



Mark Scheme (Results)

November 2021

Pearson Edexcel GCSE
In Physics (1PH0) Paper 1F

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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 |

*there will be situations where an AO1 question will include elements of recall of knowledge directly from the specification (up to a maximum of 15%). These will be identified by an asterisk in the mark scheme.

| Question number | Answer | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1(a) | C Mercury A is incorrect Jupiter is the fifth planet from the Sun B is incorrect Mars is the fourth planet from the Sun D is incorrect Venus is the second planet from the Sun | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 1(b) | D a natural satellite A is incorrect, the Moon is not an asteroid B is incorrect, the Moon is not a comet C is incorrect, the Moon is not a nebula | | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1(c) | Any two of the following 1. mass (1) 2. radius (1) 3. density (1) | allow made of different substance/ material if no other mark awarded, allow 1 mark for (Moon is) smaller or Earth is bigger | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 1(d) | substitution (1) $(W=) 6.0 \times 1.6$ evaluation (1) 9.6 unit (independent mark)(1) newton | award full marks for correct answer without working. accept N, n and/or Newton 9.6 N/n gains full marks | (3) AO2(2) AO1(1) |

Total marks for question 1 =7

| Question number | Answer | Additional guidance | Mark | | | |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------|-------|--|------------|
| 2a(i) | <p>C</p> <table border="1"> <tr> <td>ultraviolet</td> <td>infrared</td> <td>radio</td> </tr> </table> <p>A is incorrect infrared should be in K, radio should be in L and ultraviolet in J, B is incorrect radio should be in L and ultraviolet should be in K D is incorrect radio should be in L and infrared in K</p> | ultraviolet | infrared | radio | | (1) AO1 |
| ultraviolet | infrared | radio | | | | |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------|---------------------|------------|
| 2a (ii) | <p>C speed</p> <p>amplitude, frequency and wavelength are not the same for all EM waves</p> | | (1) AO1 |


| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------|
| 2(b) (i) | <p>One from:</p> <p>seeing (broken) bones (1)</p> <p>radiotherapy (1)</p> <p>detecting cracks in metals (1)</p> <p>airport security (1)</p> <p>observing the internal structure of objects(1)</p> | <p>seeing inside the body</p> | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------------------------|
| 2(b) (ii) | One from: can cause cancer (1) can cause burns(1) {damage/kills/harms} cells/tissue (1) mutates DNA/cells (1) | harms organ(s) / foetus allow (highly) ionising | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 2(c) | infrared (1) thermal (1) | must be in first sentence space must be in second sentence space award 2 marks for answers in this order | (2) AO2 |

Total marks for question 2=6 marks

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 3a | <p>A two</p> <p>B is not correct as a uranium nucleus does not split to give 3 daughter nuclei</p> <p>C is not correct as a uranium nucleus does not split to give 4 daughter nuclei</p> <p>D is not correct as a uranium nucleus does not split to give 5 daughter nuclei</p> | | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3bi | <p>A description including:</p> <p>EITHER</p> <p>neutrons are absorbed by uranium nuclei/atoms (1)</p> <p>more neutrons are produced/emitted (which are absorbed by uranium nuclei) (1)</p> <p>OR</p> <p>diagram (no labels needed)</p> <p>two nuclei/atoms splitting (1)</p> <p>four or more nuclei/atoms splitting (1)</p>  <p style="text-align: center; font-size: small;">shutterstock.com • 1177431790</p> | <p>ignore any reference to bonds</p> <p>accept hit /collide with</p> <p>accept a controlled chain reaction diagram for 2 marks</p> | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 3bii | An explanation linking: (because the moderator/it) slows down/increases the chance of absorption of(1) neutrons (1) | | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 3biii | substitution(1) $2(.0 \times 10^{17}) \times 4(.0 \times 10^{-11})$ evaluation (1) $8(.0) \times 10^6$ (J) | accept 8000000(J) accept 8MJ 8 to any other power of ten scores 1 mark award full marks for correct answer without working. | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------|
| 3c | A description including one from hydrogen nuclei/atoms join (1) helium is produced (1) one from lost (total) mass (1) mass is converted to energy (1) | nuclei/atoms join larger/heavier nucleus produced energy is released | (2) AO1 |

