



Pearson
Edexcel

Mark Scheme
(Results)

Summer 2019

Pearson Edexcel GCSE

In Physics (1PH0) Paper 1F

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Summer 2019

Publications Code 1PH0_1F_1906_MS

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.

Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.

When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

Assessment Objective		Command Word	
Strand	Element	Describe	Explain
AO1		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

Question Number	Answer	Mark
1(a) (i)	<p>all three correct (2) one or two correct (1)</p>	(2)

Question Number	Answer	Additional guidance	Mark
1(a)(ii)	<p>Q and S</p> <p>Q (1) (and) S (1)</p> <p>OR</p> <p>S (1) (and) Q (1)</p>	<p>in either order</p> <p>maximum of 1 mark if 3 letters given</p> <p>no marks if 4 or more letters given</p>	(2)

Question Number	Answer	Additional guidance	Mark
1(a)(iii)	<p>substitution (1)</p> <p>(distance =) 30×100</p> <p>evaluation (1)</p> <p>3000 (m)</p>	<p>for 1st mp accept 100×30</p> <p>OR $(30 \times 50) \times 2$</p> <p>award full marks for the correct answer without working</p> <p>allow 1 mark for</p> <p>EITHER</p> <p>30×50</p> <p>OR</p> <p>30×150</p> <p>OR</p> <p>30×250</p>	(2)

Question Number	Answer	Additional guidance	Mark
1(b)	substitution (1) 1800×1.2 evaluation (1) 2200 (N)	accept $1800 \text{ kg} \times 1.2 \text{ m/s}^2$ reject 1800×1.2^2 2160 award full marks for the correct answer without working allow 1 mark total for 2200 OR 2160 with any other power of ten	(2)

(Total for Question 1 = 8 marks)

Question Number	Answer	Additional guidance	Mark
2(a)(i)	1840 (J) (1)		(1)

Question Number	Answer	Additional guidance	Mark
2(a)(ii)	substitution (1) (efficiency =) $\frac{160}{2000}$ evaluation (1) 0.08 OR 8 (%)	Ignore any units award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
2(a)(iii)	reference to : thermal (energy) (1) OR (lost to) environment /surroundings/dissipated (1) OR transferred/changed to another form of energy (1)	IGNORE gets re-used / recycled heat OR (to) atmosphere / (to) the air /sky/ steam accept named form of energy	(1)

Question Number	Answer	Additional guidance	Mark
2(a)(iv)	<p>an answer that makes reference to any two from</p> <p>produces/ releases/makes/gives off carbon dioxide / CO₂ /greenhouse gases (1)</p> <p>produces carbon monoxide / CO (1)</p> <p>produces air pollution (1)</p> <p>produces sulphur dioxide/ SO₂ (1)</p> <p>produces soot /smoke (1)</p> <p>mining coal (1)</p>	<p>IGNORE unqualified pollutes/pollution</p> <p>IGNORE ozone layer</p> <p>IGNORE non-renewable</p> <p>IGNORE 'fumes'</p> <p>(causes) greenhouse effect OR contributes to global warming/climate change allow CO₂</p> <p>causes carbon monoxide poisoning</p> <p>accept (harmful) particles /dust</p> <p>causes <u>acid rain</u></p> <p>blackens/ stains buildings/statues</p> <p>slag heaps/ mining damages the landscape/habitats/ecosystem OR ground needs to be dug up</p>	(2)

Question Number	Answer	Additional guidance	Mark
2(b)	substitution (1) $\frac{1}{2} \times 8 \times 1.5^2$ calculation of v^2 (1) 2.25 evaluation (1) 9(.0) (j)	 9000 (j) scores 2 marks 6(.0)(j) scores 2 marks 6000 (j) scores 1 mark award full marks for the correct answer without working	(3)

(Total for Question 2 = 9 marks)

Question Number:	Answer	Additional guidance	Mark
3(a)		<p>All 3 labels correct 3 marks</p> <p>2 labels correct 2 marks</p> <p>1 label correct 1 mark</p>	(3)

