

MYP MAY 2016

CHEMISTRY ON-SCREEN EXAMINATION

Exemplar Marked Candidate Responses

This document contains exemplar material which demonstrates how the markscheme was applied to two student responses for the May 2016 session. Teachers should consider the application of the markscheme and in particular the assessment of longer, open ended responses. Teachers may wish to mark the student response themselves using the published markscheme and then compare their marking to the standard demonstrated in this document.

Question 1 (8 marks)

The main role of clothing is protection against the weather. In cold countries natural materials such as wool and fur have traditionally been used but today man-made fibres can be used to trap body heat. Extra warmth can be provided by chemical reactions.

Hand warmers contain iron powder which releases energy when exposed to oxygen in the presence of a catalyst.

The equation for the reaction is: $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$

clothing

**Question 1a** (1 mark)

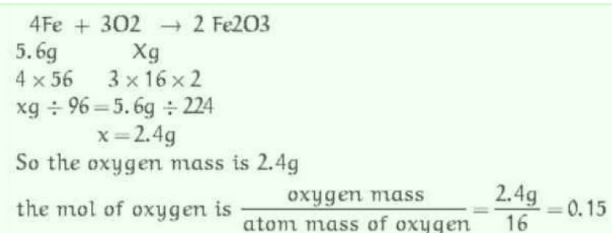
State the name given to a reaction in which heat is released.

spart out

0/1 Incorrect answer.

Question 1b (3 marks)

Using the periodic table, **calculate** how many moles of oxygen are needed to oxidize a hand warmer containing 5.6g of iron.



1/3 Correct ratio 4:3. No mention of number of moles required. No final correct answer.

Question 1c (1 mark)

State the type of bonding in iron oxide.

oxygen

0/1 Incorrect answer.

Question 1d (1 mark)

Using the periodic table, **state** the charge of iron ion in Fe_2O_3 .

Fe^{+3} O^{-2} $\text{Fe}_2^{+6}\text{O}_3^{-6}$

1/1 Correct charge for iron stated.

Question 1e (2 marks)

Select one other element that forms ions with the same charge as iron in Fe_2O_3 . **Justify** your answer.

- sodium
- carbon
- aluminium
- calcium

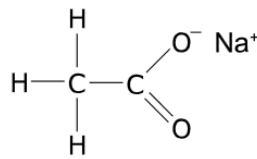
Correct element chosen.

Justify your answer.

1/2 No reason given.

Question 2 (10 marks)

Reusable hand warmers do not use iron but contain a saturated aqueous solution of sodium ethanoate (CH_3COONa) that releases heat when it undergoes the reversible process of crystallization.



Sodium ethanoate


Question 2a (2 marks)

State and **justify** whether crystallization is a physical or a chemical process.

The crystallization is the physical process. Because it means the water particles escape from the solution with the change of state without any chemical reaction.

2/2 Physical process. No chemical reaction.

Question 2b (2 marks)

Outline how a saturated solution is produced.

To make the additional reaction with the chlorine or bromine to become saturated.

0/2 Need to mention solute. Need to mention saturated solution.

Question 2c (2 marks)

Outline how the hand warmer can be reused.

when it undergoes the reversible process of crystallization the hand warmer can form the exothermic reaction which means release the energy to the surrounding. Therefore it means that we can use the heat to keep our body become warm.

0/2 Need to add heat. Need to state what happens in the reversible reaction.

Question 2d (4 marks)

Sodium ethanoate is the salt made in the neutralization reaction between ethanoic acid and a strong base.

Determine which base was used and **write down** a chemical equation for this neutralization reaction.

The base is the sodium hydroxide
ethanoic acid+sodium hydroxide=Sodium ethanoate+water

2/4 Sodium hydroxide. Only word equation 1 mark.

Question 3 (11 marks)

Fossil fuels and factory emissions are some of the main causes of environmental pollution. Unfortunately, the damaging effects of pollution spread beyond industrialized areas can be worsened by extreme climates. The ground in some countries is covered in heavy snow in the winter. When the snow melts in the spring, for a short time, the rivers and lakes will become more acidic.

Question 3a (8 marks)

Explain a problem associated with acid rain. Use scientific knowledge and understanding to support your answer.

A problem that is associated with acid rain is the erosion of limestone buildings. The pH levels of rain are supposed to be as neutral as possible (as close to pH7), however with acid rain the pH levels are below that. The acidity of the rain attacks the air pockets within the limestone and erodes the buildings, which over time could lead to buildings collapsing upon themselves.

3/8 Complete statement. Context of chemistry is confused and incomplete.

Chemists have created catalytic clothing that combines functionality with fashion. Catalytic clothing technology uses nano-sized titanium oxide TiO_2 particles that act as photocatalysts. The photocatalysts help reduce pollutant gases such as nitrogen oxides and sulfur oxides. Pollutant gases have a negative effect on ecosystems and present a risk to humans.

The catalysts are woven into clothes and help to remove pollutants by converting them into soluble compounds that are removed by washing.

Question 3b (1 mark)

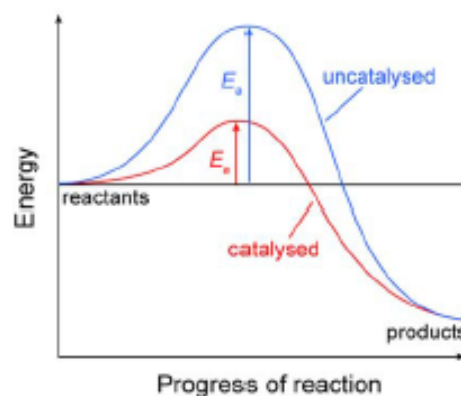
State the meaning of the term **catalyst**.

A catalyst is a compound which increases the rate of reaction.

1/1 Speeds up reaction.

Question 3c (2 marks)

The graph below is an energy profile diagram which shows the energy changes for both a catalysed reaction and an uncatalysed reaction.



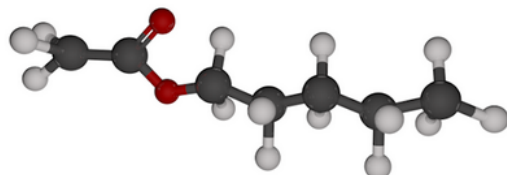
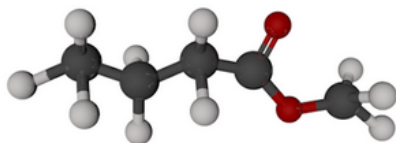
Using the graph, **outline** how catalysts work.

Catalysts work by using endothermic reactions to create the products, so that less energy can be wasted on exothermic energy release.

0/2 No mention of E_a . No mention of energy in context.

Question 4 (3 marks)

The aroma of fruits comes from characteristic chemical. For example, the aroma of an apple is mainly caused by molecules of $C_3H_7COOCH_3$ (methyl butanoate) and the aroma of pears by molecules of $CH_3COOC_5H_{11}$ (pentyl ethanoate).


Question 4a (1 mark)

In a futuristic clothing project, two students suggest using methyl butanoate and pentyl ethanoate to form new aromatic fabrics. **State** the class of chemical compound these molecules belong to.

Organic molecules

0/1 No class of organic compound stated.

Pentyl ethanoate is formed in a reaction between an acid and an alcohol.

Question 4b (1 mark)

State the name of the alcohol.

Pentanol

1/1 Correct name of alcohol.

Question 4c (1 mark)

State the name of the small molecule lost when the acid and the alcohol above react to form pentyl ethanoate.

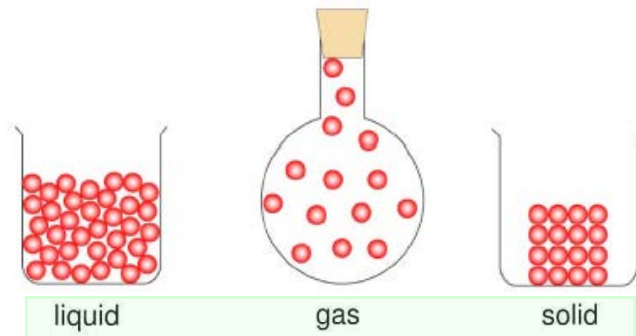
An H₂O (water) molecule

1/1 Correct name of molecule.

