Question 1 (9 marks)

Metals have been used for thousands of years and there are records to indicate they were first used 7000 years ago by early humans to make tools, weapons and ornaments. Copper was one of the earliest metals used during this period, known as the Copper Age.

Question 1a (1 mark)

Select the area in the periodic table in which copper is found.

Select
- Select
- Alkali metals
- Alkaline earth metals
- Halogens
- Transition metals

Question 1b (1 mark)

State which period copper is in.

Question 1c (2 marks)

Copper can form two stable isotopes, Cu-63 and Cu-65. **Outline** the meaning of the term *isotope*.

Question 1d (2 marks)

Using the periodic table, **identify** the number of neutrons and electrons in an atom of Cu-65.

Question 1e (1 mark)

Copper can be mixed with tin to make bronze. Many sculptures have been made using bronze.

The table below gives some data about copper, tin and bronze.

Property	Melting point / °C	Ability to corrode	Hardness / Malleability / Ductility	Conductor of electricity
Copper (Cu)	1085	Corrodes easily	Soft, malleable and ductile	High conductor
Tin (Sn)	232	Does not corrode easily	Soft, malleable and ductile	Good conductor
Bronze (88% Cu+12% Sn)	950	Resists corrosion	Hard, malleable and ductile	High conductor

Select the term that is used to describe bronze.

Select

The table below gives some data about copper, tin and bronze.

Property	Melting point / °C	Ability to corrode	Hardness / Malleability / Ductility	Conductor of electricity
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Bronze (88% Cu+12% Sn)	950	Resists corrosion	Hard, malleable and ductile	High conductor

Select
Allotrope
Alloy
Element
Molecule

erm that is used to describe bronze.

Select

Question 1f (2 marks)

Using the data from part (e), **outline** why sculptures are made from bronze.

B I U Styles

Question 2 (17 marks)

Question 2a (1 mark)

Some paints used by artists contain reactive metals. When applied to a surface, the metals in the paint will naturally tarnish over time. The paint in the image contains iron and in the presence of oxygen, the iron reacts and turns a red-brown colour.

Select the name of the reaction when iron reacts with oxygen.

Select

Question 2 (17 marks)

Question 2a (1 mark)

Some paints used by artists contain reactive metals. When applied to a surface, the metals in the paint will naturally tarnish over time. The paint in the image contains iron and in the presence of oxygen, the iron reacts and turns a red-brown colour.

Select
Decomposition
Displacement
Neutralization
Redox

of the reaction when iron
n.

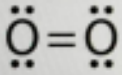
Select

Question 2b (1 mark)

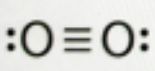
Select the Lewis structure (electron dot diagram) of an oxygen molecule.

Select

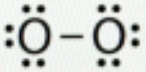
A.



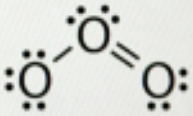
B.



C.



D.



Question 2c (3 marks)

Select options to balance the chemical equation for the reaction between iron and oxygen in air.

$$\text{?}\,Fe + \text{?}\,O_2 \rightarrow \text{?}\,Fe_2O_3$$

Question 2d (4 marks)

Calculate how many moles of oxygen react with 0.600 g of iron.

B I U x_2 x^2 Ω Σ Styles

Question 2e (2 marks)

Iron can also react with chlorine to form iron (III) chloride. The table below gives some information about the properties of each of these substances.

Identify each substance using the information in the table.

Substance	State at room temperature	Soluble in water	Conductivity at room temperature
Select	Gas	Slightly	No
Select	Solid	No	Yes
Select	Solid	Yes	No

Question 2e (2 marks)

Iron can also react with chlorine to form iron (III) chloride. The table below gives some information about the properties of each of these substances.

Identify each substance using the information in the table.

