Question		Answers	Notes	Total	Criterion
1	a	A proton is a particle found in the **nucleus** of an atom. It has a relative mass of **1** and a charge of **+1**. A neutron is a particle found in the **nucleus** of an atom. It has a relative mass of **1** and a charge of **0**. An electron is a particle found in the **orbitals** of an atom. It has a relative mass of **0** and a charge of **–1**.	*Award **(1 mark)** for each correct row.*	**3**	A
	b	the electrons were transferred ***or*** moved (from the cloth to the nylon)	*Accept electrons transferred from nylon to the cloth.*	**1**	A
	c	there will be repulsion because the two pieces of nylon must be the same charge	*Accept either positive or negative charge if given to the nylon, but they **must** be the same.*	**2**	A
	d	nothing would happen because the nylon pieces have the same charge ***or*** no particles would exchange because the nylon pieces have the same charge		**1**	A

2	a	selecting the correct equation: $v^2 = u^2 + 2as$ ***or*** $mgh = 1/2\,mv^2$ rearrange equation: $v = \sqrt{2gh}$ substitute correctly and calculate: 100 (ms^{-1})	*Award **(1 mark)** only if only 100 is seen*	**3**	A
	b	diagram 1		**1**	A
	c	Force A: air resistance / drag ***and*** Force B: weight / gravitational force	*Do **not** accept gravity.*	**1**	A
	d	$0.03 / 3.0 \times 10^{-2} / 3 \times 10^{-2}$ (g)		**1**	A
	e	uses correct equation $p = 3 \times 10^{-5}\ kg \times 100\ ms^{-1} = 3 \times 10^{-3}\ kgms^{-1}$ ***or*** $0.003\ kgms^{-1}$ ***or*** $p = 0.03\ g \times 100\ ms^{-1} = 3\ gms^{-1}$	*Seen or implied* *ECF from a and d* *Unit must be included and must agree with the value.*	**2**	A
	f	the graph should be a straight line ***and*** go through the origin as a straight line could not be drawn, the hypothesis is incorrect		**2**	C
	g	the graph shows a straight line through the origin (so) $\underline{v^2}$ proportional to r		**2**	C

3	a	chemical – electrical – light		**1**	A
	b	$12 \times 0.5 = 6$ Watts / W		**2**	A
	c	50 (coulombs)	*Ignore all units*	**1**	A
	d	a fixed voltage is supplied by the cell/battery ***Either*** the voltage drops across the resistor as the resistance increases, so does the voltage drop (hence) the voltage across the bulb decreases (bulbs brightness decreases because) brightness is related to voltage ***or*** the total resistance in the circuit is now greater the current flowing will now be smaller (as all circuit components are connected in series) the bulb draws smaller current (because bulbs brightness decreases because) brightness is related to current ***or*** energy is lost as the current travels through the resistor as resistance increases the energy loss increases (hence) the energy available for the bulb decreases (brightness decreases because) brightness is related to available energy		**5**	A

	e	***Any four reasonable points, for example:*** • the gradients of the lines are related to running costs • identification of bulb with the greatest running cost has the steepest gradient • that the *y* intercept indicates the initial cost • recognition that when the lines cross the total prices of cost and use are the same • even though the brightness is the same, the energy used is different.	*Do **not** accept "LED bulbs are more economical over time even though they are more expensive to buy" alone, as this is given in the question.*	**4**	A
	f	life span of bulb		**1**	D

4	a	How does the surface area affect the mass of water evaporated ***or*** remaining?	*WTTE*	**1**	
	b	$\text{rate} = \frac{\text{mass}}{\text{time}}$ $\frac{0.25}{0.20}$ 1.25 (g h^{-1})	*Seen or implied*	**3**	A
	c	***Any simple prediction, for example:*** • as the surface area increases the rate of evaporation increases. ***Explanation contains relevant scientific knowledge:*** • (because) the water molecules/particles have a greater area from which to escape. ***Quantitative element to prediction, for example:*** • as the area doubles the rate of evaporation doubles • as double the area means double the opportunities for the particles to escape.		**3**	B

	d	Only ***one*** each of independent and dependent variable identified – the variables do not need to be correct for this mark. Independent variable identified as surface area ***only*** Dependent variable identified as mass ***only***	Image Object **Independent variable** **Dependent variable** **Control variables** Text/MCQ/Mini-Cloze Object ☐ ☒ ☐ Mass of water ☐ ☐ ☒ Water temperature ☐ ☐ ☒ Air temperature ☐ ☐ ☒ Time ☒ ☐ ☐ Surface area ☐ ☐ ☒ Type of liquid ☐ ☐ ☒ Movement of air above the liquid	**3**	B

	e	at least five increments measurements of both mass and diameter/radius at least three repeated trials		**3**	B
	f	as area increases mass of water evaporated increases (mass evaporated is) proportional (to area) ***or*** there is a linear relationship between (area) and (mass of water evaporated) that goes through zero	*"The mass of water evaporated after one hour is proportional to area" scores both marks.*	**2**	C
	g	indication of calculation of the ratio of mass and area gradient calculated from two sufficiently spaced points 0.0284 (g cm^{-2})	*Seen or implied* *Accept the use of data points* *Units not needed*	**3**	C
	h	$0.0284 \times 4 \times 10^4$ ***Either*** 1.1 (kg) ***or*** 1136 (g) unit agrees with value	*Calculation seen or implied, ECF from h* *Accept answer in the range 1.0 to 1.2 kg.*	**3**	C D

