National
Qualifications
2024

2024 Physics

National 5

Question Paper Finalised Marking Instructions

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

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 (sqa.org.uk)) 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.

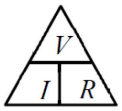
(d) Where a candidate answers part of a question incorrectly and carries the incorrect answer forward in the following part, award marks if the incorrect answer has then been used correctly in the subsequent part or 'follow-on'. (GMP 16)

(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 $R = \frac{V}{I}$. (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. Candidates are given 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

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

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

$$v = 2\,000\,000 \quad (0)$$

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^{-1}, m/s	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 $t = 4 \times 10^5$ 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 over the page 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

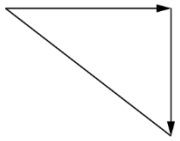
Marking instructions for each question

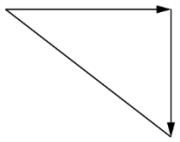
Section 1

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

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	Constant acceleration	**1**	Accept: uniform acceleration accelerating at 0.45 m s^{-2} $a = 0.45$ m s^{-2} Do not accept: acceleration alone accelerating alone increasing speed alone
		(ii)	Constant speed	**1**	Accept: 'velocity' in place of 'speed' steady speed zero acceleration $v = 9.0$ m s^{-1}
	(b)		$a = \frac{v-u}{t}$ **(1)** $a = \frac{0-9.0}{12}$ **(1)** $a = -0.75$ m s^{-2} **(1)**	**3**	Accept: $a = \frac{\Delta v}{t}$ Do not accept a response starting with: $v = at$ or $a = \frac{v}{t}$ or $a = \frac{u}{t}$ **Alternative method:** $a = gradient$ (1) $a = \frac{0-9}{72-60}$ (1) or other correct points $a = -0.75$ m s^{-2} (1) Accept: −0.8 −0.750 −0.7500
	(c)		$d =$ area under graph **(1)** $d = \left(\frac{1}{2}\times 20\times 9\right)+\left(40\times 9\right)+\left(\frac{1}{2}\times 12\times 9\right)$ **(1)** $d = 504$ m **(1)**	**3**	If incorrect substitution then MAX (1) for (implied) relationship Any attempt to use $s = \overline{v}t$ or $d = \overline{v}t$ applied to the whole graph is wrong physics, award (0) marks. If $s = \overline{v}t$ or $d = \overline{v}t$ 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: 500 504.0

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i) (A)	**Using Pythagoras:** resultant^2 = 25^2 + 12^2 **(1)** resultant = 28 N **(1)** **Using scale diagram:**  vectors to scale **(1)** resultant = 28 N **(1)** (allow ±0.5 N tolerance)	**2**	Ignore any direction stated in the final answer in this part. No requirement for arrows to be shown on diagram to calculate the magnitude of the resultant force. 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). Unless candidate reverts to a correct vector diagram, if heads of the arrows are connected on the diagram provided in the question then MAX (1) Accept: 30 27.7 27.73

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i) (B)	**Using trigonometry:** $\tan\theta = \frac{12}{25}$ **(1)** (θ=26°) direction = 116 **(1)** **Using scale diagram:**  vectors to scale **(1)** direction = 116 **(1)** (allow ±2° tolerance)	**2**	Regardless of method, if a candidate (re)draws a vector diagram (or a representation of a vector diagram eg a triangle with no arrows) in this part and the vectors have been represented incorrectly, eg head-to-head then MAX (1) Unless candidate reverts to a correct vector diagram, if heads of the arrows are connected on the diagram provided in the question then MAX (1) **Alternative methods:** $\tan\theta = \frac{25}{12}$ **(1)** (θ=64°) direction = 116 **(1)** **OR** Use of resultant value (and appropriate trigonometry) consistent with (a)(i)(A), eg $\cos\theta = \frac{12}{28}$ or $\sin\theta = \frac{25}{28}$ 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 $\tan = \frac{12}{25}$ Accept: 30° S of E 120 25.6° S of E 115.6 25.64° S of E 115.64