Question Number	Answer	Mark
3(b)(i)	<p>The only correct answer is C red-shifted</p> <p>A is not correct because the spectrum is not blue-shifted B is not correct because the spectrum is not green-shifted D is not correct because the spectrum is not violet-shifted</p>	(1) comp

Question Number	Answer	Mark
3(b)(ii)	<p>The only correct answer is D Universe</p> <p>A is not correct because the shift does not provide evidence for the expansion of Earth. B is not correct because the shift does not provide evidence for the expansion of the Milky Way Galaxy C is not correct because the shift does not provide evidence for the expansion of the Solar system</p>	(1) comp

Question Number	Answer	Additional guidance	Mark
3(c)	substitution (1) 300 : 1500 evaluation (1) 1:5	$\frac{300}{1500}$ 0.2 OR $\frac{1}{5}$ ignore any units award full marks for the correct answer without working allow 1 mark for either 5:1 OR 5	(2)

(Total for Question 3 = 7 marks)

Question Number	Answer	Additional guidance	Mark
4(a)(i)	<p>Atoms may form positive ions by losing electrons. (1)</p> <p>The electrons involved are the outer electrons (1)</p>	<p>accept any clear indication that correct word is in gap</p>	(2)

Question Number	Answer	Mark
4(a)(ii)	<p>The only correct answer is C gamma</p> <p>A is not correct because alpha radiation is not electromagnetic</p> <p>B is not correct because beta minus radiation is not electromagnetic</p> <p>D is not correct because neutron radiation is not electromagnetic</p>	(1)

Question Number	Answer	Mark
4(a)(iii)	<p>The only correct answer is A alpha</p> <p>B is not correct because beta minus travels further in air than alpha</p> <p>C is not correct because beta plus travels further in air than alpha</p> <p>D is not correct because gamma travels further in air than alpha and beta</p>	(1)

Question Number	Answer	Additional guidance	Mark
4(b)(i)	<p>one from:</p> <p>(radiation from them) (can cause) cancer / tumours (1)</p> <p>radiation sickness / radiation poisoning (1)</p> <p>(radiation from them can) mutate / alter/ deform / damage / ionise / kill {cell OR DNA OR genes} (1)</p> <p>burns skin (1)</p>	<p>accept any named type of cancer</p> <p>accept birth defects OR sterilisation</p> <p>Ignore unqualified poisoning kills you skin damage</p>	(1)

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	<p>neutron (in the nucleus) (1)</p> <p>becomes a proton (and an electron) (1)</p>	<p>down quark / d (in the neutron)</p> <p>OR mass/nucleon number stays same</p> <p>becomes an up quark / u</p> <p>OR atomic/proton number increases by 1</p> <p>$n > p + e^-$ scores 2 marks</p> <p>if no other mark scored allow for 1 mark (it) emits an electron</p> <p>OR beta (minus) is an electron</p> <p>OR energy is released</p> <p>OR loses a proton and gains a neutron</p> <p>IGNORE gaining/losing/becoming electron(s)</p>	(2)

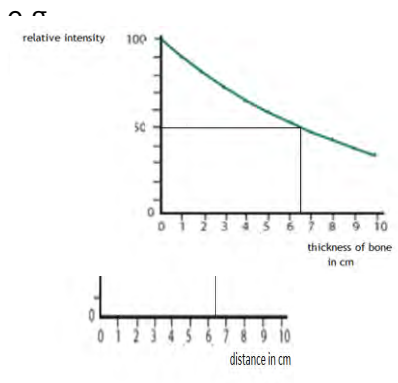
Question Number	Answer	Mark
4(c)	B 10^{-10} m	(1)

Question Number	Answer	Additional guidance	Mark
4(d)	substitution (1) $\frac{1.6726 \times 10^{-27}}{9.1094 \times 10^{-31}}$ evaluation (1) 1836 evaluation to 2 sf (1) 1800	Allow 1 mark for answers that round to 1.836 to any power of ten for this mark 1.836×10^3 OR 1.80×10^3 accept 1840 or any rounding of 1836.125 1.8×10^3 any number shown to 2 sf gets this mark award full marks for the correct answer without working	(3)

