Physics A Level | OCR A | H556

Practice Exams for A Level OCR A Physics

Paper 3: Unified Physics

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Contents

Teacher's Introduction

These practice examinations support the OCR A Level specification for Physics A (H556). This specification is new, and the first examinations began in 2017. This means that students have very limited access to past papers.

Although students can work through many relevant questions from textbooks and old syllabuses, they are unable to get a proper feel for the format, scope and length of the three papers that they will have to sit in the real examination period.

These practice examinations have, therefore, been [illegible] so that teachers can gi
in doing whole 'past papers'. Each paper follows the exact same format and mark
examination. The whole specification is addressed, and the papers meet the mini
mathematical skills and 15% [illegible] skills required by the exam board. The mark
same format as the [illegible] schemes and use the same language, so that studen
understand how mark schemes work and what the examiners are expecting

These papers are best used in their entirety, either as a mock paper sat under exa
homework exercise set in the last weeks before the examination period. This give
learn how to pace themselves correctly. They will also be less anxious as the exam
since they know better what to expect.

Questions marked with an asterisk (*) are level of response questions which test s
communication skills.

Note regarding non-write-on section
Set 3: Paper 3 contains some content that requires drawing on a graph or table. A
this test which should be handed out to students before beginning the paper.

Specification Cross-Reference Table

	Paper 1				Paper 2		
	Set 1	Set 2	Set 3	Set 4	Set 1	Set 2	S
Module 2: Foundations of physics							
2.1 Physical quantities and units	2, 4	2	1, 4, 21	1, 2, 3		1, 10	
2.2 Making measurements and analysing data	3, 20	1, 17, 18, 19, 21	2, 8, 18, 19	1, 7, 18, 19, 21	18	4, 17, 18, 19	1[illegible]
2.3 Nature of quantities	1, 8, 16, 18	2, 3, 5, 16		4, 6, 17		5	
Module 3: Forces and motion							
3.1 Motion	5, 21	5, 16, 17, 18	5, 16	2, 4, 20			
3.2 Forces in action	8, 16, 17, 18, 19, 21	4, 6, 9	4, 6, 17	2, 6, 16, 17, 18			
3.3 Work, energy and power	7, 18	18	3, 7	3, 9, 12, 13, 20			
3.4 Materials	6, 9	8, 19	4	2, 8, 19			
3.5 Newton's laws and momentum	10, 11, 18, 19	4, 7	4, 18	9, 16			
Module 4: Electrons, waves and photons							
4.1 Charge and current					1	16	
4.2 Energy, power and resistance					2, 3, 6, 16	1, 16, 17	1, [illegible]
4.3 Electrical circuits					2, 3, 6, 16		2, [illegible]
4.4 Waves					4, 5, 7, 17	3, 4, 5, 18, 19	4, [illegible]
4.5 Quantum physics					8, 18	20	

	Paper 1				Paper 2		
	Set 1	Set 2	Set 3	Set 4	Set 1	Set 2	S
Module 5: Newtonian world and astrophysics							
5.1 Thermal physics	20	11, 20, 21	9, 19, 22	10, 21, 22			
5.2 Circular motion	12, 14	22		11			
5.3 Oscillations	13	12	10, 11, 20	5			
5.4 Gravitation	21	23	12, 21				
5.5 Astrophysics and cosmology	15, 22	10, 13, 14, 15, 24	13, 14, 15	14, 15, 23, 24			
Module 6: Particles and medical physics							
6.1 Capacitors					19	2, 6	
6.2 Electric fields					9, 10	21	1
6.3 Electromagnetism					12, 20	7, 8, 9, 21	
6.4 Nuclear and particle physics					10, 11, 12, 14, 15, 21, 22	10, 11, 12, 13, 14, 22, 23	1 1 2
6.5 Medical physics					13, 23	15, 24	1

ZigZag Practice Exam Papers

Supporting A Level OCR Physics A

Practice Exam Paper 3

Set 1

Name	

Time allowed

1 hour 30 minutes

Instructions

Answer **all** of the questions and use the space provided.

Information

The total number of marks available for this paper is **70**. The number of marks available for each question is shown on the right.

For this paper, you will need:

- Data, Formulae and Relationships booklet

Additional materials required

- Pencil
- Electronic calculator
- Ruler (cm/mm)

1 Wind blows through a wind turbine. The length of each of the wind turbi

The speed of the wind is 12 m s^{-1} and the density of air is 1.2 kg m^{-3}.

