National
Qualifications
2026

2026 Physics

National 5

Question Paper Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by Qualifications Scotland appointed markers when marking external course assessments.

Qualifications Scotland
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General marking principles for National 5 Physics

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must **always** be assigned in line with these marking principles, the Physics: general marking principles (GMPs) (Physics: general marking principles - National 3 to Advanced Higher) and the detailed marking instructions for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

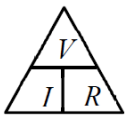
(d) Where a candidate answers part of a question incorrectly and carries the incorrect answer forward in the following part, award marks if the incorrect answer has then been used correctly in the subsequent part or 'follow-on'. (GMP 16)

(e) Award marks for non-standard symbols where the symbols are defined and the relationship is correct, or where the substitution shows that the relationship used is correct. This must be clear and unambiguous. (GMP 20)

(f) Award full marks for a correct final answer (including units if required) on its own, unless a numerical question specifically requires evidence of working to be shown, eg in a 'show' question. (GMP 1)

(g) Award marks where a diagram or sketch conveys correctly the response required by the question. It will usually require clear and correct labels (or the use of standard symbols). (GMP 19)

(h) Marks are allocated for knowledge of relevant relationships alone. Do not award a mark when a candidate writes down several relationships and does not select the correct one to continue with, for example by substituting values. (GMP 1c)

(i) Do not award marks if a 'magic triangle', eg , 

is the only statement in a candidate's response.

To gain the mark, the correct relationship must be stated eg $V = IR$ or $R = \frac{V}{I}$, etc. (GMP 2)

(j) In rounding to an expected number of significant figures, award the mark for correct answers which have up to two figures more or one figure less than the number in the data with the fewest significant figures. (GMP 6)

(Note: the use of a recurrence dot, eg $0.\dot{6}$, would imply an infinite number of significant figures and would therefore not be acceptable.)

(k) The incorrect spelling of technical terms should usually be ignored and candidates should be awarded the relevant mark, provided that answers can be interpreted and understood without any doubt as to the meaning.
Where there is ambiguity, do not award the mark. Two specific examples of this would be when the candidate uses a term:

- that might be interpreted as *reflection*, *refraction* or *diffraction*, eg 'defraction'
- that might be interpreted as either *fission* or *fusion*, eg 'fussion'

The spelling of these words is similar, but the words have totally different meanings. If the spelling (or handwriting) in an answer makes it difficult for you to interpret a candidate's intention, then do not award the mark. (GMP 22)

(l) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify**, **name**, **give**, or **state**, they need only name or present in brief form.
- **describe**, they must provide a statement or structure of characteristics and/or features.
- **explain**, they must relate cause and effect and/or make relationships between things clear.
- **determine** or **calculate**, they must determine a number from given facts, figures or information.
- **estimate**, they must determine an approximate value for something.
- **justify**, they must give reasons to support their suggestions or conclusions, eg this might be by identifying an appropriate relationship and the effect of changing variables.
- **show that**, they must use physics (and mathematics) to prove something, eg a given value. All steps, including the stated answer, must be shown
- **predict**, they must suggest what may happen based on available information.
- **suggest**, they must apply their knowledge and understanding of physics to a new situation. A number of responses are acceptable: award marks for any suggestions that are supported by knowledge and understanding of physics.
- **use your knowledge of physics or aspect of physics to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented, for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation. They will gain credit for the breadth and/or depth of their conceptual understanding.

Common issues with candidate responses

When marking National 5 Physics, there are some common issues that arise when considering candidates' answers.

There is often a range of acceptable responses which would sensibly answer a particular question. However, it is often difficult to anticipate all correct or partially correct responses to questions.

The detailed marking instructions contain ideal answers, and examples of other acceptable answers which offer guidance for interpreting candidates' responses. They may also contain advice on answers which are **not** acceptable, or only attract partial marks.

Units

Do not penalise use of upper/lower case when the abbreviated version is given, as long as it can be clearly identified, eg DB, sV, hZ, bq.

However, take care to ensure the unit has the correct prefix, eg for an answer t = 0.005 seconds, t = 5 ms is acceptable but t = 5 Ms is not.

