OCR
Oxford Cambridge and RSA

# GCE

# Physics A

Unit **H156/01:** Breadth in physics

Advanced Subsidiary GCE

# Mark Scheme for June 2018

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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.

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Annotations available in RM Assessor

| Annotation | | Meaning |
|---|---|---|
|  | Correct response | Used to indicate the point at which a mark has been awarded (**one tick per mark awarded**). |
|  | Incorrect response | Used to indicate an incorrect answer or a point where a mark is lost. |
| **AE** | Arithmetic error | Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors. |
| **BOD** | Benefit of doubt given | Used to indicate a mark awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done. |
| **BP** | Blank page | Use BP on additional page(s) to show that there is no additional work provided by the candidates. |
| **CON** | Contradiction | No mark can be awarded if the candidate contradicts himself or herself in the same response. |
| **ECF** | Error carried forward | Used in numerical answers only, unless specified otherwise in the mark scheme. Answers to later sections of numerical questions may be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a question, ECF can be given for AE, TE and POT errors but not for XP. |
| **L1** | Level 1 | L1 is used to show 2 marks awarded and L1^ is used to show 1 mark awarded. |
| **L2** | Level 2 | L2 is used to show 4 marks awarded and L2^ is used to show 3 marks awarded. |
| **L3** | Level 3 | L3 is used to show 6 marks awarded and L3^ is used to show 5 marks awarded. |
| **POT** | Power of 10 error | This is usually linked to conversion of SI prefixes. Do not allow the mark where the error occurs. Then follow through the working/calculation giving ECF for subsequent marks if there are no further errors. |
| **SEEN** | Seen | To indicate working/text has been seen by the examiner. |
| **SF** | Error in number of significant figures | Where more SFs are given than is justified by the question, do not penalise. Fewer significant figures than necessary will be considered within the mark scheme. **Penalised only once in the paper.** |
| **TE** | Transcription error | This error is when there is incorrect transcription of the correct data from the question, graphical read-off, formulae booklet or a previous answer. Do not allow the relevant mark and then follow through the working giving ECF for subsequent marks. |
| **XP** | Wrong physics or equation | Used in numerical answers only, unless otherwise specified in the mark scheme. Use of an incorrect equation is wrong physics even if it happens to lead to the correct answer. |
| **^** | Omission | Used to indicate where more is needed for a mark to be awarded (what is written is not wrong but not enough). |

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

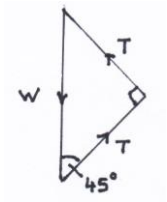
| Annotation | Meaning |
|---|---|
| **/** | alternative and acceptable answers for the same marking point |
| **Reject** | Answers which are not worthy of credit |
| **Not** | Answers which are not worthy of credit |
| **Ignore** | Statements which are irrelevant |
| **Allow** | Answers that can be 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 |

SECTION A

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 | B | 1 | |
| 2 | D | 1 | |
| 3 | B | 1 | |
| 4 | C | 1 | |
| 5 | A | 1 | |
| 6 | B | 1 | |
| 7 | A | 1 | |
| 8 | B | 1 | |
| 9 | C | 1 | |
| 10 | B | 1 | |
| 11 | C | 1 | |
| 12 | D | 1 | |
| 13 | C | 1 | |
| 14 | C | 1 | |
| 15 | B | 1 | |
| 16 | C | 1 | |
| 17 | D | 1 | |
| 18 | D | 1 | |
| 19 | D | 1 | |
| 20 | D | 1 | |
| | Total | 20 | |

