National
Qualifications
2015

2015 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 General Marking Principles 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.

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

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

The Principal Assessor and Team Leaders study a large sample of candidates' scripts and use the responses to refine the Marking Instructions (MIs) to include guidance on how to interpret different responses.

The answers given in the MIs represent ideal answers.
Additional acceptable answers are also given in the MIs to offer guidance to assist interpreting candidates' answers.
Also, advice on answers which are NOT acceptable or only attract partial marks may also be given in the MIs for some questions.

Markers are reminded that marks for each candidate response must always be assigned in accordance with general marking principles and the specific Marking Instructions for the relevant question.

(d) There are **no half marks** awarded.

(e) Mark should be awarded 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.

(f) Rounding to an expected number of significant figures, the mark can be awarded for answers which have up to two figures more or one figure less than the number in the data with the fewest significant figures.

Common issues with candidate responses:

Spelling

The incorrect spelling of technical terms should be ignored and candidates should be awarded the relevant mark. If answers can be interpreted and understood without any doubt as to the meaning, then the answer should be marked according to the MIs.
However, care should be taken to ensure that the incorrect spelling does not make the response ambiguous, leading to possible 'wrong physics'.
One notable exception is for questions requiring the response 'reflection', 'refraction' or 'diffraction'. 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.

Units

For ***non-numerical*** answers which require a unit to be ***stated*** in an answer, the incorrect spelling of the unit is not usually penalised (if the unit can be clearly identified) eg:

'What is the correct unit for the activity of a radioactive source?' Answer: 'Becquerels'. The answer: 'beckerels' would be acceptable.

Also for ***non-numerical*** answers, do not penalise upper/lower casing when the abbreviated version is given eg DB, sV, hZ, bq.

However, for ***numerical answers***, care must be taken to ensure the unit has the correct prefix, eg for an answer t = 0·005 seconds, t = 5 ms is acceptable but NOT t = 5 Ms.

It should be noted that, in any part of a question, multiple unit errors or conversion errors/ omissions **should only be penalised once**.

Eg when calculating speed from distance and time, and answer required to be in $m\,s^{-1}$.

If d = 4 km $v = \frac{d}{t}$ (1)

t = 2 minutes

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

= 200 (0)

Although the candidate has made three unit errors (not correctly converted distance or time and has omitted the final unit) only the final mark would not be awarded.

Some common units often attract wrong abbreviations in answers to numerical questions. When the abbreviation can be confused with a different unit then this would attract a unit penalty eg sec or secs as an abbreviation for seconds is NOT acceptable.

Common units and abbreviations	
Acceptable unit/Abbreviation	*NOT acceptable version*
second, s	sec, secs
ampere, amp, amps, A	
metres per second, m/s, $m\,s^{-1}$	mps, m/s^{-1}
metres per second per second, m/s/s, m/s^2, $m\,s^{-2}$	mpsps, m/s^{-2}

Standard form:
Candidates may fail to express an answer in standard form correctly.
For an answer t = 400 000 s, then t = 4 x 10^5 s would be correct but t = 4^5 s would be treated as an arithmetic error and the final mark would not be awarded.

Relationship (equation) selection:

No marks should be awarded if a 'magic triangle' eg 

was the only statement in a candidates' response.

The correct relationship must be stated eg $V = IR$ or $R = \frac{V}{I}$ etc to gain (1) mark.

Where a wrong answer to a part of a question is carried forward

- within that part of the question (eg (a)(i) and (a)(ii))
- to the next part of the question (eg (a) and (b))

this should incur no further penalty, provided that it is used correctly.

Where a question requires a Data value and the candidate has selected the wrong value, then either the candidate's wrong value may be used OR the correct data value in the subsequent answer and the response could gain full marks if correctly completed.

Example:

(a) What is the speed of microwaves?
Candidate's answer: 340 m s^{-1} This answer would attract zero marks

(b) What distance would be travelled by these microwaves in 0·34 seconds?
Candidate may use either the value given in part (a) OR the correct value for the speed of microwaves and could gain full marks if correctly completed.

The 'Additional Guidance' column of the MIs would indicate the comment 'or consistent with Q (previous answer)' to indicate that a wrong answer may be carried forward.

