OCR
Oxford Cambridge and RSA

# Higher

## GCSE

## Physics B Twenty First Century Science

### J259/03: Breadth in physics (Higher Tier)

General Certificate of Secondary Education

## Mark Scheme for June 2022

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

## MARKING INSTRUCTIONS

## PREPARATION FOR MARKING

### RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

## MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.

5. **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

**Rubric Error Responses – Optional Questions**
Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

**Multiple Choice Question Responses**
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses**
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions** (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space.

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

**The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

**The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

**In summary:**

**The skills and science content determines the level.**

**The communication statement determines the mark within a level.**

11. Annotations available in RM Assessor

| Annotation | Meaning |
|---|---|
|  | Correct response |
|  | Incorrect response |
|  | Omission mark |
| BOD | Benefit of doubt given |
| CON | Contradiction |
| RE | Rounding error |
| SF | Error in number of significant figures |
| ECF | Error carried forward |
| L1 | Level 1 |
| L2 | Level 2 |
| L3 | Level 3 |
| NBOD | Benefit of doubt not given |
| SEEN | Noted but no credit given |
| I | Ignore |

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

| Annotation | Meaning |
|---|---|
| ***/*** | alternative and acceptable answers for the same marking point |
| ✓ | Separates marking points |
| **DO NOT ALLOW** | Answers which are not worthy of credit |
| **IGNORE** | Statements which are irrelevant |
| **ALLOW** | Answers that can be accepted |
| **( )** | Words which are not essential to gain credit |
| __ | Underlined words must be present in answer to score a mark |
| **ECF** | Error carried forward |
| **AW** | Alternative wording |
| **ORA** | Or reverse argument |