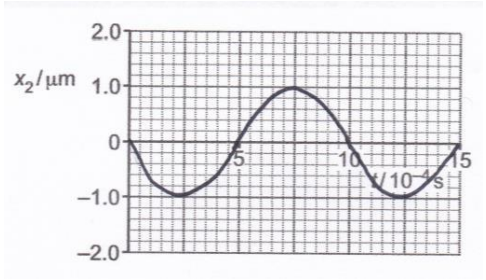
**SECTION B**

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 21 | (a) | | Distance / displacement / length measured using the (metre) rule **and** time measured using the stopwatch<br><br>($s = ½ [ v + u]t$ and $u = 0$)<br><br>$v = 2 \times$ <u>average</u> velocity | **B1**<br><br><br><br>**B1** | **Allow** this mark even if the measurements are taken after trolley has left the ramp<br><br><br><br>**Note** $v$ must be the subject<br>**Allow** $v = 2 \times$ average speed<br>**Allow** $v = 2x/t$ without the terms defined ($x$ can be $d$, $D$ or $s$)<br>**Not** $s = ½ vt$<br>**Allow** $v = x/t$, where $x$ = distance travelled along horizontal surface assuming it is smooth / negligible friction<br>**Allow** 1 mark for the following where there is no mention of timing / stopwatch:<br>Measure height / vertical distance with a (metre) rule **and** use $v = \sqrt{2gh}$ (no need to define the terms) |
| | (b) | (i) | ($v^2 = u^2 + 2as$)<br><br>$2.5^2 = 1.3^2 + 2 \times 1.10 \times a$ (Any subject)<br><br>$a = 2.1$ (m s$^{-2}$) | <br><br>**C1**<br><br>**A1** | **Allow** other methods<br><br>**Allow** this mark for $t = 0.58$ (s)<br><br>**Note** answer to 3 SF is 2.07 (m s$^{-2}$) |
| | (b) | (ii) | $ma = mg \sin\theta$ **or** $a = g \sin\theta$ **or** $2.07 = 9.81 \times \sin\theta$<br><br><br><br>$\theta = 12°$ | **C1**<br><br><br><br>**A1** | **Allow** 2.1 (m s$^{-1}$)<br>**Allow** $g = 9.8$<br>**Note** using $\tan^{-1}(2.07/9.81)$ is **wrong physics**.<br><br>Possible ECF from **(b)(i)**<br>**Allow** $g = 10$ here; it gives the same answer to 2 SF<br>**Allow** 1 mark for 78° |
| | | | **Total** | **6** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 22 | (a) | | (The resultant of the tensions in the springs is) $W$ / 4.8 (N)<br><br>Direction: up(wards) / opposite to weight / opposite to $W$ (because the total force in the vertical direction is zero) | B1<br><br>B1 | |
| | (b) | | Triangle with at least **two** forces shown, **one** angle marked and the $W$ side being longest<br><br>The (force) arrows are consistently clockwise or anticlockwise<br><br><br> | B1<br><br>B1 | **Allow** ⌞ for right angle<br>**Ignore** 'orientation' of the triangle<br>**Ignore** any other figures<br><br>**Note** all three arrows are required |
| | (c) | | $2 \times T^2 = 4.8^2$ **or** $2T\sin45° = 4.8$ **or** $T = 4.8\sin45°$<br><br>$T$ = 3.39(4) (N) | B1<br><br>B1 | **Note**: $\sin45° = \cos45°$<br><br>**Note**: $T$ must be given to at least 3 SF |
| | (d) | | 3.4 = 24$x$ **or** ($x$ =) $\frac{3.4}{24}$ **or** ($x$ =) 0.14(17) (m)<br><br>($E$ = ½ × 24 × $0.1417^2$ **or** $E$ = ½ × 3.4 × 0.1417)<br><br>energy = 0.24 (J) | C1<br><br><br><br>A1 | **Allow** the C1 mark for $E = 3.4^2/(2 \times 24)$<br>**Allow** 3.39(4) N<br>No ECF from **(c)** |
| | | | **Total** | 8 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 23 | (a) | | Weight (of tube), upthrust (and tension / *F* are the forces acting on the tube) | B1 | **Allow** 'buoyancy force' for upthrust throughout, but not just 'buoyancy' |
| | | | (For $t < 60$ s) the upthrust (on the tube) increases | B1 | |
| | | | One detail point from:<br>• Upthrust **increases** because weight of water displaced increases (up to 60s) **or** upthrust is **constant** (after 60s) because weight of water displaced is constant | B1 | **Not** 'mass' or 'volume' of water displaced<br>**Not** upthrust = weight of fluid / water displaced |
