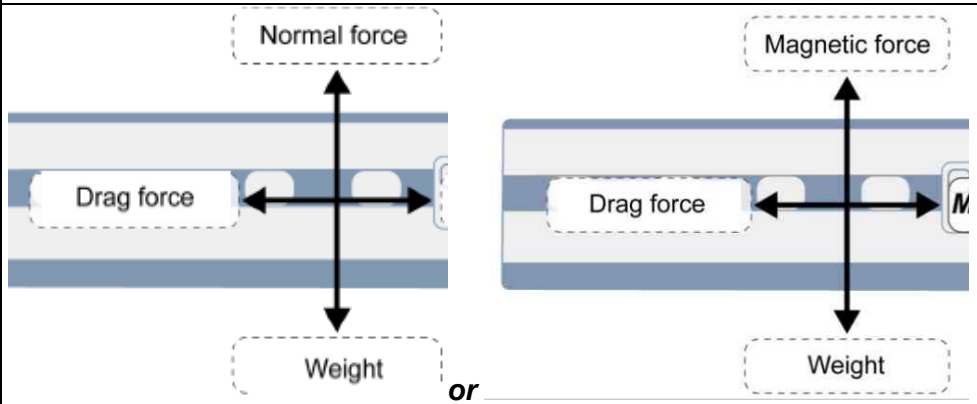
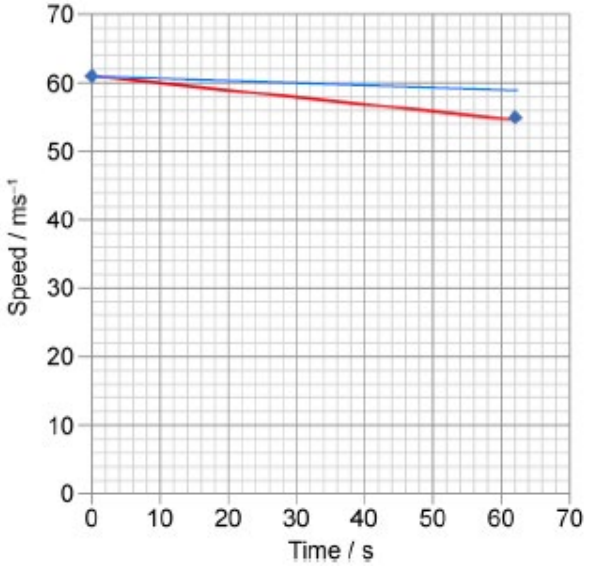
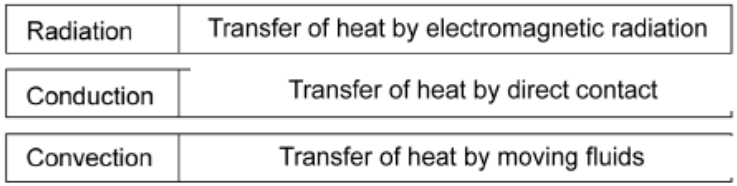
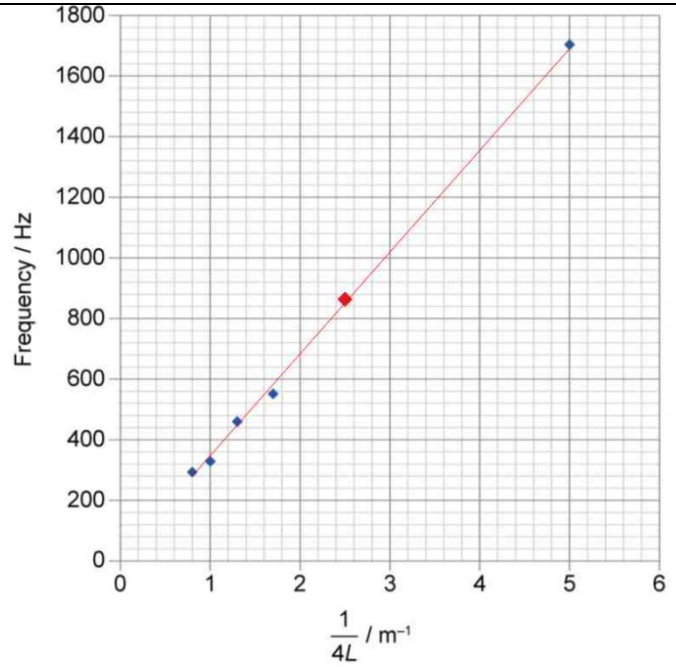
Question		Answers	Notes	Total	Crit
1	a	newtons		1	A
	b	 ***or*** 2 correct All correct	*Accept magnetic force or normal force for vertical component*	2	A
	c	Less than The drag force ***or*** air resistance is reduced The forces are balanced ***or*** resultant force is zero (at constant speed)	*WTTE* *WTTE*	3	A
	d	Evidence of speed x time **or** area calculation Use of 2 data points from graph to calculate area of trapezium ***or*** average speed 3600 or 3596 (m)	*Seen or implied (eg 61x62)* *Accept answers in the range 3534 to 3627(m) for 3 marks. Rounding not required*	3	A

