Question 1 (5 marks)

Artists use and apply their scientific knowledge and understanding to paint beautiful portraits and produce art work like the portrait shown on the right.

Watch the video below to answer the following questions.

Steve Spangler Science

Roger Oncoy

Question 1a (1 mark)

Write down what you see happening to the colours in the video when the liquid is added.

Question 1b (1 mark)

State the name of the physical process affecting the colours in the video.

Question 1c (3 marks)

Explain how the rate of the process in part (b) could be changed by altering the temperature.

Prediction

Explanation

Question 2 (7 marks)

Skin is a living organ that needs care to remain healthy. The skin contains natural oils that limit evaporation of water. Many people use cosmetic products and creams to replace the natural oil lost from the skin as part of the aging process. New creams and techniques are being developed to increase oil levels in skin.

Galvanic facial treatment_istock

Recently, a new technique in skin care is being developed in which dermatologists use small electric currents to improve the absorption of creams. This is called galvanic facial treatment.

Question 2a (1 mark)

Skin is naturally regenerated as old cells are replaced by new ones.

State the name of the cell division process by which these cells are replaced.

Question 2b (3 marks)

In galvanic facial treatment a cream containing a positively charged active ingredient is applied to the skin. A positively charged electrode is put in contact with the skin.

Explain how galvanic facial treatment can improve the absorption of the active ingredient into the skin.

Question 2c (3 marks)

Electroporation is a technique used to introduce bioactive molecules into cells. In electroporation, a voltage is applied across skin cells, which allows a small electric current to pass through cells. This current changes the characteristics of the outer layer of skin cells. If a voltage of 2 kV is applied across the face, the current passing through the skin is 250 mA.

Use the formula sheet to **calculate** the resistance of human skin.

Question 3 (10 marks)

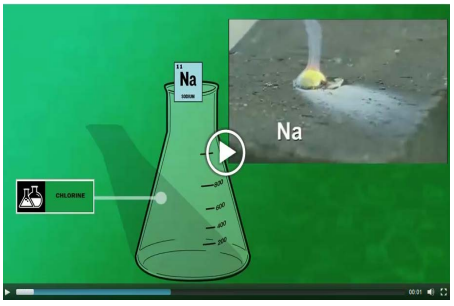
Scientists have used their creativity to produce dazzling firework displays. One of the uses of group one elements is to produce bright colours in fireworks.

The flask in the simulation contains chlorine gas. Click on the video in each tab to observe the reaction of each element with chlorine.

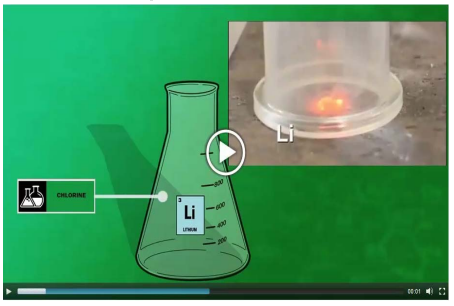
Question 3a (2 marks)

Potassium

Sodium



Lithium



Group one elements are highly reactive.
Outline the reason for the high reactivity of group one elements.

Question 3b (3 marks)

Select one reaction from the videos above and **write down** a balanced chemical equation for this reaction. Include state symbols in your answer.

Caesium (Cs) is another group one element. It will also react with chlorine.

Question 3c (2 marks)

Using your knowledge of periodic trends, **compare and contrast** the reactions between caesium and chlorine, **and** lithium and chlorine.

Question 3d (3 marks)

Francium (Fr) is also a group one element. Francium is very rare and it is never found in nature as an uncombined element.

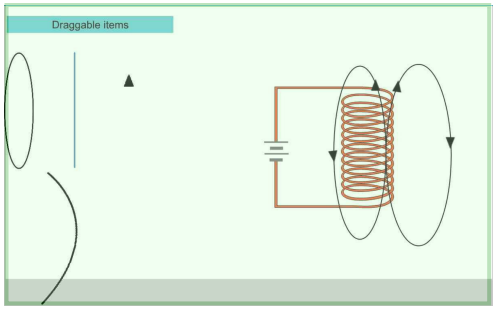
Apart from being rare, **explain** why francium is never found as an uncombined element.

Question 4 (9 marks)

When a current flows through a wire it generates a magnetic field. If the wire is coiled around a core a electromagnet can be formed.