| | | | • Constant gradient (before 60 s) because upthrust **or** volume (of water displaced) **or** mass (of water displaced) **or** weight (of water displaced) increases at a constant rate | | |
| | | | • (After $t = 60$ s / eventually / finally the) upthrust is constant because tube is (fully) submerged / container is full (of water) | | **Allow** 'no more water is displaced after 60 (s) because tube is (fully) submerged' AW |
| | | | • $F$ = upthrust – weight / $F = U - W$ (Any subject) | | |
| | (b) | | (resultant force =) 4.2 - 0.8 **or** 3.4 (N) | C1 | |
| | | | ($m$ =) 0.8/9.81 **or** 0.0815 …. (kg) | C1 | **Allow** 0.082 (kg)<br>**Not** 0.08 (kg) |
| | | | ($a = \frac{3.4}{(0.8/9.81)}$)<br>$a$ = 42 (m s$^{-2}$) | A1 | **Allow** 2 marks for $F$ = 3.4 (N), $m$ = 0.08 (kg) and hence $a$ = 42.5 or **43** (m s$^{-2}$) |
| | (c) | | There is (an increasing) friction / drag (acting on the tube) | B1 | **Allow** (water) resistance / resistive force<br>**Allow** upthrust decreases as tube comes out of water AW<br>**Not** 'drag **and** upthrust', unless the upthrust is qualified as above |
| | | | **Total** | 7 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 24 | (a) | (i) | ($P = VI = 10.0 \times 0.030$)<br><br>power = 0.30 (W) | <br><br>B1 | <br><br>**Allow** 0.3 (W) without any SF penalty<br>**Allow** 300 **m**(W) |
| | | (ii) | The component is (an NTC) thermistor.<br><br>(As $V$ or $I$ increases the) resistance of the component decreases<br><br>Any one from:<br>Component cannot be a diode / LED because of current in one direction only (AW)<br>(As $V$ or $I$ increases the) component gets warmer / increase in number density (of free charge carriers) | B1<br><br>B1<br><br><br>B1 | <br><br>**Allow** calculations at 5 V and 10 V to support this, **ignore** POT errors |
| | (b) | | $R = \frac{\rho L}{A} = \frac{1.5\times10^{-2}\times8.0\times10^{-3}}{1.2\times10^{-6}}$ **or** 100 (Ω)<br><br>(total resistance =) 168 (Ω)<br><br>(current = 3.0/168)<br><br>$I$ = 0.018 A | C1<br><br>C1<br><br><br>A1 | Possible POT error here<br>**Note** using $A = (1.2 \times 10^{-6})^2$ is wrong physics, hence this C1 mark is lost<br><br>Possible ECF from incorrect value of $R$ for this C1 mark and the next A1 mark<br><br><br>**Allow** 2 marks 0.044 (A); $A$ taken as $1.2 \times 10^{-3}$, which gives $R$ = **0.1** and $I$ = 3.0/**68.1** = 0.044 (A)<br>**Not** $I$ = 3.0/**68** = 0.044 (A) because this is wrong physics |
| | | | **Total** | **7** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 25 | (a) | | The <u>period</u> is determined by counting squares / from time-base | B1 | **Note**: Any reference to <u>wave**length**</u> will lose this mark<br>**Not** 'determine *T*' |
| | | | The frequency *f* is period$^{-1}$ | B1 | **Allow** $f = 1/T$ |
| | (b) | (i) | Correct curve with amplitude of 1.0 μm and a phase difference of 180°<br><br> | B1 | **Allow** a curve shown for a minimum of one period<br>**Allow** ± 0.2 μm for amplitude at any two points<br>**Not** 'triangular' profile for the curve |
| | | (ii) | The amplitude (at **P**) is smaller / < 3.0 (μm) / = 2.0 (μm) | B1 | **Not** displacement |
| | | | intensity ∝ amplitude$^2$ (therefore the intensity is not the same) | B1 | **Allow** $I \propto A^2$, where $I$ = intensity and $A$ = amplitude<br>**Allow** 2 marks for 'intensity is $\left(\frac{2}{3}\right)^2 \times 100 = 44\%$ |
| | | (iii) | (The path difference is) 17 (cm) **or** half wavelength **or** $\lambda/2$. | M1 | **Not** $(n + ½)\lambda$<br>**Not** <u>phase</u> difference is 17 (cm) **or** half wavelength **or** $\lambda/2$ |