Question			Expected response	Max mark	Additional guidance
2.	(a)	(ii)	$F = ma$ **(1)** $28 = 75 \times a$ **(1)** $a = 0.37\ \text{ms}^{-2}$ at 116 **(1)**	**3**	Or consistent with (a)(i)(A) and/or (a)(i)(B) Direction required for final mark. Accept: 0.4 0.373 0.3733
	(b)		adopt a streamlined position **OR** cycle behind another triathlete **OR** wear tight clothing/lycra **OR** solid wheels instead of spokes	**1**	Or any other suitable suggestion. Ignore any reference to reduction of mass or weight. Do not accept anything to do with the road surface/course. Do not accept: 'streamlining' alone 'more aerodynamic' alone no friction/no air resistance Apply +/- rule for surplus answers.
	(c)	(i)	$d = \overline{v}t$ **(1)** $4 \times 2.5 \times 10^3 = \overline{v} \times (38 \times 60)$ **(1)** $\overline{v} = 4.4\ \text{ms}^{-1}$ **(1)**	**3**	Bar not required above v Accept division of time by 4 rather than multiplication of distance by 4. Accept: 4 4.39 4.386 Accept use of other units of speed (eg km h^{-1})
		(ii)	0 (m s^{-1})	**1**	Units not required, but if included must be a unit of velocity.

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	$E_k = \frac{1}{2}mv^2$ **(1)** initial $E_k = \frac{1}{2}\times 65\times 7.0^2$ **(1)** $(=1592.5\,\text{J})$ final $E_k = \frac{1}{2}\times 65\times 3.0^2$ **(1)** $(=292.5\,\text{J})$ $(\Delta E_k = 1592.5 - 292.5)$ $\Delta E_k = 1300\,\text{J}$ **(1)**	**4**	Accept: 1000
		(ii)	$E_w = Fd$ **(1)** $1300 = F\times 2.0$ **(1)** $F = 650\ \text{N}$ **(1)**	**3**	Or consistent with (a)(i) Accept: 700 650.0
	(b)		Correct curved path shown.	**1**	Do not accept indication of curve rising above horizontal.

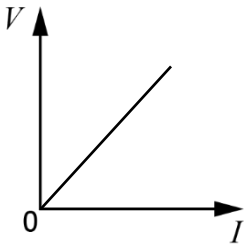
Question			Expected response	Max mark	Additional guidance
4.	(a)		$W = mg$ **(1)** $W = 67 \times 1.4$ **(1)** $W = 94$ N **(1)**	**3**	Accept: 90 93.8 93.80
	(b)		exposure to radiation **OR** pressure differential **OR** lower gravitational field strength **OR** extreme temperatures	**1**	Accept any other physics-related challenge. Ignore non-physics-related challenges, eg 'lack of air/oxygen', 'lack of food/water', Apply +/- rule for surplus answers. Accept: Different gravitational field strength 'g' for 'gravitational field strength' Do not accept: 'gravity' in place of 'gravitational field strength'.
	(c)		Acceleration increases **(1)** Justification: mass decreases (as fuel is used) **OR** gravitational field strength decreases (with altitude) **(1)** weight decreases **OR** unbalanced force increases **(1)**	**3**	**MUST JUSTIFY** Ignore any reference to air resistance/friction.

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)		not affected by weather **OR** no (distortion from) atmosphere **OR** no light pollution **OR** can use telescope during the day **OR** full range of EM waves can be observed	**1**	Accept any other reasonable answer. Accept: 'to see further' converse arguments describing disadvantages of Earth-based telescopes Do not accept: 'clearer' alone 'closer' (neither would negate a correct response) Apply +/- rule for surplus answers
	(b)	(i)	A planet outside the Solar System.	**1**	Accept: 'a planet that orbits a star other than the Sun'
		(ii)	$d = vt$ **(1)** $d = 3.0\times10^{8}$ $\times(41\times365.25\times24\times60\times60)$ **(1)** $d = 3.9\times10^{17}$ (m) **(1)**	**3**	This is not a Standard Three Marker. Calculation can be carried out in steps, but all steps must be done for the substitution mark to be awarded, eg calculation of distance for one light-year, followed by multiplying this by 41. Unit in final answer not required, but if stated, must be correct. Accept: 4×10^{17} 3.88×10^{17} 3.882×10^{17} Also accept, if using 365 days: 3.879×10^{17}
	(c)		helium and nitrogen	**1**	Must have both Any additional elements (0) marks. Accept correct chemical symbols. Accept clear indication of elements present on diagram

Question			Expected response	Max mark	Additional guidance
7.	(a)		Electrons move in one direction (only).	**1**	Accept: 'they' or '(negative) charges' in place of 'electrons' Do not accept: 'current' in place of 'electrons'
	(b)		$Q = It$ **(1)** $Q = 2.5 \times (1.5 \times 60 \times 60)$ **(1)** $Q = 14\,000$ C **(1)**	**3**	Accept: 10 000 13 500
	(c)		(As the temperature increases) the voltage across the thermistor decreases **(1)** Voltage across the resistor increases **(1)** MOSFET turns on **(1)**	**3**	Independent marks Accept: 'transistor' in place of MOSFET Do not accept: npn transistor or pnp transistor in place of MOSFET Accept: MOSFET conducts Ignore any value for switching voltage stated.