5	a	How does the temperature affect the rate of evaporation ***or*** mass evaporated in an hour? ***or*** How does the movement of air above the liquid affect the rate of evaporation ***or*** mass evaporated in an hour?		**1**	B
	b	***Any simple prediction correctly linked to the answer given in part (a), for example:*** • as the temperature increases the rate of evaporation increases • as the speed of air above the liquid increases the rate of evaporation increases. ***Explanation contains relevant scientific knowledge correctly linked to part (a), for example:*** • (because) the water molecules/particles have a greater velocity/speed they will find it easier to escape • (because) the water molecules/particles which have escaped will not re-enter the liquid. ***Quantitative element to prediction, correctly linked to part (a), for example:*** • as the temperature doubles the rate of evaporation doubles • as the speed of air doubles the rate of evaporation doubles.		**3**	B
	c	***First response box (independent variable):*** temperature ***or*** air speed ***Second response box (control variable), any one variable from the list:*** • type of liquid • air speed • air temperature • surface area	*Any control variable with corresponding independent variables*	**2**	B

6	a	<u>83.5</u> altitude ***or*** height ***and*** m temperature ***and*** °C	*Needs to be stated to this precision* *Ignore incorrect use of brackets*	**3**	C
	b	***Any two from:*** • a bar chart is used to represent discrete data • a line of best fit cannot be drawn on a bar chart • a bar chart cannot be used to determine a relationship between the independent and dependent variables.	*WTTE*	**2**	C
	c	4200 (m) this value does not lie on the line of best fit		**2**	C
	d	as the altitude increases the boiling temperature decreases this is a linear relationship		**2**	C
	e	water particles need sufficient energy to escape the surface of the water there are fewer air particles at higher altitude so there are fewer collisions with water particles which prevent their escape ***Any additional reasonable suggestion, for example:*** • energy of particles is related to temperature • at lower temperatures a greater proportion of water particles will have enough energy to escape the surface • so the boiling point is lower ***and*** justified with reference to particles.		**4**	C
	f	the hypothesis is incorrect / not supported (because) as the altitude increases the boiling point decreases		**2**	C
	g	***Accept any reasonable extension with the same independent variable***		**1**	C

7						**17**	B

	1	**2**	**3**	**4**
Independent and dependent variables	Altitude/height identified as a variable	Altitude/height is identified as the independent variable	Altitude/height is identified as the independent variable ***and*** the dependent variable is volume/diameter	
Control variables	A control variable is mentioned	A control variable is identified	A control variable is identified and attempt of discussion of assumptions eg spherical, constant temp etc	A control variable is identified and clearly reasoned discussion of assumptions eg spherical, constant temperature etc
Equipment	Some equipment is selected	Appropriate equipment is selected	Appropriate and complete equipment is selected	
Measurements	Attempt at a method but detail is insufficient for another student to follow	Method is described and could easily be followed by another student	Complete method is described, fully explained and could easily be followed by another student;	
Data collection	Appropriate number ***or*** range of data is stated	Appropriate number ***and*** range of data is stated	Appropriate number and range of data is stated and plans to repeat	Appropriate number and range of data is stated and justified and plans to repeat

<table>
<tr>
<td>8</td>
<td>a</td>
<td>Any two reasonable advantages of using solar tubes for lighting, for example:
• free light
• natural light
• no light bulbs needed
• no electricity supply needed.

Any two reasonable disadvantages of using solar tubes for lighting, for example:
• limit to how far light can go
• hole needed for solar tube
• only suitable for daytime use
• external surface will need cleaning.</td>
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<td>D</td>
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<td>b</td>
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<tr><th></th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Advantage and disadvantage</td><td>An advantage or a disadvantage</td><td>An advantage and a disadvantage</td><td>More than one advantage and more than one disadvantage</td></tr>
<tr><td>Scientific justification</td><td>A simple scientific statement</td><td>A scientific statement supported by a specific example</td><td></td></tr>
<tr><td>Environmental consideration</td><td>An environmental consideration is stated</td><td>An environmental consideration is discussed</td><td></td></tr>
<tr><td>Social consideration</td><td>A social consideration is stated</td><td>A social consideration is discussed</td><td></td></tr>
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<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Strengths and limitations</td><td>A strength or a limitation</td><td>A strength and a limitation</td><td>a strength, a limitation and any additional relevant point (either strength or limitation)</td><td>more than one strength and more than one limitation</td></tr>
<tr><td>Environmental implication</td><td>An environmental implication is implied</td><td>An environmental implication is explicitly stated</td><td>An environmental implication is discussed</td><td></td></tr>
<tr><td>Economic consideration</td><td>An economic consideration is implied</td><td>An economic consideration is explicitly stated</td><td>An economic consideration is explicitly discussed</td><td></td></tr>
<tr><td>Scientific reasoning</td><td>A simple scientific statement</td><td>A scientific statement supported by a specific example</td><td>A detailed scientific statement supported by a specific example</td><td></td></tr>
<tr><td>Concluding appraisal</td><td>A concluding appraisal linking strengths and considerations</td><td></td><td></td><td></td></tr>
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<td>14</td>
<td>D</td>
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