Marking from Image Issues:

When marking candidates' scripts on screen, it is important to start by checking the 'full response view' in case answers are continued elsewhere outside the answer boxes or spaces provided and to identify unreadable responses.

Also, for each candidate, the end of the script (up to the very last page) should be checked for any answers completed at the end. Candidates may not indicate that an answer is continued at the end of the script.

If an answer or part of an answer is unreadable, the marker should then click the "!" button *to raise an exception:*

This process is illustrated by: SQA Academy, My Courses, e-marking – MFI 2015, Section 5.4 – Exceptions or RM Assessor User Guide.

Candidates are advised in the 'Your Exams' booklet to cross out any rough work when they have made a final copy. However, crossed-out work must be marked if the candidate has not made a second attempt to answer the question. When a second attempt has been made, or started, the crossed-out working should be ignored.

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

Unless a numerical question specifically requires evidence of working to be shown, full marks should be given for a ***correct*** answer to a numerical question even if the steps are not shown explicitly. The individual marks shown below are for use when making partially correct answers.

Markers who are new to marking SQA Physics exams should study these issues closely, since the guidance illustrates common faults in candidates' answers to the 'standard three marker' type of question. Items 1-15 below illustrate how to apportion marks accordingly.

Experienced markers should also re-acquaint themselves with these examples before marking.

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

These alternative methods of reaching the answer and how to apportion marks are also included in the specific MIs for these questions.

Sometimes, a question requires a calculation which does not fit into the 'standard three marker' type of response. Full guidance on how to apportion marks will be given in the MIs for that specific question.

Question:

The current in a resistor is 1·5 A when the potential difference across it is 7·5 V. Calculate the resistance of the resistor. (3 marks)

	Candidate answer	**Mark + Comment**
1.	$V = IR$ $7{\cdot}5 = 1{\cdot}5 \times R$ $R = 5{\cdot}0\ \Omega$	1 mark, formula 1 mark, substitution 1 mark, correct answer
2.	$5{\cdot}0\ \Omega$	3 marks: correct answer
3.	$5{\cdot}0$	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.	$R = \frac{V}{I} = 4{\cdot}0$	1 mark: formula only
8.	$R = \frac{V}{I} = \_\_\ \Omega$	1 mark: formula only
9.	$R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = \_\_\ \Omega$	2 marks: formula & subs, no final answer
10.	$R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = 4{\cdot}0$	2 marks: formula & subs, wrong answer
11.	$R = \frac{V}{I} = \frac{1{\cdot}5}{7{\cdot}5} = 5{\cdot}0\ \Omega$	1 mark: formula but wrong substitution

12. $R = \frac{V}{I} = \frac{75}{1{\cdot}5} = 5{\cdot}0\ \Omega$ — 1 mark: formula but wrong substitution

13. $R = \frac{I}{V} = \frac{7{\cdot}5}{1{\cdot}5} = 5{\cdot}0\ \Omega$ — 0 marks: wrong formula

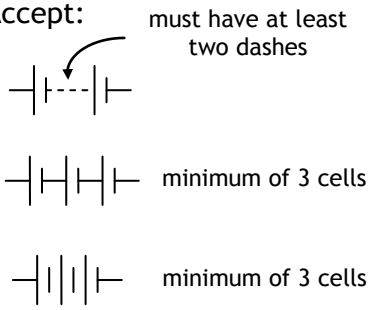
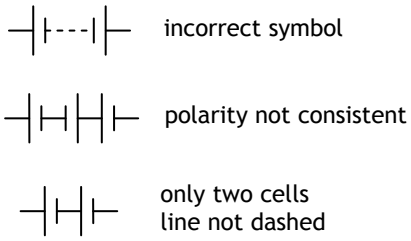
14. $V = IR$ — 2 marks: formula & subs, arithmetic error
$7{\cdot}5 = 1{\cdot}5 \times R$
$R = 0{\cdot}2\ \Omega$

15. $V = IR$
$R = \frac{I}{V} = \frac{1{\cdot}5}{7{\cdot}5} = 0{\cdot}2\ \Omega$ — 1 mark: formula only wrong rearrangement of symbols