Question			Expected response	Max mark	Additional guidance
7.	(d)		$V = 5.0 - 2.2$ **(1)** $(V = 2.8\ \text{V})$ $V = IR$ **(1)** $2.8 = 18 \times 10^{-3} \times R$ **(1)** $R = 160\ \Omega$ **(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) $5.0 = 18 \times 10^{-3} \times R_T$ $(R_T = 277.8\ \Omega)$ $V_{LED} = IR_{LED}$ $2.2 = 18 \times 10^{-3} \times R_{LED}$ (1) all substitutions $(R_{LED} = 122.2\ \Omega)$ $(R = R_T - R_{LED})$ $R = 277.8 - 122.2$ (1) $R = 160\ \Omega$ (1) For this method, if no attempt to determine resistance of resistor, MAX (1) for Ohm's law relationship **Alternative method 2:** $V_S = IR_T$ $5.0 = 18 \times 10^{-3} \times R_T$ $(R_T = 277.8\ \Omega)$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (1) both relationships $\frac{2.2}{5.0} = \frac{R_1}{277.8}$ (1) all substitutions $(R_1 = 122.2\ \Omega)$ $(R = R_T - R_{LED})$ $R = 277.8 - 122.2$ (1) $R = 160\ \Omega$ (1) For this method, if no attempt to determine resistance of resistor, MAX (1) for both relationships Accept: 200 156 155.6

Question			Expected response	Max mark	Additional guidance
8.	(a)	(i)	Suitable scales, labels, and units **(1)** All points plotted correctly 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. Axes can be transposed. A bar chart/histogram can obtain MAX (1) for scales, labels, and units.
		(ii)	6.6 V	**1**	**Must** be consistent with the curve/line the candidate has drawn. If the candidate has used a nonlinear scale in (a)(i) this mark cannot be accessed. If the candidate has not shown a line in (a)(i) this mark cannot be accessed. If the candidate has shown multiple lines at this point in (a)(i) this mark cannot be accessed. ± half a division tolerance Unit must be stated.
		(iii)	(The student) varied the resistance of the variable resistor	**1**	Any reference to altering power supply (0) marks. Accept: 'change the setting of the variable resistor' 'change the reading on the variable resistor' Do not accept: 'change the value of the variable resistor' alone
	(b)			**1**	Ignore any numerical values. Accept: Any passably straight line that would extrapolate through the origin.

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	$E_h = cm\Delta T$ **(1)** $E_h = 4180 \times 0.020 \times (100 - 6.3)$ **(1)** $E_h = 7800$ J **(1)**	**3**	Accept: 8000 7830 7833
		(ii)	$E_h = ml$ **(1)** $E_h = 0.014 \times 22.6 \times 10^5$ **(1)** $E_h = 32\,000$ J **(1)**	**3**	Accept: 30 000 31 600 31 640
		(iii)	39 800 J	**1**	Or consistent with (a)(i) and (a)(ii)
	(b)	(i)	$P = \frac{E}{t}$ **(1)** $750 = \frac{E}{180}$ **(1)** $E = 140\,000$ J **(1)**	**3**	Accept: 100 000 135 000
		(ii)	Heat loss to the surroundings. **OR** Not all the energy used by the microwave is transferred to the water.	**1**	Do not accept 'heat loss' alone Accept: Some energy is used to turn the turntable in the microwave Some energy is converted to sound.

Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	$\frac{p_1}{T_1} = \frac{p_2}{T_2}$ **(1)** $\frac{655}{294} = \frac{p_2}{287}$ **(1)** $p_2 = 639$ kPa **(1)**	**3**	If clear arithmetic error is shown in conversion of temperature to kelvin then MAX (2) marks Accept: 640 639.4 639.40
		(ii)	(As the temperature decreases) the kinetic energy of the particles decreases/particles move slower **(1)** Particles collide with the walls of the container less frequently/often OR Particles collide with the walls of the container with less force **(1)** Pressure decreases **(1)**	**3**	Independent marks Accept: 'atoms'/'molecules' in place of 'particles'. Do not accept: 'particles hit the walls of the container less' alone.
	(b)		$p = \frac{F}{A}$ **(1)** $1.02 \times 10^6 = \frac{F}{7.5 \times 10^{-4}}$ $W = mg$ **(1)** $1.02 \times 10^6 \times 7.5 \times 10^{-4} = m \times 9.8$ **(1)** $m = 78$ kg **(1)**	**4**	(1) mark for each relationship (1) mark for all substitutions (1) mark for final answer Do not accept $F = ma$ in place of $W = mg$, ie MAX (1) for $p = \frac{F}{A}$ Accept: 80 78.1 78.06