Substance	State at room temperature	Soluble in water	Conductivity at room temperature
Select (Select / Iron / Chlorine / Iron (III) chloride)	Gas	Slightly	No
	Solid	No	Yes
Select	Solid	Yes	No

Question 2f (1 mark)

State the electron configuration of chlorine.

Question 2g (4 marks)

Explain how iron and chlorine bond to form iron (III) chloride.

Question 2h (1 mark)

Iron (III) chloride is stored in bottles labelled with the following hazard symbol.

Select the meaning of the hazard symbol shown on the bottle.

Select

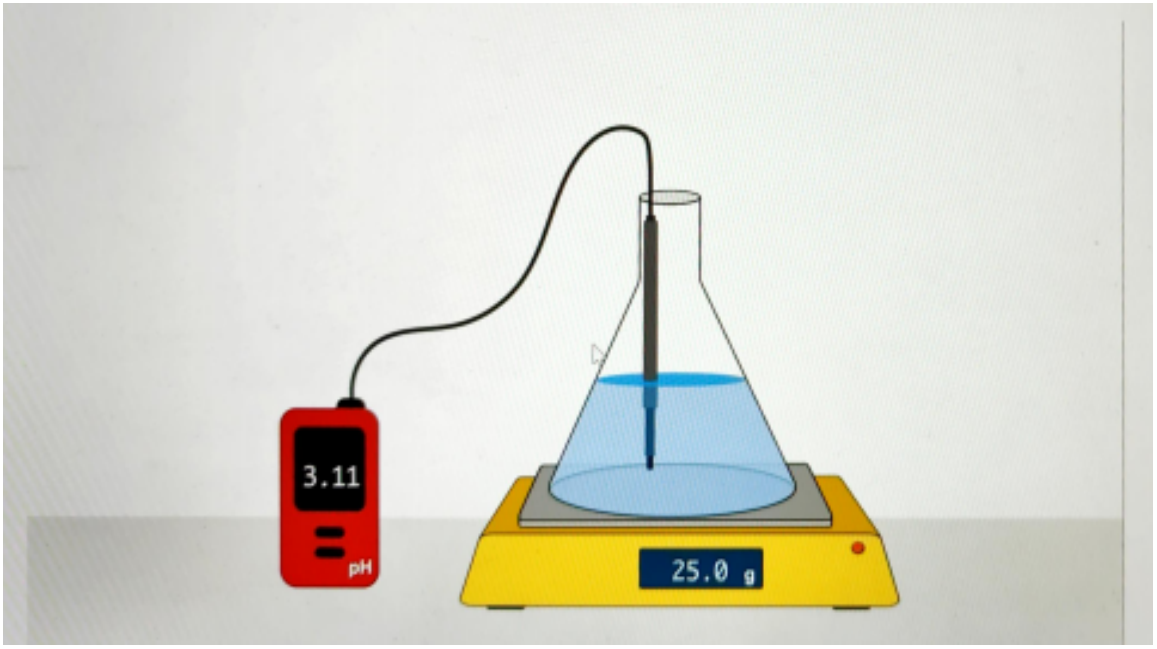
Question 3 (26 marks)

