



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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**21ST CENTURY SCIENCE**

**0608/05**

Paper 5

**October/November 2009**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen.  
You may use a pencil for any diagrams or graphs.  
Do not use staples, paper clips, highlighters, glue or correction fluid.  
**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.  
At the end of the examination, fasten all your work securely together.  
The number of marks is given in brackets [ ] at the end of each question or part question.

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1	
2	
3	
4	
5	
<b>Total</b>	

This document consists of **14** printed pages and **2** blank pages.



## Disappearing Glaciers

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Most of the planet's glaciers are in areas of high mountains where temperatures are always below 0°C. These glaciers are melting so fast that many will disappear by the middle of this century. Figures from the World Glacier Monitoring Service show that although melt rates for 2007 were much less than the record levels of the year before, the loss of ice was still very high.

If the climate warms at a rate in the middle of the range of estimates given by scientists, then there's no hope for

small glaciers. The large glaciers in Alaska and the Himalayas will take longer to melt, but even these will be much, much smaller.

Although the total mass of glaciers would vary with natural changes in temperatures and snowfall, climate scientists believe the sustained losses of recent decades are partly due to man-made global warming, with the 10 hottest years on record coming in the last 11 years.

"The general trend to increased loss rates is continuing," said Professor Haeberli of the World Glacier Monitoring Service. "2007 was a little bit less terrible than the previous year, but still a very heavy loss. It's still two times the average loss rate of the 20th century."

Although the data only covers some of the world's glaciers, its figures are supported by reports from experts from around the globe.

In 2006, the UN's Intergovernmental Panel on Climate Change forecast that if current trends continue, 80% of Himalayan glaciers will be gone in 30 years from that date, although more recent estimates have suggested 2070. Those glaciers feed all the main river systems in Asia, depended on by 40% of the world's population.

The US Geological Survey warned that sea-level could rise by as much as 1.5 metres by the end of this century, partly due to increased melting of the glaciers in Antarctica and Greenland.

1 This question is based on the article 'Disappearing Glaciers'.

(a) (i) All the research in this article took place in high mountains.

Explain why most glaciers are in high mountains.

.....[1]

(ii) In which year did the glaciers melt most?

Put a ring around the correct answer.

2006      2007      2008      2060      [1]

(b) The melting of glaciers is a measure of global warming. This is thought to be caused by an increase in carbon dioxide in the atmosphere.

Explain how carbon dioxide causes the atmosphere to heat up.

In your answer you should include

- the electromagnetic spectrum emitted from the Sun
- what happens to radiation on the Earth
- what happens to radiation in the atmosphere

.....  
.....  
.....  
.....  
.....  
.....[3]

(c) (i) Write the earliest and latest dates by which scientists expect 80% of the Himalayan glaciers to be gone.

earliest date ..... latest date ..... [2]

(ii) Explain why scientists are particularly concerned about the predicted loss of Himalayan glaciers.

.....  
.....  
.....[3]

(d) The melting of glaciers may make sea-levels rise even higher than was feared.

State and explain **one** serious consequence of sea-level rise.

.....  
.....[2]

(e) Look at the opinions of these two scientists:



**Dr Arnold**  
The amount of carbon dioxide in the atmosphere is increasing, due to the burning of fossil fuels. The global warming that is taking place must be due to this.

**Dr Gupta**  
I agree that the carbon dioxide in the atmosphere is increasing, and that the Earth is getting hotter. I just do not think that the carbon dioxide is responsible for the changes we are seeing.



(i) Use what these two scientists say to explain the difference between **correlation** and **cause**.

.....  
.....  
.....  
.....[3]

(ii) Suggest what further information Dr Gupta would need to be persuaded that Dr Arnold was right.

.....  
.....[1]

**[Total: 16]**

**Life beyond Earth**

Mankind has long wondered if there is life on other planets. In recent years, two quite different areas of research have led to some interesting findings.

**Our Solar System**

Early science fiction stories put alien life on most planets of the Solar System, but now we know that many are far too hot or too cold. Life as we know it requires energy, and most probably also liquid water. Two places in the Solar System currently seem to offer both: the planet Mars, and Enceladus, the eighth moon of the planet Saturn.