Question			Expected response	Max mark	Additional guidance
11.	(a)		(Particle) vibrations/oscillations are at 90° /right angles/perpendicular to the direction of energy transfer. **OR** (Particle) vibrations/oscillations are at 90° /right angles/perpendicular to the direction the wave is travelling.	**1**	Accept: 'particles move up and down' to indicate a vibration. 'disturbance' as an indication of vibration/oscillation Do not accept: 'particles move perpendicular…'
	(b)	(i)	$T = \frac{1}{f}$ **(1)** $7.4 = \frac{1}{f}$ **(1)** $f = 0.14$ Hz **(1)**	**3**	Accept: $f = \frac{N}{t}$ Accept: 0.1 0.135 0.1351
		(ii)	measure (the time for) more waves to pass **OR** count the number of waves in a longer period of time **OR** repeat (the measurement) and average	**1**	Do not accept answers relating to precision eg a stopclock with more decimal places.
	(c)		480 kW	**1**	
	(d)		diffraction of waves into right 'shadow' region of the harbour wall **(1)** consistent wavelengths before and after the harbour wall **(1)**	**2**	(0 marks) if no evidence of diffraction in shadow region (ie no curved sections), second mark is dependent on first mark. (0 marks) if diagram represents diffraction through a gap (ie curved sections at top) Minimum of two waves for any marks to be awarded.

Question			Expected response	Max mark	Additional guidance
12.	(a)		The speed of sound (in air)	**1**	Any extra additional information stated by the candidate would negate a correct response.
	(b)	(i)	Ray of light is incident at 90°/right angles/perpendicular to the lens **OR** Ray of light is travelling along the normal	**1**	Accept: the angle of incidence is 0° the ray is at 0°to the normal Any mention of the ray not refracting then (0 marks)
		(ii)	equal to	**1**	Accept 'the same'
	(c)		(The amplitude of the second bang is) less than (the amplitude of the first bang.) **(1)** (The reflected sound has travelled further so) the second bang has less energy than the first bang **(1)**	**2**	**MUST JUSTIFY** Accept: 'quieter' in place of less amplitude Accept for justification: energy is lost on reflection

Question			Expected response	Max mark	Additional guidance
13.			**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
14.	(a)		$\left(\frac{21.2}{5.3}\right) = 4$ half-lives **(1)** Any evidence of halving activity **(1)** (848 000→424 000→212 000 →106 000→53 000) final activity = 53 000 GBq **(1)**	**3**	
	(b)	(i)	$\left(\frac{25\times10^{3}}{0.50}\right) = 50\,000\ (\text{s})$	**1**	Unit not required, but, if stated, must be seconds.
		(ii)	$D = \frac{E}{m}$ **(1)** $25\times10^{3} = \frac{E}{2.2\times10^{-3}}$ **(1)** $E = 55$ J **(1)**	**3**	Accept: 60 55.0 55.00

Question			Expected response	Max mark	Additional guidance
15.	(a)		less energy/power from the Sun (is available at greater distance from the Sun) **OR** less light from the Sun (is available at greater distance from the Sun) **OR** would need a (very) large area of cells (to generate the same amount of power)	**1**	Accept: In case the spacecraft is in the shade of/behind planets/moons Do not accept: 'it is too far away' alone Do not accept: indication that there is no light (from the Sun) Do not accept: responses in terms of light from stars
	(b)		(plutonium/large) nucleus splits (into smaller nuclei)	**1**	Do not accept: 'atom', 'molecule' or 'particle' in place of 'nucleus'
	(c)		The neutrons released from one reaction (1) go on to split other nuclei/cause further fissions (1)	**2**	Independent marks Do not accept: 'atoms', 'molecules' or 'particles' in place of 'nuclei'
	(d)		The activity (of plutonium) decreases (with time)	**1**	Do not accept: 'radioactivity' in place of 'activity'

[END OF MARKING INSTRUCTIONS]