National
Qualifications
RESOURCE

2021 Physics

National 5

Finalised Marking Instructions

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) (http://www.sqa.org.uk/files_ccc/Physicsgeneralmarkingprinciples.pdf) 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.

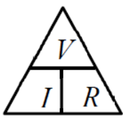
(d) Where a wrong answer to part of a question is carried forward and the wrong answer is then used correctly in the following part, give the candidate credit for the subsequent part or 'follow-on'. (GMP 17)

(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 22)

(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) Give credit 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 formulae alone. Do not award a mark when a candidate writes down several formulae and does not select the correct one to continue with, for example by substituting values. (GMP 3)

(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 6)

(k) 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 10)

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

(l) 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 25)

(m) 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: marks will be awarded 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 which 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}. (GMP 14)

If d = 4 km and t = 2 minutes

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

$$v = \frac{400}{2} \qquad (1)$$

$$v = 200 \qquad (0)$$

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 = 4×10^5 s would be correct but t = 4^5 s would be treated as an arithmetic error. (GMP 13)

Incorrect answer carried forward (GMP 17)

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) which 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)

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

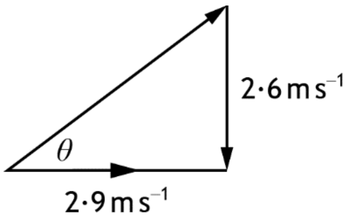
Marking Instructions for each question

Section 1

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

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	$d = vt$ **(1)** $870 = 2{\cdot}9 \times t$ **(1)** $t = 300$ s **(1)**	3	Accept: 300·0
		(ii)	2·9 m s^{-1} East	1	Must have magnitude (including unit) and direction Accept for direction: 090 90° East of North abbreviation E in place of East Do not penalise if degrees symbol is included in three-figure bearings
	(b)	(i)	$a = \dfrac{v-u}{t}$ **(1)** $= \dfrac{3{\cdot}0 - 0{\cdot}0}{15}$ **(1)** $= 0{\cdot}20$ m s^{-2} **(1)**	3	Accept: $a = \dfrac{\Delta v}{t}$ or $v = u + at$ Do not accept: $a = \dfrac{v}{t}$ or $v = at$ Accept: 0·2, 0·200, 0·2000
		(ii)	distance = area under graph **(1)** $= \left(\dfrac{1}{2} \times 15 \times 3{\cdot}0\right) + (15 \times 3{\cdot}0)$ **(1)** = 68 m **(1)**	3	If incorrect substitution then MAX (1) for (implied) relationship Any attempt to use $d = \overline{v}t$ (or $s = \overline{v}t$) applied to the whole graph is wrong physics, award (0) marks. If $d = \overline{v}t$ (or $s = \overline{v}t$) 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: 70, 67·5, 67·50

Question			Expected response	Max mark	Additional guidance
1.	(c)		Using scale diagram:  vectors to scale **(1)** direction = 048 **(1)** (allow ±2° tolerance) **Using trigonometry:** θ = $\tan^{-1}$ (2·6/2·9) **(1)** θ = 42° direction = 048 **(1)**	**2**	Accept: 48° E of N 42° N of E Can also do with $\tan^{-1}\left(\frac{2 \cdot 9}{2 \cdot 6}\right)$ Accept: 50°, 48·1°, 48·12° E of N 40°, 41·9°, 41·88° N of E or as bearings Do not penalise if degrees symbol is included in three-figure bearings

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	To reduce friction	**1**	Or similar, as long as the response makes reference to friction
		(ii)	length/width of card **(1)** time for card to pass through the (light) gate **(1)** time taken for card to reach (light) gate **(1)**	**3**	independent marks Do not accept 'vehicle' in place of 'card' Apply the ± rule to additional measurements
	(b)		1·80 (m s^{-2}) **(1)** acceleration value is not in the same proportion to the accelerating force **(1)**	**2**	The value 1·80 could be indicated on the table e.g. circled, highlighted, 'this one' or similar e.g. it doesn't follow the pattern of going up in steps of 0·4
	(c)		(gravitational) potential to kinetic	**1**	Accept: $E_p \rightarrow E_k$ or E_P to E_k Do not accept: $E_p - E_k$