Although Mars now seems too cold and dry, it may once have had life. NASA's Phoenix mission, which landed near Mars' north pole, detected water in the form of ice. It also found the soil had chemicals needed for the life of microorganisms.

The Cassini spaceprobe detected jets of water and other chemicals typical of life being ejected from geysers on the surface of Enceladus. This shows that there must be both water and warmth not far below the surface.

**Extra-solar planets**

These are planets around stars other than our Sun. Even the nearest star is about 4 light-years away, so these planets are very hard to detect, particularly from the Earth's surface.

Newer telescopes have been able to see these planets directly, even though they are extremely close to the stars that they orbit. Observations of the planets with these telescopes allow astronomers to work out what chemicals are in their atmospheres. In this way, chemicals such as methane and water have been detected. This does not prove that there is life on these distant planets, but it does show that the conditions needed for life are present there.

**Is the research worthwhile?**

Sending space-probes to search for possible life on Mars, or on Enceladus, is extremely costly. Even the telescope research into extra-solar planets is expensive. Many scientists and politicians feel that this research is interesting, but that the money could be much better spent on other projects.

2 This question is based on the article 'Life beyond Earth'.

(a) Explain why scientists would not expect to find life on

(i) the planet Mercury, which orbits very close to the Sun  
.....[1]

(ii) the dwarf planet Pluto.  
.....[1]

(b) There have been more space missions to Mars than to any other planet.

Suggest **one** reason why.

.....  
..... [1]

(c) Write down **two** chemicals, that have been discovered in moons and planets, which show the possibility of life.

..... and ..... [2]

(d) (i) State the meaning of **extra-solar planets**.

.....  
..... [1]

(ii) Detecting chemicals in the atmosphere of extra-solar planets is not easy from the Earth's surface, but it has been done using telescopes in orbit around the Earth.

Explain why orbiting telescopes are able to make better observations than those on the Earth's surface.

.....  
.....  
..... [2]

(e) The nearest star to our Solar System is 4 light-years away.

Explain the meaning of the unit **light-year**.

.....  
..... [2]

(f) Many people think that the money spent on astronomical research could be better spent on projects on Earth.

(i) Suggest one project on Earth which they might prefer and give one reason for spending money on this.

.....  
..... [2]

(ii) Give reasons for spending money on space research.

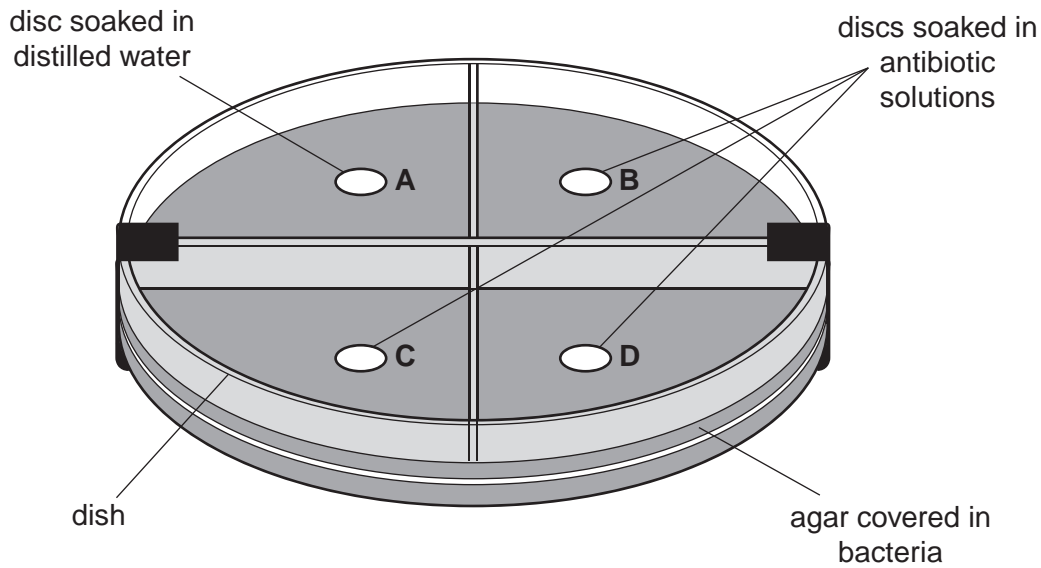
.....  
..... [2]

[Total: 14]

3 Antibiotics are chemicals that kill bacteria.

Martha investigates three different antibiotics, **B**, **C** and **D**.