13. **Subject-specific Marking Instructions**

**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

| | **Assessment Objective** |
|---|---|
| **AO1** | **Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.** |
| AO1.1 | Demonstrate knowledge and understanding of scientific ideas. |
| AO1.2 | Demonstrate knowledge and understanding of scientific techniques and procedures. |
| **AO2** | **Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.** |
| AO2.1 | Apply knowledge and understanding of scientific ideas. |
| AO2.2 | Apply knowledge and understanding of scientific enquiry, techniques and procedures. |
| **AO3** | **Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.** |
| **AO3.1** | Analyse information and ideas to interpret and evaluate. |
| AO3.1a | Analyse information and ideas to interpret. |
| AO3.1b | Analyse information and ideas to evaluate. |
| **AO3.2** | Analyse information and ideas to make judgements and draw conclusions. |
| AO3.2a | Analyse information and ideas to make judgements. |
| AO3.2b | Analyse information and ideas to draw conclusions. |
| **AO3.3** | Analyse information and ideas to develop and improve experimental procedures. |
| AO3.3a | Analyse information and ideas to develop experimental procedures. |
| AO3.3b | Analyse information and ideas to improve experimental procedures. |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 1 | (a) | | correct symbol for thermistor, in the correct place in the circuit. ✓ | 1 | 1.1 | |
| | (b) | (i) | **Any one from:**<br>wait for hot water to cool down ✓<br>mix hot water and cold water ✓<br>(use an electric) water bath (with a thermostat) ✓ | 1 | 3.3b | **IGNORE** use a thermometer.<br>**ALLOW** heat (slowly) on a stove/Bunsen burner/cooker etc., but not boil on a stove. |
| | | (ii) | less confident ✓<br><br>**AND any one from:**<br>new data point does not fit pattern / no correlation ✓<br>new data point is an anomaly / outlier ✓<br>new data point shows opposite pattern ✓ | 2 | 3.1b | <br><br><br>**ALLOW** it should be between 1300 and 1800<br>**ALLOW** it is very low compared to the others<br>**ALLOW** she said it would increase but it decreases / it didn't increase / resistance is higher at 0 |
| | (c) | | as temperature increases, resistance decreases ✓<br><br>**AND any one from:**<br>there is an anomaly / outlier (at 80°C) ✓<br>the data is (slightly) scattered ✓ | 2 | 3.1a | **DO NOT ALLOW** just negative correlation – must refer to temperature and resistance<br><br><br>**ALLOW** non-linear pattern. |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 2 | (a) | | distance is a scalar / displacement is a vector / displacement is distance with a direction ✓<br><br>(he changes direction so) the displacement is smaller than the distance / AW ✓ | 2 | 1.1<br><br>2.1 | <br><br>**ALLOW** numerical comparison for second mark e.g. distance is (at least) 36m and displacement is 12m. ✓ |
| | (b) | (i) | Jack<br>**AND**<br>4 m/s is a typical running speed / 16 m/s is too fast / AW ✓ | 1 | 2.1 | <br><br>**ALLOW** e.g. 16m/s is 57 km/h **or** 4m/s is 14 km/h<br>**ALLOW** using a smaller time interval will give a better estimate of initial acceleration. |
| | | (ii) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 1.6 (m/s$^2$) award 3 marks**<br><br>select: acceleration = change in velocity ÷ time ✓<br><br>4 ÷ 2.5 **or** 16 ÷ 10 ✓<br><br>1.6 (m/s$^2$) ✓ | 3 | <br><br>1.2<br><br>2.2 × 2 | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 3 | (a) | | (gamma rays are) ionising ✓<br>(so) kill (any / cancer) cells ✓<br><br>**AND any one from:**<br>penetrating so pass through **or** pass through tissue / named tissue / head ✓<br>the cancer/focal point receives a higher dose/concentration of /exposure to /absorbs more radiation ✓<br>multiple low energy beams minimizes damage to healthy cells ✓ | **3** | **1.1** | **IGNORE** more / less<br>**IGNORE** kills cancer / damages cells |
| | **(b)** | | contamination is when radioactive material / source is inside (or on) / in contact (with the body) ✓<br>Ben has been irradiated / gamma rays do not make Ben radioactive ✓ | **2** | **2.1** | **ALLOW** (most) gamma rays/radiation passes through the body<br>**IGNORE** rays hitting (implies they don't penetrate) |