Question 4a (3 marks)

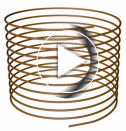
Select shapes to **construct** a diagram showing the magnetic field lines around and through the coil of wire below.



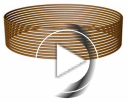
Question 4b (3 marks)

The flow of the direct current through the coil generates a force.

Select what happens to the coil when a direct current flows and **explain** why the generated force has this effect on the coil.



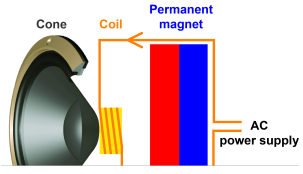
◉ Compression

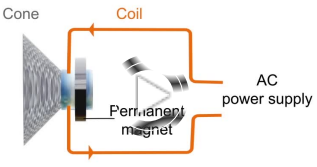


○ Extension

Music is one of the most common ways people express their ideas and feelings. The enjoyment of the beauty of music relies on electrical speakers which convert electrical signals into sound waves.

The generation of the sound wave depends on the back and forth vibrational movement of the cone.





Question 4c (3 marks)

Explain how this motion could be obtained by allowing an alternating current to pass in the coil.

Question 5 (15 marks)

A bioassay is a kind of biosensor that uses sensitive living material (cells, tissues or organisms) to measure the effects of environmental conditions or chemicals, including drugs and toxins.The LD50 (Lethal Dose 50 %) is the concentration at which 50 % of a test population of cells or organisms is killed within a specified period.

Question 5a (2 marks)

Suggest meanings for the initials in LD25.

A student designed a scientific investigation to study the effect of sodium chloride (NaCl) on germination rates in mung beans.Groups of 30 seeds were placed on absorbent material wetted with a range of sodium chloride solutions in six covered petri dishes. The numbers of germinated seeds were checked daily over 5 days.

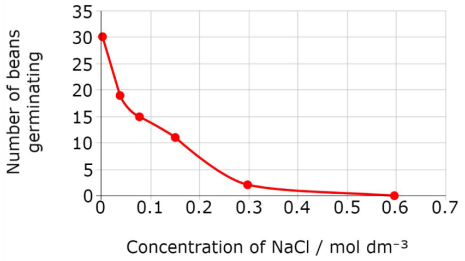
Question 5b (3 marks)

Formulate and **explain** a hypothesis that the student's experiment may have been testing.

Question 5c (2 marks)

The number of beans that had germinated at the end of the investigation are shown in the graph.

Use the graph to determine the LD50 from the student's results.



Question 5d (4 marks)

Water must move into cells for germination to start. The concentration of NaCl in seawater is about 0.5 mol dm^{-3}.

Use your answer to part (c) to **explain** why seawater cannot be used to water agricultural crops.

Question 5e (4 marks)

Explain how the student could improve **and** extend the investigation method.

Improvement

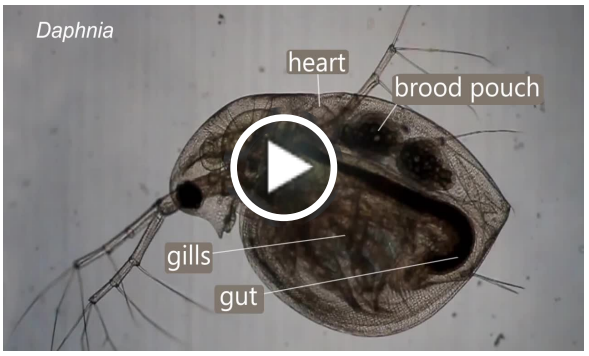
Explanation

Extension

Explanation

Question 6 (15 marks)

Daphnia are fresh-water organisms between 1 – 5 mm in length. They are found all around the world in water temperatures up to 40°C. Daphnia are transparent organisms, and their feeding, egg production and heart rates are easily observed. They mature and breed very rapidly. In the wild Daphnia are an important source of food for pond organisms. Most Daphnia will be eaten soon after hatching.



Question 6a (12 marks)

Design a scientific investigation to observe *Daphnia*'s response to varying water temperature within the range of its natural environment. In your answer you should include:

- a list of suitable equipment
- the independent, dependent and control variables
- how you will manipulate the variables
- how you will collect sufficient data
- a description of the method
- any relevant safety or ethical considerations.