Question			Expected response	Max mark	Additional guidance
3.	(a)		$f = \frac{N}{t}$ **(1)** $= \frac{27}{60}$ **(1)** $= 0{\cdot}45$ Hz	2	**'Show' question** Must state the correct relationship or (0) marks Final answer of 0·45 Hz must be shown, otherwise MAX (1) Also accept: $f = \frac{N}{t}$ **(1)** $= \frac{540}{1200}$ **(1)** $= 0{\cdot}45$ Hz
	(b)	(i)	$P = \frac{E}{t}$ **(1)** $95 = \frac{E}{1200}$ **(1)** $= 1{\cdot}1 \times 10^5$ J **(1)**	3	Accept: 1×10^5 $1{\cdot}14 \times 10^5$ $1{\cdot}140 \times 10^5$
		(ii)	Energy will also have been generated as heat/sound	1	Accept: Energy is lost to the surroundings Heat energy produced due to friction or similar
	(c)		$E_w = Fd$ **(1)** $208 = F \times 1{\cdot}3$ **(1)** $F = 160$ N **(1)**	3	Accept: 200, 160·0

Question			Expected response	Max mark	Additional guidance
4.	(a)		A natural satellite of a planet/dwarf planet	1	Do NOT accept: 'satellite of a planet' alone
	(b)		Hydra **(1)** Longest orbital period **(1)**	2	
	(c)		It received a gravitational boost/slingshot/catapult from Jupiter **(1)** (causing) an increase in its speed/kinetic energy **(1)**	2	Independent marks
	(d)	(i)	$E_k = \frac{1}{2}mv^2$ **(1)** $= \frac{1}{2} \times 454 \times \left(23 \cdot 0 \times 10^3\right)^2$ **(1)** $= 1 \cdot 20 \times 10^{11}\text{J}$ **(1)**	3	Accept: $1 \cdot 2 \times 10^{11}$ $1 \cdot 201 \times 10^{11}$ $1 \cdot 2008 \times 10^{11}$
		(ii)	There is no friction/air resistance/opposing force **(1)** Therefore there is no unbalanced force **(1)**	2	Independent marks There are no forces acting against it **(1)** No requirement for any engine force/the engine to be switched on **(1)**
	(e)		$d = vt$ (1) $= 3 \cdot 0 \times 10^8 \times (4 \cdot 4 \times 60 \times 60)$ (1) $= 4 \cdot 8 \times 10^{12}$ m (1)	3	Accept: 5×10^{12} $4 \cdot 75 \times 10^{12}$ $4 \cdot 752 \times 10^{12}$

Question			Expected response	Max mark	Additional guidance
5.			**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
6.	(a)	(i)	To reduce/limit the current (in the LEDs)	**1**	Accept: To reduce the voltage across the LEDs **OR** Protect/prevent damage to the LEDs.
		(ii)	$(V_S = V_R + V_1 + V_2 + V_3)$ $12 = V_R + 1{\cdot}8 + 1{\cdot}8 + 1{\cdot}8$ (1) $(V_R = 6{\cdot}6\ \text{V})$ $V_R = IR$ **(1)** $6{\cdot}6 = 0{\cdot}020 \times R$ **(1)** $R = 330\ \Omega$ **(1)**	**4**	Calculation of voltage across resistor may be implied by correct substitution. If no attempt to calculate the voltage across resistor, or incorrect substitution to calculate the voltage across resistor, then MAX (1) for $V = IR$ relationship. If clear arithmetic error in calculation of voltage across resistor then MAX (3). Accept: 300, 330·0
		(iii)	the green and blue LEDs have different operating voltages/ currents (than the red LEDs)	**1**	
	(b)		same brightness **(1)** same <u>voltage</u> across the red LEDs **OR** the three branches are connected in parallel, so voltage across them does not change **(1)**	**2**	First mark can only be awarded if a justification is attempted. Effect correct + justification correct **(2)** Effect correct + justification incomplete **(1)** Effect correct + justification incorrect (wrong physics) **(0)** Effect correct + no justification attempted **(0)** Incorrect or no effect stated regardless of justification **(0)** Accept: dimmer (1) provided supported by justification relating to lost volts/internal resistance. (1) Justifications that relate to the supply voltage not changing alone, would be considered incomplete.