(Total for Question 4 = 11 marks)

Question Number	Answer	Additional guidance	Mark
5(a)(i)	<p>A description to include:</p> <p>diagnosing / locating / identify/look for (1)</p> <p>tumour (1)</p>	<p>brain scan</p> <p>cancer</p> <p>award 2 marks for 'seeing where the cancer is'</p>	(2)

Question Number	Answer	Additional guidance	Mark
5(a)(ii)	<p>Any two precautions to do with:</p> <p>mp1 short half-life isotopes (1)</p> <p>mp2 shielding (1)</p> <p>mp3 distance (1)</p> <p>mp4 isolation (1)</p> <p>mp5 exposure time (1)</p> <p>mp6 transportation (1)</p> <p>mp7 storage (1)</p>	<p>protective clothing</p> <p>lead shielding</p> <p>working in another room</p> <p>working</p> <p>radiation badges</p> <p>to and around the hospital</p> <p>appropriate containers</p>	(2)

Question Number	Answer	Additional guidance	Mark
5(b)(i)	<p>Constructs a line across at an intensity of 50 (with a vertical to the thickness axis) (1)</p>  <p>(thickness =) 6.5 - 6.7 (cm) (1)</p>	award full marks for the correct answer without working	(2)

Question Number	Answer	Mark
5(b)(ii)	<p>The only correct answer is B J/kg</p> <p>None of the other options have units which are the same as J/kg</p>	(1)

Question Number	Answer	Additional guidance	Mark
5(c)(i)	Any two advantages from: no CO ₂ produced / reduces global warming more energy (per kg) no cross-country pipelines no cross-country pipelines	no harmful waste gases to atmosphere high energy density fuel IGNORE reference to unqualified non-pollution cost renewable efficiency speed of production	(2)

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	Any two reasons for unpopularity from mp1 public perception that radioactivity is dangerous mp2 radiation leaks from plant mp3 nuclear accidents mp4 risks of terrorist attacks mp5 production/storage of nuclear waste mp6 (nuclear) waste radioactive for a long time		(2)

(Total for Question 5 = 11 marks)

Question Number	Answer	Mark
6(a)(i)	<p>The only correct answer is C 20 m/s</p> <p>A is not correct because 0.2 m/s is too slow</p> <p>B is not correct because 2 m/s is too slow</p> <p>D is not correct because 200 m/s is too fast</p>	(1)

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	<p>recall (1)</p> $(\Delta GPE) = m \times g \times \Delta h$ <p>substitution (1)</p> $(\Delta GPE =) 75 \times 10 \times 20$ <p>evaluation (1)</p> <p>15 000 (J)</p>	<p>NO PoT error</p> <p>NO ecf from wrong equation</p> <p>mgh or $m \times g \times h$</p> <p>75 x 10 x 20 scores the first 2 marks</p> <p>accept 14700 (J) from using $g = 9.8$ (N/kg)</p> <p>award full marks for the correct answer without working</p>	(3)

Question Number	Answer	Additional guidance	Mark
6(b)	substitution (1) $\frac{80(2) (- 0^2)}{2 \times 4}$ evaluation (1) 800 (m)	allow 1 mark for seeing $\frac{80}{8}$ ignore any minus signs award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
6(c)(i)	(metre) rule(r) (1)	accept measuring tape/stick tape measure light gate	(1)

Question Number	Answer	Additional guidance	Mark
6(c)(ii)	<p>A description that combines the following points to produce a logical method:</p> <p>hang/attach/add/put/increase {masses / weights} (1)</p> <p>on/to (the end of) the string (over the pulley wheel) (1)</p> <p>OR</p> <p>apply a force to the trolley /string (1) (by a) pull / push / rubber band (1)</p> <p>OR</p> <p>putting trolley on a slope (1)</p> <p>allow the trolley to run down (1)</p>	<p>accept on/at/from the pulley wheel</p> <p>' pull the string'</p> <p>OR</p> <p>push the trolley scores 2 marks</p> <p>slanting the bench</p> <p>(let) gravity pull the trolley</p>	(2) exp

