National Qualifications 2016

2016 Physics

National 5

Finalised Marking Instructions

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General Marking Principles for National 5 Physics

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

(a) Marks for each candidate response must always be assigned in line with these 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) Marks 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. (Note: the use of a recurrence dot, e.g. $0{\cdot}\dot{6}$, would imply an infinite number of significant figures and would therefore not be acceptable)

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'.
Notable exceptions are for questions requiring the response 'reflection', 'refraction' or 'diffraction' and also 'fission' or 'fusion'. 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)

e.g. '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 e.g. DB, sV, hZ, bq.

However, for ***numerical answers***, care must be taken to ensure the unit has the correct prefix, e.g. 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.

e.g. 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 e.g. 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, 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}

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' e.g. 

was the only statement in a candidates' response.

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

Incorrect answer carried forward:

Where an incorrect answer to a part of a question is carried forward

- within that part of the question (e.g. (a)(i) and (a)(ii))
- to the next part of the question (e.g. (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 part...' to indicate that an incorrect 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 Marking From Image (MFI) 2016, 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.

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.

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.	$R = \frac{V}{I} = 4{\cdot}0\ \Omega$	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. $V = IR$
$7 \cdot 5 = 1 \cdot 5 \times R$
$R = 0 \cdot 2\ \Omega$ — 2 marks: formula & subs, arithmetic error

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 Instructions for each question

Section 1

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

Section 2

Question			Answer	Max Mark	Additional Guidance
1.	(a)		Q = It (1) 24 = I × 0·0012 (1) I = 20 000 A (1)	**3**	
	(b)		$24 \div 1{\cdot}6 \times 10^{-19}$ $= 1{\cdot}5 \times 10^{20}$ (electrons) (1)	**1**	Ignore negative values in substitution and/or final answer.
	(c)		(metal strip) is a conductor (1) (More) current will pass through (the strip than building) (1)	**2**	Accept: 'it conducts (electricity)' 'it has less resistance (than the building)' Accept: 'charge/electrons will pass through' 'less/no current will pass through the building' Do not accept: 'lightning/electricity will pass through'
2.	(a)		Voltmeter across resistor R (1)	**1**	Correct symbol must be used.
	(b)		increase/decrease/vary/change the <u>resistance</u> of the <u>variable resistor</u>	**1**	Accept: 'change the number of cells/batteries' 'use batter<u>ies</u> with different <u>voltages</u>' Do not accept: 'change the voltage of the battery'

Question			Answer	Max Mark	Additional Guidance
	(c)		**Numerical method:** Ohm's Law stated (1) **All** substitutions shown (2) 5 Ω (1) $V = IR$ $1 = 0 \cdot 2 \times R$ $R = 5\,(\Omega)$ $V = IR$ $2 \cdot 5 = 0 \cdot 5 \times R$ $R = 5\,(\Omega)$ $V = IR$ $3 \cdot 2 = 0 \cdot 64 \times R$ $R = 5\,(\Omega)$ $V = IR$ $6 \cdot 2 = 1 \cdot 24 \times R$ $R = 5\,(\Omega)$ (resistance of R = 5 Ω) **Graphical method:** Suitable scales and labels (1) All points plotted accurately to ±half a division (2) Line drawn and gradient calculated to be 5 Ω (1)	**4**	Ohm's Law may appear at any stage in the candidate's response To get full marks all data must be used. If only 2 or 3 correct substitutions shown (1) mark can be awarded for substitution. (ie (3) marks MAX). If no substitution or only 1 correct substitution is shown candidate cannot be awarded the substitution marks. (ie (2) marks MAX). If a candidate totals or averages the voltages and currents then (1) mark MAX for Ohm's Law. The resistance of R does not need to be stated separately. However, all calculated values must arrive at 5 Ω by correct use of Ohm's Law to gain the final mark. Unit must be shown at least once to be awarded final mark. Scale must be linear across data range. If only 2 or 3 points plotted (1) mark can be awarded for points (ie (3) marks MAX). If only 1 point plotted candidate cannot be awarded the plotting marks. (ie (2) marks MAX).
	(d)		(Resistance is) changing/not constant/increasing	**1**	Do not accept: 'resistance is decreasing'