| | | | Hence destructive (interference) | A1 | |
| | | | **Total** | 7 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 26 | (a) | (i) | ($\lambda$ = $\frac{3.00\times10^{8}}{11\times10^{9}}$)<br>$\lambda$ = 0.027 (m) | B1 | **Note** answer to 3 SF is 0.0273 (m)<br>**Possible** SF penalty for 0.03 (m) |
| | | (ii) | Diffraction / spreading of the waves (occur at the narrow slit.) | M1 | |
| | | | This is because the wavelength is similar / comparable to the width / size / length of the slit (ORA) | A1 | **Allow** 'wavelength is same as the gap (size)' AW |
| | (b) | | Speed of light is less in water (ORA) | B1 | **Allow** calculated values for air **and** water<br>**Allow** speed decreases (from air to water)<br>**Not** *v* or *c* |
| | | | Frequency is the same (in both) | B1 | **Allow** *f* is the same |
| | | | Wavelength is smaller in water (ORA) | B1 | **Allow** wavelength / $\lambda$ decreases (from air to water) |
| | (c) | | Laser / ray box **or** protractor mentioned | B1 | **Not** 'ray of light' for laser / ray box |
| | | | Ray diagram showing (incident) ray **within** the block, (refracted) ray along the straight edge of block **and** critical angle marked between the incident ray and the normal | B1 | **Allow** $C$, critical angle, $\theta$ or $i$ for the angle marked between the incident ray and normal<br>**Note**: No labelling of rays or normal is required<br>**Ignore** direction of rays<br>**Ignore** any internally reflected ray<br>**Note** this mark is for the **ray diagram. Ignore** description, unless there are multiple refracted rays shown |
| | | | (Refractive index determined using) $n = 1/\sin C$ | B1 | **Allow** any subject and terms do not need to be defined<br>**Not** bald '$n_1\sin\theta_1 = n_2\sin\theta_2$' |
| | | | **Total** | 9 | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 27 | (a) | | (They have different) wavelength / frequency | B1 | **Allow**: (They have different) photon energy / ionisation (effects)<br>**Not** wrong physics, e.g. *X-rays have longer wavelength*<br>**Ignore** uses of these wave(s) |
| | (b) | (i) | (surface area =) $4\pi \times (1.4 \times 10^9)^2$ **or** $2.46 \times 10^{19}$ ($m^2$)<br>(intensity = $\frac{P}{4\pi r^2}$)<br>intensity = $\frac{2.7 \times 10^{27}}{4\pi \times (1.4 \times 10^9)^2}$<br>intensity = $1.1 \times 10^8$ (W $m^{-2}$) | C1<br>C1<br>A0 | **Allow** $2.5 \times 10^{19}$ ($m^2$)<br>**Note**: Using $\pi \times (1.4 \times 10^9)^2$ is wrong physics; hence no marks in this show question |
| | | (ii) | $E = \frac{3.00 \times 10^8 \times 6.63 \times 10^{-34}}{5.0 \times 10^{-7}}$<br>$E = 4.0 \times 10^{-19}$ (J) | C1<br>A1 | **Note**: Answer to 3 SF is $3.98 \times 10^{-19}$ (J)<br>**Allow** $4 \times 10^{-19}$ (J) without any SF penalty |
| | | (iii) | (number per second = $\frac{2.7 \times 10^{27}}{4.0 \times 10^{-19}}$)<br>number per second = $6.8 \times 10^{45}$ ($s^{-1}$) | B1 | Possible ECF from **(b)(ii)** |
| | | | **Total** | 6 | |

**OCR (Oxford Cambridge and RSA Examinations)**
**The Triangle Building**
**Shaftesbury Road**
**Cambridge**
**CB2 8EA**

**OCR Customer Contact Centre**

**Education and Learning**
Telephone: 01223 553998
Facsimile: 01223 552627
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**OCR (Oxford Cambridge and RSA Examinations)**
**Head office**
**Telephone: 01223 552552**
**Facsimile: 01223 552553**

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