Where a candidate makes multiple unit errors or conversion errors/omissions in any part of a question, penalise once only. For example, when calculating speed from distance and time, and the answer is required to be in m s^{-1}.

If d = 4 km and t = 2 minutes

$$v = \frac{d}{t} \quad \textbf{(1)}$$

$$v = \frac{4\,000\,000}{2} \quad \textbf{(1)}$$

$$v = 2\,000\,000 \quad \textbf{(0)}$$

Although the candidate has made three unit errors, (not correctly converted distance or time and has omitted the final unit), do not award the final mark only.

Some common units often attract incorrect abbreviations in answers to numerical questions.
When the abbreviation can be confused with a different unit then the final mark cannot be awarded, eg sec or secs as an abbreviation for seconds is **not** acceptable.

Common units and abbreviations	
Acceptable unit and abbreviation	*unacceptable version*
second, s	sec, secs
hours, h	hr, hrs
ampere, amp, amps, A, a	
metres per second, m/s, m s^{-1}	mps, m/s^{-1}
metres per second per second, m/s^2, m s^{-2}	m/s/s, mpsps, m/s^{-2}
joules per kilogram per degree celsius, J kg^{-1} °C^{-1}, J/kg °C	J/kg/°C

Standard form

Where a candidate fails to express an answer in standard form correctly, treat it as an arithmetic error and do not award the final mark. For example:

For an answer t = 400 000 s, then $t = 4\times10^5$ s would be correct but $t = 4^5$ s would be treated as an arithmetic error. (GMP 10)

Incorrect answer carried forward (GMP 16)

Do not apply a further penalty where a candidate carries forward an incorrect answer to part of a question, and uses that incorrect answer correctly:

- within that part of the question, eg from (a)(i) to (a)(ii)
- or to the next part of the question, eg from (a) to (b).

Similarly, if a candidate has selected the wrong value in a question which requires a data value, then award full marks in the subsequent answer for a correct response that uses **either** the candidate's wrong value **or** the correct data value. For example:

(a) State the speed of microwaves in air.
Candidate's answer: *240 m s^{-1}*. This answer would attract zero marks.

(b) Calculate the distance travelled by these microwaves in 0.34 seconds.
The candidate may use **either** the value given in part (a) **or** the correct value for the speed, and could gain full marks if correctly completed.

Where an incorrect answer may be carried forward, this is indicated in the additional guidance column of the detailed marking instructions by the comment 'or consistent with part...'.

Standard three marker

The examples below set out how to apportion marks to answers requiring calculations. These are the 'standard three marker' type of questions.

Award full marks for a correct answer to a numerical question, even if the steps are not shown explicitly, **unless** it specifically requires evidence of working to be shown.

For some questions requiring numerical calculations, there may be alternative methods (eg alternative relationships) that would lead to a correct answer.

Sometimes, a question requires a calculation which does not fit into the 'standard three marker' type of response. In these cases, the detailed marking instructions will contain guidance for marking the question.

When marking partially correct answers, apportion individual marks as shown over the page.

Example of a 'standard three marker' question

The current in a resistor is 1.5 amperes when the potential difference across it is 7.5 volts.

Calculate the resistance of the resistor. (3 marks)