Detailed Marking Instruction for each Question

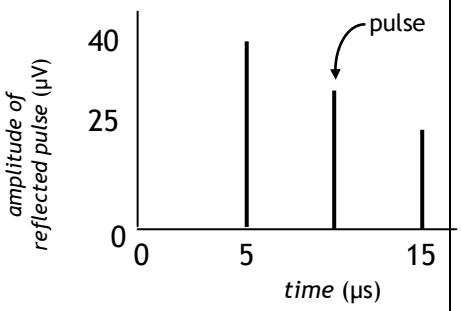
Question	Answer	Mark
1.	A	**1**
2.	A	**1**
3.	C	**1**
4.	E	**1**
5.	B	**1**
6.	D	**1**
7.	D	**1**
8.	A	**1**
9.	C	**1**
10.	E	**1**
11.	E	**1**
12.	A	**1**
13.	E	**1**
14.	C	**1**
15.	B	**1**
16.	C	**1**
17.	A	**1**
18.	B	**1**
19.	E	**1**
20.	D	**1**

Section 2

Question			Answer	Max Mark	Additional Guidance
1.	(a)		2 marks for symbols: • All correct (2) • At least two different symbols correct (1) 1 mark for correct representation of external circuit wiring with no gaps	**3**	Must be three or more cells with consistent polarity or a battery symbol. i.e. Accept:  or any of these reversed Do not accept:  Ignore any labelling. Accept  for bulb. Accept for resistor. Mark for circuit wiring dependent on at least one of the two marks for symbols.
	(b)		$V = IR$ (1) $2 \cdot 5 = 0 \cdot 5 \times R$ (1) $R = 5\ \Omega$ (1)	**3**	Or by an appropriate alternative method.

Question			Answer	Max Mark	Additional Guidance
	(c)		**Effect:** (It/lamp L is) brighter (1) **Justification:** M is in <u>parallel</u> (with resistor) (1) Greater current in/through lamp L (than that in M) (1) **OR** **Effect:** (It/lamp L is) brighter (1) **Justification:** M is in <u>parallel</u> (with resistor) (1) Greater voltage across lamp L (than across M) (1)	**3**	First mark can only be awarded if a justification is attempted. Effect correct + justification correct (3) Effect correct + justification partially correct (2) Effect correct + justification incorrect (1) Effect correct + no justification attempted (0) Incorrect or no effect stated regardless of justification (0) Accept an implication of current greater in L because 'it splits up between M and the resistor' Do not accept: • 'current going to lamp' • 'current across lamp' • 'voltage through lamp' Accept correct effect on lamp M eg' <u>Lamp M</u> is dimmer' Accept converse justifications eg 'current in lamp M is less than lamp L'

Question			Answer	Max Mark	Additional Guidance
2.	(a)		(Graph) X (1) An LED/diode/it only conducts in one direction (1)	**2**	Not independent marks - mark for explanation can only be accessed if graph X is identified. 'X' alone (1)
	(b)	(i)	$P = IV$ (1) $P = 0 \cdot 5 \times 4$ $P = 2$ (W) $E = Pt$ (1) $E = 2 \times 60$ (1) $E = 120$ J (1)	**4**	(1) for each formula (1) for correct substitutions of *I*, *V* and *t* (1) final answer and unit Alternative method: $E = ItV$ (1)+(1) $E = 0 \cdot 5 \times 4 \times 60$ (1) $E = 120$ J (1)
	(b)	(ii)	$Q = I \times t$ (1) $Q = 0 \cdot 5 \times 60$ (1) $Q = 30\ C$ (1)	**3**	

Question			Answer	Max Mark	Additional Guidance
3.	(a)	(i)	15 μs	**1**	Must have correct unit 'μs' not 'us' Accept numerical equivalent (eg 15×10^{-6} s)
		(ii)	**Method 1:** $d = v\,t$ (1) $= 5200\times15\times10^{-6}$ (1) $= 0\cdot078\ (\text{m})$ (1) (If this line is the candidate's final answer, unit required) $thickness = \frac{0\cdot078}{2}$ $= 0\cdot039$ m (1) **Method 2:** $time = \frac{15\times10^{-6}}{2}$ $= 7\cdot5\times10^{-6}$ (s) (1) $d = v\,t$ (1) $= 5200\times7\cdot5\times10^{-6}$ (1) $= 0\cdot039$ m (1)	**4**	Or consistent with (a)(i) Accept 0·04 m Each method requires to divide by 2. This can appear at any stage in the candidate response, but if this does not appear then MAX (3)
	(b)			**2**	The reflected pulse for position Z should be shown as: • a peak at a time greater than 5 μs and less than 15 μs. • an amplitude greater than 25 μV and less than 40 μV. (1) for each of the above features - independent marks Ignore any horizontal lines