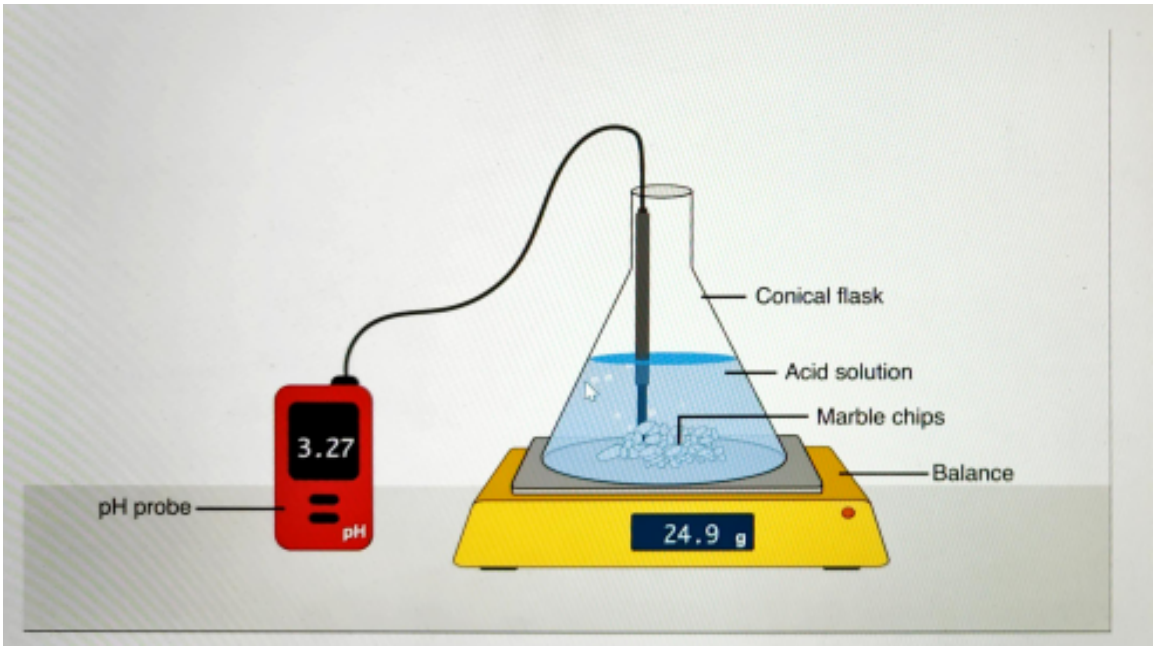
Pollution to the environment is causing damage to our planet. Sulfur dioxide can be produced from burning fossil fuels such as coal. The sulfur dioxide released to the atmosphere dissolves in water and produces sulfuric acid which makes rain acidic. Acid rain affects plant life, water sources and building materials. We can see the effect of acid rain when we look at a statue that has been exposed over time.

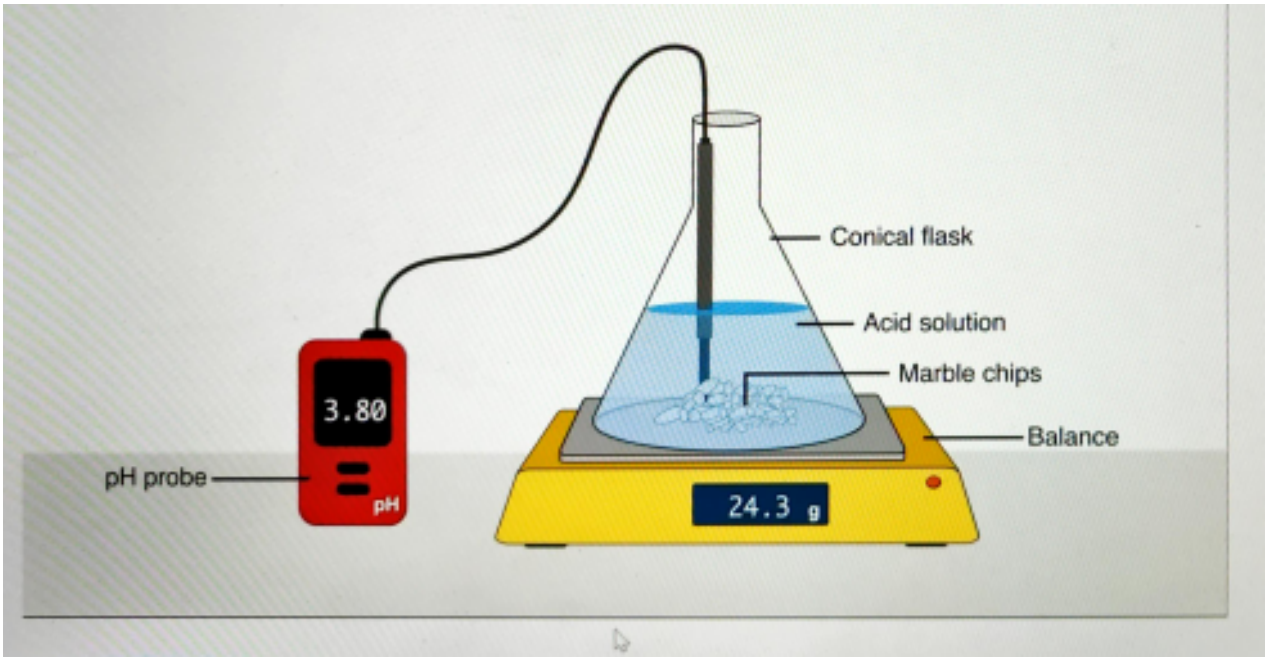
Marble is a form of calcium carbonate and is commonly used for buildings and statues. Calcium carbonate reacts with an acid to form a calcium salt, water and carbon dioxide as shown in the word equation below:

Calcium carbonate + acid → calcium salt + water + carbon dioxide

A student investigated the effects of three acidic solutions on marble chips, for seven days as shown in the animation below.







Question 3a (2 marks)

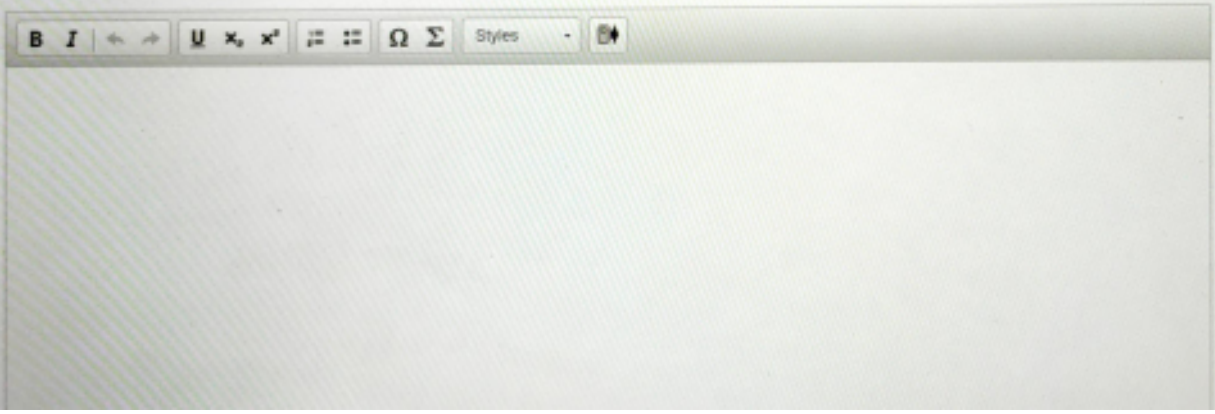
The student's processed results are shown in the table below:

Acid	Mass of marble chips / g	Trial 1	Trial 2	Trial 3	Average
Vinegar	Initial mass	33.73	41.03	39.11	–
	Mass after one week	30.59	38.24	36.24	–
	Change in mass	3.14	2.79	2.87	
Cola	Initial mass	43.15	30.98	55.73	–
	Mass after one week	43.09	30.81	55.69	–
	Change in mass	0.06	0.17	0.04	0.09
Lemon juice	Initial mass	26.37	23.90	64.17	–
	Mass after one week	25.23	22.55	62.01	–
	Change in mass	1.14	1.35	2.16	1.55

Using the data, **calculate** the average change in mass after the marble chips were exposed to vinegar for one week.

Question 3b (3 marks)

In the initial investigation, the student used a pH probe to measure the pH change. A second student used universal indicator paper to measure the pH change. **Evaluate** which method produced the most valid data.