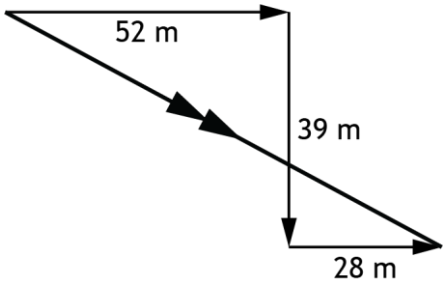
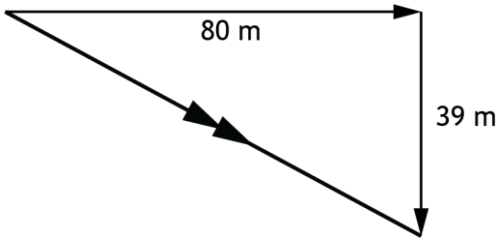
	Example response	Mark and comment
1.	$V = IR$ $7.5 = 1.5R$ $R = 5.0\ \Omega$	1 mark: relationship 1 mark: substitution 1 mark: correct answer
2.	$5.0\ \Omega$	3 marks: correct answer
3.	5.0	2 marks: unit missing
4.	$4.0\ \Omega$	0 marks: no evidence, wrong answer
5.	$\_\_\ \Omega$	0 marks: no working or final answer
6.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0\ \Omega$	2 marks: arithmetic error
7.	$R = \frac{V}{I} = 4.0\ \Omega$	1 mark: relationship only
8.	$R = \frac{V}{I} = \_\_\ \Omega$	1 mark: relationship only
9.	$R = \frac{V}{I} = \frac{7.5}{1.5} = \_\_\ \Omega$	2 marks: relationship and substitution, no final answer
10.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0$	2 marks: relationship and substitution, wrong answer
11.	$R = \frac{V}{I} = \frac{1.5}{7.5} = 5.0\ \Omega$	1 mark: relationship but wrong substitution
12.	$R = \frac{V}{I} = \frac{75}{1.5} = 5.0\ \Omega$	1 mark: relationship but wrong substitution
13.	$R = \frac{I}{V} = \frac{1.5}{7.5} = 5.0\ \Omega$	0 marks: wrong relationship
14.	$V = IR$ $7.5 = 1.5 \times R$ $R = 0.2\ \Omega$	2 marks: relationship and substitution, arithmetic error
15.	$V = IR$ $R = \frac{I}{V} = \frac{1.5}{7.5} = 0.2\ \Omega$	1 mark: relationship correct but wrong rearrangement of symbols

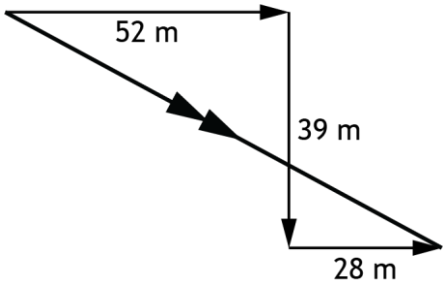
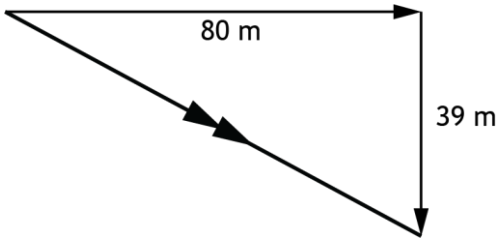
Marking instructions for each question

Section 1

Question	Answer	Mark
1.	A	**1**
2.	D	**1**
3.	D	**1**
4.	C	**1**
5.	B	**1**
6.	D	**1**
7.	E	**1**
8.	D	**1**
9.	E	**1**
10.	A	**1**
11.	B	**1**
12.	C	**1**
13.	C	**1**
14.	B	**1**
15.	E	**1**
16.	C	**1**
17.	C	**1**
18.	A	**1**
19.	C	**1**
20.	A	**1**
21.	A	**1**
22.	E	**1**
23.	E	**1**
24.	B	**1**
25.	D	**1**

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i) (A)	**Using Pythagoras:** Resultant^2 = 80^2 + 39^2 **(1)** Resultant = 89 m **(1)** **Using scale diagram:**  **OR**  Vectors to scale **(1)** Resultant = 89 m **(1)** (allow ±2 m tolerance)	**2**	Ignore any direction stated in the final answer in this part. If clear arithmetic error shown in 52 + 28 = 80 then **MAX (1) mark** for substitution consistent with arithmetic error. No requirement for arrows to be shown on diagram to calculate the magnitude of the resultant displacement. Regardless of method, if a candidate shows a vector diagram (or a representation of a vector diagram, eg a triangle with no arrows) **and** the vectors have been represented incorrectly, eg head-to-head then **MAX (1)**. Accept: 90 89.0 89.00