Question 5 (10 marks)

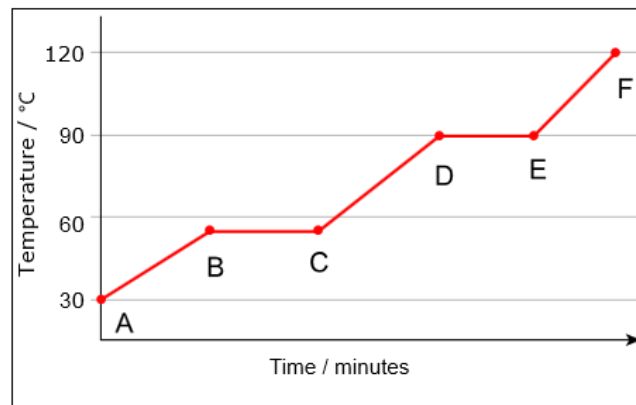
Question 5a (1 mark)

Label the three states of matter shown in the diagrams.



1/1 Correct states identified.

The diagram below shows the state changes for a pure substance which is a solid at 30°C.



Select the correct description for each of the stages.

Use kinetic theory to explain what is happening to the particles in the pure substance.

Question 5b (3 marks)

B to C

Description: **melting** *Correct change in state.*

What is happening to the particles?

The particles are heating up which is making them move faster. In B to C the particles have become liquified.

2/3 Increase in movement. No mention of space between particles or intermolecular forces.

Question 5c (3 marks)

E to D

Description: **condensation** *Correct change in state.*

What is happening to the particles?

The particles were a gas and then they cooled. Now the particles are cooled enough to be turned into a liquid.

1/3 No mention of separation of particles. No mention of energy of particles.

Question 5d (3 marks)

D to C

 Description: boiling *Incorrect change in state.*

What is happening to the particles?

The liquid is heating up. The particles are moving faster and will create a gas.

0/3 Particles will decrease in motion. No mention of energy. No mention of intermolecular forces.
Question 6 (27 marks)

Water is a compound made from two different elements bonded together.

Question 6a (1 mark)

State the two elements in water.

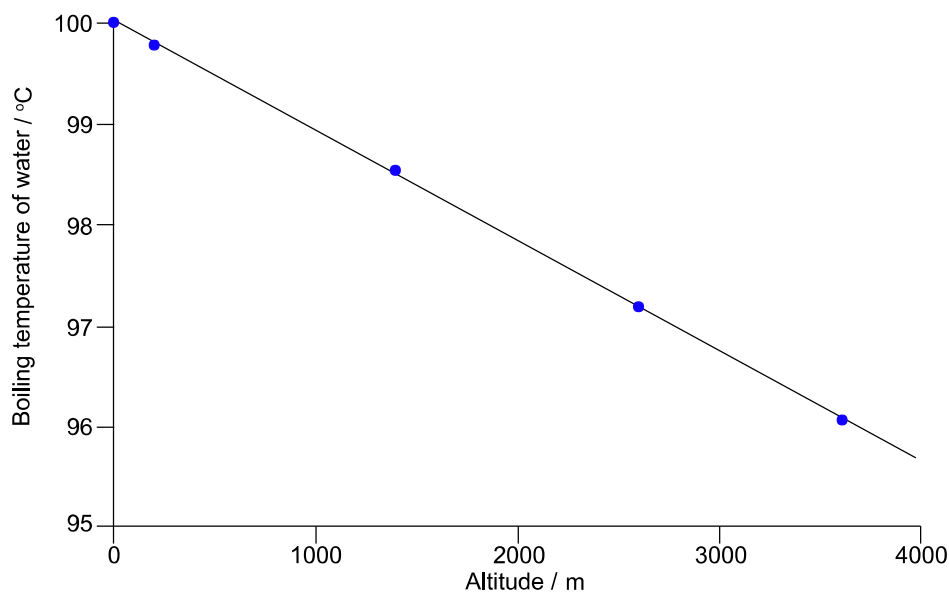
 Element one: Hydrogen
 Element two: Oxygen *1/1*
Question 6b (2 marks)

 Use particle theory to **outline** what is happening to the particles when a substance boils.

the particles vibrate vigorously and the force keeping the particles becomes looser and then the particles get further apart and bounce off each other as they collide

1/2 No mention of change in state.

The boiling temperature of water at standard pressure is 100 °C. The table shows the boiling temperature of water measured at different IB schools. IB schools are located at different heights above sea level. The height above sea level is known as altitude and it can be measured in metres.



Question 6c (3 marks)

Using the graph, **write down** values to complete the table.

Location	Altitude / m	Boiling temperature of water / °C
Bangkok	1	100.0
Belgrade	210	99.8
Bogota	2625	97.2
Canberra	605	99.4
Kathmandu	1400	98.6
La Paz	3640	96.1
Nairobi	1667	98.0
New Delhi	210	99.8
Tehran	1138	98.8

2/3

Question 6d (1 mark)

State a suitable hypothesis that could be tested using the data in the table.

the lower the altitude the higher the boiling point temperature of water is.

2/3

Question 6e (4 marks)

Some new IB schools at different locations would like to add data to the table. **Identify** the variables.

Independent variable:

altitude

Dependent variable:

boiling point

Control variables:

purity of water

3/4

Question 6f (16 marks)

Design a method to investigate the boiling temperature of water at different altitudes. In your answer, include:

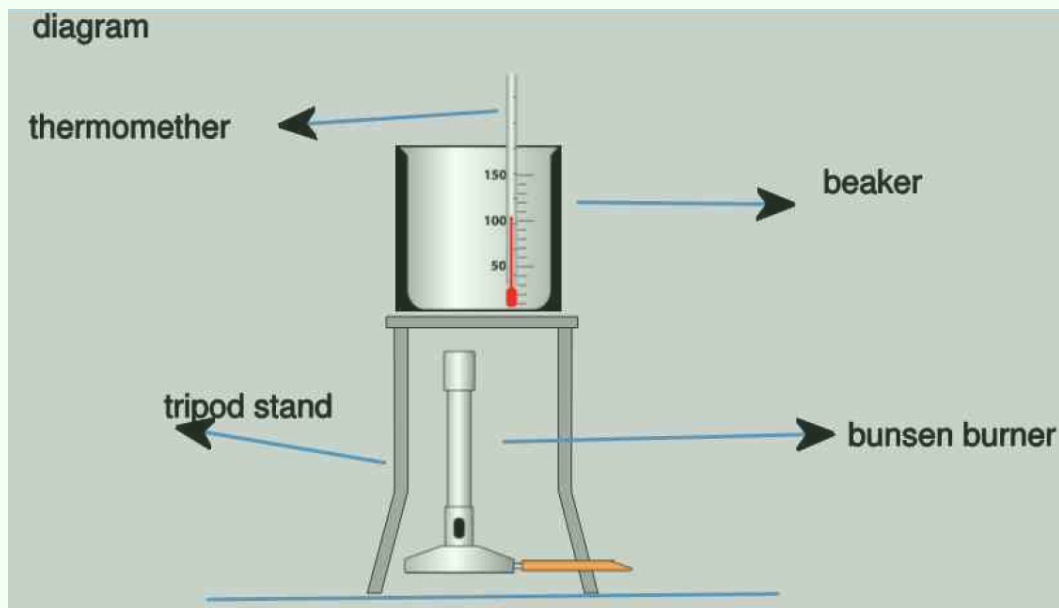
- A hypothesis that your method will test
- How you will manipulate the variables
- A diagram of how you will arrange your equipment
- How you will collect sufficient data
- How you will ensure your method is safe

hypothesis: the higher the altitude the lower the boiling point

variables: i will manipulate the variables by conducting the experiment in different location with different altitudes

data: i will calculate the data by visiting the place and measuring the boiling point

safety: i will check to see the urity of the water so i do not get the wrong data



3/16 Band 3-6

- Method does not control variable

- Diagram incomplete equipment

- No mention of safety and hot objects.