Question Number	Answer	Additional guidance	Mark
6(c)(iii)	<p>Any one from:</p> <p>speed (at the start/end of the run) (1)</p> <p>time (between changes in speed) (1)</p>	<p>(different/additional) speed / velocity</p> <p>appropriate ticker tape(s)</p>	(1)

(Total for Question 6 = 10 marks)

Question Number	Answer	Additional guidance	Mark
7(a)	<p>an explanation linking two from:</p> <p>identifies curve Q is the black can OR that curve P is for the silver can (1)</p> <p>(because, as) black is a better emitter</p> <p>(then) (curve) Q shows a faster rate of cooling (1)</p> <p>OR</p> <p>(curve) Q is steeper (1)</p>	<p>IGNORE reference to absorb</p> <p>allow Q is at a lower temperature/stays cooler</p> <p>OR</p> <p>P is at a higher temperature /stays hotter</p> <p>may quote numbers from graph e.g. curve Q cools by 75(°C) in 20 minutes but curve P only shows a 60(°C) in the same time</p>	(2)

Question Number	Answer	Mark
7(b)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>AO targeting: 6 marks AO1 strand 2 (6 marks)</p> <ul style="list-style-type: none"> • uses a thermometer • inserted into the can • uses a stopwatch / timer • uses a measuring cylinder / beaker with markings • sets up apparatus with lamp a fixed distance from each can • that distance is the same for each can • the measured volume is the same for each can • a starting temperature is measured • (aiming) to get the same start temperature • each, in turn, is heated for the same time • as measured on a stopwatch • a final (maximum) temperature is read • OR takes a series of temperature readings with time • and plots a graph of temperature(s) against time • the one heating up the most is the best absorber <p>N.B. fully credit any of these in a diagram e.g. bullet points 1-8 may all be seen in a diagram</p>	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	<ul style="list-style-type: none"> Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	<ul style="list-style-type: none"> Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Summary for guidance

Level	Mark	Additional Guidance	General additional guidance - the decision within levels
	0	No rewardable material.	Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
Level 1	1-2	<u>Additional guidance</u> isolated statement about apparatus or procedure or the science involved	<u>Possible candidate responses</u> (diag?) uses/puts a thermometer in the can/water OR measures a temperature OR uses heater to heat the cans Or puts water in the cans
Level 2	3-4	<u>Additional guidance</u> some procedure detail but with omissions	<u>Possible candidate responses</u> (diag?) uses a thermometer to measure the temperature rise in the cans OR uses the heater to heat the cans for a fixed time Or uses the same amount of water in each can
Level 3	5-6	<u>Additional guidance</u> more detailed and structured procedure	<u>Possible candidate responses</u> (diag?) uses a thermometer to measure the temperature rise in the cans AND uses the heater to heat the cans for a fixed time Or uses the same amount of water in each can

Question Number	Answer	Additional guidance	Mark
7(c)(i)	one of: X-ray(s) (1) gamma (rays) (1)	X γ any other waves mentioned contradicts	(1)

Question Number	Answer	Additional guidance	Mark
7(c)(ii)	an explanation linking two from: blue (star) emits light at higher energy (than red) blue has shorter wavelength/higher frequency than red so blue star has higher (surface) temperature than red	or reverse arguments	(2)

(Total for Question 7 = 11 marks)

Question Number	Answer	Mark
8(a)	<p>C red</p> <p>The only correct answer is C red</p> <p>A is not correct because blue has a shorter wavelength than red</p> <p>B is not correct because green has a shorter wavelength than red</p> <p>D is not correct because yellow has a shorter wavelength than red</p>	(1)