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i) (B)	**Using trigonometry:** $\tan\theta = \frac{39}{80}$ **(1)** $(\theta = 26°)$ direction = 116 **(1)** **Using scale diagram:**  **OR**  vectors to scale **(1)** direction = 116 **(1)** (allow ±2° tolerance)	**2**	Or use of resultant value (and appropriate trigonometry) consistent with (a)(i)(A). Regardless of method, if a candidate shows a vector diagram (or a representation of a vector diagram eg a triangle with no arrows) **and** the vectors have been represented incorrectly, eg head-to head then **MAX (1)**. **Alternative methods:** $\tan\theta = \frac{80}{39}$ (1) $(\theta = 64°)$ direction = 116 (1) **OR** Use of resultant value (and appropriate trigonometry) consistent with (a)(i)(A), eg $\cos\theta = \frac{80}{89}$ or $\sin\theta = \frac{39}{89}$ Ignore the degree symbol if the direction is stated as a bearing. Accept: 26° South of East 64° East of South Can obtain first mark for scale diagram method from suitable diagram in part (a)(i)(A) if not drawn in this part. However, the candidate must attempt an answer in this part. Ignore any magnitude stated in the final answer in this part. Do not accept incorrect statements of trig functions at substitution stage, eg $\tan = \frac{39}{80}$ Accept: 30° S of E 120 26.0° S of E 116.0 25.99° S of E 115.99

Question			Expected response	Max mark	Additional guidance
1.	(a)	(ii)	$s = \bar{v}t$ **(1)** $89 = \bar{v} \times 18$ **(1)** $\bar{v} = 4.9\ \text{ms}^{-1}$ at 116 **(1)**	**3**	Or consistent with (a)(i)(A) and/or (a)(i)(B) Bar not required above v. Accept $d = vt$ provided it is followed by a substitution of the value for displacement. Direction required for final mark. Accept: 5 4.94 4.944
	(b)		$d =$ area under graph **(1)** $d = \left(\frac{1}{2} \times 10 \times 16\right) + \left(7 \times 16\right)$ **(1)** $d = 192$ m **(1)**	**3**	If incorrect substitution, then **MAX (1)** for (implied) relationship. Any attempt to use $s = \bar{v}t$ or $d = \bar{v}t$ applied to the whole section of the graph is wrong physics, award **(0) marks**. If $s = \bar{v}t$ or $d = \bar{v}t$ is used for each section of the graph and the results added to give the correct total distance then full marks can be awarded. Accept: 190 192.0 192.00

Question			Expected response	Max mark	Additional guidance
2.	(a)		Correct curved path shown	**1**	Do not accept curve rising above horizontal.
	(b)	(i)	$d = \bar{v}t$ **(1)** $9.1 = 13 \times t$ **(1)** $t = 0.70$ s **(1)**	**3**	Bar not required above v. Accept: 0.7 0.700 0.7000
		(ii)	$a = \frac{v-u}{t}$ **(1)** $9.8 = \frac{v-0}{0.70}$ **(1)** $v = 6.9$ ms^{-1} **(1)**	**3**	Or consistent with (b)(i) Accept: $a = \frac{\Delta v}{t}$ Do not accept a response starting with: $v = at$ **OR** $a = \frac{v}{t}$ Accept: 7 6.86 6.860
	(c)		Same time. **(1)** Vertical/downward acceleration is the same. **(1)**	**2**	**MUST JUSTIFY** Accept: 'same acceleration due to gravity' Justifications discussing 'falling at same rate' or 'same vertical velocity' are insufficient, ie would not be treated as wrong physics. Justifications of falling at the same speed or velocity are incorrect, ie would be treated as wrong physics, so **(0) marks** for question.

Question			Expected response	Max mark	Additional guidance
3.			**Award 3 marks** where the candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 2 marks** where the candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. **Award 1 mark** where the candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem. **Award 0 marks** where the candidate has not demonstrated an understanding of the physics involved. There is no evidence that they have recognised the area of physics involved, or they have not given any statement of a relevant physics principle. Award this mark also if the candidate merely restates the physics given in the question.	**3**	Candidates may use a variety of physics arguments to answer this question. Award marks based on candidates demonstrating overall good, reasonable, limited, or no understanding.

