AQA

# A-LEVEL
# Physics

7408/2 - Paper 2

Mark scheme

June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

# Physics - Mark scheme instructions to examiners

## 1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

## 2. Emboldening

**2.1** In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
**2.2** A bold **and** is used to indicate that both parts of the answer are required to award the mark.
**2.3** Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

## 3. Marking points

### 3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

### 3.2 Marking procedure for calculations

Full marks can usually be given for a correct numerical answer without working shown unless the question states 'Show your working'. However, if a correct numerical answer can be evaluated from incorrect physics then working will be required. The mark scheme will indicate both this and the credit (if any) that can be allowed for the incorrect approach.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

A calculation must be followed through to answer in decimal form. An answer in surd form is never acceptable for the final (evaluation) mark in a calculation and will therefore generally be denied one mark.

## 3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

## 3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are likely to be restricted to calculation questions and should be shown by the abbreviation ECF or *conseq* in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

## 3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited (eg fizix) **unless** there is a possible confusion (eg defraction/refraction) with another technical term.

## 3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

## 3.7 Ignore / Insufficient / Do <u>not</u> allow

'Ignore' or 'insufficient' is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

'Do **not** allow' means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

## 3.8 Significant figure penalties

Answers to questions in the practical sections (7407/2 – Section A and 7408/3A) should display an appropriate number of significant figures. For non-practical sections, an A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the **final** answer in a calculation to a specified number of significant figures (sf). This will generally be assessed to be the number of sf of the datum with the least number of sf from which the answer is determined. The mark scheme will give the range of sf that are acceptable but this will normally be the sf of the datum (or this sf -1).

An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark. For a question beginning with the command word 'Show that…', the answer should be quoted to **one more** sf than the sf quoted in the question eg 'Show that X is equal to about 2.1 cm' –

answer should be quoted to 3 sf. An answer to 1 sf will not normally be acceptable, unless the answer is an integer eg a number of objects. In non-practical sections, the need for a consideration will be indicated in the question by the use of 'Give your answer to an appropriate number of significant figures'.

## 3.9 Unit penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the correct unit for the answer to a calculation. The need for a unit to be quoted will be indicated in the question by the use of 'State an appropriate SI unit for your answer'. Unit answers will be expected to appear in the most commonly agreed form for the calculation concerned; strings of fundamental (base) units would not. For example, 1 tesla and 1 Wb $m^{-2}$ would both be acceptable units for magnetic flux density but 1 kg $m^2$ $s^{-2}$ $A^{-1}$ would not.

## 3.10 Level of response marking instructions

Level of response mark schemes are broken down into three levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are two marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

## Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level. i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme

An answer which contains nothing of relevance to the question must be awarded no marks

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **01.1** | Specific latent heat of fusion is the <u>energy</u> (required) to change $1\ \text{kg}$ / unit mass of material from the solid state to the liquid state or melt/fuse ✓<br><br>Without a change of temperature or at the freezing/melting temperature/point ✓ | The direction of energy transfer must be consistent with the direction of the change of state (If energy to change… is given then required or needed is implied)<br><br>2nd mark stands alone. | 2 | AO1 |
| **01.2** | (Dividing both sides of the equation $\Delta Q = m\,c\,\Delta\theta$ by $\Delta t$ gives $\Delta Q/\Delta t = m\,c\,\Delta\theta/\Delta t$ or $\Delta\theta = (\Delta Q/\Delta t) \times \Delta t/m\,c$ where $m = \rho V$ )<br><br>$\Delta\theta = 2700 \times (60 \times 60) / (4.5 \times 1000 \times 4200)$ ✓<br><br>Full substitution correct✓<br><br>temperature rise = $\Delta\theta = 0.51\ (\text{K})$ ✓ (= $0.514\ \text{K}$) | Working <u>must be seen</u> as there is a self-cancelling error with two 1000 factors.<br>So answer alone gains the 3rd mark only.<br><br>Firs mark can be gained if (60x 60) is absent even if not re-arranged.<br><br>The change of temperature may be written as a difference between 28 °C and an unknown temperature (allow in kelvin written either way round ie with incorrect sign)<br><br>1 sig fig is **not** acceptable.<br><br>Useful numbers:<br>$4.5 \times 1000 \times 4200 = 1.89 \times 10^{7}$<br>$2700/(4500\times4200) = 1.4 \times 10^{-4}$<br>Max 2 if:<br>Omits (60 x 60) giving $1.43 \times 10^{-4}$ K<br>Omits 60 giving $8.57 \times 10^{-3}$ | 3 | AO2 |