The purpose of a wind turbine is to convert the kinetic energy of the win

(a) Calculate the area, A, of the vertical circle swept out by the blades as

A = ...

(b) Assuming that the wind blows perpendicularly to A, show that the m
passes through A is 1×10^5 kg s^{-1} to one significant figure.

(c) Hence calculate the maximum possible input power, P_{IN}, of the turbi

P_{IN} = ...

(d) Betz's law states that the theoretical maximum power efficiency of a
Assuming this to be true, calculate the maximum power output, P_{OUT},

P_{OUT} = ...

2 A conker is tied to the end of a length of string. A student whirls the conk
constant speed.

One of the forces acting on the conker is the tension, T, in the string.

Assume air resistance can be ignored.

(a) (i) Draw arrows on **Fig. 2.1** to show all the forces acting on the conker

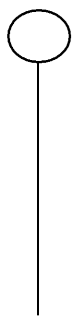

Fig. 2.1

(ii) Draw arrows on **Fig. 2.2** to show all the forces acting on the con
the circle.

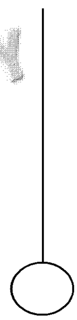

Fig. 2.2

(iii) Explain why the magnitude of T will be different in the two situ **Fig. 2.2**.

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....

Fig. 2.3 shows how the tension, T, varies with time, t.

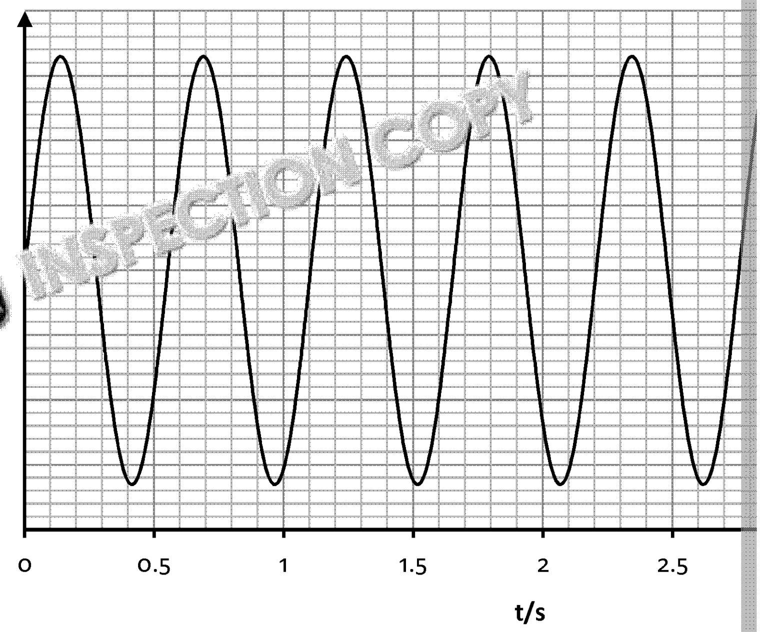

Fig. 2.3

(b) (i) Mark with an X one point on the graph when the conker is at th

(ii) What is the angular frequency, ω, of the conker's motion?

ω = ...

The string has length 45 cm, and the conker has mass 30 g.

(iii) Show that the centripetal force, F, acting on the conker is appro

F = ...

(c)* The student wishes to find the maximum linear speed at which the c breaking the string. The student decides not to whirl the conker fast breaks because this is potentially dangerous.

Describe another experiment that the student could **safely** perform t of the string. You may wish to include a diagram in your answer.

Explain how this value could be used to find an expression for the m the conker can be whirled.

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3 **(a)** State **two** properties of the strong nuclear force.

1: ....

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2: ....

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(b) Below is a table showing the radius, R, and nucleon number, A, of thr

Nucleus	R/ 10⁻¹⁵ m	A
Hydrogen	1.25	1
Iron	4.78	56
Uranium	7.74	238

(i) Calculate the mean density, ρ, of the iron nucleus shown in the t

ρ = ...

Experiments suggest that R is proportional to $A^{1/3}$.

(ii) Use data from the table to assess whether or not this relationshi range of A.