Question			Expected response		Max mark	Additional guidance
4.	(a)		(engine) thrust  weight	**(1)** **(1)**	**2**	**(1)** for each force correctly labelled with corresponding direction. Accept if arrows do not touch rocket. **For upward force:** Accept: 'Rocket thrust' 'Engine force' 'Force from exhaust gases on rocket' Do not accept: 'Upward force' alone 'Upthrust' **For downward force:** Accept: 'Force of gravity' 'Force due to gravity' 'Gravitational pull' 'Pull of gravity' Do not accept: 'Gravitational field strength' 'Gravity' 'Weight/gravity' 'Gravity pulling down' Ignore friction/air resistance/drag. Ignore horizontal forces. Where a candidate has identified more than two vertical forces, apply +/− rule for other vertical forces eg reaction force from ground.
	(b)	(i)	$W = mg$ $W = 5.5\times10^5\times9.8$ $W = 5.4\times10^6$ N	**(1)** **(1)**	**2**	**'Show' question** Final answer of 5.4×10^6 N or its numerical equivalent, including unit, must be shown or **MAX (1)**.
		(ii)	$F = ma$ $F = 5.5\times10^5\times4.1$ $(Th - W = F)$ $Th - 5.4\times10^6 = (5.5\times10^5\times4.1)$ $Th = 7.7\times10^6$ N	**(1)** **(1)** **(1)** **(1)**	**4**	Accept: 8×10^6 7.66×10^6 7.655×10^6

Question			Expected response	Max mark	Additional guidance
4.	(c)	(i)	$(\text{At } 550 \text{ km, length of orbit} = 43500 \text{ km})$ $d = vt$ **(1)** $43500 = 29000 \times t$ **(1)** $t = 1.5$ h **(1)**	**3**	Allow ±50 km of tolerance for length of orbit. Accept answer in other units of time. Accept: 2 1.50 1.500
		(ii)	$\left(\text{number of orbits} = \frac{24}{1.5}\right)$ number of orbits = 16 **(1)**	**1**	Or consistent with (c)(i). For candidates bringing forward other units of time and converting 1 day into the same units, follow usual significant figure rules.
	(d)		(As the satellite re-enters it experiences) friction (with the Earth's atmosphere) **(1)** kinetic energy is converted into (heat and) light (energy). **(1)**	**2**	Independent marks Accept: 'Air resistance' 'Drag' Accept: Kinetic energy is converted into heat Accept: E_k for kinetic energy E_h for heat

Question			Expected response	Max mark	Additional guidance
5.	(a)		$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_s$ **(1)** $V_2 = \left(\frac{24}{36 + 24}\right) \times 6.0$ **(1)** $V_2 = 2.4$ V **(1)**	**3**	**Alternative method 1:** $V = IR$ **(1)** $6.0 = I \times (36+24)$ $(I = 0.10$ A) $V = IR$ $V = 0.10 \times 24$ **(1)** $V = 2.4$ V **(1)** **(1)** for Ohm's Law **(1)** for all substitutions **(1)** for final answer and unit **Alternative method 2:** $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ **(1)** $\frac{V_1}{6.0} = \frac{24}{(36 + 24)}$ **(1)** $V_1 = 2.4$ V **(1)** Accept: 2 2.40 2.400
	(b)	(i)	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ **(1)** $\frac{1}{R_T} = \frac{1}{36} + \frac{1}{36}$ **(1)** $(R_T = 18\ \Omega)$ Total resistance $= 18 + 24$ **(1)** $= 42\ \Omega$ **(1)**	**4**	Do not accept wrong relationship eg $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + R_3$ **OR** $R_T = \frac{1}{R_1} + \frac{1}{R_2}$ **(0) marks** Accept: $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ if followed by substitution of the two 36 Ω resistors alone, otherwise **(0) marks**. Accept imprecise working towards a value for parallel resistance. $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{36} + \frac{1}{36} = 18\ \Omega$ accept If arithmetic error in parallel resistance calculation, can still access mark for adding the 24 Ω resistance, ie **MAX (3)**.