| | **(c)** | | **Any one from:**<br>X-ray energy/intensity/properties can be controlled ✓<br>X-ray machine can be switched on and off / gamma rays emitted continuously/randomly ✓<br>X-ray machine can be used at any time/will not run out / gamma source will decay and lose its activity ✓<br>X-ray machines are cheaper/more common/ in most hospitals. ✓<br>(Gamma) radiotherapy is a more specialist treatment so not available in all hospitals. ✓ | **1** | **2.1** | **IGNORE** less ionising / references to safety / risk |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 4 | (a) | | **(Similarity) Any one from:**<br>both transverse ✓<br>both electromagnetic / part of electromagnetic spectrum ✓<br>both travel at same speed (in a vacuum) ✓<br>both can travel in a vacuum / don't need a medium ✓<br>both non-ionising ✓<br>both reflect/refract ✓<br>both carry energy ✓<br><br>**(Difference) Any one from:**<br>microwaves longer wavelength / ORA ✓<br>microwaves lower frequency / ORA ✓<br>microwaves not visible / ORA ✓ | **2** | **1.1** | **IGNORE** references to faster/slower / different speeds (there is a speed calculation in part b)<br><br>**DO NOT ALLOW** contradictions e.g. light has shorter wavelength and lower frequency |
| | **(b)** | **(i)** | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 2.0 × $10^8$ (m/s) award 4 marks**<br><br>select: speed = distance ÷ time ✓<br>unit conversion: 90km = 90 000 m **and** 450μs = 450 × $10^{-6}$s ✓<br>90 000 ÷ (450 × $10^{-6}$) ✓<br>2.0 × $10^8$ (m/s) ✓ | **4** | **1.2 × 2**<br><br>**2.1 × 2** | **ALLOW** 3 marks for 2 × $10^n$, n ≠ 8 (missing or incorrect unit conversion)<br><br>**IGNORE** v = f λ calculations |
| | | **(ii)** | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 4% (%) award 2 marks**<br><br>450-432 **or** 18 ✓<br>((18 ÷ 450) × 100%) = 4 (%) ✓ | **2** | **1.2** | **ALLOW** 1 mark for 0.04<br>**ALLOW** 1 mark for 96% (from 432/450)<br>**ALLOW** 1 mark for 4.17% / 4.2% (from 18/432) |
| | | **(iii)** | **Any one from:**<br>decrease in time / increase in speed the cost is too great ✓<br>10% is more than the decrease in time / increase in speed ✓<br>time delay is already very small / 18 μs is a very small improvement (increase in cost not worthwhile) ✓ | **1** | **3.1b** | Candidate response must compare cost or 10% to speed or time e.g. not much faster for the cost |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 5 | (a) | (i) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 0.28 (W) award 3 marks**<br><br>select: power = energy ÷ time ✓<br>5.6 ÷ 20 ✓<br>0.28 (W) ✓ | 3 | <br><br><br>**1.2**<br>**2.1 × 2** | **ALLOW** 2 marks for 0.175 (W) (used wrong energy value) |
| | | (ii) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 62.5 (%) award 3 marks**<br><br>select: efficiency = useful output ÷ total input ✓<br>3.5 ÷ 5.6 ✓<br>(0.625 × 100%) = 62.5 (%) ✓ | 3 | <br><br><br>**1.2**<br>**2.1 × 2** | **ALLOW** for 3 marks 63%<br>**ALLOW** for 2 marks 0.625 or 0.63 |
| | (b) | (i) | thermal insulation prevents/reduces thermal energy transfer ✓<br><br>(inefficiency is caused by) friction in the motor / resistance in the wires of the motor ✓ | 2 | 1.1 | **ALLOW** insulation stops hot objects cooling down / reduces heat loss / maintains/keeps temperature/heat<br><br>**ALLOW** hotter motor has a higher resistance |
| | | (ii) | **Any one from:**<br>lubricate (the motor) / reduce friction ✓<br>smoother bearings ✓<br>use wires with lower resistance ✓ | 1 | 2.2 | <br><br><br>**ALLOW** thicker wires |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 6 | (a) | | **Any two from:**<br>around every charge there is an electric field ✓<br><br>charges exert/experience forces (on each other) ✓<br><br>like charges repel / hairs repel each other / hair is repelled by the dome / negative repels negative ✓ | **2** | **1.1** | |
| | **(b)** | **(i)** | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = $2.4 \times 10^{-7}$ (A) award 3 marks**<br><br>select: I = V ÷ R ✓<br>120 000 ÷ ($5.0 \times 10^{11}$) ✓<br>$2.4 \times 10^{-7}$ (A) ✓ | **3** | **1.2**<br>**2.1 × 2** | **ALLOW** 2 marks for $2.4 \times 10^{n}$, n ≠ -7 (missing or incorrect unit conversion) |