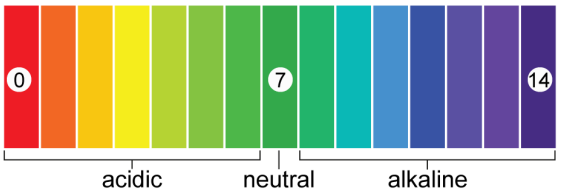
A student suggested that Daphnia's response to increasing temperature is a useful model to understand human responses to temperature.

Question 6b (3 marks)

Discuss whether or not this conclusion is valid.

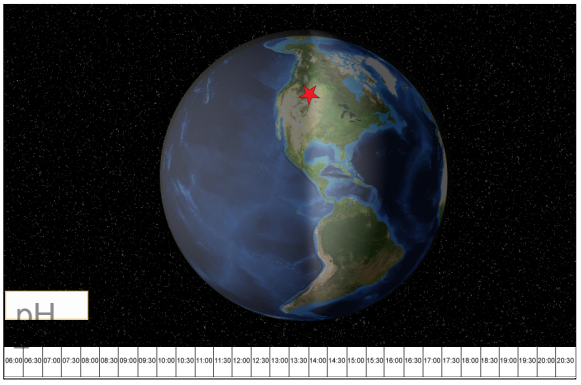
Question 7 (14 marks)

The pH scale is used to measure acidity. Solutions with pH values less than seven are acidic, solutions with pH values greater than seven are alkaline.



Question 7a (2 marks)

The freshwater organisms in a pond are part of a complex food web. *Daphnia* feed on single celled plants called algae.A student wanted to investigate whether the algae and Daphnia living in a pond changed the pond's environment during a 12 hour period. Use the simulation to collect values of pH. **Select** appropriate times of day and record the data in the table below.

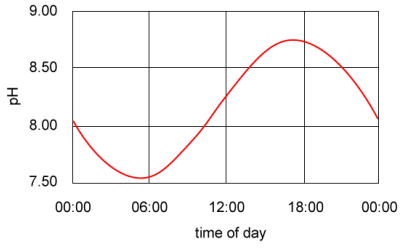


Question 7b (6 marks)

By interpreting your data from part (a), **explain** your results using scientific knowledge from your MYP studies.

Question 7c (6 marks)

The graph below shows how the pH of the pond changes over a 24 hour period in the summer.



Describe how the shape of the graph would change in winter and **explain two** reasons for any differences.

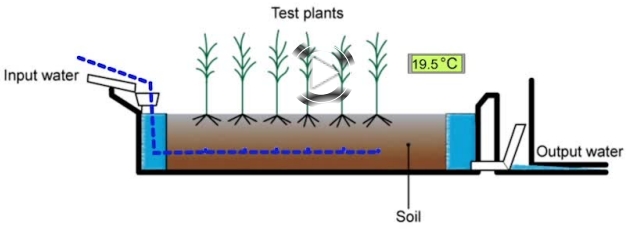
Description

Reason 1

Reason 2

Question 8 (16 marks)

Storm water comes from rainfall that collects in paved and built up areas. As the water collects it picks up nutrients from the surroundings. Sometimes storm water is deliberately drained through an area of land covered with plants that tolerate flooding before it reaches a pond or river. The “ecologically enhanced” storm water treatment system limits the amount of nutrients that are carried by the water and so reduces the over fertilization of the pond. Your school has access to a plant test bed used to model treatment systems that remove nutrients from storm water. An animation of this test bed is shown.



Question 8a (4 marks)

Identify the variables that you could test in the model plant test bed.

Independent variable

Dependent variable

Control variable 1

Control variable 2

Question 8b (2 marks)

Formulate a testable hypothesis to investigate the effect of the independent variable on the dependent variable from part (a).

Question 8c (10 marks)

Describe how you would use the model test bed to collect data that would help you test the hypothesis you gave in part (b). You may wish to include additional equipment in your method.

Question 9 (13 marks)

A disease outbreak may occur in a certain geographical area, or may extend over several countries. The outbreak may last for a few days or weeks, or for several years.

The World Health Organization also points out that an outbreak can be a re-appearance of a long absent disease caused by a pathogen. Any suspected outbreak should be reported and investigated.

The graphic shows some different disease outbreaks that have occurred over the years around the world.