(iii) Explain how you would expect the density of a uranium nucleus of an iron nucleus as calculated in (i). No further calculation is r

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4 This question is about the coloured interference pattern seen on a thin la

A thin layer of oil of thickness t floats on top of water. The refractive indic below.

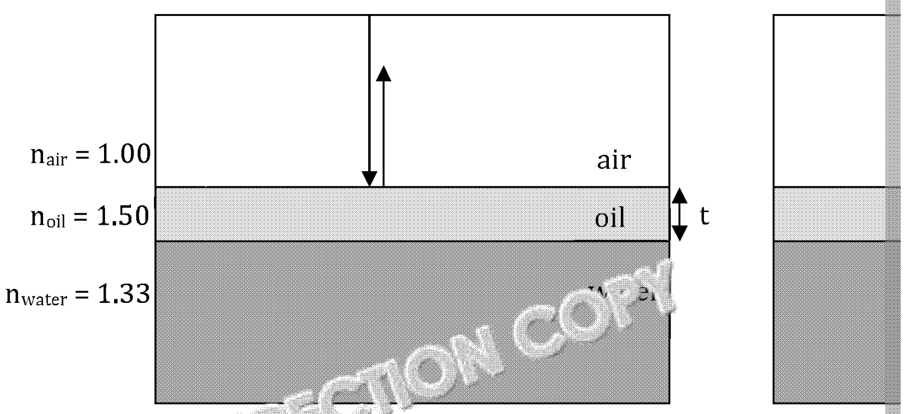

Fig. 4.1

A ray o[illegible] light enters normally from the air. The ray is partially refle shown by the arrows in **Fig. 4.1.** The ray is also partially transmitted into ray is reflected at the oil–water boundary, as shown by the arrows in **Fig.** interfere.

A phase shift of 180° occurs whenever light reflects from the surface of a refractive index than the one in which it was travelling (but not otherwis

(a) State the boundary, or boundaries, at which a 180° phase shift occurs

....

(b) State the path difference between the two reflected waves in terms o layer, when the **first order constructive** maximum is formed.

Use this to write the wavelength of light in oil in terms of the thickne

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(c) Using the definition of the refractive in[illegible] o[illegible], n_{OIL}, and the wave e relationship between the thic[illegible] f [illegible], t, and the wavelength of lig

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....

The reflected light appears orange to an observer in air. The wavelength

(d) Calculate the thickness, t, of the oil film.

t = ...

5 **(a)** **Fig. 5.1** shows a simple representation of an electron gun.

In the electron gun in **Fig. 5.1** a beam of electrons enters a region of field. The potential difference between the plates is V.

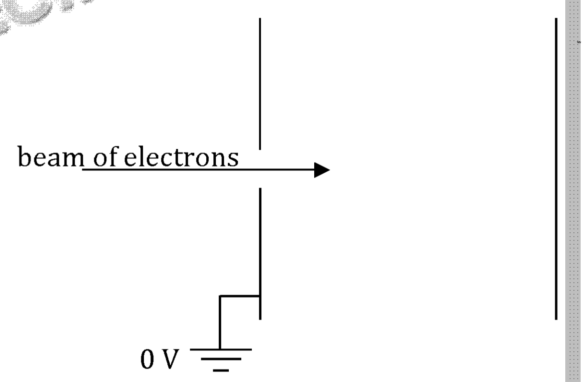

Fig. 5.1

(i) Assuming that the electrons enter the region with negligible vel potential difference between the plates, V, that will result in the plate at a velocity v = 0.01c.

potential differen

(ii) The muon is a fundamental particle with the same charge as the greater.

If the beam contained muons instead of electrons, calculate the difference between the plates, V, that would result in the muons a velocity v = 0.01c.

potential differen

(b) A mixed beam of electrons and muons travels at v = 0.01c.

(i) Calculate the ratio

$$\frac{\text{de Broglie wavelength of muon}}{\text{de Broglie wavelength of electron}}$$

ratio = ...