Question 3c (2 marks)

Using the pH data below, **identify** which acidic solution had the largest decrease in acidity. **Justify** your answer.

Acid	pH	Trial 1	Trial 2	Trial 3	Average
Vinegar	Initial pH	3.11	3.12	3.16	–
	pH after one week	5.63	5.62	5.62	–
	Change in pH	2.52	2.50	2.46	2.49
Cola	Initial pH	2.78	2.74	2.78	–
	pH after one week	5.39	5.42	5.44	–
	Change in pH	2.61	2.68	2.66	2.65
Lemon juice	Initial pH	2.43	2.53	2.48	–
	pH after one week	5.84	6.05	6.01	–
	Change in pH	3.41	3.52	3.53	3.49

Question 3d (17 marks)

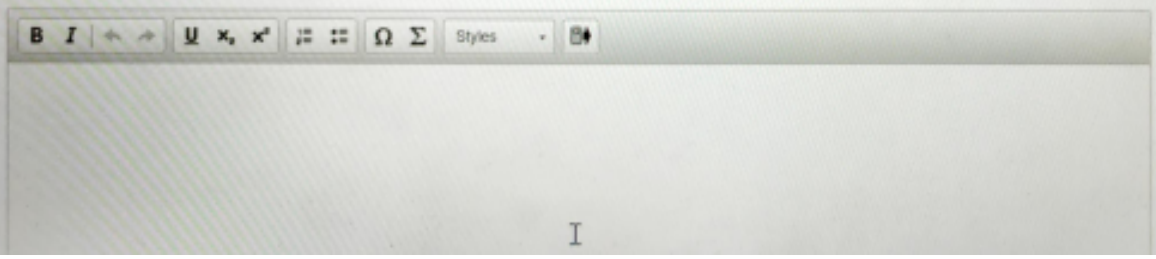
Various sizes of marble chips can be used for different types of outdoor decorative paths.

A student wants to investigate the effect of acid rain on marble. They will use sulfuric acid to model the effect of acid rain.

A student wants to investigate the effect of acid rain on marble. They will use sulfuric acid to model the effect of acid rain.

Design a method to investigate the effect of 0.1 mol dm^{-3} sulfuric acid on six different sizes of marble chips. In your answer you should include:

- the independent, dependent and two control variables
- a list of equipment that is needed
- a description of how you will collect sufficient data
- a description of the method
- an outline of how you will make sure the method is safe.



Question 4 (17 marks)

Environmental pollution is causing changes to our climate. Climate change is a key factor in the increasing risk of wildfires. Early firefighters used water whereas today various chemicals are also used. Firefighting tools such as fire extinguishers have changed over time.

An MYP student is investigating the effectiveness of a home-made fire extinguisher that produces carbon dioxide to extinguish flames. The video below shows an example of this type of extinguisher.

Video | Method

The method the student used is given below.

1. Measure 100 cm^3 of vinegar and place it in a teapot.

2. Measure 1 spoon of baking soda (sodium bicarbonate, $NaHCO_3$).

Video Method

The method the student used is given below.

1. Measure 100 cm^3 of vinegar and place it in a teapot.
2. Measure 1 spoon of baking soda (sodium bicarbonate, $NaHCO_3$).
3. Add the baking soda to the teapot.
4. Pour the carbon dioxide that is produced in the reaction over lit candles without spilling any of the liquid inside the teapot.
5. Record how many lit candles can be extinguished with the carbon dioxide produced.
6. Repeat steps 1 to 5 using 2 spoons, 3 spoons, 4 spoons and 5 spoons of baking soda.

Question 4a (3 marks)

Identify the independent variable, the dependent variable and one control variable in the student's method.

Independent variable:

Dependent variable:

Question 4b (3 marks)

Formulate a hypothesis for the student's investigation.