She uses a dish containing nutrient jelly (agar) covered with bacteria.



She soaks one disc of filter paper in distilled water and places it in area **A**.

Three further discs of filter paper, each soaked in a different antibiotic, are placed at **B**, **C** and **D**.

All the discs of filter paper are 5 mm in diameter.

Martha then seals the dish with tape and leaves it in a warm place for 2 days.

(a) Working with bacteria can be dangerous.

Suggest **two** safety precautions Martha should take when setting up her experiment.

.....

.....

..... [2]

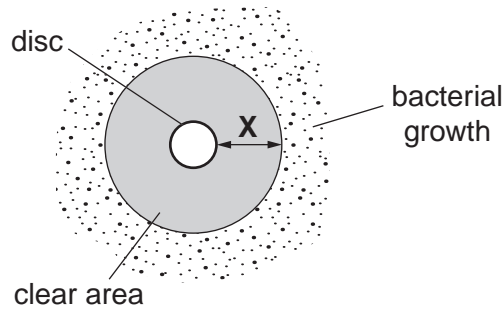
(b) Explain why Martha soaks one of the discs in **distilled water**.

.....

..... [1]

(c) After two days, Martha looks at the dish.

She sees a clear area around two of the discs. The bacteria in the clear areas have died.



She measures the distance **X** for each area.

The table shows her results.

disc	distance X
A	0
B	9
C	0
D	5

(i) Which antibiotic, **B**, **C** or **D**, kills most bacteria?

.....[1]

(ii) Explain your answer.

.....  
.....[1]

(d) Martha repeats her experiment four more times.

(i) Suggest why Martha repeats her experiment.

.....  
.....[1]

(ii) Suggest **two** factors that must be kept the same in all the experiments so that results can be compared.

.....  
.....  
.....[2]



(e) Martha notices that, in all of her experiments, no bacteria are killed by antibiotic C.

Suggest and explain a reason for this.

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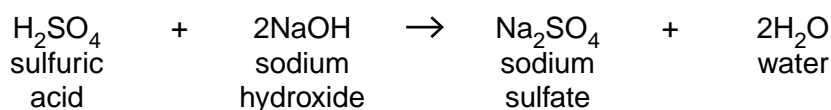
..... [2]

**[Total: 10]**

- 4 Acid rain is produced when the pollutant gas sulfur dioxide reacts with oxygen and water in the air. Acid rain contains sulfuric acid,  $\text{H}_2\text{SO}_4$ .

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Sulfuric acid reacts with sodium hydroxide to produce a neutral solution of sodium sulfate.

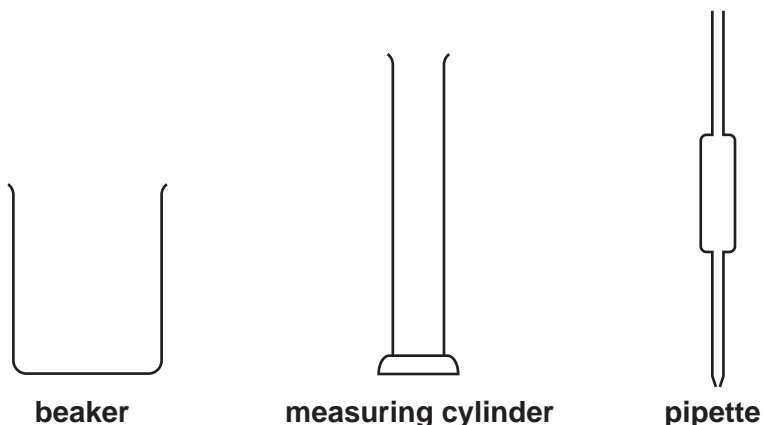


Using this reaction, Ali measures the concentration of sulfuric acid in three different samples of rain water, **A**, **B** and **C**.

Ali uses the following procedure, called a titration.

