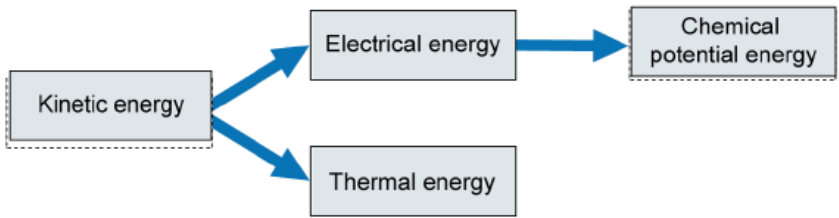


Question	Answers	Notes	Total	Criterion	
1	a	Radio waves travel <input type="text" value="at the same speed as"/> light waves in a vacuum. Radio waves have <input type="text" value="a longer wavelength than"/> light waves.		2	A
	b	Diffraction		1	A
	c	Evidence of conversion of km to m Correct answer (0.00002) Expressed in standard form 2×10^{-5} (s)	<i>Seen or implied</i> <i>Award if an incorrect answer is expressed in standard form.</i> <i>Award 3 marks if 2×10^{-5} alone is seen</i>	3	A
	d	Accept any reasonable suggestion [max 2] <ul style="list-style-type: none"> • Able to communicate while moving (e.g. boats) • Communication over larger distances or with other countries or to previously inaccessible locations • High speed communication is possible • No failures of wired connections or saves material or money required for wired connections • Led to the development of (named) new technology 	<i>Do not accept messages can be sent without the need for wires</i> <i>Each named piece of technology can be awarded 1 mark</i>	2	D

2	a	29 is the <input type="text" value="number of protons"/> in the nucleus 63 is the <input type="text" value="total number of protons and neutrons"/> in the nucleus		2	A
	b	<input type="text" value="C"/> Correct image selected Beta (particles) are electrons <i>or</i> beta (particles) are negatively charged (so they are) deviated toward the positive plate in an electric field	<i>Only consider the justification if C is selected</i>	3	A
	c	Evidence of use of half-life <i>or</i> beginning mass of the sample is 100 g, half of it is 50 g 60 ± 2 (h)	<i>Award 2 marks for correct answer with no working shown</i>	2	A
	d	Half-life (time period) is suitable to allow treatment <i>or</i> short enough to limit the long-term effects Beta or gamma radiation can kill cancer cells <i>or</i> tumours	<i>Ignore references to penetrating power</i>	2	A

3	a	Use of KE equation 468750(J)	<i>Seen or implied</i> <i>Accept any correctly rounded answer to two or more sig figs for 2 marks</i> <i>Accept answers correctly stated in kJ</i>	2	A
	b	Use of $v^2 = u^2 + 2as$ (-) 10.4166... Rounded correctly to (-)10.4 $m\ s^{-2}$ or m/s^2	<i>Accept loss in KE = work done by force</i> <i>Award three marks if only 10.4 is seen</i> <i>Award this unit mark separately. Superscripts must be used correctly. Do not accept ^2.</i>	4	A
	c	Heat energy cannot be used (by the car) or cannot perform work	<i>WTTE. Do not accept wasted / lost energy as this is given in the question</i>	1	A
	d	 <p>All correct for one mark</p>		1	A
	e	Accept any point from the list, [max 1] <ul style="list-style-type: none"> energy (stored in the battery) can be transformed into kinetic energy energy (stored in the battery) can be transformed into electrical energy to drive the car 	<i>Do not accept the car's battery is recharged</i> <i>WTTE</i>	1	A
	f	Burning fuel produces carbon dioxide/ CO ₂ Link to climate change or greenhouse effect	<i>Do not accept unnamed greenhouse gas emissions or pollution</i> <i>WTTE</i>	2	D