Question			Expected response	Max mark	Additional guidance
7.	(a)		$V_2 = \frac{R_2}{R_1 + R_2} V_s$ **(1)** $V_2 = \frac{3400}{16\ 600 + 3400} \times 5 \cdot 0$ **(1)** $V_2 = 0 \cdot 85$ V **(1)** (which is greater than 0·7 V)	**3**	Method 2: $V = IR$ $5 \cdot 0 = I \times (16\,600 + 3400)$ $(I = 2 \cdot 5 \times 10^{-4})$ $V = IR$ $= 2 \cdot 5 \times 10^{-4} \times 3400$ $= 0 \cdot 85$ V (1) mark for Ohm's Law (even if only seen once) (1) mark for all substitutions (1) mark for final answer including unit Method 3: $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (1) $\frac{V_1}{5 \cdot 0} = \frac{3400}{(16\,600 + 3400)}$ (1) $V_1 = 0 \cdot 85$ V (1) Resistances may be kept in kΩ in all methods Accept: 0·9, 0·850, 0·8500
	(b)	(i)	The control circuit operates at 5 V, the floodlight at 230 V.	**1**	Accept: The two parts of the circuit operate at different voltages. The floodlight requires a higher current than can be supplied in the transistor circuit.
		(ii)	$P = IV$ **(1)** $575 = I \times 230$ **(1)** $= 2 \cdot 5$ A **(1)**	**3**	Accept: 3, 2·50, 2·500
		(iii)	3 A	**1**	Or consistent with 7 (b)(ii)

Question			Expected response	Max mark	Additional guidance
8.	(a)		$E_h = cm\Delta T$ **(1)** $E_h = 810 \times 2{\cdot}5 \times (250 - 22)$ **(1)** $E_h = 4{\cdot}6 \times 10^5$ J **(1)**	**3**	Calculation of temperature change may be implied by correct substitution. If no attempt to calculate the temperature change or incorrect substitution to calculate the temperature change then MAX (1) for relationship.If clear arithmetic error in calculation of temperature change then MAX (2). Accept: 5×10^5 $4{\cdot}62 \times 10^5$ $4{\cdot}617 \times 10^5$
	(b)	(i)	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ **(1)** $\frac{1}{R_T} = \frac{1}{174} + \frac{1}{174} + \frac{1}{174}$ **(1)** $R_T = 58{\cdot}0\,\Omega$ **(1)**	**3**	If wrong equation used eg $R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ then (0) marks Accept imprecise working towards a final answer $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{174} + \frac{1}{174} + \frac{1}{174} = 58{\cdot}0\,\Omega$ accept Accept 'product over sum' method, provided it is done correctly for all three resistances. Accept: 58, 58·00, 58·000
		(ii)	$P = \frac{V^2}{R}$ **(1)** $P = \frac{230^2}{58 \cdot 0}$ **(1)** $P = 910\,\text{W}$ **(1)**	**3**	Or consistent with (b)(i) Accept alternative methods using both $V = IR$ and $P = IV$ or $P = I^2R$ (1) mark for both relationships (1) mark for all substitutions including accounting for currents/powers for all three branches, if worked out for each individual branch (1) mark for final answer including unit Accept: 900, 912, 912·1
	(c)		greater time **(1)** specific heat capacity (of oil) is greater (than clay brick) **(1)**	**2**	

Question			Expected response	Max mark	Additional guidance
9.	(a)		$p_1V_1 = p_2V_2$ **(1)** $p_1 \times 12 = 2\cdot5\times10^5 \times 960$ **(1)** $p_1 = 2\cdot0\times10^7$ Pa	**2**	SHOW question Must start with a correct relationship or (0) marks. Final answer of $2\cdot0 \times 10^7$ Pa or its numerical equivalent including unit must be shown otherwise a maximum of (1) can be awarded. Accept use of $pV = \text{constant}$ for the relationship
	(b)	(i)	$\dfrac{p_1}{T_1} = \dfrac{p_2}{T_2}$ **(1)** $\dfrac{2\cdot0\times10^7}{294} = \dfrac{1\cdot9\times10^7}{T_2}$ **(1)** $T_2 = 280$ K **(1)**	**3**	Substitution of temperature in °C MAX (1) mark for relationship. Accept: $\dfrac{p_1V_1}{T_1} = \dfrac{p_2V_2}{T_2}$ (1) $\dfrac{2\cdot0\times10^7\times12}{294} = \dfrac{1\cdot9\times10^7\times12}{T_2}$ (1) $T_2 = 280$ K (1) Accept: 300, 279, 279·3 Accept correct answer expressed in °C
		(ii)	(The decrease in temperature) decreases the kinetic energy of the gas particles/the particles move slower. **(1)** The particles hit the walls of the container less often/frequently. **(1)** The particles hit the walls of the container with less force. **(1)** (since $p = \dfrac{F}{A}$ and A is constant, the pressure decreases)	**3**	Independent marks Accept: 'atoms'/'molecules' in place of 'particles' Do not accept: 'particles hit the container/walls less' alone.