Question			Answer	Max Mark	Additional Guidance
3.	(a)		** SHOW THAT ** Must start with the correct equation or (0) $E_h = cm\Delta T$ (1) $E_h = 4180 \times 6 \cdot 0 \times 25$ (1) $E_h = 627000$ J	**2**	Final answer of 627 000 J or its numerical equivalent, including unit, must be shown, otherwise a maximum of (1) can be awarded For alternative methods calculating c, m or ΔT there must be final statement to show that calculated value of c, m or ΔT is the same as the value stated in the question/data sheet to gain the second mark. eg $E_h = cm\Delta T$ (1) $627\,000 = 4180 \times m \times 25$ (1) $m = 6 \cdot 0$ kg i.e. same mass as stated in question If c substituted as 4·18 it must be clear that the energy calculated is then in kJ.
	(b)	(i)	$P = \frac{E}{t}$ (1) $1800 = \frac{627000}{t}$ (1) $t = 350$ s (1)	**3**	Accept: 300 s 350 s 348 s 348·3 s Do not accept: 'secs'
		(ii)	Heat (energy) is lost (from the water) to the washing machine/drum /surroundings/clothing **OR** Some of the energy is used to heat up the washing machine/element/drum/clothing	**1**	Do not accept: 'heat loss' alone – it must be clear where it is going

Question			Answer	Max Mark	Additional Guidance
	(c)		Voltage across thermistor decreases (1) MOSFET/transistor switches off/deactivates (1) Relay switches off/relay switch opens/relay deactivates (1)	**3**	(3) independent marks Do not accept 'voltage through thermistor decreases'. Ignore any stated values of switching voltage. Ignore reference to it being an npn transistor. As these are independent marks, ignore any extraneous information, even if incorrect.

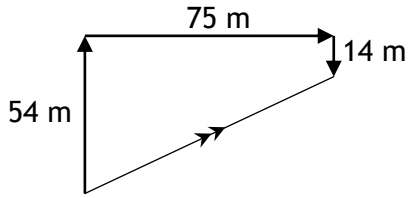
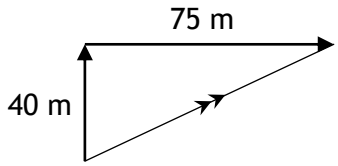
Question			Answer	Max Mark	Additional Guidance
4.	(a)		(black bulb) thermometer, photodiode, phototransistor, thermistor, thermocouple, CCD, thermochromic film	**1**	Do not accept: Skin (Infrared/thermal imaging) camera Photographic film thermogram
	(b)		Gamma (radiation/rays)	**1**	
	(c)	(i)	** SHOW THAT ** Must start with the correct equation or (0) $v = f\lambda$ (1) $3{\cdot}0\times10^{8} = 1{\cdot}2\times10^{9}\times\lambda$ (1) $\lambda = 0{\cdot}25$ m	**2**	Final answer of 0·25 m or its numerical equivalent, including unit, must be shown, otherwise a maximum of (1) can be awarded. For alternative methods calculating v or f there must be final statement to show that calculated value of v or f is the same as the value stated in the question/data sheet to gain the second mark.
		(ii)	Microwave (radiation)	**1**	Accept: 'microwaves'