Total marks for question 3= 9

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------|
| 4 (a) (i) | substitution (1) ($\Delta GPE =$) $64 \times 10 \times 24$ evaluation (1) 15 000 (J) | accept 15 360(J) or 15 400(J) award full marks for correct answer without working. | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------|
| 4 (a) (ii) | substitution (1) ($KE =$) $\frac{1}{2} \times 64 \times 6^{(2)}$ calculation of 6^2 (1) evaluation (1) 1200 (J) | accept 1152(J) award full marks for correct answer without working. 192 (J) scores 2 marks | (3) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------|
| 4(a) (iii) | an explanation linking any two from: the kinetic energy (store)/it decreases (to zero) (1) (the energy) has dissipated (1) to the surroundings (1) thermal energy (store) increases (1) | transferred to ground/brake(s) pads make the brakes hot | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------|---------------------|------------|
| 4 (b) (i) | 5000(J) | 24 000 – 19 000 | (1) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------|
| 4 (b) (ii) | substitution (1) (efficiency =) $\frac{19000}{24000} (x100\%)$ evaluation(1) 0.79 or 79% | allow 0.8 do not award 79 without percentage award full marks for correct answer without working. | (2) AO2 |

Total marks for Question 4 = 10

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------|---------------------|------|
|-----------------|--------|---------------------|------|

| | | | |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------|
| 5(a)(i) | <p>D travelling more slowly</p> <p>A is incorrect, more passengers would increase the stopping distance</p> <p>B is incorrect, worn tyres would increase the stopping distance</p> <p>C is incorrect, if the car needed new brakes this would increase the stopping distance</p> | | (1) AO1 |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------|

| Question number | Answer | Additional guidance | Mark |
|------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------|
| 5 (a)(ii) | <p>identification of horizontal line as reaction time (1)</p> <p>evaluation (1)</p> <p>0.6 (s)</p> | <p>award full marks for correct answer without working</p> <p>0.7 scores 1 mark</p> | (2) AO3 |

| Question number | Answer | Additional guidance | Mark |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------|
| 5b | <p>A description including two from let the car roll down the slope from the same point on the slope (1)</p> <p>measure distance it travels (along horizontal surface) (1)</p> <p>change the surface/ use different surfaces (1)</p> | <p>see how far it travels</p> <p>allow time it takes to stop</p> | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------|---------------------|------------|
| 5(c)(i) | 0.52 | | (1) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 5 (c) (ii) | addition and division (1) $\frac{0.35 + 0.32 + 0.38 + 0.33}{4}$ evaluation (1) 0.35 (m) | $\frac{0.35 + 0.32 + 0.52 + 0.38 + 0.33}{5}$ accept 0.345 (m) award full marks for correct answer without working. accept 0.38 for 2 marks (five results included in average) | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------|
| 5c(iii) | Any one from make the slope steeper(1) add more books/blocks (1) push/pull the trolley (1) | accept 'higher slope/high slope accept means of reducing friction e.g. use lubricant | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------|
| 5(d) | substitution (1) $(a =) \frac{12 - 2(.0)}{4(.0)}$ evaluation (1) 2.5 (m/s ²) | award full marks for correct answer without working. | (2) AO2 |

Total marks for question5 = 11

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 6 (a) | B force A is incorrect, mass is a scalar quantity C is incorrect, energy is a scalar quantity D is incorrect, distance is a scalar quantity | | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 6 (b) (i) | A plan including four of the following measurement of appropriate distance (1) measurement of appropriate time (1) use of speed = $\frac{\text{distance}}{\text{Time}}$ (1) detail (1) e.g. repeat and average, use ruler/stop clock, mark a line near the top and bottom of liquid | | (4) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 6(b)(ii) | An explanation linking two from: add more lines (at equal distances)(1) measure the time of fall for each distance (1) compare the times (1) | use longer test tube / use different heights of liquid / use different sections of the liquid e.g. {equal times = constant speed} / {shorter time = acceleration} | (2) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 6 (c) | substitution (1) $(v^2 - 0 =) 2 \times 10 \times 1.5$ evaluation (1) 5.5(m/s) | accept numbers that round to 5.5 e.g. 5.477 30(m/s) gains 1 mark for correct substitution but no square root taken award full marks for correct answer without working. | (2) AO2 |