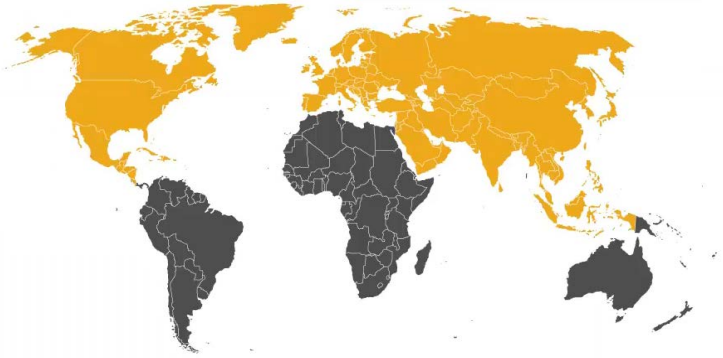
541 - 542: The plague of Justinian (Bubonic Plague) It ravaged areas of modern-day Europe, Northern Africa, and Russia, killing 5,000 people a day at its peak.

Areas affected/pandemic

1829 - 1851: The second cholera pandemic

This pandemic began, like the first, with outbreaks along the Ganges River delta in India. From there, the disease spread along trade routes to Asia, Europe and North America in 1829, lasting 20 years. Symptoms included vomiting, dehydration and diarrhea. The disease is thought to have killed over 100,000 people.

Areas affected/pandemic



1918 - 1923: The flu pandemic (Spanish flu)

The 1918 Spanish Flu Pandemic coincided with the end of the First World War and struck worldwide. It was a one of the worst influenza pandemics in history, killing at least 75 million people between 1918 and 1923.

Areas affected/pandemic

2002 - 2003: SARS (Severe Acute Respiratory Syndrome)

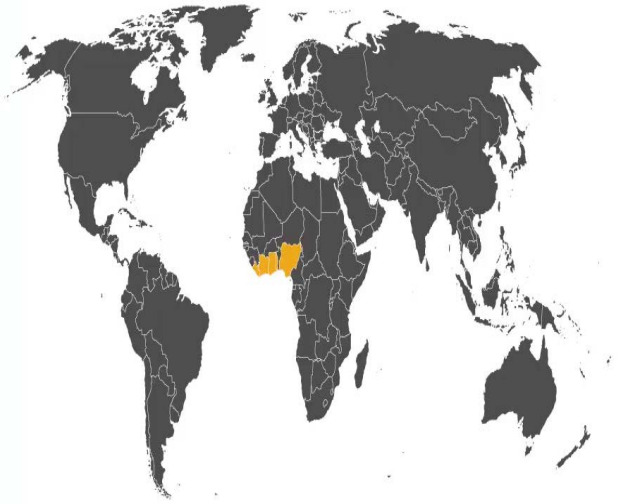
Severe Acute Respiratory Syndrome (SARS) struck in 2002. It started in mainland China and spread throughout Asia in a 12-month period, killing around 775 people. It was caused by the corona virus.

Areas affected/pandemic

2014: West Africa Ebola virus

There were 3,069 confirmed cases as of September 2014, and the figure is now said to exceed 3,800. The outbreak has a mortality rate of around 50 percent.

Areas affected/pandemic

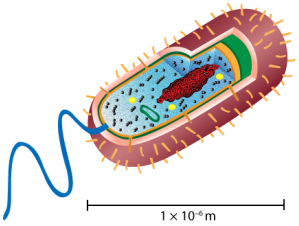


Question 9a (2 marks)

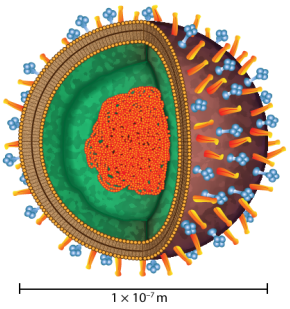
State two ways in which pathogens could enter the body**.**

The images below show the structure of bacteria and viruses.