Question			Answer	Max Mark	Additional Guidance
	(c)	(i)	** SHOW THAT ** Must start with the correct formula or (0) $f = \frac{1}{T}$ (1) $= \frac{1}{4 \cdot 0 \times 10^{-6}}$ (1) $= 2 \cdot 5 \times 10^{5}$ Hz	**2**	Final answer of $2 \cdot 5 \times 10^{5}$ Hz or its numerical equivalent, including unit, must be shown, otherwise a maximum of (1) can be awarded. Alternative method: $T = \frac{1}{f}$ (1) $= \frac{1}{2 \cdot 5 \times 10^{5}}$ (1) $= 4 \cdot 0 \times 10^{-6}$ s This is the same as the period (of the ultrasound pulse) For the alternative method, the final statement **must** be included; otherwise a maximum of (1) can be awarded.
		(ii)	$v = f \lambda$ (1) $5200 = 2 \cdot 5 \times 10^{5} \times \lambda$ (1) $\lambda = 0 \cdot 021$ m (1)	**3**	Accept: 0·02 m 0·021 m 0·0208 m Must use frequency value of $2 \cdot 5 \times 10^{5}$ Hz.

Question			Answer	Max Mark	Additional Guidance
	(d)		(Speed of ultrasound in brass is) less (than in steel). (1) Takes greater time to travel (same) distance/thickness. (1)	**2**	First mark can only be awarded if a justification is attempted. Effect correct + justification correct (2) Effect correct + justification incorrect (1) Effect correct + no justification attempted (0) Incorrect or no effect stated regardless of justification (0) Must link increased time and same distance/ thickness for justification mark. Could be done by reference to a formula. Accept: 'slower' Do not accept up/down arrows in place of words.

Question			Answer	Max Mark	Additional Guidance
4.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 mark Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The student has demonstrated a limited understanding of the physics involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The student has demonstrated a reasonable understanding of the physics involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding of the physics involved. The student shows a good comprehension of the physics of the situation and has provided 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. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates "no", "limited", "reasonable" or "good" understanding.

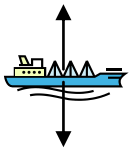
Question			Answer	Max	Additional Guidance
5.	(a)		Correctly labelled the angle of incidence **and** angle of refraction	**1**	No need for arcs. Can use words or symbols, I, θ_i etc.
	(b)		Decreases	**1**	Accept: 'slows down' 'changes to $1{\cdot}2 \times 10^8$ m s^{-1}' Do not accept: 'changes' alone
	(c)		B	**1**	Or clearly identified, eg circled in table
	(d)		$P = \frac{F}{A}$ (1) $= \frac{61000}{1{\cdot}1 \times 10^{-5}}$ (1) $= 5{\cdot}5 \times 10^9$ Pa (1)	**3**	Accept N m^{-2} Accept 1-4 sig fig: 6×10^9 Pa $5{\cdot}5 \times 10^9$ Pa $5{\cdot}55 \times 10^9$ Pa $5{\cdot}545 \times 10^9$ Pa

Question			Answer	Max Mark	Additional Guidance
6.	(a)		Increases	**1**	
	(b)	(i)	**Choice:** (source) X (1) **Explanation:** beta (source required) (1) long half-life (1)	**3**	First mark can only be awarded if an explanation is attempted. Choice correct + explanation correct (3) Choice correct + explanation partially correct (2) Choice correct + explanation incorrect (1) Choice correct + no explanation attempted (0) Incorrect or no choice made regardless of explanation (0) Having chosen source X, can explain why each of the other three sources should not be used. Having chosen source X, can explain that a beta source should be used but that source Y is not suitable because it has too short a half-life.
		(ii)	Time for activity to (decrease by) half **OR** Time for half the nuclei to decay	**1**	Do not accept: Time for radiation/radioactivity/ count rate to half