Total marks for question 6 =9

| Question number | Answer | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 7(a) | A black B is incorrect as no blue light shines on the object C is incorrect as no green light shines on the object D is incorrect as no red light is reflected from the object | (1) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| 7 (b) (i) | C specular reflection A is incorrect as the reflection is not diffuse B is incorrect as it is not refraction D is incorrect as it is not refraction | | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------|
| 7 (b) (ii) | An explanation linking: (the surface/metal ball) is smooth/shiny (1) (for each ray of light) the angle of incidence is equal to the angle of reflection (1) | like a mirror the reflection is even / there is no scattering full marks can be awarded for labelled diagrams | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 7 c(i) | <p>similarity</p> <p>(both) change direction /bend/refract (rays of light) (1)</p> <p>OR</p> <p>(rays of light/they) pass/go (straight) through the (optical) centre / focus(1)</p> <p>difference</p> <p>one converges the other diverges (1)</p> | <p>accept ray through centre described as 'bottom ray'</p> <p>accept 'top ray' accept refracts/bends in different ways</p> <p>do not allow 'change in direction of top ray' this is a similarity</p> | (2) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------|--------------------------------------------------|------------|
| 7c(ii) | (the power of) P is less than (the power of) Q | <p>ORA</p> <p>allow Q is greater /bigger</p> | (1) AO2 |

| Question number | Indicative content | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 7d* | <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>Refraction</p> <ul style="list-style-type: none"> • Angle of incidence marked • Angle of refraction marked • Angles are measured from the normal • Angle of refraction is bigger than the angle of incidence • Rays of light travel in straight lines • Refraction occurs at a boundary between two materials of different (optical) density • The angle of incidence is less than the angle of refraction when light passes into a less dense medium (glass into air) • Refraction is a change in direction of a light ray. • Refracted rays bend away from the normal when light passes into a less dense medium (glass into air) • The ray in the more dense medium (glass) travels more slowly ORA <p>Total Internal Reflection</p> <ul style="list-style-type: none"> • Possible critical angle marked • Light stays inside the glass • Only occurs when the incident light is in the more dense medium • Only occurs when the incident angle is equal to greater than the critical angle • Critical angle for glass is about 42° • Angle of incidence is equal to the angle of reflection | (6) AO1 |

| Level | Mark | Descriptor |
|---------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 0 | No rewardable material. |
| Level 1 | 1-2 | <p>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1)</p> <p>Presents a description which is not logically ordered and with significant gaps. (AO1)</p> |
| Level 2 | 3-4 | <p>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)</p> <p>Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)</p> |
| Level 3 | 5-6 | <p>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1)</p> <p>Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)</p> |

| Level | Mark | Additional Guidance | General additional guidance - the decision within levels e.g. - 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> isolated fact(s) about refraction or total internal reflection(TIR) | <u>Possible candidate responses</u> naming of any rays of light or any angles in text or on diagrams light changes direction/bends TIR ray stays inside the glass / does not go into air refracted ray goes through glass and air |
| Level 2 | 3-4 | <u>Additional guidance</u> simple description of refraction and TIR or facts about one and more detail of the other | <u>Possible candidate responses</u> Angle or ray identified For refraction light changes direction from glass into air or TIR angles are equal inside the glass |
| Level 3 | 5-6 | <u>Additional guidance</u> detailed description of refraction and TIR | <u>Possible candidate responses</u> For refraction light changes direction from glass into air AND TIR angles are equal inside the glass |

Total marks for question 7 = 13

| Question number | Answer | Additional guidance | Mark |
|-----------------|---------------------------------------------------|-----------------------------------------------------|------------|
| 8(a) | uses data taken from x axis (1) 28(cm) (1) | award full marks for correct answer without working | (2) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 8 b(i) | a description to include count the number of waves(1) (arriving/passing a point) in a specific time(1) use frequency = $\frac{\text{number of waves}}{\text{time}}$ (1) | ignore in one second count the number of waves in one second scores 2 marks (MP1 and MP3) find the time between one wave and the next scores 2 marks (MP1 and MP2) | (3) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 8 b(ii) | substitution (1) $1.5 = 0.7 \times \lambda$ rearrangement and evaluation 2.1(4) m | $\frac{1.5}{0.7}$ allow $\frac{0.7}{1.5}$ for 1 mark award full marks for correct answer without working. $\lambda = v/f$ scores 1 mark | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 8 b(iii) | A description to include: mention of oscillations/vibrations (1) EITHER transverse – (oscillations) perpendicular to direction of wave (travel) (1) OR longitudinal – (oscillations) in same direction as wave (travel) (1) | up and down OR side to side (movements) OR back and forth transverse movement up and down but longitudinal is side to side (1 mark only) | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------------|
| 8 (c) | substitution $(x) = 330 \times 4.0$ evaluation 1300 (m) | accept 1320 (m) award full marks for correct answer without working. | (2) AO2 |