- 1 Measure  $25.0\text{ cm}^3$  of the rain water into a conical flask.
- 2 Add a few drops of indicator.
- 3 Add sodium hydroxide solution slowly from a burette.
- 4 Stop adding sodium hydroxide solution when the indicator changes colour.

(a) (i) Look at these three pieces of apparatus.



Which of these pieces of apparatus would be the best choice for measuring  $25.0\text{ cm}^3$  of each sample of rain water?

..... [1]

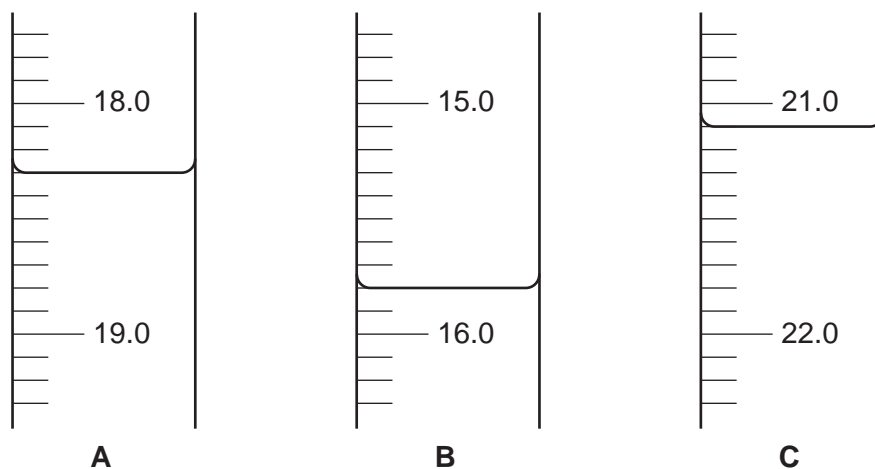
(ii) Explain why this is the best choice.

.....  
..... [1]

- (b) Ali fills the burette with sodium hydroxide solution to the 0.0 cm<sup>3</sup> mark before each titration.

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The diagrams show the position of the meniscus in the burette at the end of each titration.



- (i) Write down the volumes of sodium hydroxide used in each titration in this table.

sample of rain water	volume of sodium hydroxide (cm <sup>3</sup> )
<b>A</b>	
<b>B</b>	
<b>C</b>	

[2]

- (ii) List the three samples of rain water, **A**, **B**, and **C** in order of **increasing** concentration of sulfuric acid.

least concentrated ..... [2]

- (c) (i) Why does Ali add the sodium hydroxide solution **slowly**?

..... [1]

- (ii) Explain why Ali adds indicator to the rain water.

..... [1]

(d) Ali uses the **same** burette for each titration.

He uses a **different** piece of the same type of apparatus to measure  $25.0\text{cm}^3$  of each sample of rain water.

Explain why.

.....

.....

.....

.....[2]

**[Total: 10]**

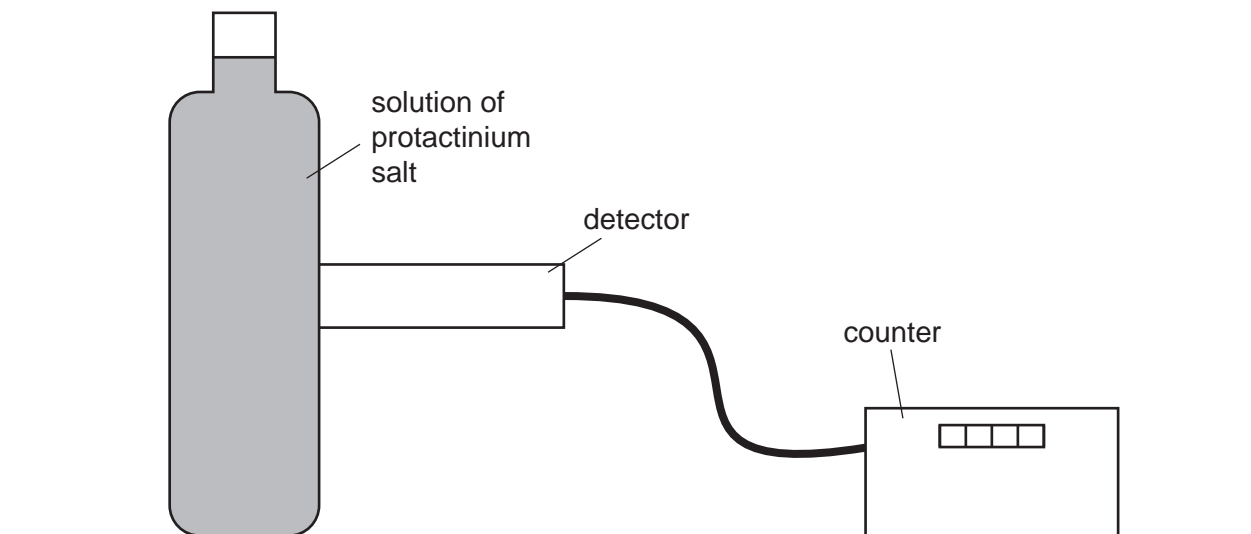
- 5 Radioactive substances get less active with time.  
After one half-life, the activity is half what it was at the start.  
Two students are going to measure the half-life of a radioactive isotope of protactinium.  
Before making measurements of the radiation given out by the protactinium salt, the students make 5 measurements of the background count.