Question 7 (14 marks)

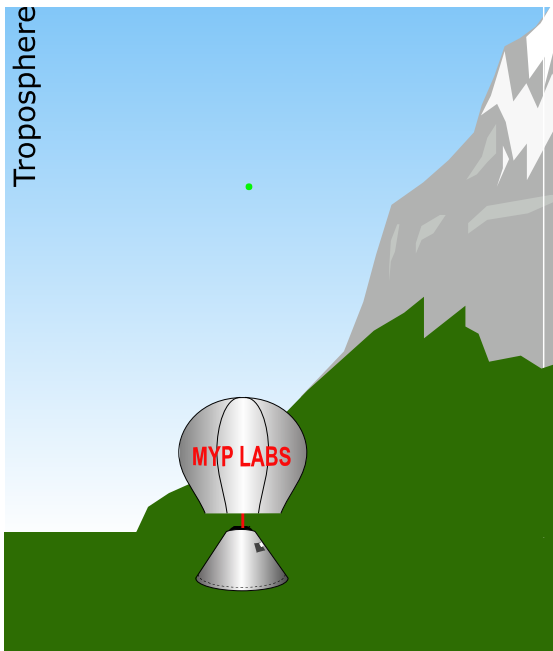


Artist: Frieso Hoewelkamp

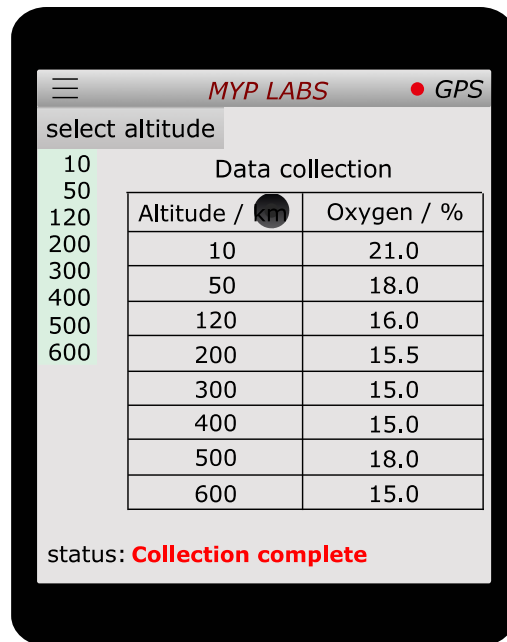
Use the simulation to collect samples of gas from each of the required parts of the atmosphere in the table below. Record the percentage of oxygen obtained at each level.

Question 7a (5 marks)

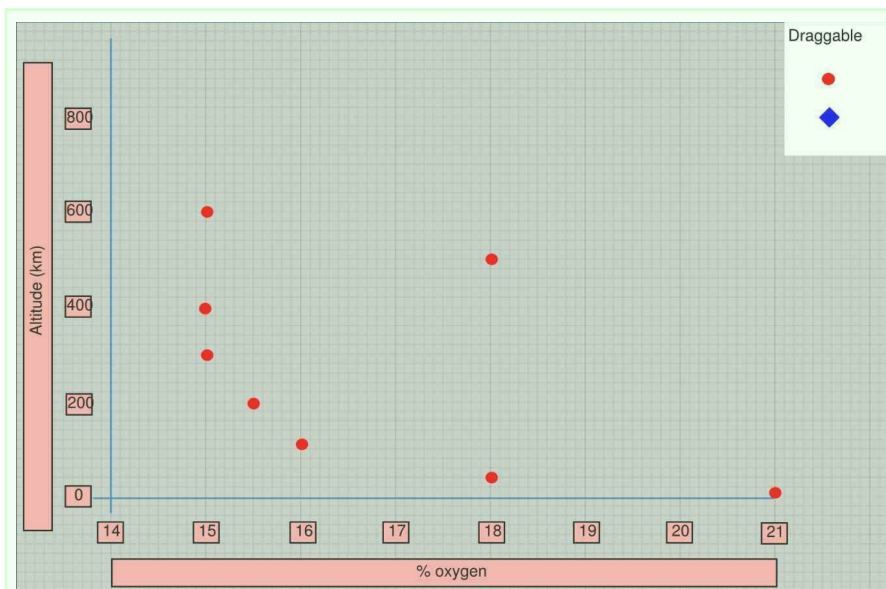
Simulation



Completed results



Plot a graph of percentage of oxygen against altitude. Label the axes.



Question 7b (2 marks)

Justify whether all of the data should be included in the graph.

No, not all the data should be included because the data point at 500 km of altitude does not portray the trend correctly and in fact would suggest that one would receive more oxygen at 500 km.

2/2

Second samples collected from the atmosphere were sent to your school laboratory for analysis. It was suggested that you analyse the samples to determine the percentage of oxygen in each sample. One method that could be used is to light a birthday cake candle and place it in a dish of water so that the candle is held in place. A test tube is then filled with the gas sample and placed over the candle so that the bottom of the test tube is under the water. The candle will burn until the oxygen has been used up.



Question 7c (1 mark)

State a suitable hypothesis for the birthday cake candle investigation.

If the test tube is filled with gas from a higher altitude in the atmosphere, then the candle will burn out quicker and less water will replace the space consumed by the oxygen.

0/1

Question 7d (2 marks)

State the independent and dependent variables in this investigation.

Independent variable: % oxygen in test tube

Dependent variable: Duration of which the candle stays lit

2/2

Question 7e (1 mark)

Suggest an improvement to the method you saw in the animation.

When placing the test tube over the candle it should be made sure that it is a closed system and therefore no contents can enter or escape the test tube.

0/1

Question 7f (3 marks)

A gas remains in the test tube. **Suggest** a test to identify this combustion product.

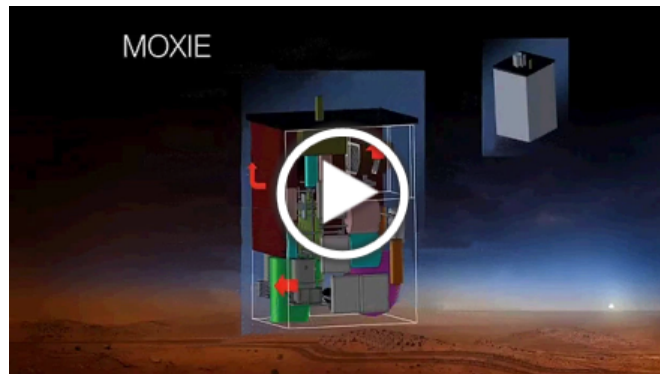
Attempt to add different gases and see which react with the gaseous substance in order to identify what it is. Furthermore, one could attempt different physical changes to see what it is. The remaining gas will most likely be a high concentration of nitrogen.

0/1

Question 8 (5 marks)

In July 2014, NASA announced that they will be sending a new rover to Mars. Seven experiments will be included on the rover. One of the experiments is called MOXIE (**Mars Oxygen In-situ resource utilization Experiment**). MOXIE will convert the Martian atmosphere, which is approximately 96% carbon dioxide, into oxygen.

Question 8a (3 marks)

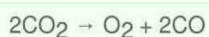


Adapted from: www.nasa.gov/press/2014/july

The word equation for the chemical reaction that will take place is:

carbon dioxide → oxygen + carbon monoxide

Write down the word equation above as a balanced chemical equation and add state symbols.



2/3 No state symbols. Correctly balanced. Correct reactants and products.

Question 8b (2 marks)

Outline the uses of oxygen and why it is important that NASA produces oxygen on Mars.

Oxygen is important for animal cell respiration, and if the human population is to live on Mars, it is extremely necessary that oxygen be present there. Additionally, although plants produce oxygen and absorb carbon dioxide during the daytime on earth, they still need to absorb oxygen in the night time, which is why it is necessary for plantlife as well.

1/2 Need to add additional use of oxygen apart from respiration.