4	a	How does the distance a ball roll affect the time taken?	WTTE	1	B																								
	b	<table border="1"> <thead> <tr> <th></th> <th>Independent variable</th> <th>Dependent variable</th> <th>Control variable</th> </tr> </thead> <tbody> <tr> <td>Mass of the ball</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Time taken</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Size of the ball</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Distance travelled by the ball</td> <td><input checked="" type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Angle of the slope</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table> <p>IV – distance only</p> <p>DV – time only</p> <p>CV – mass, size, angle of slope only</p>		Independent variable	Dependent variable	Control variable	Mass of the ball	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Time taken	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Size of the ball	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Distance travelled by the ball	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Angle of the slope	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		3	B
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c	<p>weight of the ball or gravitational force or gravity</p> <p>Use of Newton’s Second Law or $F = ma$ or Newton’s First Law to correctly link force and acceleration</p>	<p><i>No need to explain why the force is constant (and link this to the constant acceleration) for the second marking point</i></p>	2	B																									
d	<p>B</p> <p>Any two from [max 2]</p> <ul style="list-style-type: none"> graph goes through the origin, or when $s = 0$ then $t_2 = 0$ relationship is proportional gradient = $\frac{1}{2} a$ 	<p><i>Only consider the justification if graph B is selected</i></p>	3	B																									
e	<p>Unit = s^2</p> <p>4.7961 or 4.8 or 4.796 or 5</p> <p>4.80</p>	<p><i>Do not accept s^2. Accept unit and value in table or response box.</i></p> <p><i>Seen or implied. Accept 4.79 for 1 mark for correct calculated value incorrectly rounded</i></p> <p><i>Award two marks for correctly rounded value to 2 dp only</i></p>	3	C																									

f	<p>Accept any reasonable response, for example [max 1]</p> <ul style="list-style-type: none"> • not using common units • measurements with a device like this relies on another person having the same tool to compare with • all water clocks are different • comment relating to difficulty in getting the regular flow of water required or difficulty of construction 	<p><i>WTTE</i></p> <p><i>Do not accept that the water clock is not an accurate/reliable instrument for measuring time without further details</i></p>	1	C
g	Stopwatch or stopclock or chronometer or timer		1	C
h	<p>Any reasonable single IV selected</p> <p>Any two reasonable CV, for example [max 2]</p> <ul style="list-style-type: none"> • mass of the ball • surface of the ramp • size of the ball • distance • angle of slope <p>Any reasonable RQ linking IV and DV</p>	<p><i>Do not accept distance or non-specific "type" of ball for IV</i></p> <p><i>Do not accept temperature, gravity, pressure, same measuring equipment or IV given above for CV</i></p>	4	C