Question			Expected response	Max mark	Additional guidance
5.	(b)	(ii)	Voltage (across 24 Ω resistor) increases. **(1)** Total resistance in the circuit decreases. **(1)** Current (in 24 Ω resistor) increases. **(1)** **OR** Voltage (across 24 Ω resistor) increases. **(1)** Resistance of parallel section of circuit decreases. **(1)** Parallel section's (share of the supply) voltage decreases. **(1)**	**3**	For first method, it must be clear that the total resistance of the circuit has decreased. Can be justified by calculation: **(1)** statement that voltage increases **(1)** use of correct total resistance/resistance of parallel section **(1)** calculation of correct current/voltage for the 24 Ω resistor Or consistent with (a) **and** (b)(i), eg If a candidate determines the correct voltage across the 24 Ω resistor in (a) and a total resistance greater than 60 Ω in (b)(i), they can state that the voltage across the 24 Ω resistor decreases and provide a suitable justification for that effect.

Question			Expected response	Max mark	Additional guidance
6.	(a)		Direction of electron flow (continually) changing back and forth/to and fro.	**1**	Must answer in terms of electrons/charges (NOT current alone). Must indicate repeated changing of direction. Can be represented by a diagram indicating movement of electrons in both directions.
	(b)	(i)	When the current (in the flex) is too high/great **(1)** the fuse breaks/melts. **(1)**	**2**	Independent marks For first mark, must indicate that the current is too high. Accept: 'Fuse blows' 'Fuse breaks the circuit'
		(ii)	13 A (fuse is required) **(1)** $P = IV$ **(1)** $1500 = I \times 230$ **(1)** $I = 6.5\ (\text{A})$ **(1)**	**4**	If no fuse value is stated, award **(0) marks**. Unit required for fuse rating. No significant figure penalty as value of current is an intermediate step. Rounding of value for current must be correct, ie **MAX (3) marks** if rounding is incorrect. Marks for relationship and/or substitution may be implied by correct substitution or value for current. Accept 3 A fuse if consistent with arithmetic error in calculation of current. Can be done by calculating the maximum power rating for a 3A fuse: $P = IV$ **(1)** $P = 3 \times 230$ **(1)** $P = 690$ W 690 W < 1500 W **(1)** Note: For this method, if 690 W appears with no calculation award **MAX (1)** for correct selection of fuse.

Question			Expected response	Max mark	Additional guidance
6.	(c)	(i)	$E_h = cm\Delta T$ **(1)** $E_h = 4180 \times 9.5 \times (65 - 12)$ **(1)** $E_h = 2.1 \times 10^6$ J	**2**	**'Show' question** Final answer of 2.1×10^6 J or its numerical equivalent, including unit, must be shown or **MAX (1)**.
		(ii) (A)	$P = \frac{E}{t}$ **(1)** $1.5 \times 10^3 = \frac{2.1 \times 10^6}{t}$ **(1)** $t = 1400$ s **(1)**	**3**	Accept: 1000
		(ii) (B)	Heat energy is lost (from the water) to the surroundings. **OR** Some of the energy is used to heat dishwasher/dishes/element.	**1**	Do not accept heat loss alone, there must be an indication of where the heat is going.
	(d)		Voltage across the thermistor decreases. **(1)** MOSFET/transistor switches off/ deactivates. **(1)** Relay switches off/opens/ deactivates. **(1)**	**3**	Independent marks Do not accept: 'Voltage through thermistor' 'Voltage in thermistor' Do not accept: npn transistor or pnp transistor in place of MOSFET Accept: MOSFET does not conduct MOSFET is not saturated Ignore any values of switching voltage.

Question			Expected response	Max mark	Additional guidance
7.	(a)		The line (of best fit) does not go through the origin **(1)** as the temperature has not been plotted in kelvin. **(1)**	**2**	Independent marks Accept: 'The graph does not go through the origin.' 'To show direct proportionality it should pass through the origin.' Origin may be indicated by eg (0,0) or 'y-intercept of 0' Do not accept: 'Does not pass through 0' alone, as an indication of origin. Accept: The graph has not been plotted in kelvin.
	(b)		The gas particles move more slowly.	**1**	Accept: The gas particles have less kinetic energy Do not accept: 'Collisions with walls of container are less frequent' alone
	(c)		So that the gas is heated evenly. **OR** So that the temperature of the water is evenly distributed.	**1**	Accept: 'So the capillary tube is heated evenly'
	(d)		$p = \frac{F}{A}$ **(1)** $1.02 \times 10^5 = \frac{F}{0.82 \times 10^{-6}}$ **(1)** $F = 0.084$ N **(1)**	**3**	Accept: 0.08 0.0836 0.08364