Question 9 (7 marks)

Common salt, NaCl, is used in cooking but many other salts also have important uses in food. The table shows a list of salts used as food additives, their taste and their other uses.

ammonium chloride	salty and quite bitter	in licorice and in baking to give cookies a very crisp texture
calcium chloride	salty and bitter	maintains crispness and firmness of fruits and vegetables
magnesium chloride	salty and bitter	in tofu as a thickener
potassium chloride	salty and slightly bitter	a substitute for sodium chloride
sodium chloride	salty	a flavouring and a preservative

Using information from the table, a student hypothesized “*The salty taste of salts is caused by the presence of a group one ion.*”

Question 9a (4 marks)

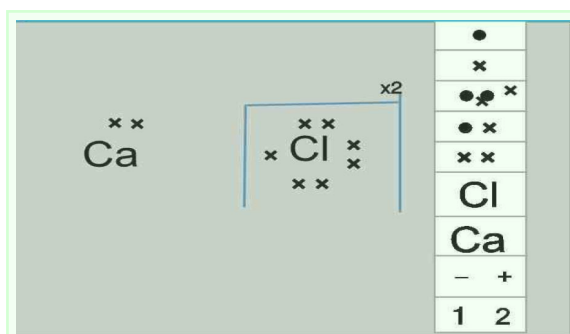
Comment on the validity of the hypothesis above. Use scientific reasoning to support your answer.

This hypothesis is not valid at all since some elements from the table don't belong on group 1 ions in the periodic table. Since group 1 have one electron in the outer shell. But in the table we can see that Ca and Mg both are group 2 ions. Therefore this is not a valid hypothesis.

2/4 Correct and justified statement about the validity of the hypothesis and about the presence of identified group 2 ions. No mention of chloride ions in all salts. No mention of link of chloride ions causing salty taste.

Question 9b (1 mark)

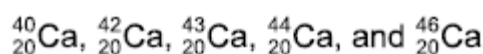
Draw a Lewis (electron dot or dot cross) structure showing the electron configuration of CaCl₂.



0/1 No correct structure.

Question 9c (2 marks)

Calcium has 24 isotopes but only five are stable:



Calculate the average number of neutrons of the five isotopes of calcium.

$$20 + 22 + 23 + 24 + 26$$

DEG +/-

115

ans ÷ 5 23

The average = 23 neutrons

2/2 Correct final answer.

Question 10 (9 marks)

Sodium hydrogen carbonate, NaHCO_3 , is used in cooking as a raising agent. When a cake is baked, the raising agent reacts with the moisture in the liquid ingredients to produce carbon dioxide. The carbon dioxide produced causes the cake to rise and gives the characteristic texture and grain.



The thermal decomposition of baking soda is an endothermic reaction. It is shown by the following equation:



The thermal decomposition of NaHCO_3 is used in some fire extinguishers. These extinguishers are very effective in extinguishing oil, grease and electrical fires. The carbon dioxide that is released prevents combustion. The carbon dioxide smothers the fire as it is more dense than air.



<https://www.911fireextinguishers.com/product/badger-trade-advantage-trade-10-lb-abc-fire-extinguisher-w-wall-hook/>

Question 10a (4 marks)

Explain why a carbon dioxide fire extinguisher is more appropriate than just water for an oil, grease of electrical fire.

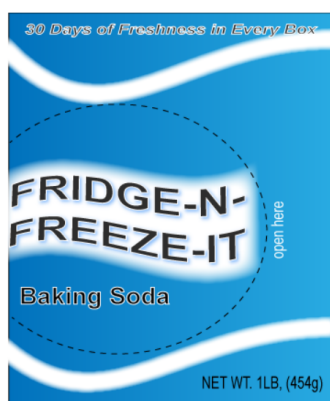
Oil and grease are highly flammable liquids and ignite very quickly. This means that they need something very strong to put them out. Carbon dioxide in the fire extinguishers, starves the fires of oxygen much more effectively than the water does which means that they can be put out much faster and won't spread as much. Water does not starve the fire of air like the carbon dioxide does as it evaporates very fast and doesn't create the layer that is needed to starve a fire which is of a big scale.

Electrical fires and water would not be a good idea as water and electricals react which could increase the fire size instead of reducing it. The carbon dioxide fire extinguisher wouldn't have a bad effect and, much like with oil and grease would reduce the oxygen supply to the fire as well. It also wouldn't evaporate much like water would meaning that if the electrical fire was to carry on, the blanket that the fire extinguisher has made of carbon dioxide foam, would put out any other fires as they are still starved of any oxygen so would not be able to ignite.

3/4 Removal of oxygen. Water will evaporate and boil in fires. Conductivity of water identified. Repeat first point made.

Sodium hydrogen carbonate is an amphoteric salt which means that I can react with both strong acids and strong bases. Many bad odours are caused by acidic substances for instance sour milk and rotting fish.

Question 10b (1 mark)

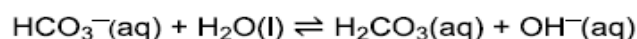


Suggest how sodium bicarbonate could react with either sour milk or rotting fish to remove the bad aroma.

By reacting with the moisture in the sour milk and rotting fish

0/1 No mention of neutralisation.

The hydrogen carbonate ion is in equilibrium with water as shown in the following equation:



Question 10c (4 marks)

Explain how adding an acid would affect the equilibrium above and would affect the quantity of H_2CO_3

by adding an acid to the reactants, the equilibrium position would move to the right to try and compensate for the addition. It shifts to try and keep balance in the equation so no side has more energy.

The quantity of H_2CO_3 would be less as the equilibrium is trying to compensate for the more products it has now. This means it would reduce the amount of reactants so that equilibrium is still present in this reaction.

1/4 Shift in equilibrium in correct direction stated. The quantity of H_2CO_3 increases and not decrease.

Question 11 (16 marks)

The desserts known as Jell-O® was created in the 19th century in the United States. When Jell-O® is manufactured, gelatine is dissolved in hot water with sugar, citric acid, artificial flavour and colouring. Once cooled below 15 °C the Jell-O® slowly forms a gelatine network which holds a liquid such as water or juice.



The Kraft Heinz Company
Discovery Corporate Services Ltd
www.commons.wikimedia.org/wiki/Category:Beef_steaks
www.commons.wikimedia.org/wiki/Cheese
www.commons.wikimedia.org/wiki/Category:Popcorn

Ingredient	% Mass	
Powdered gelatine	7.0%	i
Sugar	90.0%	i
Citric acid	1.8%	i
Artificial stabilizer	0.2%	i
Artificial colourings	0.7%	i
Artificial flavouring	0.3%	i

Powdered gelatine

Gelatine comes from the collagen in animal and fish bones. It forms a gel.

Artificial stabilizer

for example, Adipic acid is a substance used to help gelling.

Artificial colourings

Used to enhance the appearance of food. Has been linked to hyperactivity in children

Sugar

Used as a sweetener

Artificial flavouring

Mixtures of between 5 to 50 chemicals used to recreate the taste and smell of natural foods

Citric acid

A natural preservative found in citrus fruits that is used to give a sour, fruity taste.

Question 11a (2 marks)

Discuss why gelatine networks can become unstable when the temperature rises above 15 °C.

The gelatine molecules form a gelatine network at 15°C or lower, however when the temperature rises the bonds between gelatine molecules begin to break causing gelatine to become powder that is mixed with water again.

1/2

Question 11b (2 marks)

Use the list of ingredients to **determine** how to produce a colourless drink with the taste of oranges.

needed	not needed	ingredients
<input checked="" type="radio"/>	<input type="radio"/>	sugar
<input type="radio"/>	<input checked="" type="radio"/>	adipic acid
<input checked="" type="radio"/>	<input type="radio"/>	citric acid
<input type="radio"/>	<input checked="" type="radio"/>	colouring
<input checked="" type="radio"/>	<input type="radio"/>	gelatine
<input checked="" type="radio"/>	<input type="radio"/>	artificial flavour
<input checked="" type="radio"/>	<input type="radio"/>	water

0/2

Question 11c (12 marks)

Discuss and **evaluate** either a social implication or an ethical implication of using additives such as sugar and artificial colourings in the preparation of food.

You should use scientific reasoning to support your answer and consider:

- The benefits of food additives
- The limitations of food additives
- The effects of food additives on an individual and a community
- Your appraisal of whether or not additives should be used in the preparation of food.

Food additives make foods like Jello for example seem more interesting for people. This benefits some sectors of the world as producers of foods with colored additives gain more money as their foods seem to be more appealing and eye-catching for the society members. Food additives can be mostly attractive for little children.