The mixed beam of electrons and muons enters a region of magnetic
magnetic field acts into the page and separates the beam into two in

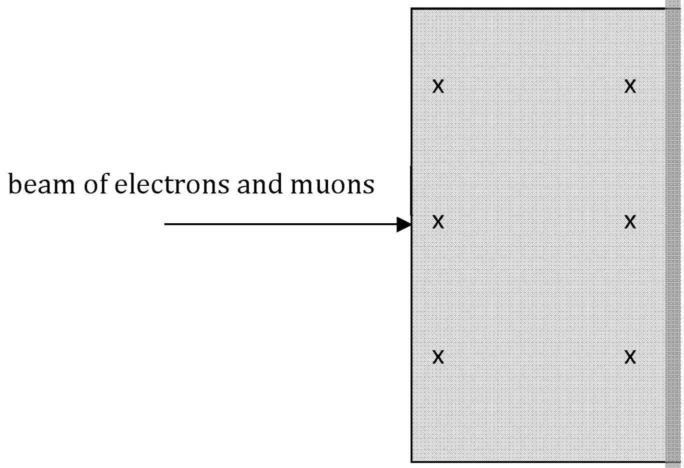

Fig. 5.2

(ii) Sketch and label the paths of both the electrons and muons onto

(iii) The magnetic field strength is 30 mT.

Calculate the radius of the muon's path.

radius = ...

6 A student uses an electrical method to determine the specific heat capacit

Fig. 6.1 shows the set-up of the experiment.

The student uses an immersion heater to heat the block and measures th every four minutes.

Fig. 6.2 shows the results in the form of a graph of temperature against ti

The software has fitted a trend line to the points.

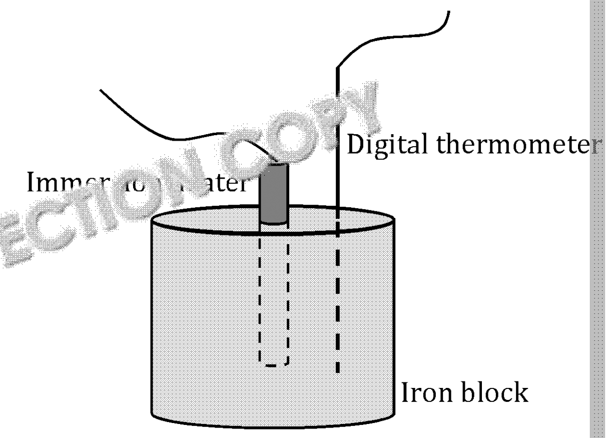

Fig. 6.1

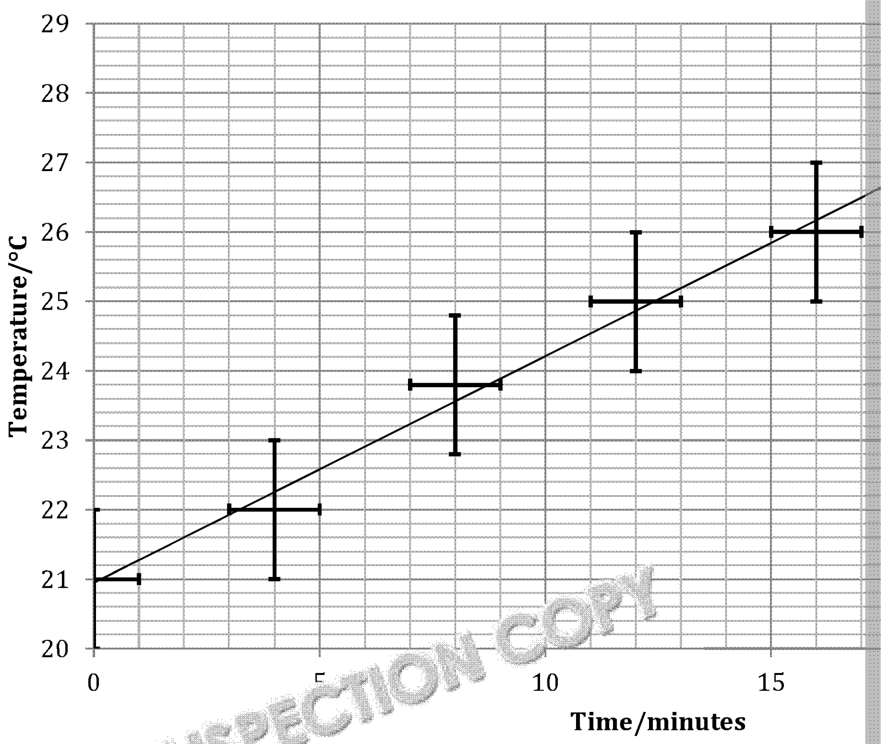

Fig. 6.2

(a)* Use **Fig. 6.2** to calculate the specific heat capacity of iron together wi

You will need the following data:

Mass of iron block = 1.000 kg ± 0.001 kg

Power of immersion heater = 2.4 W ± 0.1 W

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(b) Given that the accepted value for the specific heat capacity of iron is
or not the student has taken accurate results.

