Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

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**PHYSICS** **9702/21**

Paper 2 AS Level Structured Questions **May/June 2018**

MARK SCHEME

Maximum Mark: 60

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Cambridge Assessment International Education

## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

| Question | Answer | Marks |
|---|---|---|
| 1(a) | a scalar has magnitude (only) | **B1** |
| | a vector has magnitude and direction | **B1** |
| 1(b) | power: scalar<br>temperature: scalar<br>momentum: vector<br><br>*(two correct 1 mark, all three correct 2 marks)* | **B2** |
| 1(c)(i) | arrow labelled R in a direction from 5° to 20° north of west | **B1** |
| 1(c)(ii) | $v^2 = 28^2 + 95^2 - (2 \times 28 \times 95 \times \cos 115°)$<br>**or**<br>$v^2 = [(95 + 28\cos 65°)^2 + (28\sin 65°)^2]$ | **C1** |
| | $v = 110\ \text{ms}^{-1}$ ($109.8\ \text{ms}^{-1}$) | **A1** |
| | **or** (scale diagram method) | |
| | triangle of velocities drawn | **(C1)** |
| | $v = 110\ \text{m s}^{-1}$ (allow 108–112 $\text{m s}^{-1}$) | **(A1)** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | a body continues at (rest or) constant velocity unless acted upon by a resultant force | **B1** |
| 2(b)(i)1. | from 0–2 s, distance = ½ × 2 × 6.8 (= 6.8 m)<br>**and**<br>from 2–3 s, distance = ½ × 1 × 3.4 (= 1.7 m) | **C1** |
| | magnitude of displacement = 5.1 m | **A1** |
| | direction of displacement is down(wards) | **B1** |
| 2(b)(i)2. | $(\Delta E) = mg\Delta h$ **or** $(E) = mgh$ **or** $(E) = Wh$ | **C1** |
| | $(\Delta)E = 15 \times 5.1$<br>$= (–)\ 77\,\text{J}$ | **A1** |
| 2(b)(ii) | $a = (v – u) / t$ **or** $a$ = gradient **or** $a = \text{d}v/\text{d}t$ | **C1** |
| | $a = 3.4\,\text{m}\,\text{s}^{-2}$ | **A1** |
| 2(b)(iii) | $T – W = ma$ **or** $T – mg = ma$ | **C1** |
| | $T = 15 + (15 / 9.81) \times 3.4 = 20\,\text{N}$ or $20.2\,\text{N}$ | **A1** |
| 2(b)(iv) | $E = F / A\varepsilon$ **or** $E = \sigma / \varepsilon$ <u>and</u> $\sigma = F / A$ | **C1** |
| | $\varepsilon = 20 / (2.8 \times 10^{-5} \times 1.7 \times 10^{11})$ | **C1** |
| | $= 4.2 \times 10^{-6}$ | **A1** |
| 2(b)(v) | block is in equilibrium/has no resultant force | **B1** |
| | block could be stationary (**or** have constant velocity/speed)<br>(so no, not possible to deduce) | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 3(a) | mass is the property (of a body/object) resisting changes in motion<br>**or**<br>mass is the quantity of matter (in a body) | **B1** |
| 3(b)(i) | force on A (by B) equal <u>and opposite</u> to force on B (by A) **or** both A and B exert equal and opposite forces on each other | **B1** |
| | force is rate of change of momentum <u>and</u> time (of contact) is same | **B1** |
| 3(b)(ii) | $p = mv$ **or** $3M \times 0.40$ **or** $M \times 0.25$ **or** $3M \times 0.2$ **or** $Mv$ | **C1** |
| | $(3M \times 0.40) – (M \times 0.25) = (3M \times 0.2) + Mv$ | **C1** |
| | $v = (3 \times 0.40) – 0.25 – (3 \times 0.2)$<br>$= 0.35\,\text{m}\,\text{s}^{-1}$ | **A1** |
| 3(b)(iii) | **1.** relative speed of approach $= 0.40 + 0.25$<br>$= 0.65\,\text{m}\,\text{s}^{-1}$ | **A1** |
| | **2.** relative speed of separation $= 0.35 – 0.20$<br>$= 0.15\,\text{m}\,\text{s}^{-1}$ | **A1** |
| 3(b)(iv) | (relative) speed of separation not equal to/less than (relative) speed of approach **or** answers (to (b)(iii) are) not equal **and** so inelastic collision | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 4(a)(i) | time for one oscillation/one vibration/one cycle<br>**or**<br>time between adjacent wavefronts/points in phase<br>**or**<br>shortest time between two wavefronts/points in phase | **B1** |
| 4(a)(ii) | distance moved by wavefront/energy during one cycle/oscillation/period (of source)<br>**or**<br>minimum distance between two wavefronts<br>**or**<br>distance between two adjacent wavefronts<br>**or**<br>minimum distance between two points having the same displacement and moving in the same direction | **B1** |
| 4(b)(i) | $v = \lambda / T$ **or** $v = f\lambda$ <u>and</u> $f = 1 / T$ | **C1** |
| | $\lambda = 20 \times 0.60$<br>$= 12$ cm | **A1** |
| 4(b)(ii) | phase difference $= 360° \times (0.20/0.60)$ **or** $360° \times (0.40/0.60)$<br>$= 120°$ **or** $240°$ | **A1** |
| 4(b)(iii) | $I \propto A^2$ | **C1** |
| | $I_Q/I_P = A_Q^2/A_P^2$<br>$= 2.0^2/3.0^2$<br>$= 0.44$ | **A1** |
| 4(b)(iv) | displacement $= 1.00 – 3.00$<br>$= –2.00$ mm | **A1** |