Question			Expected response	Max mark	Additional guidance
10.			**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
11.	(a)	(i)	Amplitude correctly indicated and labelled	**1**	
		(ii)	Wavelength correctly indicated and labelled	**1**	
	(b)		$v = f\lambda$ **(1)** $340 = 250 \times \lambda$ **(1)** $\lambda = 1{\cdot}4$ m **(1)**	**3**	Accept:1, 1·36, 1·360
	(c)	(i)	Suitable scales, labels and units **(1)** All points plotted accurately to ± half a division **(1)** Best fit curve **(1)**	**3**	A non-linear scale on either axis prevents access to any marks (0) Allow broken axes from origin (with or without symbol), but scale must be linear across data range. A bar chart can obtain MAX (1) for scales, labels and units. Axes can be transposed.
		(ii)	800 Hz	**1**	**Must** be consistent with the line the candidate has drawn. ± half a division tolerance If the candidate has not shown a curve or line in (c)(i) this mark cannot be accessed. If the candidate has used a non-linear scale in (c)(i) this mark cannot be accessed.
		(iii)	Repeat (measurements and average) **(1)**	**1**	Accept: • Increase the range of lengths. • Increase the number of different lengths. If candidates use the term 'accurate' and/or 'precise' in their response, they must be used correctly, otherwise (0)

Question			Expected response	Max mark	Additional guidance
12.	(a)		Activity (of DNA probe/solution) decreases too much with the time (to still be suitable)	**1**	Accept: Activity will be too low after a week Not enough beta particles per second/unit time will be emitted to be detected, after one week Do not accept radioactivity in place of activity Do not accept answers relating to short half-life alone
	(b)	(i)	Any suitable source	**1**	Apply ± rule for surplus answers Do not accept: cosmic microwave background radiation
		(ii)	$A=\frac{N}{t}$ **(1)** $5 \cdot 5=\frac{N}{60}$ **(1)** $N=330$ (decays) **(1)**	**3**	
		(iii)	Move the Geiger-Müller tube closer (to the tissue sample).	**1**	Accept: Place shielding around apparatus

Question			Expected response	Max mark	Additional guidance
13.	(a)	(i)	(induced nuclear) fission	**1**	
		(ii)	The neutrons produced in first reaction can go on to cause further reactions/split more nuclei **(1)** this process repeats/a chain reaction occurs. **(1)**	**2**	Independent marks. Accept: 'hit'/'collides' If a candidate indicates that a single nucleus repeatedly splits award (0) marks.
	(b)		1 -> ½ -> ¼ -> ⅛ evidence of halving **(1)** 3 half-lives **(1)** 96 years **(1)**	**3**	Final answer must have appropriate unit.
	(c)	(i)	$H = Dw_r$ **(1)** $H = 2{\cdot}2 \times 10^{-6} \times 3$ **(1)** $(= 6{\cdot}6 \times 10^{-6}\ \text{Sv})$ $H = 3{\cdot}4 \times 10^{-6} \times 1$ **(1)** $(= 3{\cdot}4 \times 10^{-6}\ \text{Sv})$ $H_{total} = 1{\cdot}0 \times 10^{-5}\ \text{Sv}$ **(1)**	**4**	Acceptable to carry out calculations using μGy Unit for final answer must be sieverts (or μSv, etc) Accept: 1×10^{-5} $1{\cdot}00 \times 10^{-5}$ $1{\cdot}000 \times 10^{-5}$
		(ii)	$N = \dfrac{20 \times 10^{-3}}{1{\cdot}0 \times 10^{-5}}$ **(1)** $N = 2000$ (shifts) **(1)**	**2**	Or consistent with (c)(i)

[END OF MARKING INSTRUCTIONS]

The following table provides information on each question including: Course content being assessed, Skills assessed (see Physics Understanding Standards materials for a definition of each code); Maximum Mark; A-type marks.