Question			Expected response	Max mark	Additional guidance
8.	(a)		Both angles indicated and labelled, and the normal labelled.	**1**	Accept: i and r I and R θ_i and θ_r N for normal
	(b)	(i)	Suitable scales, labels and units. **(1)** All points plotted accurately to ± half a division. **(1)** Best fit curve/line. **(1)**	**3**	If a non-linear scale is used over the range of the data on either axis **(0) marks**. Allow broken axes from origin (with or without symbol), but scale must be linear across data range. Axes can be transposed. A bar chart/histogram can obtain **MAX (1)** for scales, labels and units.
		(ii)	31°	**1**	**Must** be consistent with the line the candidate has drawn. If a non-linear scale is used over the range of the data on either axis this mark cannot be accessed. If candidate has not shown a line in (b)(i) this mark cannot be accessed. ± half a division tolerance. Unit must be stated.

Question			Expected response	Max mark	Additional guidance
8.	(c)		$V_R = 5.0 - 2.2$ **(1)** $(V_R = 2.8\ \text{V})$ $V = IR$ **(1)** $2.8 = 25\times10^{-3}\times R$ **(1)** $R = 110\ \Omega$ **(1)**	**4**	If no attempt to calculate voltage across resistor, then **MAX (1)**. If clear arithmetic error in calculation of voltage, then **MAX (3)**. **Alternative method 1:** $V_s = IR_T$ **(1)** $5.0 = 25\times10^{-3}\times R_T$ $(R_T = 200\ \Omega)$ $V_{LED} = IR_{LED}$ $2.2 = 25\times10^{-3}\times R_{LED}$ **(1)** all substitutions $(R_{LED} = 88\ \Omega)$ $(R = R_T - R_{LED})$ $R = 200 - 88$ **(1)** $R = 110\ \Omega$ **(1)** For this method, if no attempt to determine resistance of resistor, **MAX (1)** for Ohm's Law relationship. **Alternative method 2:** $V_s = IR_T$ $5.0 = 25\times10^{-3}\times R_T$ $(R_T = 200\ \Omega)$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ **(1)** both relationships $\frac{2.2}{5.0} = \frac{R_1}{200}$ **(1)** all substitutions $(R_{LED} = 88\ \Omega)$ $(R = R_T - R_{LED})$ $R = 200 - 88$ **(1)** $R = 110\ \Omega$ **(1)** For this method, if no attempt to determine resistance of resistor, **MAX (1)** for both relationships. Accept: 100 112 112.0

Question			Expected response	Max mark	Additional guidance
8.	(d)	(i)	$v = f\lambda$ **(1)** $3.0\times10^{8} = f\times520\times10^{-9}$ **(1)** $f = 5.8\times10^{14}$ Hz **(1)**	**3**	Accept: 6×10^{14}Hz 5.77×10^{14}Hz 5.769×10^{14}Hz
		(ii)	Blue **(1)** has a greater frequency (than green). **OR** has a smaller wavelength (than green). **(1)**	**2**	Accept: 'Has the greatest frequency' **OR** 'Has the smallest wavelength' Do not accept: 'Has a high frequency' **OR** 'Has a small wavelength'

Question			Expected response	Max mark	Additional guidance
9.			**Award 3 marks** where the candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 2 marks** where the candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. **Award 1 mark** where the candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem. **Award 0 marks** where the candidate has not demonstrated an understanding of the physics involved. There is no evidence that they have recognised the area of physics involved, or they have not given any statement of a relevant physics principle. Award this mark also if the candidate merely restates the physics given in the question.	**3**	Candidates may use a variety of physics arguments to answer this question. Award marks based on candidates demonstrating overall good, reasonable, limited, or no understanding.