Question Number	Answer	Additional guidance	Mark
8(b)	<p>an explanation linking:</p> <p>infrared is absorbed / blocked (by the armchair/objects) / cannot pass through it</p> <p>OR</p> <p>radio waves can go through (the armchair/objects) (1)</p> <p>WITH</p> <p>(infrared and radio have) different wavelengths / frequencies</p> <p>OR infrared requires 'line-of-sight' (idea)</p> <p>OR radio waves do not require 'line-of-sight' (idea)</p> <p>OR diffraction (idea)</p> <p>(1)</p>	<p>allow stopped</p> <p>transmitted</p> <p>accept comparison</p>	(2)

Question Number	Answer	Additional guidance	Mark
8(c)(i)	evidence of use of scale on horizontal distance axis only (1) 12 (cm) (1)	may be seen on the diagram range 11.5 to 12.5 (cm) award full marks for the correct answer without working 6 (cm) or 30(cm) scores 1 mark (evidence of use)	(2)

Question Number:	Answer	Additional guidance	Mark
8(c)(ii)	a description to include: moves up and down (1) at right angles / normal / perpendicular to (direction of) wave/travel (1)	independent marking points vertical (oscillations) not in the (direction of) wave / travel accept 'transverse wave' for 2nd MP	(2)

Question Number:	Answer	Additional guidance	Mark
8(d)	recall and substitution (1) $(v =) 0.25 \times 1.5$ evaluation (1) 0.38 (m/s)	accept 0.375 or 0.37 (m/s) accept 37.5, 37 or 38 for 1 mark only award full marks for the correct answer without working	(2)

(Total for Question 8 = 9 marks)

Question Number:	Answer	Additional guidance	Mark												
9(a)	<table border="1"> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>7</td> <td>6</td> </tr> <tr> <td></td> <td>8</td> <td>6</td> </tr> <tr> <td></td> <td>(1)</td> <td>(1)</td> </tr> </table>					7	6		8	6		(1)	(1)	<p>one mark for each column</p> <p>must have both numbers in a column correct to get the mark</p>	(2)
	7	6													
	8	6													
	(1)	(1)													

Question Number	Answer	Additional guidance	Mark
9(b)(i)	Geiger (Müller counter) (1)	<p>GM {tube/meter} or other appropriate detector e.g. dosimeter, film badge, scintillation counter</p> <p>accept incorrect spellings such as "giga"</p> <p>ignore radioactive counter</p>	(1)

Question Number	Answer	Additional guidance	Mark
9(c)	<p>processing (1)</p> <p>$\frac{125\,000}{1\,000\,000}$</p> <p>OR</p> <p>$\frac{1}{8}$</p> <p>OR</p> <p>3 half-lives or 3×5700</p> <p>evaluation (1)</p> <p>17 100</p>	<p>accept an appropriate attempt using more than one halving</p> <p>17 000</p> <p>award full marks for the correct answer without working</p>	(2)


Question Number	Answer	Mark
9(d)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">A03 and A02 (6 marks)</p> <p>A03</p> <ul style="list-style-type: none"> • most go straight through to P • some are deflected through small angles to Q • few have deflections greater than 90° to R • or are even reflected (bounce back off the foil) to R <p>A02</p> <ul style="list-style-type: none"> • alpha positive is repelled by positive nucleus • atom being mostly empty space • atoms have a small nucleus • nucleus has a big mass / density • +ve charge concentrated into a very small space 	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> No awardable content
Level 1	1-2	<ul style="list-style-type: none"> Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	<ul style="list-style-type: none"> Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	<ul style="list-style-type: none"> Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

