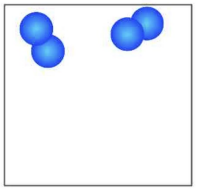
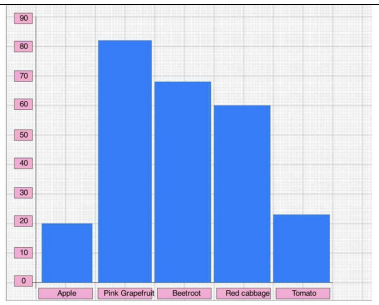
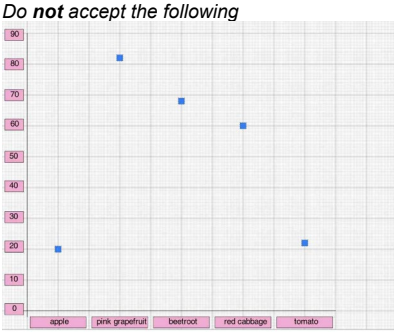
Question		Answers		Total	
1	a	6 H_2O + 6 CO_2 → $C_6H_{12}O_6$ + 6 O_2 Reactants correct Products correct	*Do **not** accept ? in front of glucose*	**2**	**A**
	b	Alcohol	*Accept hydroxyl, do **not** accept hydroxide*	**1**	**A**
	c	C A. B. C. D. 		**1**	**A**
	d	Mixture		**1**	**A**
	e	***Band 1: pigment C*** ***Band 2: pigment B*** ***Band 3: pigment A*** One correct All correct		**2**	**A**
	f	Measurement of solvent front from application point: 10.0 Measurement of band from the application point: 9.8 Calculation of Rf = 0.98 ± *0.01*		**3**	**A**

2	**a**	7		**1**	**A**
	b	Increase the acidity of the soil ***or*** decrease the pH By adding sulfuric acid / H_2SO_4	*Award second mark only if first is awarded, accept any acid.*	**2**	**A**
	c	100 g mol^{-1} ***or*** g/mol	*Accept g*	**2**	**A**
	d	H_2O CO_2	*Accept in either order*	**2**	**A**
	e	$CaSO_4$	*Correct subscripts required*	**1**	**A**
	f	7		**1**	**A**

3	**a**	Reactants correct: N_2 + O_2 Products correct: 2NO		**2**	**A**
	b	Two or more particles randomly placed and not touching	*Do **not** accept if particles are touching such as below* 	**1**	**A**
	c	Random (motion) High (kinetic) energy	*WTTE,* *Accept high speed*	**2**	**A**
	d	Nitrogen monoxide or emission is a gas or a gas is produced Gas (particles) spread ***or*** move ***or*** travel out From an area of high concentration to an area of low concentration A correct use of the word “diffusion”	 *Movement can be implied* *WTTE*	**4**	**A** **D**

4	**a**	Colorimeter ***and*** because it gives quantitative data ***or*** more accurate/precise data **or** removes human error	*ORA*	**1**	**C**
	b	***If:*** The concentration of red pigment ***or*** yellow pigment is increased ***Then:*** The yolk colour will become darker/deeper or more orange or closer to 16 on the YolkFan scale ***Because:*** The pigment changes the colour of the yolk	*Accept response in any box or in a single box*	**3**	**B**
	c	62		**1**	**C**
	d	Method B ***and*** The thermometer is measuring where the egg white or proteins are ***or*** In the other method the thermometer is measuring the temperature of the water (not the egg white)	*Correct method must be selected*	**1**	**C**
	e	*Accept any single value in the range or a range* 62 – 70 °C Because that was the maximum temperature that the individual components of the egg denatured		**3**	**C** **D** **C**

5	**a**	***IV:*** Type of vinegar ***DV:*** pH of egg white ***or*** tenderness of the egg ***or*** taste ***Accept any reasonable CV, for example [max 2]*** • Volume of solution • Temperature • Size of egg • Initial concentration of solution • % of salt • Time • Type of egg	*Do **not** accept amount*	**4**	**B**
	b	How does the type of vinegar affect The final pH of the egg whites ***or*** The tenderness of the egg	*ECF IV from 5a*	**2**	**B**
	c	The pH decreases	*Accept values that imply a decrease in pH*	**1**	**C**
	d	Repeat the investigation with a new pH meter ***or*** method to determine the pH such as universal indicator	*WTTE*	**1**	**C**