	e	 *y* intercept is the same Always above original line	*Candidate's line has no end markers* *Allow approximately the same starting point, ignore end point* *Do **not** accept positive gradient (showing acceleration)*	**2**	A

2	**a**	Power ***and*** equal to	*Both required*	**1**	A
	b	Evidence of use of transformer equation ***or*** power in = power out 12 000 (V)	*Seen or implied* *Award 2 marks for correct answer* *Accept 651V for 2 marks if the number of turns from the diagram is used to calculate the primary voltage*	**2**	A
	c	Use of P=IV Power supplied (98% efficiency) 14112 (W)	*Seen or implied* *Accept correct answer rounded to 2sf or more in W or kW for 2 marks*	**2**	A
	d	***Accept any points from the list [max 2]*** • By increasing the voltage, the current is reduced • Energy is wasted as heat in the wires • (Increasing voltage or decreasing current) reduces energy wasted (as heat) • R is fixed value (property of wire) • more energy or power is supplied to the destination	*ORA*	**2**	A

3	**a**	 All correct		**1**	A
	b	D		**1**	A
	c	Condensation	*Accept "it condenses"*	**1**	A
	d	Condensation occurs on cold surfaces ***or*** Salt water is only cold at the top of the cup		**1**	A
	e	***Any two points from the list, [max 2]*** • salt water is more dense (than pure water) • melted cold water remains near surface • convection of salt water does not occur ***or*** less convection in saltwater than in pure water ***Conclusion:*** (so) heat is transferred less quickly (in the salt water)	*WTTE for all points* *WTTE* *Do **not** award the final mark unless the first and second marks are awarded*	**3**	A
	f	***First marking point:*** Melted cold water would be distributed ***or*** Stirring would increase (heat transfer by) convection ***Second marking point:*** Melting time for the ice in salt water would decrease ***or*** Melt time would be the same for both ice cubes or Melt time would be less for both cubes	*WTTE* *WTTE*	**2**	B

4	**a**	How does the length of a tube affect the <u>frequency</u> of the sound produced?	*WTTE*	**1**	B
	b	At least three of one material only, no other material included At least three of one diameter only 5 lengths of 2.5 cm diameter wood only	 *Award third mark only if first 2 marks awarded*	**3**	B
	c	IV is length ***or*** wood is the only material with five different lengths Material ***and*** diameter should be controlled	*Accept description of length as IV* *WTTE*	**2**	B
	d	Two data points taken from the graph Correct calculation using pair of points ***or*** double IV and halve DV ***or*** comparing products of x and y values So hypothesis supported	 *Award 1 mark only if the candidate identifies the fact that as length increases, frequency decreases but performs no calculation or processing to confirm if this is inverse proportionality* *WTTE* *Do **not** award the third mark unless marking points one and two are awarded*	**3**	C
	e	4L value = 0.4 ***and*** 1/4L value 2.5	*Values must be to 1 d.p.*	**1**	C