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|---|---|---|---|---|
| **01.3** | (When the pump is working at speed) the pump is <u>doing work</u> (on the water) ✓<br><br>work (and heat both) can raise the temperature of a body (as stated in the 1st Law of thermodynamics) (this may be expressed as work is converted to thermal energy) OWTTE<br>**OR**<br>The pump increases the randomness / turbulence of the water/molecules<br>**OR**<br>The <u>mean</u> square speed/*mean* kinetic energy is proportional to the (absolute) temperature. ✓ (this may be given in the form on an equation) OWTTE | (Lenient mark – a reference to random motion or more collisions may gain this mark but a simple increase in kinetic energy is not enough)<br><br>Do not penalise answers that go nowhere unless they directly contradict a marked answer. | 2 | 2 AO3 |
| **Total** | | | **7** | |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **02.1** | (The electric field strength at a point) is the force per unit charge ✓<br>On a (small) <u>positive</u> charge (at that point) ✓(only given if an attempt is made at the first mark) | An equation is not sufficient unless the symbols are defined. Unit charge can be replaced by coulomb.<br>(Reference to a point is not needed as it is in the question but a reference to moving between points or other points can cancel a mark.)<br>If "mass" appears in the answer, it must be a synonym for "object". | 2 | AO1 |

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| **02.2** | (At B) the (magnitude) of the electric field strength due to $Q$ = the magnitude of the electric field strength due to the $46\ \mu C$ charge ✓<br><br>$\frac{46 \times 10^{-6}}{4\pi\varepsilon_o(0.054)^2} = \frac{Q}{4\pi\varepsilon_o(0.066)^2}$ ✓<br><br>$(Q = 46 \times 10^{-6}\left(\frac{0.066}{0.054}\right)^2)$<br><br>$Q = 6.9 \times 10^{-5}$ (C) ✓ (68.7 μC rounding must be correct) | This first mark may be inferred from the equation but must refer to an electric field.<br><br>(Note: the answer $5.6 \times 10^{-5}$ shows that an inverse square has not been used)<br>A correct answer gains full marks.<br>Allow first and second marks even with arithmetic errors ie $10^{-6}$ missing, distances in mm and the constant $4\pi\varepsilon_o$ not present<br><br>Award one mark if they use the inverse square coulomb law equation to correctly calculate one side of the equation ( $\frac{46 \times 10^{-6}}{4\pi\varepsilon_o(0.054)^2}$ =) $1.4 \times 10^8$. | 3 | AO2 |

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| **02.3** | Work must be done on the positive proton because P is at a positive potential<br>**OR**<br>Work must be done (on the positive proton) due to the repulsive forces / because like charges repel.OWTTE ✓<br><br>The potential at infinity is zero. ✓ | | 2 | AO3<br>AO1 |

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| **02.4** | (As the ball falls) it experiences both vertical and horizontal <u>forces/accelerations</u> ✓<br><br>The ball is given a constant acceleration<br>**OR**<br>The motion is in a straight line<br>**OR**<br>The motion is at $30^{o}$ to the vertical (away from the wall) ✓<br><br>In this 2nd mark a wrong answer will gain zero marks even if accompanied by a correct answer. | 'Horizontal' needs to be accompanied by some implication that it is away from the wall. This may be by some reference to repulsion from the wall.<br>Moves diagonally can imply straight<br>"Moving away and downwards" does not imply straight.<br>Do not credit "horizontal straight line" or "vertical straight line"<br>'gravity ' on its own is not a force whereas weight is. | 2 | 2 AO3 |

