uncertainty (Maximum 4 marks) Any point omitted or incorrect (3 marks). *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Basic explanation	B1 × 6	**Explanation** 1. $A = A_0e^{-\lambda t}$ 2. $\ln A = \ln A_0 - \lambda t$ 3. A graph of ln$A$ against t will be a straight line with gradient (-) λ 4. half-life = ln2/λ **Determination** 1. Line of best fit drawn 2. Gradient determined using a large triangle 3. decay constant in the range 0.5 to 0.7 min^{-1} 4. half-life in the range 1.0 to 1.4 min **Uncertainty** 1. Worst line of fit drawn 2. Correct attempt to determine uncertainty

Question			Answer	Marks	Guidance
			Some attempt to determine λ or half-life No attempt at uncertainty. (Maximum 2 marks) *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.		
			Total	**9**	

Question			Answer	Marks	Guidance
21	a	i	The force is right angles to the motion / velocity. The particle describes a circle in the plane of the paper.	B1 B1	
		ii	Particle experiences a force perpendicular to motion / velocity. It moves to the right and either comes out or goes into the plane of the paper (in a parabolic path).	B1 B1	
	b	i	$V \propto 1/r$ or distance = 3R V = 5400 (V)	C1 A1	
		ii1	$5400 = \dfrac{Q}{4\pi \times 8.85 \times 10^{-12} \times 0.04}$ (Any subject) $Q = 2.4 \times 10^{-8}$ (C)	C1 A1	Possible ecf from**(b)(i)**
		ii2	$E = \dfrac{2.4 \times 10^{-8}}{4\pi \times 8.85 \times 10^{-12} \times 0.04^2}$ $E = 1.35 \times 10^{5}$ (N C^{-1})	C1 A1	Possible ecf from **(b)(ii)1**
	c		The magnitude of the electric potential is the same for both particles at the midpoint but of opposite sign. The (total) potential at the midpoint is zero.	B1 B1	
			Total	**12**	

Question			Answer	Marks	Guidance
22	a		The splitting of a (uranium) nucleus as a neutron is absorbed (into two fragment nuclei and neutrons).	B1	
	b		The moderator slows down the fast-moving neutrons. The neutrons lose significant amount of their kinetic energy when colliding with moderator nuclei. or The moderator does not absorb the neutrons The control rods absorb the neutrons. The rate of fission reactions is less / reduced.	B1 B1 B1 B1	
	c	i	2	B1	
		ii	Zero	B1	
		iii	Δm = 236.053 – 235.840 = 0.213 u $\Delta E = [0.213 \times 1.661 \times 10^{-27}] \times (3.0 \times 10^8)^2 = 3.184 \times 10^{-11}$ (J) number of reactions per second = $10^9/3.184 \times 10^{-11}$ number of reactions per second = 3.1×10^{19} (s^{-1})	C1 C1 C1 A1	
			Total	**11**	

Question			Answer	Marks	Guidance
23	a		Simple scatter: X-ray (photon) is scattered by an atomic electron. Pair production: An X-ray (photon) transforms into an electron and positron pair.	B1 B1	
	b		$\frac{hc}{\lambda} = 2 \times 9.11 \times 10^{-31} \times (3.0 \times 10^{8})^{2}$ $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{2 \times 9.11 \times 10^{-31} \times (3.0 \times 10^{8})^{2}}$ $\lambda = 1.2 \times 10^{-12}$ (m)	C1 C1 A1	**Allow** 2 marks for 2.4×10^{-12} (m); factor of 2 omitted in the first line.
	c		The intensity decreases with thickness of muscle / bone. The decrease is exponential. The attenuation (absorption) coefficient μ of bone must be greater than the μ of muscle because there is a significant decrease in the intensity from x = 3.0 cm to 4.0 cm.	B1 B1 B1 B1	
			Total	**9**	