	f	 Data point plotted correctly (2.5, 860) Line of best fit has roughly equal distribution of data points above and below line (judge by eye)	*Award the mark if the point is plotted within the correct square i.e.* (2.5±0.1, 860±20)	**2**	C
	g	Image Object $\frac{1}{v}$ v $\frac{1}{4L}$ $\frac{v}{4L}$ Text/MCQ/Mini-Cloze Object ○ ◉ ○ ○		**1**	C

	h	Calculation seen and points separated by more than 1000Hz in y Correct value 343±10 m s^{-1}	*Consistent with their LOBF in part g* *Accept m/s or Hz m* *Award unit mark separately*	**3**	C

<table>
<tr><td rowspan="4">5</td><td>a</td><td>W=mg

3 (N)</td><td>Seen or implied</td><td>2</td><td>C</td></tr>
<tr><td>b</td><td>Accept any two variables from the list, [max 2]
• Length of wire
• Thickness or diameter
• Material or type of wire or density of wire
• Force of the pluck or strum of the string</td><td>WTTE</td><td>2</td><td>C</td></tr>
<tr><td>c</td><td>Table Object
<table><tr><th>tension (N)</th><th>frequency (Hz)</th></tr><tr><td>4.9</td><td>180</td></tr><tr><td>14.7</td><td>280</td></tr><tr><td>24.5</td><td>460</td></tr><tr><td>39.3</td><td>509</td></tr><tr><td>49.0</td><td>588</td></tr></table>
Column headers: Tension and Frequency

Units for both quantities in headers only

39.28 correctly rounded to 39.3 (N) to give consistent dps

Results in order</td><td>Accept tables arranged in columns or rows

Accept results in ascending or descending order</td><td>4</td><td>C</td></tr>
<tr><td>d</td><td>Accept any relevant suggestion for example, [max 1]
• increased range of data
• repeat measurements
• values of the IV in between the values already used
• regular intervals of the IV

Accept any correctly linked justification for example, [max 1]
• pattern in data will be more clearly visible
• reduce the effect of random errors on the line of best fit
• line of best fit would be more accurate/reliable</td><td></td><td>2</td><td>C</td></tr>
</table>

	e	***Accept any reasonable IV, for example [max 1]*** • length • thickness ***or*** diameter • material • temperature ***Accept any two reasonable CV, for example [max 2]*** • length • thickness or diameter • material • temperature • tension	*Award 0 marks for this question if tension is selected as IV* *Do not award CV mark if it is the same as the IV*	**3**	B
	f	***If, then:*** linking their IV with frequency ***Because:*** Attempt at explanation linked to their IV and frequency	*Does not have to be correct for the first marking point* *Award 0 marks if the hypothesis relates tension and frequency*	**2**	B

6	**a**	***Accept any reasonable suggestion, for example [max 1]*** • increased reliability • reference to background noise • to identify anomalies	*Do **not** accept "to take an average",* *Do **not** accept "to improve accuracy/validity" without clarification* *WTTE*	**1**	C
	b	113 113	*Do **not** accept answers with additional decimal places e.g. 113.3*	**2**	C
	c	105 (dB)		**1**	C