Food additives such as artificial colorings can be useful as they can sometimes be used for medicinal purposes such as gummy bear-colored- vitamins. The artificial coloring and the molding of some medicines makes it easier for parents to maintain the health of their children.

Also, adding sugars and food coloring to some types of foods can be useful to the society members as they can sometimes make better relations between people who are eating together, as they might communicate by talking on the good, sweet taste of the food. It can also be good to use colored foods at parties and social events to attract the people invited.

Eventhough foods that have artificial coloring can be fun sometimes, artificial coloring is not very healthy for peoples bodies and especially not children. Artificial colorings can increase the hyperactivity in children.

Other additives such as artificial flavorings can cause the loss of cultural identity. The use of artificial flavorings to food will cause a different taste from the natural foods. Sometimes, the additives can change the appearance, smell and taste of the natural foods; the high intake of foods with additive preservatives may cause communities to leave and forget the natural foods they are used to eat. The loss of traditional foods and the loss of taste of the traditional foods in the community will eventually lead to the loss of cultural identity.

Also, having many foods with added sugars and artificial colorings may be a problem for diabetic children and adults. These foods will be wanted by younger children who will crave them as they see other society members eating them; however this may affect their health conditions.

Personally, I find that additives should be used in the preparation of foods, however they should be limited and not overused. In the end, it will be shameful to forget our own natural foods and instead always eat sweet tasting, sugary, colored foods that have no meaning to us and the old generations.

6/12 - A statement about a specified additive linked to a social impact (weak).

- Link to limitation of additive.

- Band 6-8.

Question 1 (8 marks)

The main role of clothing is protection against the weather. In cold countries natural materials such as wool and fur have traditionally been used but today man-made fibres can be used to trap body heat. Extra warmth can be provided by chemical reactions.

Hand warmers contain iron powder which releases energy when exposed to oxygen in the presence of a catalyst.

The equation for the reaction is: $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$

clothing

**Question 1a** (1 mark)

State the name given to a reaction in which heat is released.

Thermal reaction

0/1 Not correct answer.

Question 1b (3 marks)

Using the periodic table, **calculate** how many moles of oxygen are needed to oxidize a hand warmer containing 5.6g of iron.

moles = molecular mass ÷ mass
moles = 56 ÷ 5.6 = 10 moles

0/3 Number of moles not correct. No ratio. No final answer.

Question 1c (1 mark)

State the type of bonding in iron oxide.

Ionic bonding

1/1 Correct answer.

Question 1d (1 mark)

Using the periodic table, **state** the charge of iron ion in Fe_2O_3 .

The iron ion has a charge of 3+

1/1 Correct charge identified.

Question 1e (2 marks)

Select one other element that forms ions with the same charge as iron in Fe_2O_3 . **Justify** your answer.

- sodium
- carbon
- aluminium
- calcium

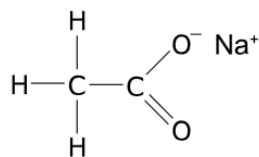
Correct element chosen.

Aluminium has the same oxidation number than iron, 3^+ (even though iron can be 2^+ or 3^+). Therefore, as an ion, aluminium would, too, have a charge of 3^+ , as it would lose 3 electrons.

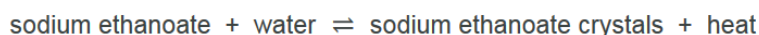
2/2 Correct statement about choice of element.

Question 2 (10 marks)

Reusable hand warmers do not use iron but contain a saturated aqueous solution of sodium ethanoate (CH_3COONa) that releases heat when it undergoes the reversible process of crystallization.



Sodium ethanoate


Question 2a (2 marks)

State and **justify** whether crystallization is a physical or a chemical process.

Crystallization is a physical process since it involves evaporation causes a change in physical state.

1/2 Physical process. Correct answer but incorrect justification.

Question 2b (2marks)

Outline how a saturated solution is produced.

A saturated solution is produced when the double covalent bond in the original reactant is broken through different means such as Hydrogenation, Bromination and Polymerisation.

0/2 No mention of solute. No mention of saturated solution.

Question 2c (2 marks)

Outline how the hand warmer can be reused.

The hand warmer can be reused since the reaction is a reversible one. Following Le Chatelier's principle, we can determine that the hand warmer can be reused by adding more concentrations of heat or sodium ethanoate crystals in order for the hand warmer to be available for use once again. This is because it shifts the equilibrium to the left.

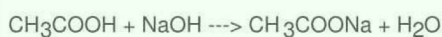
2/2 Heat mentioned. Second mark awarded as it makes reference to Le Chatelier's principle and it demonstrates understanding of equilibrium.

Question 2d (4 marks)

Sodium ethanoate is the salt made in the neutralization reaction between ethanoic acid and a strong base.

Determine which base was used and **write down** a chemical equation for this neutralization reaction.

The base used was NaOH (Sodium Hydroxide)



4/4 Sodium hydroxide chosen. Correctly balanced. Correct products. Correct reactants.

Question 3 (11 marks)

Fossil fuels and factory emissions are some of the main causes of environmental pollution. Unfortunately, the damaging effects of pollution spread beyond industrialized areas can be worsened by extreme climates. The ground in some countries is covered in heavy snow in the winter. When the snow melts in the spring, for a short time, the rivers and lakes will become more acidic.

Question 3a (8 marks)

Explain a problem associated with acid rain. Use scientific knowledge and understanding to support your answer.

Some problems that are associated with acid rain are the erosion of limestone and acidic fresh water. Some cities have buildings and monuments made of limestone, which is destroyed by acid rain. The more acid rain an area that has a lot of limestone gets, the more erosion will occur. The problem with that is people can lose their homes and businesses which will leave them unemployed and homeless. The other common problem is fresh water lakes and rivers become more acidic. People require fresh water to drink and without that, the human race will go extinct. Humans can drink a certain amount of acid but too much can result in death. Also, rivers that lead out into the ocean will be carrying that acidic water. When that water reaches the ocean it can greatly affect ocean life, depending on the area. Coral is a very sensitive part of the ocean and even the slightest bit of acidic change to the water can make them bleach themselves and perish.

6/8 Detailed statement produced. Cause and effect explained. Context is not strong with links to chemistry.

Chemists have created catalytic clothing that combines functionality with fashion. Catalytic clothing technology uses nano-sized titanium oxide TiO_2 particles that act as photocatalysts. The photocatalysts help reduce pollutant gases such as nitrogen oxides and sulfur oxides. Pollutant gases have a negative effect on ecosystems and present a risk to humans.

The catalysts are woven into clothes and help to remove pollutants by converting them into soluble compounds that are removed by washing.

Question 3b (1 mark)

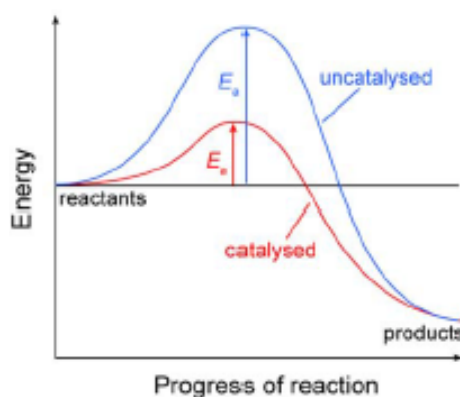
State the meaning of the term **catalyst**.

Catalyst means something that absorbs and holds gases.

0/1 Speeding up reaction not stated.

Question 3c (2 marks)

The graph below is an energy profile diagram which shows the energy changes for both a catalysed reaction and an uncatalysed reaction.



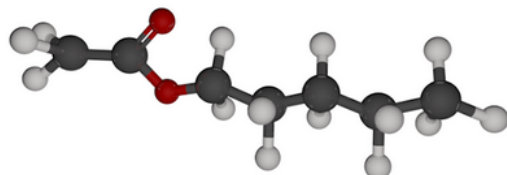
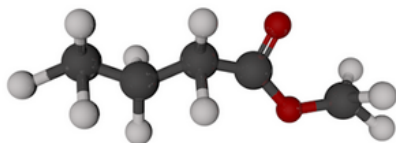
Using the graph, **outline** how catalysts work.