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7 The nucleus of radon-219 has a radius of 7.5×10^{-15} m. Its chemical symb

(a) Assuming the nucleus can be thought of as a point charge, calculate:

(i) the electric field strength, E, at the surface of the nucleus.

E = ...

(ii) the electric potential at the surface of the nucleus.

V = ...

(iii) the electrical potential energy of a proton at the surface of the n

energy = ...

$^{219}_{86}$Rn decays to an isotope of polonium, ^{215}Po, by alpha decay, with a half-

(b) **(i)** Write the nuclear equation for this decay.

....

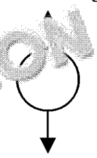
(ii) A sample of $^{219}_{86}$Rn contains 5.2×10^{17} ... nuclei initially. Cal
remaining after one minute.

m = ...

END OF QUESTION PAPER

Preview of Questions Ends Here

Set 2: Paper 3

Question			Answer	Marks	
1	(a)	(i)	Lines parallel and equally spaced Arrows point from 11.2 kV plate to 0 V plate	B1 B1	
		(ii)	$E = V / d = 11.2 \times 10^{3} / 5.00 \times 10^{-2}$ $E = 2.24 \times 10^{5}$ (V m^{-1})	C1 A1	
	(b)		$W = mg = \rho Vg = 810 \times 4 / 3 \pi (1.86 \times 10^{-6})^{3} \times 9.81$ $W = 2.14 \times 10^{-13}$ (N)	C1 A1	
	(c)	(i)	Electric/electrostatic force (upwards)  Weight (downwards)	B1	Th siz
		(ii)	EQ = W gives $Q = 2.14 \times 10^{-13} / 2.24 \times 10^{5}$ $Q = 9.6 \times 10^{-19}$(C) to 2 s.f.	C1 A1	 EC
	(d)		e is a factor of 1.6×10^{-19} (C)	B1	Ac 1.6 Do
			Total	**10**	
2	(a)	(i)	As wire cuts field lines / as flux linkage varies, emf induced Direction of induced emf varies with direction of swing Velocity of 'pendulum' varies sinusoidally and so magnitude of emf varies sinusoidally	B1 B1 B1	Ac
		(ii)	P at highest or lowest point on curve	B1	
		(iii)	1 square = 0.4 cm 14 squares = 5.6 cm $\varepsilon = 5.6$ cm $\times 5.0 \times 10^{-9}$ V cm^{-1} $\varepsilon = 2.8 \times 10^{-8}$ (V)	 B1 B1	
		(iv)	1 square = 0.4 cm 7 squares = 2.8 cm T = 2.8 cm × 5.0 s cm^{-1} = 14 s $\omega = 2\pi / T = {}^{-1}2\pi / 14 = 0.45$ (rad s^{-1})	 B1 B1	
	(b)		magnitude of emf lower frequency lower (graph stretched)	B1 B1	
			Total	**10**	
3	(a)		Wein's law: $\lambda_{max} \propto \frac{1}{T}$ $\lambda_1 T_1 = \lambda_2 T_2$ 483 × 5780 = 821 × T T = 3400 (K)	 C1 C1 A0	
	(b)	(i)	(Total radiant) power (output)	B1	
		(ii)	$L = I \times 4\pi R^{2} = 6.27 \times 10^{-8} \times 4\pi (551 \times 9.5 \times 10^{15})^{2}$ $= 2.16 \times 10^{31}$ (W)	C1 A1	