If:

then:

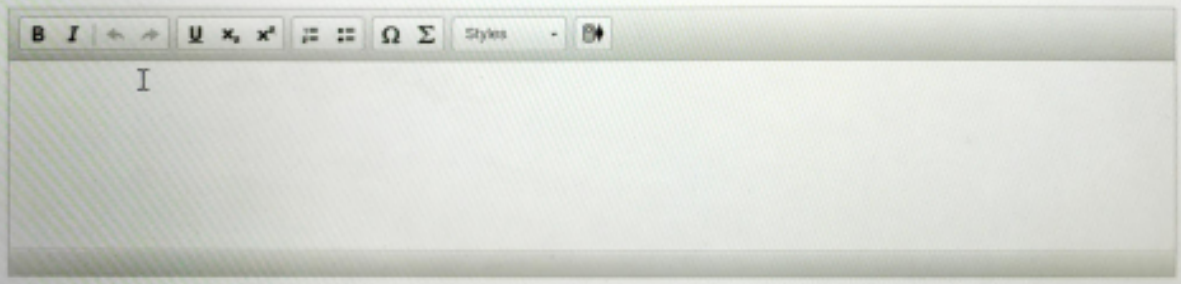
Question 4c (2 marks)

Identify two limitations in the student's method.

Limitation 1:

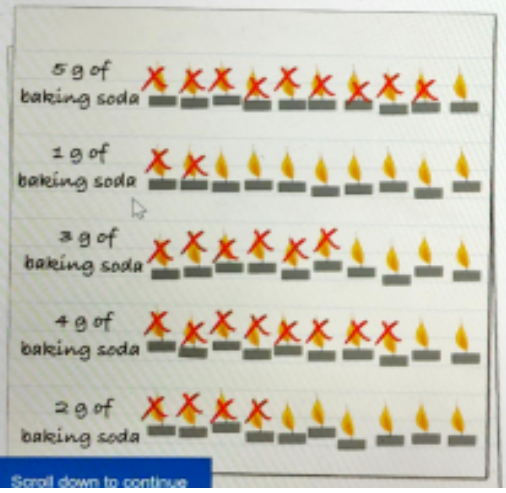
Question 4d (1 mark)

Suggest a different independent variable to extend the student's investigation.



Question 4e (3 marks)

Another student has completed a similar investigation. Their raw data is given below.



Scroll down to continue

Organize and **present** the student's raw data collected during the experiment.

Create New Table

Reset

Question 4f (5 marks)

Plot the data from part (e) in a graph and add a line of best fit.

x axis label:

y axis label:

Question 5 (7 marks)

There are many types of modern fire extinguishers. A recent innovation is the fire extinguisher ball. The animation below shows three different extinguishers that all use dry powder to extinguish a fire.

The table below gives some data about these extinguishers.

	 Handheld fire extinguisher	 Hanging fire extinguisher	 Fire extinguisher ball
Weight / kg:	3.2	5.6	1.3
Area that can be extinguished /m²:	2	3	35
Expiry time:	Needs periodic refill and maintenance	5 years with periodic maintenance	5 years
Direction:	Can be sprayed at one point at a time	Sprays vertically downwards	Spreads uniformly in all directions
Operation:	Manual operation by trained user	Automatic operation controlled by sensors	Can be dropped or thrown into a fire and operates after it is touched by a flame at 85°C

Question 5a (3 marks)

A student formulated the following research statement.

> The heavier the fire extinguisher, the larger the area that can be extinguished.

Discuss the validity of the research statement. You should include data from the table to support your answer.

B I U x_2 x^2 Ω Σ Styles

Question 5b (3 marks)

All of the fire extinguishers were tested indoors in a laboratory. Use the data in the table to **identify** which extinguisher would be best for use on a forest fire. **Justify** your answer.

B I U x_2 x^2 Ω Σ Styles

Question 5c (1 mark)

During forest fires, trees burn in a combustion reaction. Combustion reactions are chemical reactions that produce heat.

Select the type of reaction in which heat is produced.