| Question | Answer | Marks |
|---|---|---|
| 5(a)(i) | waves spread at (each) slit/gap | B1 |
| 5(a)(ii) | constant phase difference (between (each of) the waves) | B1 |
| 5(b)(i) | $n\lambda = d\sin\theta$ | B1 |
| | $d\sin\theta$ is the same **and** $3\lambda_1 = 4\lambda_2$ so $\lambda_2 / \lambda_1 = 0.75$ | A1 |
| 5(b)(ii) | $\lambda_2 / \lambda_1 = 0.75$ and $\lambda_1 - \lambda_2 = 170$<br><br>$\lambda_1 = 680\,\text{nm}$ | A1 |

| Question | Answer | Marks |
|---|---|---|
| 6(a) | joule / coulomb | B1 |
| 6(b)(i) | lamps have same p.d./lamp<u>s</u> have p.d. of 2.7 V | B1 |
| | current = 0.15 + 0.090<br><br>= 0.24 A | A1 |
| 6(b)(ii) | $R = (4.5 - 2.7) / 0.24$<br><br>**or**<br><br>$R_P = 18\,(\Omega)$ and $R_Q = 30\,(\Omega)$<br>$I / R_T = 1/18 + 1/30$ and so $R_T = 11.25$<br>$4.5 = 0.24 \times (R + 11.25)$ | C1 |
| | $R = 7.5\,\Omega$ | A1 |

| Question | Answer | Marks |
|---|---|---|
| 6(b)(iii) | $R = \rho l / A$ | C1 |
| | $R_P / R_Q = [(2.7/0.15)/(2.7/0.09)]$ (= 0.60) | C1 |
| | ratio $= 0.60 \times 2^2$<br>$= 2.4$ | A1 |
| 6(b)(iv) | less p.d. across resistor/greater p.d. across <u>P</u> | B1 |
| | greater current through <u>P</u> and so resistance (of P) increases | B1 |

| Question | Answer | Marks |
|---|---|---|
| 7(a) | arrow pointing vertically down the page | B1 |
| 7(b) | $E = ½mv^2$ | C1 |
| | $E = 460 \times 1.60 \times 10^{-19}$ (= $7.36 \times 10^{-17}$ (J)) | C1 |
| | $v = [(2 \times 460 \times 1.60 \times 10^{-19})/(9.11 \times 10^{-31})]^{½}$<br>$= 1.3 \times 10^7 \, m s^{-1}$ | A1 |
| 7(c) | $\beta^-$ particles have range of/different/various speeds/velocities/momenta/energies | M1 |
| | so they follow different paths | A1 |