A catalyst works by absorbing a lot of the energy released during a reaction but it produces the same product as a reaction not using a catalyst.

0/2 No mention of lowering energy required. Same end point not valid for mark.

Question 4 (3 marks)

The aroma of fruits comes from characteristic chemical. For example, the aroma of an apple is mainly caused by molecules of $C_3H_7COOCH_3$ (methyl butanoate) and the aroma of pears by molecules of $CH_3COOC_5H_{11}$ (pentyl ethanoate).



Question 4a (1 mark)

In a futuristic clothing project, two students suggest using methyl butanoate and pentyl ethanoate to form new aromatic fabrics. **State** the class of chemical compound these molecules belong to.

Esters.

1/1 Correct class of molecule.

Pentyl ethanoate is formed in a reaction between an acid and an alcohol.

Question 4b (1 mark)

State the name of the alcohol.

pentanol

1/1 Correct name of alcohol.

Question 4c (1 mark)

State the name of the small molecule lost when the acid and the alcohol above react to form pentyl ethanoate.

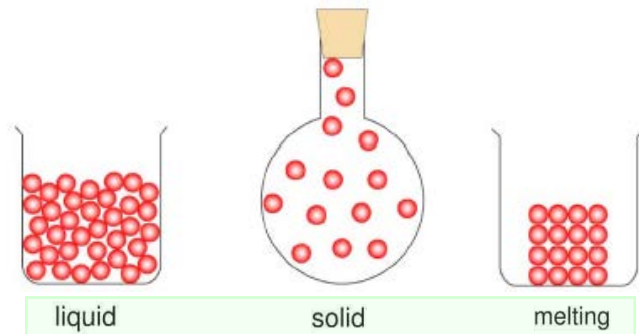
H₂O

0/1 Formula given and not name.

Question 5 (10 marks)

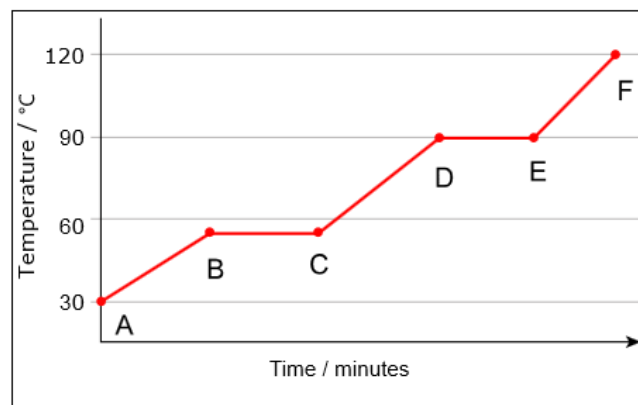
Question 5a (1 mark)

Label the three states of matter shown in the diagrams.



1/1 Correct states identified.

The diagram below shows the state changes for a pure substance which is a solid at 30°C.



Select the correct description for each of the stages.

Use kinetic theory to explain what is happening to the particles in the pure substance.

Question 5b (3 marks)

B to C

Description: melting Correct state change.

What is happening to the particles?

The particles have been heated up and are moving quite quickly and will stay at around 58 degrees until every part of the substance becomes liquid.

2/3 Increase in motion of particles. No mention of distance between particles.

Question 5c (3 marks)

E to D

Description: condensation Correct state change identified.

What is happening to the particles?

As the question asks from E to D, the particles just finished turning into a gas at point E as more heat gets applied and the particles move faster. If it goes from E to D (D being a liquid beginning to become a gas) The reaction going on here is clearly condensation.

1/3 No mention of decrease of energy. No mention of particles getting closer.

Question 5d (3 marks)

D to C

 Description: no change in state *Correct change in state.*

What is happening to the particles?

From D to C, there is no change in state because it is only being cooled down from a liquid to a solid again. D is when the particles are moving really quickly and they are in the process of turning into a gas while point C is a part where the particles have just turned to a liquid. Therefore, going from D to C is a slowing down of the particles, but it still stays a liquid. They are just getting slower as the next step would be solidification.

2/3 No mention of particles getting closer together. Particles decrease in motion.

Question 6 (27 marks)

Water is a compound made from two different elements bonded together.

Question 6a (1 mark)

State the two elements in water.

 Element one: Hydrogen 1/1

 Element two: Oxygen
Question 6b (2 marks)

 Use particle theory to **outline** what is happening to the particles when a substance boils.

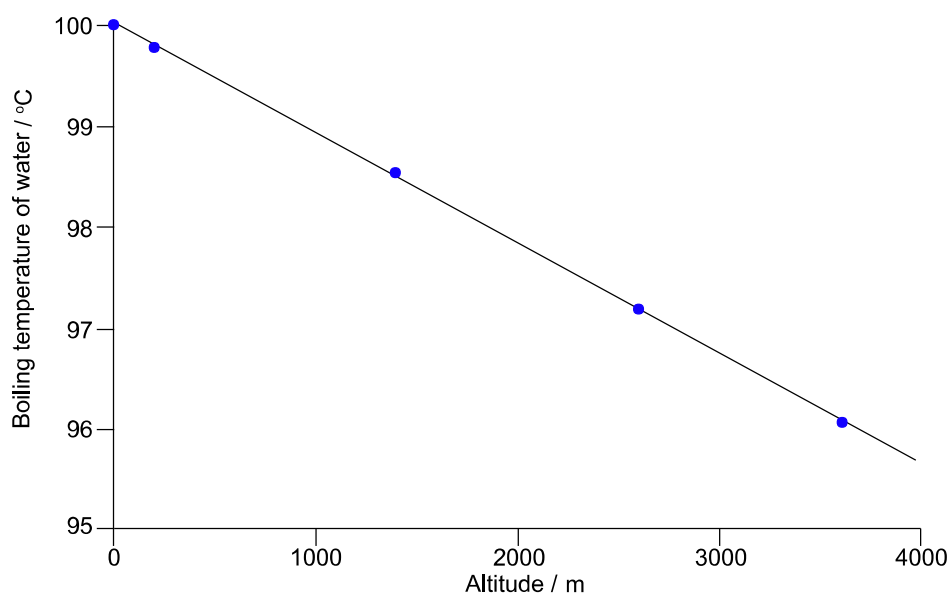
When a substance boils the internal energy of the substance changes as it is becoming a gas.

The difference in internal energy can be measured as the heat given off.

The particles in the substance start to move freely away from each other in their changing from liquid to gas form. The forces of attraction between the particles begin to decrease as there are almost no forces of attraction between particles in gaseous state.

1/2

The boiling temperature of water at standard pressure is 100 °C. The table shows the boiling temperature of water measured at different IB schools. IB schools are located at different heights above sea level. The height above sea level is known as altitude and it can be measured in metres.



Question 6c (3 marks)

Using the graph, **write down** values to complete the table.

Location	Altitude / m	Boiling temperature of water / °C
Bangkok	1	100.0
Belgrade	210	99.8
Bogota	2625	97.2
Canberra	605	99.4
Kathmandu	1400	98.6
La Paz	3640	96.1
Nairobi	1750	98.0
New Delhi	210	99.8
Tehran	1138	98.7

2/3

Question 6d (1 mark)

State a suitable hypothesis that could be tested using the data in the table.

(hypothesis or research question?)

If the altitude (m) at which water is boiled is increased then the boiling point of the water will consequently decrease because the increase in pressure, as a result of increase of altitude, helps in decreasing the forces of attraction between the water molecules therefore making it easier to boil.

1/1

Question 6e (4 marks)

Some new IB schools at different locations would like to add data to the table. **Identify** the variables.