Select
- Select
- Decomposition
- Electrolysis
- Endothermic
- Exothermic

Question 6 (15 marks)

High levels of anxiety about school work may cause disruption to sleep. The wellness industry has developed a number of products to help improve sleep.

Video Script

Scientists have suggested that we need to sleep for 7-8 hours to wake up feeling rested and refreshed.

We need sleep for the body to reset its biochemical systems ready for the next day.

If we do not have enough sleep then our understanding of situations, reaction times and decision making can all be affected.

In studies of some of the worst disasters in recent times, sleep deprivation was identified as a direct cause.

Some of the effects of lack of sleep might be a reduction in communication skills, difficulty in critical and creative thinking, a reduction in self-management skills, lower social skills, as well

Video Script

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Some of the effects of lack of sleep might be a reduction in communication skills, difficulty in critical and creative thinking, a reduction in self-management skills, lower social skills, as well as not being able to multi-task or make decisions.

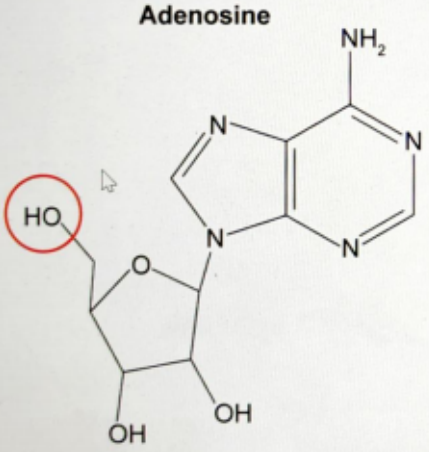
After a night of interrupted sleep, people may reach for coffee or other drinks containing caffeine to "wake them up". In the brain there are molecules such as adenosine which signal to the body that you need sleep.

Adenosine levels rise while a person is awake which causes the body to want to sleep. Sleep reduces the level of adenosine. The structure of adenosine is very similar to caffeine. Caffeine works by tricking the brain to believe there are lower levels of adenosine in the body.

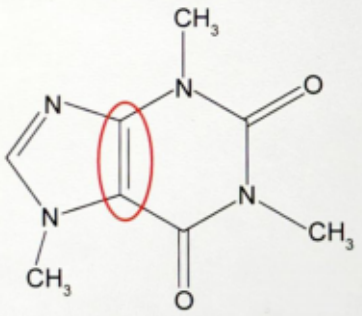
Question 6a (2 marks)

The structures of adenosine and caffeine are shown below.

Adenosine



Caffeine



Identify the functional groups that are circled in adenosine and caffeine.

Adenosine: Select

Caffeine: Select

Question 6a (2 marks)

The structures of adenosine and caffeine are shown below.

Adenosine

Caffeine

Identify the functional g cled in adenosine and caffeine.

Adenosine: Select

Caffeine: Select

Select
Alcohol
Alkene
Carboxylic acid
Ester

Question 6b (13 marks)

Many adults have to travel across the world for work. Sleeping away from home may result in interrupted sleep. Sleep sprays are solutions that contain extracts from plants which are sprayed onto your pillow or body before going to sleep. The aim is that the spray will reduce interruption to sleep. This means you will wake up refreshed in the morning.

Spray A	Spray B	Spray C	Spray D

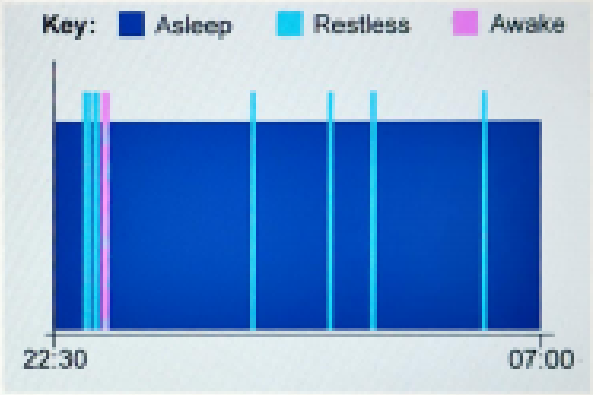
Spray A

Cost / USD:	$23
Volume / ml:	30
Cost per sleep / USD:	$0.38
Plant extracts:	Lavender, basil and jasmine