6	**a**	***Title:*** correctly linking Vitamin C concentration with juice type ***x axis***: juice type ***and*** y axis: vitamin C concentration ***y axis scale:*** evenly spaced increments that start at zero ***y axis unit:*** mg $100cm^{-3}$ (juice) ***Plotting:*** all values plotted correctly	 *Do **not** accept the following* 	**5**	**C**
	b	Heat treated juice (pasteurized) Vitamin C is broken down at high temperatures Reference to oxidized or denatured	*Loss of vit C must be linked with high temperature* *Do **not** accept evaporate or killed*	**3**	**C**

	c	Change in vitamin C concentration: 375-350=25±5 (μg cm^{-3}) Rate of change of vit C concentration: 25/21=1.19 (μg cm^{-3} day^{-1})	*Decrease can be implied i.e. 375-350* *Accept values in the range 0.95-1.43*	**2**	**C**
	d	The vitamin C will not be oxidized ***or*** oxidized as much Because the pulp ***or*** juice is not exposed to oxygen ***or*** lower exposure to oxygen Due to protective layer of the peel Therefore invalid	*Award the 4th mark only if marking point 2 or 3 is scored*	**4**	**C**

7			**16**	

	1 mark	**2 marks**	**3 marks**	**4 marks**	***Notes***
1.V	Explicitly states metals as IV ***or*** appropriate DV	Explicitly states metals as IV ***and*** appropriate DV	Explicitly states metals as IV ***and*** appropriate DV ***and*** one CV	Explicitly states metals as IV ***and*** appropriate DV ***and*** two CVs	*Only requirement is to state using the terminology of IV, DV and CV. No need to explain further.* ***DV*** *This should be what is measured and can come from the whole response. Could be mass change/amount of bubbles produced/change in pH.* ***Do not accept*** *calculated values as DV unless explicitly shown how calculated from measured values.* ***CV*** *Volumes of liquids/mass of metal/time for reaction* ***Do not accept "****keeping equipment the same" as a CV.*
2.E	Specified equipment considers IV ***or*** DV ***or*** CV	Specified equipment considers IV ***and*** DV ***or*** IV ***and*** CV ***or*** DV ***and*** CV	Specified equipment considers IV ***and*** DV ***and*** one CV	Specified equipment considers IV ***and*** DV ***and*** two CVs	*Equipment needs to be correct for the given situation and stated CVs.* *There are several investigations that could be carried out here so equipment should be linked.* *Balance to measure mass changes over time (so balance and stopwatch/timer)* *pH change of solution added to the metal so pH meter* *Gas production due to reactivity and so measuring cylinder/gas syringe or other acceptable way to measure gas - eudiometer* ***Accept*** *whole cans as equipment for IV, ruler/balance to measure size/mass of sample of metal* ***Do not accept*** *equipment that is mentioned in the question / instructions.*

3.M	Method is linked to IV **or** DV	Method is linked to IV ***and*** DV but is incomplete	Method linked to IV ***and*** DV and can be followed to give results	Method linked to IV ***and*** DV and can be followed and include details on how to control main CVs	*A method that does not include how to vary the IV is incomplete.* *Limited information about CVs mean that data is unlikely to be relevant for example salt production – as different metals mass of salt produced not same.* *If metals are not same mass/size then this would produce an incomplete method.*
4.D	Any reference made to different variations of the IV	At least five variations of the IV ***or*** at least three trials	At least five values of the IV ***and*** at least three trials	At least five values of the IV ***and*** at least three trials ***and*** takes an average	*The values of the five or more variations should be explicitly stated for 3 or 4 marks.* *The information could be in a table.*