Total marks for Question 8 = 11

| Question number | Answer | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 9(a) | B ionising and emitted by unstable nuclei A is incorrect stable nuclei do not give radioactive emissions C is incorrect not all radioactive emissions are neutral D is incorrect not all radioactive emissions are neutral | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------|-------------------------------------------------|------------|
| 9(b) | same number of protons (1) different number of neutrons (1) | same atomic number different mass number | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------|
| 9(c)(i) | An explanation to include; there is no aluminium to absorb β particles (1) (therefore) more β particles reach the G-M tube (1) | aluminium absorbs/stops/blocks beta particles accept reverse arguments accept radiation for beta particles | (2) AO2 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------------------------------|----------------------------------------|------------|
| 9 c (ii) | (idea of) background radiation | a named source of background radiation | (1) AO3 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------|------------------------------------|------------|
| 9c (iii) | becquerel | accept Bq accept close spelling | (1) AO1 |

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

| Question number | Indicative content | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 9d* | <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>Dangers of exposing people to radioactive sources/radiation.</p> <ul style="list-style-type: none"> • it is ionising • may cause cancer • may destroy /kill cells • can mutate DNA • can burn the skin <p>Protection of hospital staff using radioactive sources/radiation.</p> <ul style="list-style-type: none"> • use tongs to carry radioactive sources • use lead containers to store sources • stay at a distance from radioactive sources • use sources for as short a time as possible • wear (lead lined) protective clothing (PPE) • give treatments from behind a shield /wall • wear a radiation badge (dosimeter) | (6) AO1 |

| Level | Mark | Descriptor |
|---------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 0 | No rewardable material. |
| Level 1 | 1–2 | <p>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1)</p> <p>Presents a description which is not logically ordered and with significant gaps. (AO1)</p> |
| Level 2 | 3–4 | <p>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)</p> <p>Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)</p> |
| Level 3 | 5–6 | 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) |
|--|--|--------------------------------------------------------------------------------------------------------|

| Level | Mark | Additional Guidance | General additional guidance - the decision within levels e.g. - 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> At least one isolated fact about the dangers of radiation and/or protection from radiation | <u>Possible candidate responses</u> it's ionising causes cancer burns you kills cells mutates DNA wear a radiation badge use tongs work from behind a shield use protective clothing |
| Level 2 | 3-4 | <u>Additional guidance</u> simple explanation of the dangers of radiation and a fact about protection or reverse OR detailed explanation of the dangers of radiation or protection from radiation | <u>Possible candidate responses</u> radiation is ionising and can kill cells so wear a radiation badge or use tongs and stay at a distance from radiation source as it can cause cancer or use tongs to stay at a distance from radiation sources and wear a radiation badge |
| Level 3 | 5-6 | <u>Additional guidance</u> detailed explanation of the dangers of radiation and protection from radiation | <u>Possible candidate responses</u> radiation is ionising and can kill cells and use tongs and stay at a distance from the radiation source |

Total marks for question 9 = 13

| Question number | Answer | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 10 (a) | <p>The only correct answer is D the discovery of cosmic microwave background (CMB) radiation</p> <p>A is not correct because it does not indicate the Universe had a beginning</p> <p>B is not correct, it is evidence against the geocentric model of the Universe</p> <p>C is not correct, it is evidence for other solar systems</p> | (1) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------|
| 10(b) | <p>A description to include:</p> <p>wavelength (of the light) (1)</p> <p>appears to increase (1) [increase must be linked with wavelength]</p> | <p>Red shift/Doppler effect</p> <p>(Red shift) shows galaxy moving away</p> <p>accept answers in terms of frequency</p> | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------|
| 10 (c) | <p>similarity (both have) expanding Universe (1)</p> <p>difference one from: Steady State, Universe has no beginning (1)</p> <p>Steady State theory requires the continual formation of new matter, the Big Bang theory does not (1)</p> | <p>different interpretation of CMBR</p> | (2) AO1 |

| Question number | Answer | Additional guidance | Mark |
|-----------------|--------|---------------------|------|
|-----------------|--------|---------------------|------|

| | | | |
|-------------------|------------------|--|--------------------------------------------------------------|
| 10 (d) (i) | 1050 ± 20 (km/s) | | (1) AO3 marked with dii |
|-------------------|------------------|--|--------------------------------------------------------------|

| Question number | Answer | Additional guidance | Mark |
|------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 10 (d)(ii) | attempt at $\frac{\Delta y}{\Delta x}$ (1) evaluation (1) 70 ± 5 unit (1) km/s/Mpc | could be seen on graph award 2 marks for correct answer without working independent mark km/s Mpc s ⁻¹ or per second | (3) AO3 |

| Question number | Answer | Additional guidance | Mark |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------------------------|
| 10 (d)(iii) | an explanation linking: points are scattered widely about the line (on graph) (1) giving wide range of possible gradients (1) | there are many possible best fit lines | (2) AO3 |

(Total for Question 10 = 11 marks)