5	a	<p>(If) The surface area increases and (<i>then</i>) the time taken to fall will increase</p> <p>(because) air resistance will increase</p> <p>(because) the parachute will have more collisions with air particles</p>	<p><i>WTTE Accept correct responses appearing in any box</i></p>				3	B																													
b		<table border="1"> <thead> <tr> <th></th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> </tr> </thead> <tbody> <tr> <td>V (Variables)</td> <td>time implied as dependent variable</td> <td>independent variable of surface area and dependent variable of time stated</td> <td>independent variable of surface area and dependent variable of time stated and two control variables stated</td> <td>independent variable of surface area and dependent variable of time stated and two control variables stated and with correct justification</td> </tr> <tr> <td>E (Equipment)</td> <td>equipment to measure time or length</td> <td>equipment to measure time and length</td> <td></td> <td></td> </tr> <tr> <td>M (Method)</td> <td>attempt at a method linked to surface area or time</td> <td>method is described with measurements of surface area and time but not detailed enough to be followed by another student</td> <td>complete method is described with measurements of surface area and time and could easily be followed by another student</td> <td></td> </tr> <tr> <td>D (Data)</td> <td>at least five increments or three trials</td> <td>at least five increments and three trials</td> <td>at least five increments and three trials and plans to calculate an average</td> <td></td> </tr> <tr> <td>S (Safety)</td> <td>mentions a relevant precaution for example when working at height, use of scissors for cutting materials or to make sure the drop area is clear</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>					1	2	3	4	V (Variables)	time implied as dependent variable	independent variable of surface area and dependent variable of time stated	independent variable of surface area and dependent variable of time stated and two control variables stated	independent variable of surface area and dependent variable of time stated and two control variables stated and with correct justification	E (Equipment)	equipment to measure time or length	equipment to measure time and length			M (Method)	attempt at a method linked to surface area or time	method is described with measurements of surface area and time but not detailed enough to be followed by another student	complete method is described with measurements of surface area and time and could easily be followed by another student		D (Data)	at least five increments or three trials	at least five increments and three trials	at least five increments and three trials and plans to calculate an average		S (Safety)	mentions a relevant precaution for example when working at height, use of scissors for cutting materials or to make sure the drop area is clear				13	B
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6	a	<p>Correct reading from scale 42.8 ± 0.1</p> <p>$d_i = 12.8 \pm 0.1$</p> <p>cm</p>	<p>Allow ECF if calculation $d_i = (\text{reading} - 30)$ is evident</p> <p>Unit mark can be awarded independently if seen anywhere in the answer</p> <p>Award 3 marks for 12.8 cm with no working shown</p>	3	C												
	b	<table border="1"> <thead> <tr> <th>Distance from candle to lens / cm</th> <th>Distance from lens to screen / cm</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>90.1</td> </tr> <tr> <td>20</td> <td>16.4</td> </tr> <tr> <td>30</td> <td>12.8</td> </tr> <tr> <td>40</td> <td>11.6</td> </tr> <tr> <td>50</td> <td>11.1</td> </tr> </tbody> </table> <p>Column headings (using symbols or words) and units in header only</p> <p>All data in order and complete</p> <p>d_o to one decimal place or nearest cm</p> <p>All d_i data expressed to consistent number of decimal places</p>	Distance from candle to lens / cm	Distance from lens to screen / cm	10	90.1	20	16.4	30	12.8	40	11.6	50	11.1	<p>Accept non-subscripts for d_o and d_i</p> <p>Accept data in rows or columns</p> <p>ECF from part a</p>	4	C
Distance from candle to lens / cm	Distance from lens to screen / cm																
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	c	<p>m</p> <p>5.87</p> <p>0.170</p>		3	C												
	d	0.187		1	C												
	e	<p>C</p> <p>A correct justification, for example [max 1]</p> <ul style="list-style-type: none"> the equation shows that a straight line or linear relationship is expected the best fit line should not include the anomalous data point reference to numbers of data points above and below the best fit line 	<p>Correct graph must be selected to award the justification mark</p>	2	C												

	f	<p>Y intercept stated as 5.8 ± 0.1</p> <p>$f = 0.172 \pm 0.003$ (m)</p>	<p><i>ECF if wrong graph selected in e</i></p> <ul style="list-style-type: none"> - graph A - <i>accept</i> 4.7 ± 0.1 - graph B – <i>accept</i> 5.5 ± 0.1 - graph D – <i>accept</i> 4.5 ± 0.1 <p>Award the second point for evidence of a calculation involving 1/intercept</p>	2	C
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7	a	A Forces are unbalanced or net force is not zero			WTTE	2	A
	b		1	2	3	7	D
		Ad (Advantages)	a statement of an advantage	a statement of two or more advantages or a statement of one advantage with an explanation	a statement of two or more advantages with at least one explained		
		Dis (Disadvantages)	a statement of a disadvantage	a statement of two or more disadvantages or a statement of one disadvantage with an explanation	a statement of two or more disadvantages with at least one explained		
Con (Conclusion)	a simple conclusion						

8						
		1	2	3	4	
	Env (Environmental)	a statement of one use of drones in environmental monitoring	a statement of one use of drones in environmental monitoring and how this use relates to science or at least two statements of the use of drones in environmental monitoring	a statement of at least two uses of drones in environmental monitoring and a statement of how one use is a benefit to science	a statement of at least two uses of drones in environmental monitoring and a statement of how these uses are a benefit to science	
	Soc (Social implications)	a positive or a negative social implication for an individual	a positive and a negative social implication for an individual	a positive and a negative social implication for an individual with one supported by further justification	a positive and a negative social implication for an individual with both supported by further justification	
	Pol (Political implications)	a positive or a negative political or security implication for a location	a positive and a negative political or security implication for a location	a positive and a negative political or security implication for a location with one supported by further justification	a positive and a negative political or security implication for a location with both supported by further justification	
Con (Concluding appraisal)	a concluding opinion is given	a concluding appraisal linking to previous arguments				
					14	D