Question			Answer	Max Mark	Additional Guidance
		(iii)	(high frequency) electromagnetic wave	**1**	Accept: 'EM wave' '(high energy) photon' 'electromagnetic radiation' Do not accept: 'electromagnetic ray' 'part of the electromagnetic spectrum' 'transverse wave' Ignore additional information
	(c)		2 hours	**1**	Unit required Accept 1·9 to 2·1 h

Question			Answer	Max Mark	Additional Guidance
7.	(a)	(i)	**Using Pythagoras:** Resultant^2 = $(6{\cdot}0 \times 10^3)^2$ + $(8{\cdot}0 \times 10^3)^2$ (1) Resultant = 10×10^3 N (1) **Using scale diagram:**  vectors to scale (1) Resultant = 10×10^3 N (1) (allow $\pm 0{\cdot}5 \times 10^3$ N tolerance)	**2**	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) Ignore any direction stated in the final answer in this part. can obtain first mark for scale diagram method from suitable diagram in part (a) (ii) if not drawn in this part

Question			Answer	Max Mark	Additional Guidance
		(ii)	**Using trigonometry:** tan θ = 6/8 (1) θ = 37˚ (1)	**2**	Or use of resultant value consistent with (a)(i) 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) Can also do with other trig functions: sin θ = 6/10 cos θ = 8/10 allow 1-4 sig fig: 40˚ 37˚ 36·9˚ 36·87˚
			Using scale diagram:  angles correct (1) θ = 37˚ (1) (allow ±2˚tolerance)		Must be an attempt to calculate the angle relative to the $8{\cdot}0 \times 10^3$ N force. ie Can use trig method to calculate the complementary angle, but must subtract this from 90˚ otherwise (0) If a candidate calculates or determines the 37˚ then goes on to express this as a three figure bearing MAX (1) Any reference to compass points in final answer is incorrect – MAX (1) can obtain first mark for scale diagram method from suitable diagram in part (a) (i) if not drawn in this part

Question			Answer	Max Mark	Additional Guidance
		(iii)	$F = ma$ (1) $10 \times 10^3 = 5 \cdot 0 \times 10^6 \times a$ (1) $a = 2 \cdot 0 \times 10^{-3}$ m s^{-2} (1)	**3**	or consistent with (a) (i)
	(b)		buoyancy force/upthrust/force of water on ship/flotation force (1)  weight/force of gravity (1) (These) forces are balanced (1)	**3**	Independent marks Must describe forces on ship (i.e. not 'ship pushes down on water') Allow a clear description without a diagram but must indicate direction of force(s) eg weight/force of gravity acts down on ship (1) buoyancy force/upthrust/force of water on ship acts up (1) Do not accept: 'gravity' alone 'buoyancy' alone 'upward force' alone Ignore horizontal forces Accept: An explicit statement that 'forces are equal and opposite'

Question			Answer	Max Mark	Additional Guidance
8.	(a)	(i)	• length/width of card (1) • time taken for card to pass (through) the light gate (1) • time taken (for trolley to travel from starting position) to light gate (1)	**3**	Independent marks Accept: • 'length of trolley' – the card and trolley have the same length • 'time for trolley to pass (through) light gate' Do not accept: • 'time from electronic timer' alone • 'time from stop-clock' alone • 'time from light gate' • 'time for trolley to go down ramp' • 'time for trolley to cut beam' – it is the card that cuts the beam Ignore additional information
		(ii)	reaction time (can cause error with the stop clock reading) **OR** card may not have passed straight through light gate **OR** Length/width of card not measured properly (eg ruler not straight along card) OR other suitable reason	**1**	Do not accept: • 'trolley might have been pushed' • 'human error' alone • 'experiment not repeated' If more than one reason stated apply the +/- rule (see page three)
	(b)		$a = \frac{v-u}{t}$ (1) $= \frac{1 \cdot 6 - 0}{2 \cdot 5}$ (1) $= 0 \cdot 64 \text{ ms}^{-2}$ (1)	**3**	Accept: $a = \frac{\Delta v}{t}$ Do not accept: $a = \frac{v}{t}$ Accept 0·6 m s^{-2}