Question	Part	Course content	Skills assessed	Maximum Mark	A-type marks
Section 1					
1		Dynamics - Vectors and scalars	K1	1	
2		Dynamics - Newton's laws	K2	1	
3		Dynamics - Newton's laws	K3	1	1
4		Dynamics - skills	S4	1	1
5		Dynamics - Projectile motion	S6	1	
6		Space - Space exploration	K1	1	
7		Space - Space exploration	S4	1	
8		Space - Cosmology	S4	1	1
9		Space - Cosmology	S6	1	
10		Electricity - Electrical charge carriers	K3	1	1
11		Electricity - Electrical charge carriers	S2	1	
12		Electricity - Ohm's Law	S4	1	1
13		Electricity - Practical electrical and electronic circuits	S1	1	
14		Properties of matter - Specific latent heat	S6	1	
15		Properties of matter - Specific latent heat	K3	1	
16		Properties of matter - Gas laws and the kinetic model	S4	1	1
17		Properties of matter - Gas laws and the kinetic model	K2	1	
18		Properties of matter - Gas laws and the kinetic model	S4	1	
19		Waves - Wave parameters and behaviours	K3	1	
20		Waves - Refraction of light	K1	1	
21		Waves - Refraction of light	K1	1	
22		Radiation - Nuclear radiation	S6	1	
23		Radiation - Nuclear radiation	K2	1	
24		Radiation - Nuclear radiation	S6	1	1
25		Radiation - Nuclear radiation	K3	1	
Section 2					
1	(a)(i)	Dynamics -Vectors and scalars	K3	3	
	(a)(ii)	Dynamics -Vectors and scalars	K1	1	
	(b)(i)	Dynamics - Acceleration	K3	3	
	(b)(ii)	Dynamics - Velocity-time graphs	S4	3	
	(c)	Dynamics - Vectors and scalars	S4	2	2
2	(a)(i)	Dynamics -Acceleration	S1	1	
	(a)(ii)	Dynamics -Acceleration	S1	3	1
	(b)	Dynamics - Newton's laws	S6	2	2
	(c)	Dynamics - Energy	K1	1	
3	(a)	Waves - Wave parameters and behaviours	K3	2	
	(b)(i)	Electricity - Electrical power	K3	3	

	(b)(ii)	Dynamics - Energy	K2	1	
	(c)	Dynamics - Energy	K3	3	
4	(a)	Space - Space exploration	K1	1	
	(b)	Space - Space exploration	S6	2	1
	(c)	Space - Space exploration	K2	2	2
	(d)(i)	Dynamics - Energy	K3	3	
	(d)(ii)	Space - Space exploration	K2	2	1
	(e)	Waves - Wave parameters and behaviours	K3	3	1
5		Space	K2	3	2
6	(a)(i)	Electricity - Electrical power	K1	1	
	(a)(ii)	Electricity - Ohm's Law	K3	4	3
	(a)(iii)	Electricity - Electrical power	K2	1	1
	(b)	Electricity - Practical electrical and electronic circuits	S6	2	2
7	(a)	Electricity - Ohm's Law	K3	3	
	(b)(i)	Electricity - Practical electrical and electronic circuits	K2	1	1
	(b)(ii)	Electricity - Electrical power	K3	3	
	(b)(iii)	Electricity - Electrical power	S6	1	
8	(a)	Properties of matter - Specific heat capacity	K3	3	
	(b)(i)	Electricity - Practical electrical and electronic circuits	K3	3	
	(b)(ii)	Electricity - Electrical power	K3	3	
	(c)	Properties of matter - Specific heat capacity	S6	2	1
9	(a)	Properties of matter - Gas laws and the kinetic model	K3	2	
	(b)(i)	Properties of matter - Gas laws and the kinetic model	K3	3	2
	(b)(ii)	Properties of matter - Gas laws and the kinetic model	K2	3	2
10		Electricity (+ dynamics)	K2	3	2
11	(a)(i)	Waves - Wave parameters and behaviours	S3	1	
	(a)(ii)	Waves - Wave parameters and behaviours	S3	1	
	(b)	Waves - Wave parameters and behaviours	K3	3	
	(c)(i)	Waves - skills	S3	3	1
	(c)(ii)	Waves - skills	S2	1	
	(c)(iii)	Waves - skills	S7	1	
12	(a)	Radiation - Nuclear radiation	K2	1	1
	(b)(i)	Radiation - Nuclear radiation	K1	1	
	(b)(ii)	Radiation - Nuclear radiation	K3	3	
	(b)(iii)	Radiation - skills	S7	1	1
13	(a)(i)	Radiation - Nuclear radiation	K1	1	
	(a)(ii)	Radiation - Nuclear radiation	K2	2	1
	(b)	Radiation - Nuclear radiation	S4	3	
	(c)(i)	Radiation - Nuclear radiation	K3	4	2
	(c)(ii)	Radiation - units, prefixes, and scientific notation	S4	2	1