Independent variable:

Altitude at which water is boiled (m)

Dependent variable:

The boiling point of the water (degrees celcius)

Control variables:

The volume of water being boiled (cm³)

The substance of the container in which the water is being boiled

The type of fuel being used to heat the water

4/4

Question 6f (16 marks)

Design a method to investigate the boiling temperature of water at different altitudes. In your answer, include:

- A hypothesis that your method will test
- How you will manipulate the variables
- A diagram of how you will arrange your equipment
- How you will collect sufficient data
- How you will ensure your method is safe

Collect all required apparatus

Measure 20 cm³ of water using a measuring cylinder and pour the liquid into a glass beaker

Starting at an altitude of 0 m Place the beaker onto the tripod stand with a busen burner directly underneath

Place a thermometer into the beaker and ensure that the water is at room temperature (25 degrees celcius)

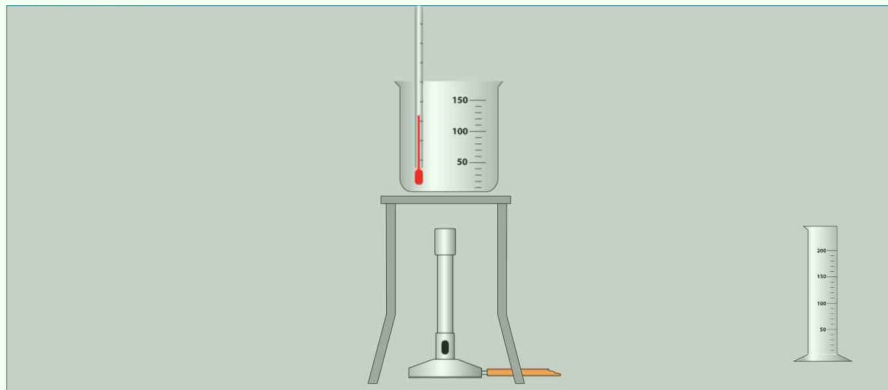
Start heating the water ensuring mittens are worn and a fire extinguisher is nearby

Once bubbles are noticable in the solution note the reading of the thermometer once again

Repeat steps 2-6 until you have 5 tests for the specific altitude

Repeat step 7 for each altitude including 0, 5, 10, 15, and 20 m or by another constant factor. Manipulate the altitude by either scaling a local hill or moving up the floors of a building.

Ensure data is placed in a table with average boiling point calculated for each of the five altitude's



9/16 Band 7-11

- Missing equipment for measuring altitude.

- No care with hot objects.

Question 7 (14 marks)

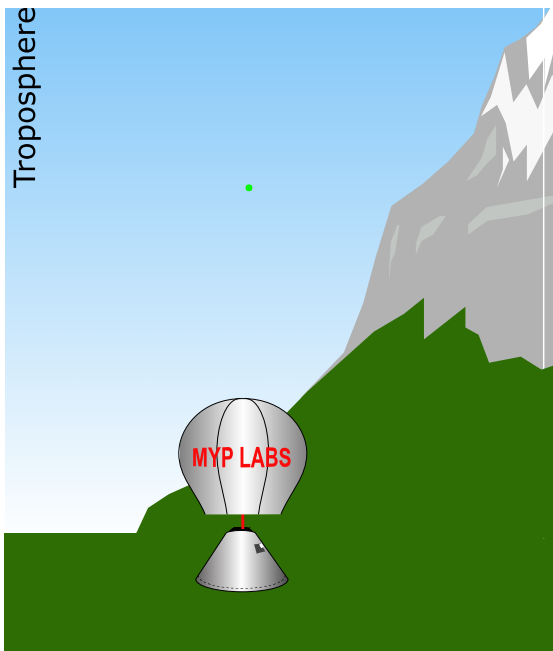


Artist Frieso Hoevelkamp

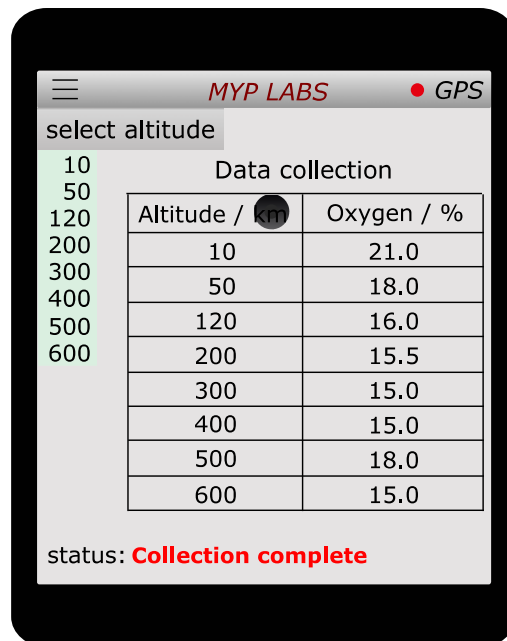
Use the simulation to collect samples of gas from each of the required parts of the atmosphere in the table below. Record the percentage of oxygen obtained at each level.

Question 7a (5 marks)

Simulation



Completed results



Plot a graph of percentage of oxygen against altitude. Label the axes.



4/5 Mark deducted as not all points plotted.

Question 7b (2 marks)

Justify whether all of the data should be included in the graph.

Not all the data, there is one outlier (500km), and some do not follow the increments (10km) 2/2

Second samples collected from the atmosphere were sent to your school laboratory for analysis. It was suggested that you analyse the samples to determine the percentage of oxygen in each sample. One method that could be used is to light a birthday cake candle and place it in a dish of water so that the candle is held in place. A test tube is then filled with the gas sample and placed over the candle so that the bottom of the test tube is under the water. The candle will burn until the oxygen has been used up.



Question 7c (1 mark)

State a suitable hypothesis for the birthday cake candle investigation.

As the oxygen percentage increases, the time taken for the candle to turn off increases 1/1

Question 7d (2 marks)

State the independent and dependent variables in this investigation.

Independent variable: The samples at different altitudes
 Dependent variable: The time taken for the candle to turn off

1/2 Do not accept altitude in place of oxygen.

Question 7e (1 mark)

Suggest an improvement to the method you saw in the animation.

Create it in a vacuumed room where no oxygen is present

0/1 Not valid improvement.

Question 7f (3 marks)

A gas remains in the test tube. **Suggest** a test to identify this combustion product.

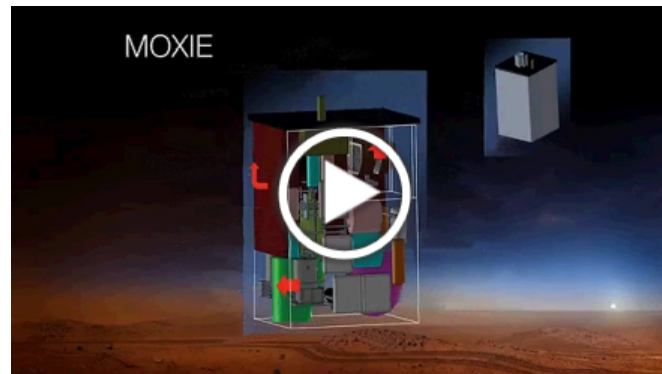
Add milky water to the test tube, it should turn white if carbon dioxide is present.

2/3 Correct result. Correct gas identified.

Question 8 (5 marks)

In July 2014, NASA announced that they will be sending a new rover to Mars. Seven experiments will be included on the rover. One of the experiments is called MOXIE (**Mars Oxygen In-situ resource utilization Experiment**). MOXIE will convert the Martian atmosphere, which is approximately 96% carbon dioxide, into oxygen.

Question 8a (3 marks)

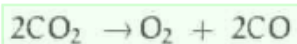


Adapted from: www.nasa.gov/press/2014/july

The word equation for the chemical reaction that will take place is:

carbon dioxide → oxygen + carbon monoxide

Write down the word equation above as a balanced chemical equation and add state symbols.



2/3 Correctly balanced. Correct reactants and products. No state symbols.

Question 8b (2 marks)

Outline the uses of oxygen and why it is important that NASA produces oxygen on Mars.

Oxygen is one of the main things for human being to support their lives by breathing, as human needs oxygen. Oxygen is also used to burn stuff, as fire needs oxygen to burn.

It is important that NASA produces oxygen on Mars is because it will help human to have higher oxygen level during the exploration of Mars, and it will also be a fuel for rockets from Mars.

2/2 Oxygen required for life. Oxygen used for fuel.