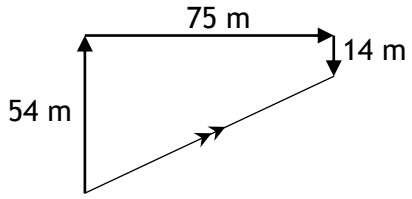
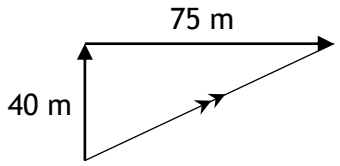
Question			Answer	Max Mark	Additional Guidance
5.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 mark Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The student has demonstrated a limited 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 Mark	Additional Guidance
6.	(a)	(i)	normal drawn and labelled	**1**	Must be 'passably' perpendicular and straight Does not need to be dashed Accept: 'N' or 'n' as label
		(ii)	Both angles indicated and labelled	**1**	Accept: i and r I and R θ_i and θ_r If normal has been incorrectly drawn, then this mark is still accessible, provided angles are indicated to the normal and labelled. Accept angles indicated either entering or leaving the Perspex block
	(b)	(i)	8°	**1**	Allow ±0·5° tolerance Unit must be included
		(ii)	Any single value between 40° and 42° inclusive.	**1**	Unit must be included
	(c)		Any one of: To obtain more reliable results Eliminate rogue results/outliers To allow an average/mean to be calculated More accurate	**1**	Do not accept: 'more precise' 'better results' 'to make it a fair test'

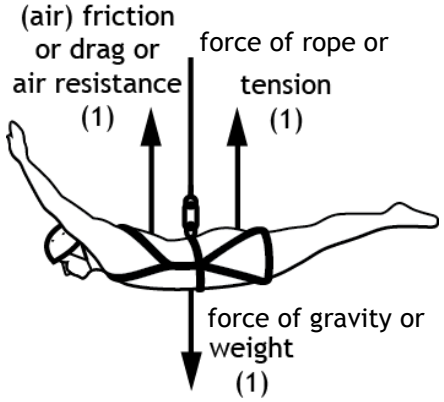
Question			Answer	Max Mark	Additional Guidance
7.	(a)		$A = \frac{N}{t}$ (1) $A = \frac{7{\cdot}92 \times 10^{18}}{900}$ (1) $A = 8{\cdot}8 \times 10^{15}$ Bq (1)	**3**	Accept: 9×10^{15} Bq **OR** $A = \frac{N}{t}$ (1) $A = \frac{7{\cdot}92 \times 10^{18}}{15}$ (1) $A = 5{\cdot}28 \times 10^{17}$ decays per min (1)
	(b)		$8{\cdot}8 \times 10^{15} \times 4{\cdot}49 \times 10^{-14}$ (1) $= 400$ W (1)	**2**	Or consistent with part (a) Accept: 400 W 395 W 395·1 W **Alternative method:** (not a standard three marker) ($P = \frac{E}{t}$) no mark for equation $P = \frac{7{\cdot}92 \times 10^{18} \times 4{\cdot}49 \times 10^{-14}}{900}$ (1) $P = 400$ W (1)
	(c)		Any one of: (Alpha is) more easily absorbed/stopped/blocked (Alpha) is absorbed by thinner materials/less dense materials. Gamma is absorbed by thicker materials/more dense materials. (Alpha) is less penetrating (than gamma). Gamma is more penetrating (than alpha)	**1**	Must be a comparison. Do not accept: 'Alpha is absorbed by a sheet of paper' alone 'Gamma is absorbed by lead' alone Do not accept comparison of range in air alone

Question			Answer	Max Mark	Additional Guidance
8.	(a)	(i)	$D = \frac{E}{m}$ (1) $D = \frac{9 \cdot 6 \times 10^{-5}}{0 \cdot 5}$ (1) $D = 1 \cdot 9 \times 10^{-4}$ Gy (1)	**3**	Accept: 2×10^{-4} Gy $1 \cdot 9 \times 10^{-4}$ Gy $1 \cdot 92 \times 10^{-4}$ Gy $1 \cdot 920 \times 10^{-4}$ Gy Accept: J kg^{-1}
		(ii)	$H = Dw_R$ (1) $H = 1 \cdot 9 \times 10^{-4} \times 1$ (1) $H = 1 \cdot 9 \times 10^{-4}$ Sv (1)	**3**	Accept answer consistent with that given in part (i) If incorrect radiation weighting factor selected then (1) MAX for correct equation
	(b)		No. of half-lives = $\frac{144}{36}$ = 4 (1) 12 → 6 → 3 → 1·5 → 0·75 mark for evidence of activity halving (1) Final Answer: 0·75 kBq (1)	**3**	Accept: 750 Bq Accept calculation using division by 2^4 eg $\left(A = \frac{A_0}{2^n} \right)$ $= \frac{12}{2^4}$ (1) +(1) $= 0 \cdot 75$ kBq (1) substitution shows evidence of halving the activity (1) and 4 half-lives (1)