Spray A	Spray B	Spray C	Spray D

Spray A

Cost / USD:	$23
Volume / ml:	30
Cost per sleep / USD:	$0.38
Plant extracts:	Lavender, basil and jasmine



Sleep quality:	1 time awake, 6 times interrupted sleep, 8 min awake
Reviewer's comment on waking up:	*I felt sleepy on waking but energized later in the day.*

A hotel is investigating which sleep spray should be provided for long-distance bus drivers to improve their sleep while staying at the hotel. Using the information above and your wider MYP studies, **discuss** and **evaluate** which sleep spray the hotel company should select. In your

A hotel is investigating which sleep spray should be provided for long-distance bus drivers to improve their sleep while staying at the hotel. Using the information above and your wider MYP studies, **discuss** and **evaluate** which sleep spray the hotel company should select. In your answer, you should include:

- an outline of why enough sleep is important for long-distance bus drivers
- a comparison of the impact of each spray on the quality of sleep
- a discussion of the economic considerations of using different sleep sprays
- an evaluation with justification of your choice of spray that the hotel should choose.

Question 7 (9 marks)

Ingredients of sleep sprays often include lavender and sometimes frankincense extracts. The ways these extracts are produced are very different. Frankincense has traditionally been produced in a way that has not changed for hundreds of years, while lavender cultivation has become big business around the world. The video below outlines how each plant extract is obtained.

Video Script

Frankincense is harvested by families in villages.

The frankincense is formed from cutting the tree by hand. Liquid from the tree collects at the place where it is cut and hardens into a solid. This solid is low grade frankincense.

It takes several cuttings of the tree to make the best quality frankincense.

Each family takes their harvest to market to be sold. This is called the primary product. The frankincense can be used as it is or it can be further processed.

Before it can be used in wellness products, the frankincense must be distilled to produce a concentrated extract with higher purity.

Lavender is grown as bushes in fields.

When ready the lavender is harvested by machine. This is called the primary product.

It is sold in bulk and taken to factories to be distilled to produce the lavender extract.

The lavender extract can now be used in many wellness products.

The table below gives data about the production of frankincense and lavender extracts.

	Frankincense	**Lavender**
Source	From the boswellia tree. On the endangered species of plants list	From the lavender bush. Easy to replant and harvest
Growing conditions	Dry climate, rocky landscape, low volume of water needed to grow	Temperate climates on land that could be used to grow food. High volume of water needed to grow
Labour	Farmers in small villages	Farmed in large agricultural areas
Social	Supports farmers who have been harvesting this product for centuries. Low transport costs to take to market	Large scale farming methods and undertaken by large corporations. Highly industrialized process
Cost of 15 ml of extract / $	90.67	30.67
Mass of primary product to produce 15 ml of extract / kg	0.25	1.36

Labour	Farmers in small villages	Farmed in large agricultural areas
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Cost of 15 ml of extract / $	90.67	30.67
Mass of primary product to produce 15 ml of extract / kg	0.25	1.36
Production per year	Each family farm will have 1-2 trees. Average yield of a tree is 261 g (low mass, family-based production)	Average yield of a lavender field is 3264 kg per acre (unlimited, industrialized commercial production)

Using the information provided, **discuss** which plant extract would be the best for the sleep spray industry to use.

In your answer you should consider:

- the social impact of each extract

Using the information provided, **discuss** which plant extract would be the best for the sleep spray industry to use.

In your answer you should consider:

- the social impact of each extract
- the environmental impact of each extract
- the final choice of extract with justification.

B I U Styles