| | | **(ii)** | **Any two from:**<br>wooden ruler/it is a conductor ✓<br>voltage of dome is very large ✓<br>charge on dome is very small ✓<br>use of Q = It and answer to **(i)** to estimate discharge time of 6.25 s ✓<br>discharge time is slow due to high resistance ✓ | **2** | **3.2b** | **ALLOW** the ruler/it provides a path to earth<br>**ALLOW** because the voltage is 120 000<br><br>**ALLOW** E = VQ **and** 0.18J |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 7 | (a) | (i) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 1.6 × $10^{-3}$ ($m^2$) award 3 marks**<br><br>select: Pressure = force ÷ area / $A = F \div P$ ✓<br>0.48 ÷ 300 ✓<br>1.6 × $10^{-3}$ ($m^2$) / 0.0016 ($m^2$) ✓ | 3 | **1.2**<br>**2.1 × 2** | **IGNORE** any other formulas<br>**DO NOT ALLOW** 4.8 (candidate may have multiplied 0.48 N by 10 N/ kg) |
| | | (ii) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 0.025 (m) award 3 marks**<br><br>select: $p = h\rho g$ ✓<br>300 = h × 1200 × 10 / $h$ = 300 ÷ 12000 ✓<br>0.025 (m) ✓ | 3 | **1.2**<br>**2.1 × 2** | **DO NOT ALLOW** power of ten errors |
| | (b) | | **Any three from:**<br>(to float) weight of water displaced = weight of block ✓<br>volume of salty water displaced is less (than pure water) ✓<br>block is submerged less/smaller depth below water ✓<br>salty / denser water exerts more pressure on block ✓<br>pressure increases with depth ✓<br>upthrust increases with density ✓<br>more upthrust with depth / less depth gives same upthrust ✓ | 3 | **1.1 × 3** | **IGNORE** density comparisons (given in table)<br>**IGNORE** explanations about copper<br><br>**ALLOW** the force pushing up increases with density<br>**ALLOW** the force pushing up increases with depth<br>**NOT JUST** more upthrust |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 8 | (a) | | mark crosses at (two or more) points on ray ✓<br>connect crosses using <u>ruler</u> ✓<br><br>**OR**<br><br>Put protractor underneath apparatus ✓<br>Shine ray along line on protractor ✓ | 2 | 1.2 | **ALLOW** align/use a ruler along the path of the ray ✓<br>**ALLOW** draw a line/points/crosses along the path of the ray / use a ruler (and pencil) to draw a line ✓ |
| | (b) | | normal line drawn perpendicular to mirror (judge by eye) ✓<br>reflected ray drawn using ruler at correct angle (judge by eye) ✓ | 2 | 1.2 | **DO NOT ALLOW** discontinuous rays<br>**ALLOW** no arrow on reflected ray but **NOT** if backwards arrow |
| | (c) | | **(Production) Any one from:**<br>infrared is emitted by normal (incandescent) light bulb ✓<br>infrared lamp / laser / LED ✓<br>infrared in sunlight ✓<br>infrared emitted by hot object ✓<br><br>**(Detection) Any one from:**<br>thermometer to detect temperature change ✓<br>infrared sensor ✓<br>infrared / thermal camera ✓ | 2 | 3.3a | **IGNORE** infrared light / light source unless it is clear that it is produced by a lamp or other device<br>**ALLOW** remote control / tv remote<br>**ALLOW** heat an object / use a heater<br><br>**ALLOW** thermocouple, heat sensor, thermochromic paper.<br>**IGNORE** heat detector |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 9 | (a) | (i) | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 6.0 (Nm) award 3 marks**<br><br>select: moment = force × distance ✓<br>20 × 0.3 ✓<br>6.0 (Nm) ✓ | 3 | **1.2**<br>**2.1 × 2** | **ALLOW** 2 marks for 3 (Nm) (used radius of smaller gear) |
| | | (ii) | **EITHER**<br>forces equal and opposite ✓<br>moment smaller on B (and in opposite direction) ✓<br>**OR**<br>forces equal / same (magnitude) ✓<br>moment smaller on B and in opposite direction ✓ | 2 | 1.1 | <u>Opposite</u> must be seen at least once to gain both marks. |
| | (b) | | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 36 award 2 marks**<br><br>24 × (30÷15) **or** 48 **or** 0.75 seen anywhere ✓<br>(48 × (15÷20)) = 36 ✓<br>**OR**<br>ratio of teeth = 30÷20 **or** 1.5 seen anywhere ✓<br>(= 24 × (30÷20)) = 36 ✓ | 2 | 2.2 | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 10 | a | | chemical (store) in battery decreases ✓<br><br>**AND any one from:**<br>thermal (store) in wires increases ✓<br>thermal (store) in blades increases ✓<br>thermal (store) in surroundings increases ✓ | 2 | 1.1 | **ALLOW** energy is transferred from the chemical store as AW for decreases<br><br>**IGNORE** kinetic energy<br>**ALLOW** transfers to thermal as AW for increases and condone 'turns into' |
| | b | i | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 0.025 (T) award 3 marks**<br><br>select: F = BIL ✓<br>$2.4 \times 10^{-4} = B \times 0.80 \times 0.012$ ✓<br>0.025 (T) ✓ | 3 | <br><br><br>1.2<br>2.1 × 2 | |