Question			Answer	Max Mark	Additional Guidance
9.	(a)	(i)	**Using Pythagoras:** Resultant^2 = 40^2 + 75^2 (1) Resultant = 85 m (1) **Using scale diagram:**  **or**  Vectors to scale (1) Resultant = 85 m (1) (allow ±5 m tolerance)	**2**	Ignore any direction stated in this part. If clear arithmetic error shown in 54-14 = 40, then MAX (1) mark for substitution consistent with arithmetic error. No requirement for any arrows on diagram to calculate the magnitude of the displacement. 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:** $\tan\theta = \frac{75}{40}$ (1) $(\theta = 62°)$ direction = 062 (1) **Using scale diagram:**  **or**  Angles correct (1) direction = 062 (1) (allow ±2° tolerance)	**2**	Or use of <u>resultant</u> value (and appropriate trigonometric function) consistent with (a)(i) Accept: 62° East of North 28° North of East Accept: 60° E of N 060 62° E of N 062 61·9° E of N 061·9 61·93° E of N 061·93 Ignore the degree symbol if direction is stated as a bearing Accept (for either method): 62° appropriately indicated on diagram (either written on directly or using clearly defined symbol), provided the resultant has an arrow indicating the correct direction (diagram may be in part (a)(i)).

Question			Answer	Max Mark	Additional Guidance
	(b)	(i)	$\bar{v} = \frac{s}{t}$ (1) $\bar{v} = \frac{85}{68}$ (1) $\bar{v} = 1{\cdot}3 \text{ m s}^{-1}$ at bearing 062 (1)	**3**	Or consistent with part (a) for magnitude and direction Must have direction for final mark. Accept: 1 m s $^{-1}$ 1·3 m s^{-1} 1·25 m s $^{-1}$ Accept: $v = \frac{s}{t}$ Accept: $\bar{v} = \frac{d}{t}$ or $v = \frac{d}{t}$, provided it is followed by a substitution of the value for displacement
		(ii)	distance is greater (than displacement) (1) same time (1)	**2**	Or by calculation of speed showing correct substitution for distance (1) and time (1) ie $v = \frac{d}{t}$ $v = \frac{143}{68}$ (1)+(1) $(v = 2{\cdot}1 \text{ m s}^{-1})$

Question			Answer	Max Mark	Additional Guidance
10.	(a)		$a = \frac{v-u}{t}$ (1) $a = \frac{2\cdot5-0}{1\cdot4}$ (1) $a = 1\cdot8\ \text{m s}^{-2}$ (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: 2 m s^{-2} 1·8 m s^{-2} 1·79 m s^{-2} 1·786 m s^{-2}
	(b)		distance = area under graph (1) $= (½\times1\cdot4\times2\cdot5)+(1\cdot6\times2\cdot5)+(½\times1\cdot6\times1\cdot2)$ (1) $(=1\cdot75+4+0\cdot96)$ = 6·71 m (1)	**3**	If incorrect substitution then MAX (1) for (implied) equation. Any attempt to use $s = \bar{v}t$ (or $d = \bar{v}t$) applied to whole graph (eg 3·7 × 3·0) is wrong physics, award (0) marks. If $s = \bar{v}t$ (or $d = \bar{v}t$) is used for each section of the graph and the results added to give the correct total distance then full marks can be awarded. Ignore incorrect intermediate units eg m^2 Accept: 7 m 6·7 m 6·71 m 6·710 m
	(c)			**3**	(1) for each force correctly labelled with corresponding direction. Accept: 'pull of rope' 'gravitational pull' 'pull of gravity' Do not accept: 'pull/force of air descender' 'gravity' alone 'upward force' alone Ignore horizontal forces