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<td>6</td>
<td>d</td>
<td>
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Variables</td><td>sound intensity level as dependent variable
or
number of layers/thickness of cardboard as independent variable</td><td>sound intensity level as dependent variable
and
number of layers/thickness of cardboard as independent variable</td><td>IV and DV correct and one control variable stated and justified
or
IV and DV correct and two control variables stated</td><td>independent, dependent variable and two control variables are stated and justified</td></tr>
<tr><td>Hypothesis</td><td>attempt at a hypothesis linked to either sound intensity level or number of layers/thickness of cardboard</td><td>testable hypothesis linking sound intensity level and number of layers/thickness of cardboard</td><td>hypothesis links sound intensity level and number of layers/thickness of cardboard, is testable and with an attempted explanation referencing relevant scientific knowledge</td><td></td></tr>
<tr><td>Method</td><td>attempt at a method linked to either sound intensity level or number of layers/thickness of cardboard</td><td>attempt at method linked to sound intensity level and number of layers/thickness of cardboard but insufficient detail to be followed by another student and not likely to give relevant data</td><td>method linked to sound intensity level and number of layers/thickness of cardboard described and could easily be followed by another student and will produce relevant data</td><td></td></tr>
<tr><td>Data collection</td><td>reference to different increments or trials</td><td>at least five different numbers of cardboard layers/thicknesses or three trials</td><td>at least five different numbers of cardboard layers/thicknesses and three trials</td><td></td></tr>
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<td>13</td>
<td>B</td>
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7	**a**	Mars seems to go backwards ***or*** changes direction If Earth was the centre, Mars would orbit in a circular path/ellipse around Earth **or** Mars would seem to follow a straight-path or an arc ***or*** reference to changing distance between Earth and Mars	*WTTE* *WTTE*	**2**	D
	b	Calculation of time in s: $4x10^{11}/3x10^{8}$ = 1330(s) ***or*** use of ratio to give 1330(s), 1333(s), 1333.3(s) Conversion and rounding 22 (minutes)	*Accept any correct value of time in s rounded or unrounded for first mark* *Award two marks for correct answer alone*	**2**	A D
	c	***Accept any two points from the list [max 2]*** • the launch date is calculated to give the shortest journey time • the launch date gives the shortest distance to travel • in order to minimise fuel • in order to minimise communication time • the launch date is calculated to reach a specific landing spot on Mars	*WTTE for all*	**2**	D

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<td>8</td>
<td></td>
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<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Technical (planning the journey)</td><td>One technical challenge is stated</td><td>One technical challenge is stated with a partial explanation
or
Two technical challenges stated</td><td>Two technical challenges stated with a scientific explanation for at least one</td><td>Two technical challenges stated with a scientific explanation for both</td></tr>
<tr><td>Economic advantages and disadvantages (for the government of a country)</td><td>One economic advantage or disadvantage is stated</td><td>One economic advantage and disadvantage is stated
or
Two advantages or disadvantages are stated</td><td>One economic advantage and one disadvantage are stated with further discussion for one</td><td>One economic advantage and one disadvantage are stated with further discussion for both</td></tr>
<tr><td>Political implications</td><td>One political implication is stated</td><td>One political implication is stated with further discussion
or
two political implications are stated</td><td>Two political implications are stated and further discussion for one</td><td></td></tr>
<tr><td>Concluding appraisal</td><td>A simple conclusion</td><td>A concluding appraisal with reference to issues raised</td><td></td><td></td></tr>
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</td>
<td>13</td>
<td>D</td>
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9		***Effect of low temperature, for example [max 1]*** • too cold for humans to live • too cold for humans to grow food ***Correctly linked suggestion to overcome the effect of low temp [max 1]*** • reference to minimising heat transfer through insulation of housing/clothing ***Effect of radiation, for example [max 1]*** • (exposure to) too much radiation is harmful to health ***or*** can cause cancer ***Correctly linked suggestion to overcome effect of UV radiation [max 1]*** • reference to a method of absorbing or reflecting the radiation ***Effect of low gravity, for example [max 1]*** • reference to health problems caused by low gravity eg poor circulation, muscle wasting, bone density • difficulties in moving around compared to Earth ***Correctly linked suggestion to overcome effect of low gravity [max 1]*** • need to exercise to build muscle mass or maintain bone density • wear a weighted suit	*Do **not** accept constant heating without mention of insulation as a solution* *Accept responses suggesting the use of rotation to simulate gravity if this is clearly expressed.*	**6**	D