| | | ii | **Any two from:**<br>current in opposite directions on either side of coil ✓<br>(so) force in opposite directions on either side of coil ✓<br>(so) net moment on coil (so it rotates) ✓<br>commutator/split ring changes direction of current in coil to provide rotation ✓<br>magnetic field around coil interacts with magnet field of magnet ✓<br>the current is perpendicular to the magnetic field ✓ | 2 | 1.1 | **ALLOW** one side of the coil is forced up, the other side is forced down / |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 11 | (a) | | 3(.0) to 3.1 (kHz) ✓ | 1 | 1.2 | |
| | (b) | | **Any two from:**<br>sounds transmit from drum to inner ear/ nerves<br>**or** sound transmit through (small) bones<br>**or** bones (in middle ear) vibrate<br>✓<br><br>bones only vibrate in a limited frequency range ✓<br>amplitude of vibration depends on frequency ✓ | 2 | 1.1 | **IGNORE** eardrum vibrates / from eardrum to brain<br><br>**IGNORE** loudness depends on frequency (stem) |
| | (c) | | **Any two from:**<br>two peaks in loudness ✓<br><br>correct use of x **and** y readings from Fig 11.1 ✓<br><br>increasing pitch / sound gets 'higher' ✓ | 2 | 3.2b | **ALLOW** e.g. loud, quiet, then gets loud (again)<br><br>**ALLOW** e.g. at 500 Hz it is 79 / at 5 kHz it is 78.4 / 80.4 at 800Hz / 76.3 at 1.5 kHz / Condone 1 small square errors in readings |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 12 | (a) | | work done (on particles by gravity) ✓<br><br>(as) particles get closer ✓<br><br>particles gain (kinetic) energy ✓ | 3 | 1.1 | **ALLOW** volume of cloud/it decreases or pressure increases or density of cloud increases<br>**DO NOT ALLOW** density/volume of particles decrease<br>Look for contradictions e.g. volume and density decrease – this loses the second marking point<br><br>**ALLOW** particles move faster<br>**IGNORE** collisions but **ALLOW** faster particle collisions |
| | (b) | (i) | larger stars produce more energy ✓<br><br>idea that the outward pressure/expansion (due to fusion) is in balance with (stronger) gravity (so more fusion) ✓ | 2 | 2.1 | **ALLOW** relative output as AW for energy |
| | | (ii) | **Any one from:**<br>each star formed from a different nebula ✓<br>stars might be different ages / stages in life cycle ✓<br>it is difficult to make accurate measurements of stars ✓ | 1 | 2.2 | **ALLOW** idea that differences may be due to redshift<br>**ALLOW** (due to) inaccurate measurements/data |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 13 | (a) | | 21 ÷ 6 (=3.5) **or** 3.5 x 6 = 21 **or** 21 is shared between six (as they are in series) ✓ | 1 | 2.2 | |
| | (b) | | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 0.070 award 3 marks**<br><br>20mA **or** 0.02 A **or** *P* = *VI* (in any form) **or** 20 x 3.5 **or** 70 ✓<br><br>0.02 × 3.5 ✓<br><br>0.07 (W) ✓ | 3 | <br><br>1.2<br><br>2.1 × 2 | |
| | (c) | | (current for 7 LEDs is) 4 mA (from graph at 3V) ✓<br><br>(intensity of **one** LED:) when 6 LEDs (20mA) is 1.0<br>**OR** when 7 LEDs (4 mA) is 0.25<br>✓<br><br>Conclusion: 7 LEDs is dimmer or 6 LEDs is brighter<br>**AND either compares**<br>(total LED intensity for 6 and 7 LEDs) 6.0 **and** 1.75<br>**or** (single LED intensity) 1.0 **and** 0.25<br>✓ | 3 | 3.2a | (p.d. for 7 LEDs is 21÷7 = 3.0 V) – no mark<br><br>Two or three marks can only be obtained by using the data in both Figs 13.2 and 13.3<br>**ALLOW** 7 LEDS dimmer **and either:**<br>3V and 3.5V **or** 0.012 W and 0,07 W<br>**IGNORE** e.g. dimmer because more resistance as this does not assess the AO element<br><br>**ALLOW** the first marking point also for 0.25 as this is obtained by using 4mA<br><br>Special case:<br>**ALLOW** Resistance $R_6$ (for 6 diodes in series) = $\frac{3.5}{20 \times 10^{-3}}$ = 175 Ω ( 1 mark)<br><br>Resistance $R_7$ (for 7 diodes in series) = $\frac{3.0}{4 \times 10^{-3}}$ = 750 Ω (1 mark)<br><br>And conclusion dimmer for 7 because higher resistance **AND** 175 Ω **AND** 750 Ω |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | | | | | **ALLOW MAX 2** for 0.175 and 0.75 and the conclusion (forgot to convert mA ) So 0.175 would get a mark but **IGNORE** 6 x 175 compared with 7 x 175 - the data shows that diodes don't work like that |

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