8	**a**	$Na^{+}_{(aq)}$ and $Cl^{-}_{(aq)}$ are charged particles Ions are mobile when dissolved in water ***or*** ions can conduct electricity	*Accept explanations of the idea using other ionic salts and ions*	**2**	**D**
	b	Pacific (ocean) water Highest electrical conductivity or highest dissolved salts		**2**	**C**
	c	1.4 +/- 0.2 (mmol dm^{-3})	*Unit not required*	**1**	**D**
	d	A correct statement about crop A and crop B ***A correct use of data for crop A, for example [max 1]*** • crop A decreases rapidly to 20% (at low salinity of 0.5 mmol dm^{-3}) • decrease in % yield starts at 0.15 mmol dm^{-3} for crop A ***A correct use of data for crop B, for example [max 1]*** • crop B yield starts decreasing at a higher concentration of salt and at a lower rate • decrease in % yield starts at 0.8 mmol dm^{-3} for crop B		**3**	**D**

9	**a**	Latin America ***and*** Caribbean Surrounded by saline water ***or*** Little surface water suitable for drinking or irrigation Freshwater required for high populations		**3**	**D**

9	b		**14**	**D**

A comparison of the efficiencies of the three systems

Mark	Descriptor	Notes
1	The efficiency of two systems stated	The three systems are thermal, membrane and solar ***Examples of statements*** • operates at high temperatures -so inefficient with respect to energy requirements • clogging of tubes would make the process inefficient • high maintenance required • low energy – implies good use of energy so efficient • comparison: Solar based system is inferior to heat based system based on overall efficiency (based on energy usage) ***Examples of justifications*** • the highest and most efficient system is the thermal based set-up [,,,] suitable for large scale industrial use, [...] water in a larger amount and in a short time. • do ***not*** accept reference to CO_2 as a scientific justification for efficiency
2	The efficiency of all three systems stated ***or*** The efficiency of two systems compared to each other	
3	The efficiency of all three systems compared to each other	
4	The efficiency of all three systems compared to each other ***and*** scientific justification	

The economic impacts of the three systems

Mark	Descriptor	Notes
1	A statement about an economic impact of one system	***Examples of statements*** • membrane based high cost for maintenance due to clogging • expensive to build • energy use = cost implied • due to the high operating temperatures, some salts [...] deposit on the tubes and can cause clogging. This may require financial aid in order to be maintained [...] ***Examples of comparisons*** • The thermal based system is not that expensive .. the membrane based system is the most expensive to build and it costs a lot to maintain...Solar based which is the easiest to construct and the cheapest as well... • the membrane based system has a much bigger economic impact, as it is expensive to build and to maintain [due to membrane change] while both the thermal-based one and solar based one are easy to construct and have a low maintenance cost
2	A statement about an economic impact of two systems	
3	A statement about an economic impact of all three systems ***or*** A comparison of any two systems	
4	A comparison of the economic impacts of all three systems	

The environmental impacts of the three systems		
Mark	**Descriptor**	**Notes**
1	A statement about an environmental impact of one system	***Examples of statements*** • Emissions of CO_2 • The thermal based system generate high level of CO_2 and can cause increased greenhouse gases which can lead to increase in the global temperature ***Example of comparisons*** • The thermal based system has a large CO2 emissions (24 kg). The membrane based system has large but lesser emissions than the thermal based system (5,3 kg) • The thermal based method uses a lot of energy to heat up and produce steam. The method produces 24 kg of carbon dioxide. This is extremely harmful for the environment. The membrane system is lesser energy but still requires energy...producing 5.3 kg of carbon dioxide. Solar is cleaner and produces 0 kg carbon dioxide.
2	A statement about an environmental impact of two systems	
3	A statement about an environmental impact of all three systems ***or*** A comparison of any two systems	
4	A comparison of the environmental impacts of all three systems	

An appraisal of the three systems		
Mark	**Descriptor**	**Notes**
1	A simple concluding statement	***Example of a simple conclusion*** • The three systems are a great way to increase the amount of fresh water ***Example of an appraisal*** • Out of all 3 systems the thermal based system is the most efficient due to...but is the worst on the environment, while the solar based system is the cleanest form...therefore the thermal based system should be used.
2	A concluding appraisal with a choice that is justified	