Question 9 (7 marks)

Common salt, NaCl, is used in cooking but many other salts also have important uses in food. The table shows a list of salts used as food additives, their taste and their other uses.

ammonium chloride	salty and quite bitter	in licorice and in baking to give cookies a very crisp texture
calcium chloride	salty and bitter	maintains crispness and firmness of fruits and vegetables
magnesium chloride	salty and bitter	in tofu as a thickener
potassium chloride	salty and slightly bitter	a substitute for sodium chloride
sodium chloride	salty	a flavouring and a preservative

Using information from the table, a student hypothesized “*The salty taste of salts is caused by the presence of a group one ion.*”

Question 9a (4 marks)

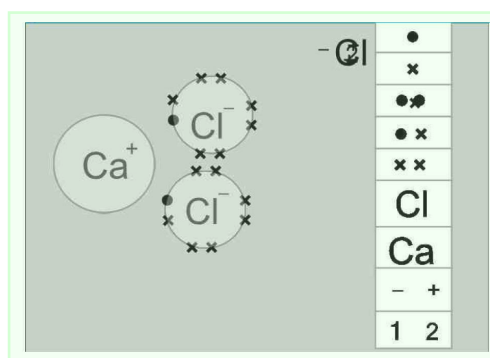
Comment on the validity of the hypothesis above. Use scientific reasoning to support your answer.

The hypothesis above is not valid. This is because not all salts are ionic compounds made up of a group 1 element. There are many salts that do not include group 1 elements in their compounds and therefore do not have the presence of a group one ion and still taste salty such as ammonium chloride, calcium chloride, and magnesium chloride etc...

2/4 Hypothesis rejected based on not all salts have group 1 element. Understanding that other salts are not group 1. No mention of all salts containing chloride ions.

Question 9b (1 mark)

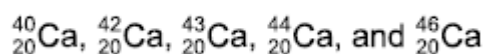
Draw a Lewis (electron dot or dot cross) structure showing the electron configuration of CaCl₂.



0/1 Charge on calcium not correct.

Question 9c (2 marks)

Calcium has 24 isotopes but only five are stable:



Calculate the average number of neutrons of the five isotopes of calcium.

$$\frac{20 + 22 + 23 + 24 + 26}{5} = 23 \text{ neutrons}$$

2/2

Question 10 (9 marks)

Sodium hydrogen carbonate, NaHCO_3 , is used in cooking as a raising agent. When a cake is baked, the raising agent reacts with the moisture in the liquid ingredients to produce carbon dioxide. The carbon dioxide produced causes the cake to rise and gives the characteristic texture and grain.



The thermal decomposition of baking soda is an endothermic reaction. It is shown by the following equation:



The thermal decomposition of NaHCO_3 is used in some fire extinguishers. These extinguishers are very effective in extinguishing oil, grease and electrical fires. The carbon dioxide that is released prevents combustion. The carbon dioxide smothers the fire as it is more dense than air.



<https://www.911fireextinguishers.com/product/badger-trade-advantage-trade-10-lb-abc-fire-extinguisher-w-wall-hook/>

Question 10a (4 marks)

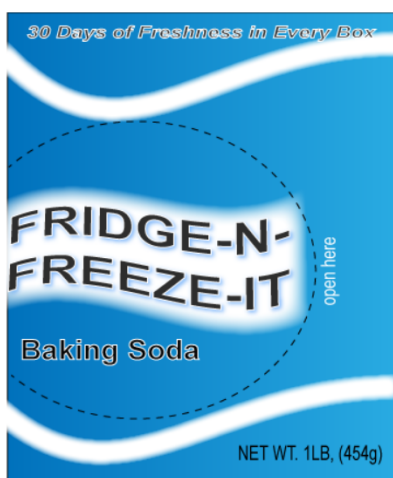
Explain why a carbon dioxide fire extinguisher is more appropriate than just water for an oil, grease or electrical fire.

A carbon dioxide fire extinguisher is more appropriate than just water for an oil, grease or electrical fire because carbon dioxide is more dense than water which allows it to smother the fire. The release of carbon dioxide prevents combustion.

0/4

Sodium hydrogen carbonate is an amphoteric salt which means that it can react with both strong acids and strong bases. Many bad odours are caused by acidic substances for instance sour milk and rotting fish.

Question 10b (1 mark)

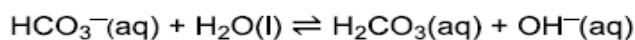


Suggest how sodium bicarbonate could react with either sour milk or rotting fish to remove the bad aroma.

As sour milk or rotting fish, which are both acids, react with sodium hydrogen carbonate, it will act as a base. This strong base will help neutralize the reaction. This will in turn remove the bad aroma.

1/1

The hydrogen carbonate ion is in equilibrium with water as shown in the following equation:



Question 10c (4 marks)

Explain how adding an acid would affect the equilibrium above and would affect the quantity of H_2CO_3

Adding an acid would disrupt the equilibrium above as the H^+ ions in an acid would react with the OH^- in the equation. This would decrease the concentration OH^- so the equation would no longer be at equilibrium. In order to reach equilibrium again, a forward reaction will have to occur to compensate for the loss of OH^- by producing more of it. Eventually, the reaction will reach equilibrium again.

Adding an acid would affect the quantity of H_2CO_3 present by increasing its concentration.

4/4

Question 11 (16 marks)

The desserts known as Jell-O[®] was created in the 19th century in the United States. When Jell-O[®] is manufactured, gelatine is dissolved in hot water with sugar, citric acid, artificial flavour and colouring. Once cooled below 15 °C the Jell-O[®] slowly forms a gelatine network which holds a liquid such as water or juice.



Ingredient	% Mass	
Powdered gelatine	7.0%	1
Sugar	90.0%	1
Citric acid	1.8%	1
Artificial stabilizer	0.2%	1
Artificial colourings	0.7%	1
Artificial flavouring	0.3%	1

Powdered gelatine
Gelatine comes from the collagen in animal and fish bones. It forms a gel.

Artificial stabilizer
for example, Adipic acid is a substance used to help gelling.

Artificial colourings
Used to enhance the appearance of food. Has been linked to hyperactivity in children

Sugar
Used as a sweetener

Artificial flavouring
Mixtures of between 5 to 50 chemicals used to recreate the taste and smell of natural foods

Citric acid
A natural preservative found in citrus fruits that is used to give a sour, fruity taste.

Question 11a (2 marks)

Discuss why gelatine networks can become unstable when the temperature rises above 15 °C.

Because more kinetic energy would make gelatine bonds unstable.

1/2

Question 11b (2 marks)

Use the list of ingredients to **determine** how to produce a colourless drink with the taste of oranges.

needed	not needed	ingredients
<input checked="" type="radio"/>	<input type="radio"/>	sugar
<input type="radio"/>	<input type="radio"/>	adipic acid
<input checked="" type="radio"/>	<input type="radio"/>	citric acid
<input type="radio"/>	<input type="radio"/>	colouring
<input type="radio"/>	<input type="radio"/>	gelatine
<input checked="" type="radio"/>	<input type="radio"/>	artificial flavour
<input checked="" type="radio"/>	<input type="radio"/>	water

2/2

Question 11c (12 marks)

Discuss and **evaluate** either a social implication or an ethical implication of using additives such as sugar and artificial colourings in the preparation of food.

You should use scientific reasoning to support your answer and consider:

- The benefits of food additives
- The limitations of food additives
- The effects of food additives on an individual and a community
- Your appraisal of whether or not additives should be used in the preparation of food.

benefits of food additives

It makes people explore many flavours without spending lots of money as the esters that are used for flavouring can be mass produced.

It does not cause allergies because flavourings have different chemical properties than actual foods

the limitations of food additives

food additives can make people confused about the actual flavour of food, with the food additives.

Some food additives can cause harms to body because they are not natural to human bodies

Rather than improving the quality of the food, people tend to just improve the food additives instead because they provide more benefits financially.

People might benefit and not benefit at the same time so I will not choose side because some can benefit by trying out peach flavour while having a peach allergy because we make artificial flavourings that provide the same flavours. And others might argue that ever since we made artificial additives the quality of actual food has gone down.

7/12 Band 6-8

- A correct link to benefit of additive.

- No statement about specified additive linked to either social or ethical implication.

- A relevant social implication for individual.