Question			Answer	Max Mark	Additional Guidance
9.	(a)	(i)	suitable curved path (1)	**1**	Do not accept an indication of stone rising
	(b)	(i)	$a = \frac{v-u}{t}$ (1) $9 \cdot 8 = \frac{v-0}{0 \cdot 80}$ (1) $v = 7 \cdot 8$ ms^{-1} (1)	**3**	Accept: $a = \frac{\Delta v}{t}$ $v = u + at$ Do not accept a response starting with: $a = \frac{v}{t}$ OR $v = at$ Accept: 8 m s^{-1} 7·8 m s^{-1} 7·84 m s^{-1}

Question			Answer	Max Mark	Additional Guidance
		(ii)	$\bar{v} = 3{\cdot}9 \text{ m s}^{-1}$ (1) $d = \bar{v}\,t$ (1) $= 3{\cdot}9 \times 0{\cdot}80$ (1) $= 3{\cdot}1 \text{ m}$ (1)	**4**	Accept $d=vt$ without a bar over the v. Accept $d=st$ only if it is made clear, by a suitable substitution, that s is a speed. Where no formula is stated, an incorrect substitution cannot imply a correct formula. **Alternative method 1:** $E_k = E_p$ (1) $\frac{1}{2}mv^2 = mgh$ (1) $\frac{1}{2} \times m \times 7{\cdot}8^2 = m \times 9{\cdot}8 \times h$ (1) $h = 3{\cdot}1 \text{ m}$ (1) Allow mass to be cancelled or a value substituted **Alternative method 2:** height = area under (velocity-time) graph (1) velocity-time graph showing acceleration drawn (1) substitutions correct (1) final answer correct (1) For this method the formula and/or graph can be implied by a correct substitution.
	(c)		(it will take the) same (time)	**1**	Allow: 'unchanged' 'equal' Ignore additional information.

Question			Answer	Max Mark	Additional Guidance
10.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 mark Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The student has demonstrated a limited understanding of the physics involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The student has demonstrated a reasonable understanding of the physics involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding of the physics involved. The student shows a good comprehension of the physics of the situation and has provided 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. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates "no", "limited", "reasonable" or "good" understanding.

Question				Max Mark	Additional Guidance
11.	(a)	(i)	$E_P = mgh$ (1) $E_P = 0{\cdot}040 \times 9{\cdot}8 \times 0{\cdot}50$ (1) $E_P = 0{\cdot}20$ J (1)	**3**	Accept: 0·2 J 0·20 J 0·196 J
		(ii)	kinetic (energy) to heat (and sound) OR kinetic (energy) of the marble to kinetic (energy) of the sand.	**1**	Accept: E_k to E_h Do not accept: 'kinetic to sound' alone
	(b)	(i)	suitable scales, labels and units (1) all points plotted accurately to ± half a division (1) best fit <u>curve</u> (1)	**3**	A non-linear scale on either axis prevents access to any marks. (0) For a suitable scale: The diameter scale between 0·03 m and 0·08 m must take up at least five major divisions of the graph paper The height scale between 0·05 m and 0·45 m must take up at least five major divisions of the graph paper. A bar chart can obtain a MAX of (1) - for scales, labels and units Allow broken axes from origin (with or without symbol), but scale must be linear across data range. Axes can be swapped Ignore any extrapolation Independent marks

Question			Answer	Max Mark	Additional Guidance
		(ii)	Consistent with best fit curve from (b)(i).	1	Or consistent with best fit line or dot-to-dot line. Unit required ± half a division tolerance If candidate has not shown a curve or line in (b) (i) this mark cannot be accessed.
		(iii)	Any two from: • Repeat (and average) • Take (more) readings in the 0·15 (m) to 0·35 (m) drop height range • Increase the height range • level sand between drops • or other suitable improvement (1) each	2	If more than two improvements stated apply the +/- rule (see page three) Accept 'take more readings' as an implication of repetition.
	(c)	(i)	suitable variable eg • mass/weight of marble • angle of impact • type of sand • diameter of marble • radius of marble • density of marble • volume of marble • speed of marble • time of drop	1	Do not accept: 'size of marble' alone 'time' alone 'amount of…' These are insufficient rather than incorrect responses. If more than one variable stated apply the +/- rule (see page three)
		(ii)	How independent variable can be measured/changed (1) State at least one other variable to be controlled (1)	2	Consistent with (c) (i) Independent marks Accept: 'drop from same heights as before' as an implication of control of height

[END OF MARKING INSTRUCTIONS]