Bacteria



Viruses

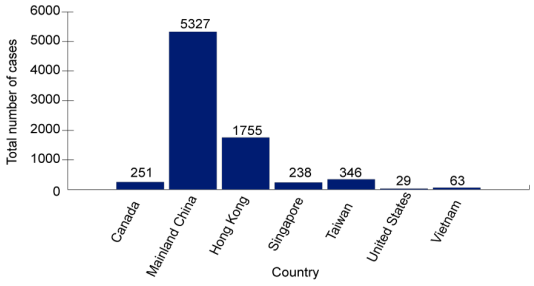


Question 9b (2 marks)

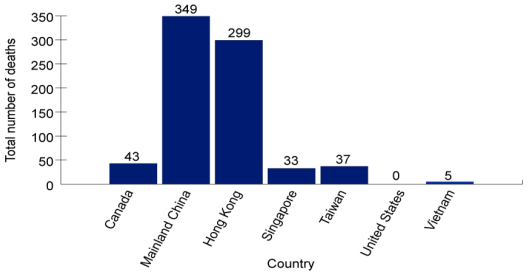
List two differences in structure between bacteria and viruses**.**

Severe acute respiratory syndrome, commonly referred to as SARS, is a respiratory illness that is contagious and sometimes fatal. SARS was first identified in mainland China in November 2002 and within only a few months, the disease spread across the world.

Total number of cases of SARS



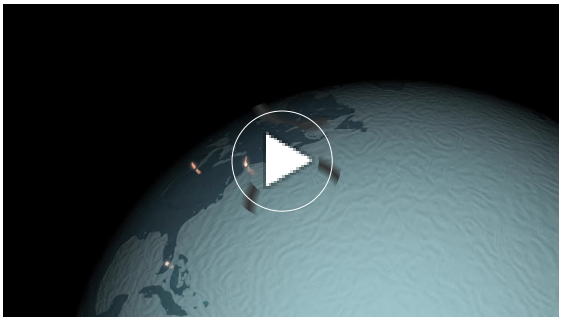
Total number of deaths from SARS

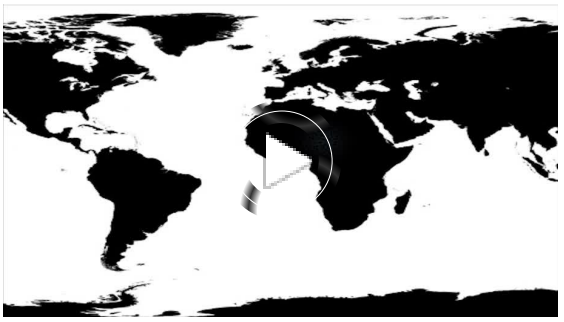


Question 9c (4 marks)

A journalist reported that mainland China had a higher death rate than Hong Kong from this outbreak of SARS. Use the information in the graphs to **explain** if this report is accurate.

The animations below show how a disease can spread rapidly around the world.





Question 9d (2 marks)

Outline how a disease can move quickly around the world.

Question 9e (3 marks)

Describe the social effects on your local community that could be caused by a worldwide disease outbreak.

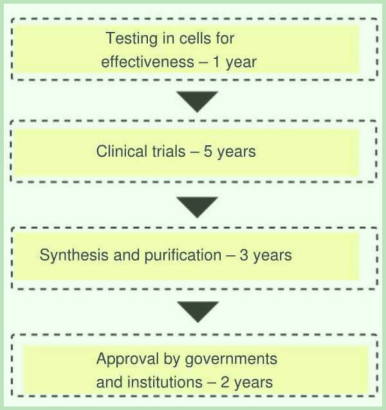
Question 10 (16 marks)

Local governments are responsible for ensuring access to healthcare for their populations. They should do their best to give access to quality health services for all. However, around two billion people worldwide – more than 80 % of them in low-income countries – have inadequate or no access to essential medicines and vaccines, and many have difficulty paying for medical care. The death toll due to limited access to medicines is estimated at ten million people a year.

The research, development and testing of new drugs is a lengthy, very costly process which is rigidly controlled by governments in many countries. In most countries, drugs must be subjected to thorough laboratory and clinical studies that demonstrate their usefulness and safety. Before studies on humans are permitted, the drugs are extensively tested on animals and cell cultures.

Question 10a (2 marks)

Organize the stages of the drug development process into the correct order.



Question 10b (14 marks)

Once a pharmaceutical company develops a new drug or medicine, they have the exclusive right to produce and sell it for up to 20 years. No other companies or governments are legally allowed to copy and produce the drug. After 20 years the drug may be made by any company more cheaply.

Discuss and **evaluate** the consequences of the 20 year timescale when developing drugs to control disease outbreaks. In your answer you should consider:

- the impact of drugs on pathogen transformation
- the ethical issues of limiting access to expensive new drugs on an individual and a community
- the economic considerations of the company investing in research
- the relationship between the factors you have discussed.