Question			Expected response	Max mark	Additional guidance
10.	(a)		$t = \frac{0.028}{2}$ **(1)** $d = vt$ **(1)** $d = 340 \times \frac{0.028}{2}$ **(1)** $d = 4.8$ m **(1)**	**4**	**Alternative method:** $d = vt$ **(1)** $d = 340 \times 0.028$ **(1)** $d = \frac{340 \times 0.028}{2}$ **(1)** $d = 4.8$ m **(1)** The mark for division of time or distance by two is an independent mark. It is incorrect physics to divide the speed by two. **MAX (1)** for relationship. Accept: 5 4.76 4.760
	(b)		(The forces are) balanced.	**1**	Accept: (The forces are) equal (in size) and opposite (in direction) Do not accept: 'Lift equals weight' alone
	(c)	(i)	64 000 waves pass a point each second.	**1**	Accept: 64 000 waves are produced each second There are 64 000 waves each second Do not accept: 64 kilo-waves (pass a point each second)
		(ii)	$\left(f_w = \left(\frac{v}{v - v_{bat}} \right) \times f_{bat} \right)$ $f_w = \left(\frac{340}{340 - 8.6} \right) \times 64\,000$ **(1)** $f_w = 66\,000$ Hz **(1)**	**2**	Accept: 70 000 65 700 65 660

Question			Expected response	Max mark	Additional guidance
11.	(a)		Beta particles will (also) be absorbed by (6mm of) aluminium. **(1)** Alpha radiation will be absorbed by (100 mm of) air. **(1)**	**2**	Accept: The source is too far away for alpha to be detected. Apply +/− rule for additional responses
	(b)	(i)	The count rate/reading will include the source and background (count). **OR** Background (count rate) will need to be subtracted. **OR** To determine the count rate/reading due to the source (alone).	**1**	Accept: To determine the corrected count rate To correct the count rate Do not accept responses in terms of measuring/subtracting the activity, rather than count rate.
		(ii) (A)	15 minutes	**1**	Allow ±0.5 minute tolerance
		(ii) (B)	4 half-lives identified **(1)** (4 × 15 minutes) time = 60 minutes **(1)**	**2**	Or consistent with (b)(ii)(A). Accept evidence of halving four times for the first mark, eg $1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8} \rightarrow \frac{1}{16}$
		(iii)	Limit time of exposure. **OR** Increase distance from source. **OR** Place shielding in the way.	**1**	Any other reasonable suggestion that addresses one of these issues. Accept: 'Wear gloves' Responses regarding protective clothing other than gloves must indicate the factor that makes them protective (eg lead-lined apron). If the factor is not stated then such responses are treated as insufficient. Do not accept: 'Limit exposure' alone 'Do not touch with bare hands' alone Accept safety precautions for transporting source, eg place source in a lead-lined box. Apply +/− rule for additional incorrect responses.

Question			Expected response	Max mark	Additional guidance
12.	(a)		Activity (of the source) decreases (with time). **OR** Fewer radioactive particles emitted per second.	**1**	Accept: 'The activity will be (too) low' Do not accept: 'The source will be weaker/less strong' 'The radiation decreases' 'The radioactivity decreases'
	(b)	(i)	Fast moving/high-energy electron.	**1**	Accept: An electron emitted from the nucleus (of an atom) Do not accept: Electron alone
		(ii) (A)	$\left(E = 0.960 \times 1.60 \times 10^{-13}\right)$ $E = 1.54 \times 10^{-13}\ \left(\text{J}\right)$ **(1)**	**1**	Accept: 1.5×10^{-13} 1.536×10^{-13} 1.5360×10^{-13}
		(ii) (B)	$D = \frac{E}{m}$ **(1)** $D = \frac{5.0 \times 10^{11} \times 1.54 \times 10^{-13}}{0.064}$ **(1)** $D = 1.2$ Gy **(1)**	**3**	Or consistent with (b)(ii)(A). An attempt to calculate the absorbed dose received from a single beta particle is wrong physics. **MAX (1)** for relationship. Accept: 1 1.20 1.203
		(iii)	$H = Dw_R$ **(1)** $H = 1.2 \times 1$ **(1)** $H = 1.2$ Sv **(1)**	**3**	Or consistent with (b)(ii)(B).

[END OF MARKING INSTRUCTIONS]