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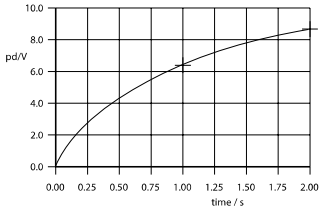
| **Total** | | | **9** |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **03.1** | (refers to a capacitor that)<br>stores/holds/changes by $370\ \mu C$ of charge ✓<br>for every $(1)$ volt/volt change (of pd across its plates) ✓<br>**OR**<br>reference to charge to pd OR charge to voltage ratio✓<br>includes units C or coulomb and V or volt ✓ | "Unit of pd" is no substitute for using volt and "unit of charge" is no substitute for coulomb.<br><br>However the alternative marking could give a single mark for $370 \times 10^{-6}$ units of charge per unit of pd.<br><br>An equation may contribute towards the first mark but only if the symbols are identified. A second mark can be given if the units are identified.<br><br>Ignore poor phrasing like 'per unit volt passing through'. | 2 | AO1 |
| **03.2** | (Using time constant = $R\ C$)<br>(R = $1.0 / 370 \times 10^{-6}$)<br>R = $2.7 \times 10^{3}\ (\Omega)$ ✓ | Check that the unit on answer line has not been altered | 1 | AO1 |
| **03.3** | First mark for marking a cross at $2$ s and $8.5$ V (by eye) ✓<br>Second mark for graph starting at the origin and having a decreasing gradient ie not reaching horizontal ✓<br>  <br> | Cross must be in the bottom half but not on the 8.0 V major grid line or exactly half way up (9.0 V)<br>If a series of plotting crosses are given only consider the one placed at 2 s for the first mark. | 2 | AO2 |

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| **03.4** | (Using $T_{½} = 0.69\ RC = 0.69 \times 1.0$)<br>$T_{½} = 0.69$ (s) ✓ | 1 sig fig is not acceptable | 1 | AO1 |
| **03.5** | (Use of $Q = Q_o(1 - e^{-\frac{t}{RC}}) = CV_o(1 - e^{-\frac{t}{RC}})$)<br><br>mark for max charge = $CV_o$ which may come from substitution or seeing 3.6(2) × $10^{-3}$ C ✓<br><br>$3.0 \times 10^{-3} = 370 \times 10^{-6} \times 9.8\ (1 - e^{-t})$ ✓<br><br>mark for substitution ($0.8274 = (1 - e^{-t})$ so $e^{t} = 1/0.173 = 5.79$)<br><br>$t$ = 1.7 s or 1.8 s ✓<br>**OR**<br>voltage $V = Q/C = 3 \times 10^{-3} / 370 \times 10^{-6}$<br>$= 8.1(1)$ V✓<br><br>(Substitute into $V = V_o(1 - e^{-\frac{t}{RC}})$ )<br>$8.1 = 9.8\ (1 - e^{-t})$ ✓<br><br>$t$ = 1.7 s or 1.8 s ✓ | Alternative mark scheme uses the voltage as proportional to the charge.<br><br>Do not allow use of the graph for 2nd mark and 3rd mark.<br><br>An answer only gains only the last mark. Evidence of working must be shown which shows substitution into a ($1-e^{-t}$) form of the equation. | 3 | AO2 |
| **Total** | | | **9** | |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **04.1** | The direction of the induced emf (when there is a change of flux linkage) is such that it will (try) to oppose the change (of flux) that is producing it ✓ owtte | A reference to emf is needed rather than induced current as this is dependent on a circuit. Ignore reference to current if emf is given. | 1 | AO1 |

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| **04.2** | (The reading shows a dc) current flow which then becomes zero (when the magnet stops moving) ✓ | The reading does not have to be steady. So reading increasing or pulsing up before falling to zero is okay. There should be no hint that the reading changes direction. | 1 | AO2 |

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| **04.3** | (The induced current produces) a north pole on the right hand side of the coil. ✓<br><br>which opposes the motion of the bar magnet<br>**OR**<br>and the two north poles repel each other<br>**OR**<br>to try to maintain the (small) magnetic field as the magnet approaches the coil (without this the magnet would increase the magnetic field beside the coil) ✓ | The polarity of the coil may be shown on the diagram.<br><br>The two marks are independent but the second mark does not stand completely alone as it has to be said in context. EG 'Two North poles repel' on its own will not gain a mark. | 2 | AO1<br>AO2 |