Question			Answer	Marks	
		(iii)	$L = 2.16 \times 10^{31} / 3.75 \times 10^{26}$ = 57 600 solar units (Read off graph for temperature = 3000 K) Antares is a red supergiant star	C1 C1 A1	EC
			Total	**8**	
4		*	**Level 3 (5–6 marks)** A detailed diagram, a list of all equipment required and a logical description of the method and graphical analysis used to calculate λ are all included, plus clear safety precautions. *The answer shows strong understanding and is in a clear logical order and structure. The answer includes appropriate details with evidence where applicable.* **Level 2 (3–4 marks)** A diagram, a list of most of the equipment required and a description of the method and analysis used to calculate λ are included, plus some safety precautions *The answer shows some understanding and is ordered in a somewhat logical structure. The answer includes details that are largely appropriate, with some evidence where applicable.* **Level 1 (1–2 marks)** A list of some of the equipment required with an attempt to describe the method and analysis used to calculate λ, plus one safety precaution *The answer shows limited understanding and is unordered. The answer includes details and evidence that are inappropriate to the question.*	B1 × 6	So Di Sh an Eq 1. 2. 3. 4. 5. 6. Me 1. 2. 3. 4. 5. 6. 7. 8. 9. An 1. 2. 3. 4. Sa 1. 2. 3.
			Total	**6**	

Question			Answer	Marks	
5	(a)	(i)	Vectors join nose to tail All labels correct Right angle and one other correct angle marked	B1 B1 B1	Th ful \
		(ii)	T = mgcos 15° $= 0.7 \times 10^3 \times 9.81 \times \cos 15°$ $= 6.6 \times 10^3$ (N)	C1 C1 A0	
		(iii)	Extension × [illegible] [illegible] $10^3 \times 1.2 / (\pi \times (1.7 \times 10^{-2})^2 \times 120 \times 10^9)$ $= 7.3 \times 10^{-5}$ m	C1 C1 A0	 EC Us
		(iv)	$E = ½Fx = ½ \times 6.6 \times 10^3 \times 7.5 \times 10^{-5}$ = 0.25 (J)	C1 A1	EC Us
	(b)	(i)	Gain in KE = loss in PE so ½~~m~~v² = ~~m~~gh $v^2 = 2 \times 9.81 \times 30 = 589$ v = 24 (m s^{-1})	C1 C1 A1	
		(ii)	One from: length of wagon not measured correctly change in height less than 30 m (as centre of mass is above ground level) dissipation of energy into other forms	B1	
			Total	**13**	
6	(a)		6.25 ± 0.50 % uncertainty in I^2 = 2 × % uncertainty in I = (2 × 0.1 × 100) / 2.5 = 8 % 0.08 × 6.25 = 0.5	B1 C1 C1 A0	 NO
	(b)	(i)	gradient = 60 / 6.6 = 9.1 (°C A^{-2})	M1 A1	Pe Ac
		(ii)	$I^2Rt = mc\,\Delta\theta$ $R = mc\,\Delta\theta / I^2t$ = [illegible] × [illegible]ent / t R = [illegible] × 9.1 / (9.0 × 60) = 3.5 (Ω)	C1 C1 C1 A1	 EC
		(iii)	Any <u>two</u> from: stir water to ensure even temperature record final **maximum** temperature after current is switched off lid on beaker use water X degrees below room temperature and heat to X degrees above to balance heat transfer	B1 × 2	No me
			Total	**11**	

Question			Answer	Marks
7	(a)*		**Level 3 (5–6 marks)** Detailed description of experimental set-up and procedure, plus a clear description of the observations and an accurate explanation of the conclusions that can be drawn. *The answer shows strong understanding and is in a reasonable order and structure. The answer includes appropriate details with evidence where applicable.* **Level 2 (3–4 marks)** Description of experimental set-up and procedure, plus a description of some observations and an explanation of some conclusions that can be drawn. *The answer shows some understanding and is ordered in a somewhat logical structure. The answer includes details that are largely appropriate, with some evidence where applicable.* **Level 1 (1–2 marks)** Attempt to describe experimental set-up and/or procedure, plus a description of at least one observation and an explanation of at least one conclusion that can be drawn. *The answer shows limited understanding and is unordered. The answer includes details and evidence that are inappropriate to the question.*	B1 × 6
	(b)	(i)	From A to B the electric potential energy of the alpha particle increases and the kinetic energy decreases From B to C the electric potential energy of the alpha particle decreases and the kinetic energy increases	B1 B1
		(ii)	Arrow on gold nucleus pointing away from B	B1
		(iii)	$F = qQ / 4\pi\varepsilon_0 r^2$ $= \dfrac{(2 \times 1.6 \times 10^{-19} \times 79 \times 1.6 \times 10^{-19})}{4\pi \times 8.85 \times 10^{-12} \times (9.5 \times 10^{-15})^2}$ = 400 N	C1 C1 A1
			Total	**12**

Preview of Answers Ends Here