Question			Answer	Max Mark	Additional Guidance
11.			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 Mark	Additional Guidance
12.	(a)		$W = mg$ (1) $W = 3{\cdot}00 \times 10^3 \times 9{\cdot}8$ (1) $W = 2{\cdot}9 \times 10^4$ N (1)	**3**	Do not accept 10 or 9·81 for g Accept: 3×10^4 N $2{\cdot}9 \times 10^4$ N $2{\cdot}94 \times 10^4$ N $2{\cdot}940 \times 10^4$ N
	(b)	(i)	light (energy) → electrical (energy)	**1**	Accept: light → electric 'to' instead of arrow Do not accept: light → electricity solar → electrical light — electrical(no direction)
		(ii)	Maximise the light received (from the Sun) (or similar)	**1**	Accept: So that they always face the Sun (or similar)
		(iii)	$E = Pt$ (1) $E = 395 \times 2 \times 60 \times 60$ (1) $E = 2{\cdot}8 \times 10^6$ J (1)	**3**	Accept: 3×10^6 J $2{\cdot}8 \times 10^6$ J $2{\cdot}84 \times 10^6$ J $2{\cdot}844 \times 10^6$ J
	(c)	(i)	(4 × 10 =) 40 N (1)	**1**	Unit must be stated
		(ii)	$m = 3{\cdot}00 \times 10^3 - 1{\cdot}00 \times 10^3$ (1) $= 2{\cdot}00 \times 10^3$ (kg) $a = \frac{F}{m}$ (1) $a = \frac{40}{2{\cdot}00 \times 10^3}$ (1) $a = 0{\cdot}02$ m s^{-2} (1)	**4**	Or consistent with (c)(i) Calculation of mass may be implied by correct substitution. If no attempt to calculate the mass, or incorrect substitution to calculate the mass, then MAX (1) for equation. If clear arithmetic error in calculation of mass then MAX (3).

Question			Answer	Max Mark	Additional Guidance
13.	(a)		(Two) nuclei combine (to form a larger nucleus). (1)	**1**	Do not accept: 'atoms' or 'particles' as an alternative to 'nuclei'
	(b)		5505 (°C) (1)	**1**	Unit not required but if stated must be correct.
	(c)		** SHOW THAT ** Must start with the correct equation or MAX (1) for speed of light $d = vt$ (1) $d = 3 \cdot 0 \times 10^8 \times$ (1) $(365 \cdot 25 \times 24 \times 60 \times 60 \times 640)$ (1) $d = 6 \cdot 1 \times 10^{18}$ m	**3**	Final answer of $6 \cdot 1 \times 10^{18}$ m or its numerical equivalent, including unit, must be shown, otherwise a maximum of (2) can be awarded (1) mark for initial equation (In this case, allow the equation to be preceded by a calculation of time and/or statement of the speed of light) (1) mark for obtaining speed of light from Data Sheet (independent mark) (1) mark for correct substitution of all parts of the time. Calculation can be done in stages, e.g. calculation of distance for one light-year, followed by multiplying this by 640. Accept number of days in a year to be 365. For alternative methods calculating v or t there must be final statement to show that calculated value of v is speed of light or t is equivalent to 640 years.
	(d)		The light/radiation from the explosion has not reached the Earth yet. **OR** The light/radiation takes time/640 years to reach Earth/to get here.	**1**	Do not accept: Explanation in terms of distance rather than time, eg 'It's 640 light-years away' alone.

[END OF MARKING INSTRUCTIONS]