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| **04.4** | (Use of $\varepsilon = Blv$ as the straight leading edge of the coil is the only conductor that cuts the magnetic flux lines. Also using $v = s / t$)<br><br>$t = Bls/\varepsilon$ ✓<br><br>(There must be some evidence of use for the mark but the mark can come from substituting numbers, eg $t = 0.38 \times 0.032 \times 0.032 / 2.9 \times 10^{-4}$)<br><br>$t = 1.3(4)$ (s)✓<br><br>**OR**<br><br>(Using $\varepsilon = (-)N\,\Delta\phi/\Delta t$ then $\Delta t = \Delta(BA)/\varepsilon$)<br>$t = BA/\varepsilon$ ✓<br><br>(There must be some evidence of use for the mark but the | Useful numbers $BA = 3.89 \times 10^{-4}$<br><br>Although the first mark can come from substituting numbers the equation mark may be lost if it is obvious that the equation is not understood by the way substitutions are made (this does not include a simple AE slip). This loss of a mark is directed at the candidate who quotes several equations and happens to hit on the correct equation but fails to use it properly.<br>Failure to square the side length is a PE.<br><br>Answer only gains 2 marks. | 2 | AO2 |

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| | mark can come from substituting numbers,<br>eg.$t = 0.38 \times .032^2 / 2.9 \times 10^{-4}$)<br>$t = 1.3(4)$ (s) ✓ | | | |

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| **04.5** | (using $\varepsilon = BAN\omega \sin \omega t$ which give a maximum value of $\varepsilon_{max} = BAN\omega$ )<br>$\omega$ (= $\varepsilon_{max} / BAN$) = $5.1 \times 10^{-3} / (0.38 \times (0.032)^2$ ✓<br>$\omega = 13(.1)$ (rad $s^{-1}$) ✓ | Candidates who cannot maximise/remove sin $\omega t$ gain no marks.<br>{may see $\omega = 5.1 \times 10^{-3} / 3.9 \times 10^{-4}$} | 2 | AO2 |

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| **Total** | | | **8** |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **05.1** | $\gamma$ radiation because it is very / the most penetrating<br>**OR**<br>$\gamma$ radiation because it is penetrating enough to irradiate all sides of the instruments.<br>**OR**<br>$\gamma$ radiation is penetrating so instruments can be sterilised without removing the packaging.<br>✓ OWTTE | The quoted radiation must be gamma only and not a mixture.<br><br>It is not sufficient to just state 'gamma'. The <u>mark is based on the reason</u> for the choice. | 1 | AO3 |
| **05.2** | To become radioactive the nucleus has to be affected which (ionising) radiation does not do<br>**OR**<br>(Ionising) radiation <u>only</u> affects the outer electrons and not the nucleus.<br>**OR**<br>The energy of the radiation is insufficient to induce radioactivity. (For this mark high energy is not the same as highly ionizing)<br>**OR**<br>(ionising) radiation does not affect the nucleus ✓ owtte | | 1 | AO2 |

<table>
<tr>
<td>05.3</td>
<td>(Conclusion using the inverse square law $I = k/d^2$)<br>Make the point that $I \times d^2$ should be constant if the inverse square law is operating. ✓ owtte<br><br>Show calculations using data from <u>3 rows</u>.<br>The column may be completed in the following ways. ✓<br><br>
<table>
<tr><th>Corrected count rate count $s^{-1}$</th><th>$I \times d^2$ Using $I$ as count rate</th><th></th><th>$I \times d^2$ Using $I \propto$ count in 1.0 minute</th></tr>
<tr><td>150</td><td>6.00</td><td>Or</td><td>361</td></tr>
<tr><td>23.3</td><td>5.83</td><td></td><td>349</td></tr>
<tr><td>4.03</td><td>4.03</td><td></td><td>242</td></tr>
</table>
</td>
<td>Accept 2 sig figs and 1 sig fig in the case of the 4 and 6 in the second column shown here.<br>The mark is mainly based on the technique used.<br><br>The written answer must be enough to indicate a conclusion.<br>This mark can be gained even if there is a slip in the table.<br><br>The conclusion mark can be gained even if the second mark is lost because only two data points are taken.<br><br>Look out for different approaches. Eg.use the CCR at one distance to predict the CCR at other distances if the inverse function is followed. Eg CCR might be in order 9013,1440 and 360.</td>
<td>2</td>
<td>AO1</td>
</tr>
<tr>
<td>05.4</td>
<td>Mark given for any of these ideas (max 2)<br>The random nature of the radiation count (although small in this case)<br><br>Dead-time in the G-M detector<br><br>$d$ is not the real distance between source and detector or source is not a point source<br><br>The source may not be a pure gamma emitter.<br>(Gamma and beta is acceptable but not gamma and alpha together)<br><br>A reference to short half-life provided that an explanation of how this has an effect on separate measurements eg activity</td>
<td>No credit for unexplained bland statements such as ‘because of systematic errors’ or ‘more data needs to be taken to be certain’ etc.<br><br>Note: reference to background count does not gain a mark because the corrected count-rate is supplied in the question.</td>
<td>2</td>
<td>2 AO1</td>
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| | changes during the measurements. | | | |
| | Assumes no absorption between source and detector(although small in this case)<br>✓✓ | | | |