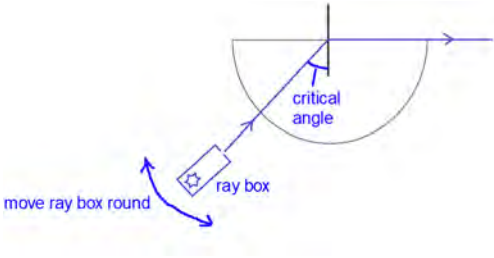
Summary for guidance

Level	Mark	Additional Guidance	General additional guidance - the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1-2	<u>Additional guidance</u> unlinked statement from the diagram or table or knowledge of the atom	<u>Possible candidate responses</u> most particles go to P (<i>from table</i>) OR particles refract/bend to Q (<i>from diagram</i>)
Level 2	3-4	<u>Additional guidance</u> One link between any TWO of diagram, table, knowledge about atoms.	<u>Possible candidate responses</u> Most particles go straight through (the gold) to P (<i>from table and diagram</i>) OR Most particles go to P which means an atom is mainly space (<i>from table and knowledge</i>) OR particles are reflected because there is a nucleus (<i>diagram and knowledge</i>)
Level 3	5-6	<u>Additional guidance</u> One link between diagram AND table AND knowledge about atoms	<u>Possible candidate responses</u> Most particles go straight through (the gold) to P which means an atom is mainly space OR A few particles reflected back to R which means an atom has a nucleus

(Total for Question 9 = 13 marks)

Question Number	Answer	Mark
10(a)(i)	 <p data-bbox="284 600 343 633"> <input type="checkbox"/> B </p> <p data-bbox="272 663 699 696">The only correct answer is B</p> <p data-bbox="272 725 1011 759">A is not correct because it has a smaller power than B</p> <p data-bbox="272 788 884 822">C is not correct because it is a diverging lens</p> <p data-bbox="272 860 884 893">D is not correct because it is a diverging lens</p>	(1)

Question Number	Answer	Additional guidance	Mark
10(a)(ii)	<p data-bbox="268 1151 759 1189">rearrangement and substitution (1)</p> $\frac{1}{5}$ <p data-bbox="268 1350 740 1384">unit conversion and evaluation (1)</p> <p data-bbox="268 1458 373 1491">20 (cm)</p>	<p data-bbox="783 1451 1018 1603">award full marks for the correct answer without working</p> <p data-bbox="783 1637 1034 1709">accept 0.2 for one mark only</p>	(2)

Question Number	Answer	Additional guidance	Mark
10(b)	<p>a description to include any four from:</p> <p>shine a ray (of light) into the block (1)</p> <p>into the block through the curved surface along a radius (1)</p> <p>{change angle / move ray(box)} until the angle of refraction is 90° / TIR just occurs (1)</p> <p>measure angle of incidence {when refracted angle is 90° / when TIR just occurs} (1)</p> <p>repeat measurement of critical angle (1)</p>	 <p>credit marking points in the diagram if they are clear</p> <p>allow 'calculate' for 'measure'</p> <p>plot angle i against angle r</p> <p>if light only enters block at straight edge, maximum 1 mark (for MP1)</p>	(4)

Question Number	Answer	Additional guidance	Mark
10(c)(i)	<p>examples:</p> <p>planets have moons (1)</p> <p>the Earth rotates (spins) (1)</p> <p>planets orbit the Sun (1)</p> <p>Pluto is no longer a planet (1)</p> <p>orbits are elliptical (not circular) (1)</p> <p>there are more planets than previously thought (1)</p> <p>ours is not the only solar system (1)</p> <p>Earth is {round/spherical/not flat} (1)</p> <p>planets are not wandering stars.</p>	<p>answers must be to do with the solar system</p>	(1)

Question Number:	Answer	Additional guidance	Mark
10(c)(ii)	<p>smooth curve drawn on the graph (1)</p> <p>horizontal line drawn from 4.6 Earth years to intercept the drawn line/curve (1)</p> <p>EITHER: their reading from line / curve (1)</p> <p>OR</p> <p>430±30 (million km) (1)</p>	<p>accept curve up to Mars followed by a straight line</p> <p>plot point at year length = 4.6</p> <p>reading on distance axis ± half small square from their graph</p> <p>award full marks for the correct answer without working</p>	(3)

(Total for Question 10 = 11 marks)