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| **Total** | | | **6** |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **06.1** | $2.0\ \text{cm}$ ✓ (allow 1.96 to 2.00 cm)<br>(answer alone gains mark and ignore number of sig.figs) | (The depth halves in $19\text{s}$. With the graph being exponential the depth will halve every $19\text{s}$. $57/19 = 3$ so the halving occurs $3$ times. $16\ \text{cm} \rightarrow 8\ \text{cm} \rightarrow 4\ \text{cm} \rightarrow 2\ \text{cm}$) | 1 | AO3 1a |
| **06.2** | use more water/greater depth/greater volume (in the existing cylinder)<br>(this should give the same half-life) ✓ | Assume the word water is present in the answer if there is no reference to it. Eg 'greater depth' is taken as 'greater depth of water'. | 1 | AO3 1b |
| **06.3** | closing the tap more<br>Or<br>using a more viscous fluid (density is not the same as viscosity)<br>Or<br>using a wider cylinder<br>Or<br>use a smaller diameter capillary/narrow tube✓ | To decrease the decay constant the depth decrease rate should be reduced ie the cylinder should take longer to empty)<br><br>Changes to the tube need to be specific.<br><br>Also tube needs to be identified | 1 | AO2 1f |
| **06.4** | (Using $T_{½} = \ln 2/\lambda = 0.693/1.42 \times 10^{-11}$)<br>$T_{½} = 4.9(4.88) \times 10^{10}$ (year) ✓ | | 1 | AO1 1b |

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| **06.5** | (~~Use of $N = N_0 e^{-\lambda t}$ mass is proportional to number so~~<br>$m = m_0 e^{-\lambda t}$<br>$m_0 = m\, e^{+\lambda t}$ )<br>$\lambda t$ = $1.42 \times 10^{-11} \times 4.47 \times 10^{9}$ or 0.0635✓<br><br>$(m_0 = 1.23 \times 10^{-3}\ e^{1.42 \times 10^{-11} \times 4.47 \times 10^{9}})$<br>$m_0 = 1.31 \times 10^{-3}$ (g) ✓(allow and look out for unit being modified to mg)<br><br>mark for 3 sig figs but must be attached to a final answer for mass with some attempt at a relevant exponential calculation ✓ | May calculate N = $8.51(2) \times 10^{18}$ and $N_0$ $9.07 \times 10^{18}$ but marks will be the same | 3 | AO2 1f |

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|---|---|---|---|---|
| **06.6** | ($N$ = mass/87$u$ = $1.23 \times 10^{-6}$ /($87 \times 1.661 \times 10^{-27}$ )<br><br>$N$ = $8.5(1) \times 10^{18}$ ✓<br>(this does not have to be calculated out for the mark)<br><br>($\lambda$ = $1.42 \times 10^{-11}$ / ($365 \times 24 \times 60 \times 60$) = $4.50 \times 10^{-19}$ )<br>($A$ = $\lambda N$ = $4.50 \times 10^{-19} \times 8.51 \times 10^{18}$ )<br>A = $3.8(4)$ ✓ (this calculation must use in seconds)<br><br>Bq, B/becquerel, counts $s^{-1}$ or $s^{-1}$ ✓ | In first mark is obtainable from calculating number of moles and then multiplying by Avogadro's number.<br>{$n$ = $1.23 \times 10^{-6}$/87 = $1.41 \times 10^{-5}$<br>$N$ = $1.41 \times 10^{-5} \times 6.02 \times 10^{23}$}<br>A power of 10 error will count as an AE and will allow an error carried forward.<br><br>Answer must follow working showing correct process as correct answer can come from incorrect working | 3 | AO1 1a<br>AO2 1f |

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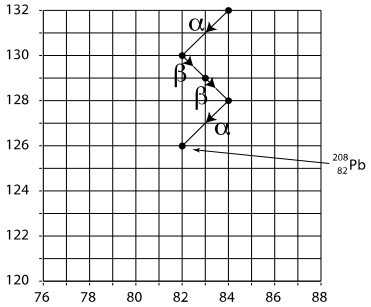
|---|---|---|---|
| **Total** | | | **10** |

| Question | Answers | Additional Comments/Guidance | Mark | ID details |
|---|---|---|---|---|
| **07.1** | First mark for either both $\alpha$'s or both $\beta^-$'s arrows shown correctly ie $\alpha$ arrow moving down 2 and left 2 or $\beta^-$ arrow moving down 1 and right 1 ✓(must be sequential)<br>Second mark for fully correct ✓<br>  | The first mark is independent of the start position.<br>The question asks for arrows, so a series of positions marked does not gain marks.<br>One mark can be awarded if all the lines with arrows are included but in wrong direction with lines. | 2 | AO2 1f |

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|---|---|---|---|---|
| **07.2** | **Any 3 marking points from 1 to 5**<br>[1]Strong nuclear force (SNF) affects nucleons or protons and neutrons. ✓<br>[2]SNF attraction extends up to 3 fm (allow 1–4 fm) ✓<br>[3]The SNF is repulsive below about 0.8 fm (allow 0.3 to 1 fm and prevents the nucleus totally collapsing) ✓<br>[4]Electromagnetic/electrostatic repulsive force (only) acts between protons ✓<br>[5]EM forces are long range/infinite/acts across whole nucleus/acts on all protons(so increases as proton number increases) ✓<br>**PLUS one of following that explains the imbalance**<br>More neutrons are needed to hold nucleus together / add to binding force/increase instability/reduce stability (owtte)<br>Or<br>Fewer protons are required so as to reduce the repulsion/reduce instability/increase stability (owtte) ✓ | Baryons/hadrons may replace nucleons.<br>If 'strong force' rather than 'strong nuclear force' is used only penalise once.<br>Any wrong statement made in the first group of marking points then this section has a maximum 2 marks out of 3. | Max 4 | AO2 1a (x2)<br>AO3 1b (x2) |

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| **07.3** | $^{205}_{82}\mathrm{Pb} + {}^{0}_{-1}\mathrm{e} = {}^{205}_{81}\mathrm{Tl} + \upsilon_{(\mathrm{e})}$ | The electron may be represented by $e^-$ or $\beta^-$ without the super and subscript. | 1 | AO2 1f |

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| | ✓ mark for full equation | Q may be added to the end of the equation.<br>Encouraged by the following question 'gamma' might appear on the RHS of the equation. Simply ignore gamma. | | |

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| **07.4** | Orbiting electrons in the atom <u>fall</u> (to fill the positions vacated by inner orbiting electrons releasing their energy as em (gamma) radiation, ✓<br>The excited <u>nucleus</u> emits gamma radiation (as it de-excites)✓ | Mark leniently in first mark. Just need to see photons are related to outer electron movement.<br>Allow radiation due to it being above 0 kelvin<br>For the second mark 'nucleus' must be mentioned but electrons must not. | 2 | AO3 1a<br>AO3 1b |

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|---|---|---|---|---|
| **07.5** | It is because:<br>It only emits $\gamma$-rays.<br>$\gamma$-rays are weakly ionising/cause less damage to body than other radiations.<br>$\gamma$-rays can penetrate/escape from the body.<br>It has low toxicity.<br>Half-life is short enough not to remain in the body for too long after the medical examination.<br>Half-life is long enough to complete the diagnosis.<br>It can be prepared in the hospital/close to the hospital.<br><br>Any 2 ✓✓ | | 2 | AO1 1a |

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|---|---|---|---|---|
| **Total** | | | **11** | |

| | Keys to Objective Test Questions (each correct answer is worth 1 mark) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Qu** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Ans | **A** | **C** | **C** | **B** | **B** | **A** | **D** | **C** | **B** | **D** | **C** | **A** | **C** |
| **Qu** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | |
| Ans | **D** | **D** | **B** | **C** | **C** | **C** | **C** | **A** | **A** | **C** | **C** | **D** | |