measurement number	1	2	3	4	5	mean
count per 10 seconds	2	4	3	4	2	

(a) Calculate the mean count per 10 seconds.

mean count per 10 seconds ..... [1]

- (b) A solution of the protactinium salt is freshly prepared and put into a bottle. A radiation detector is placed next to the bottle.



The count rate is recorded for three minutes. The results are shown in the table.

time from start (seconds)	0	20	40	60	80	100	140	180
corrected count per 10 seconds	260	215	170	149	112	98	68	46

- (i) Each reading on the counter was corrected by subtracting the mean background count.

Explain why the students had to subtract the background count.

.....  
 ..... [1]

- (ii) At first the students recorded the rate every 20 seconds, but later only every 40 seconds.

Explain why.

.....  
 ..... [2]

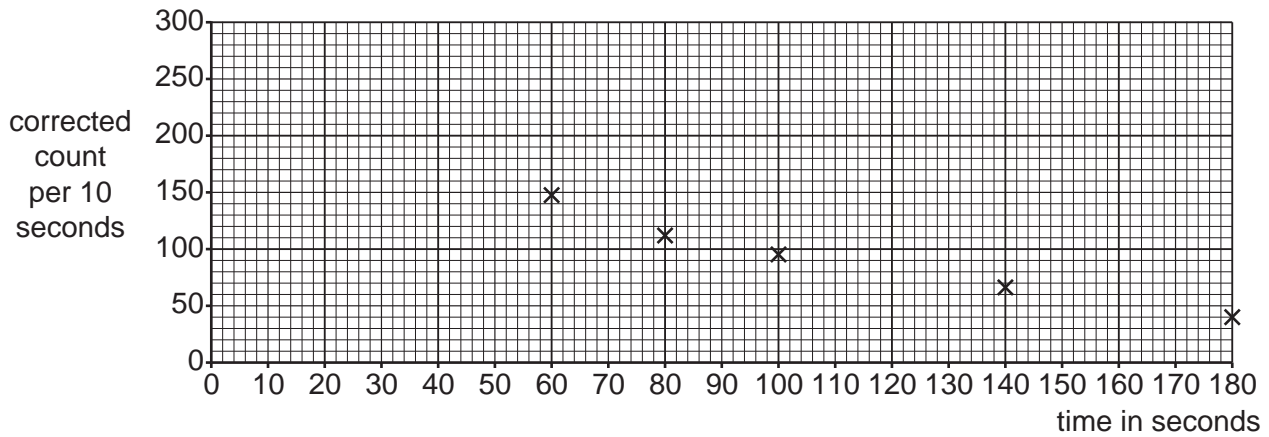
- (iii) The results from this experiment are very variable.

Suggest how the students could get data which are more reliable.

.....  
 .....  
 ..... [2]

- (c) The data from the table are plotted on the graph below.  
The first three data points are missing.

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- (i) Add the first three data points to the graph. [2]
- (ii) Draw a best-fit curve through the points. [1]
- (iii) The half-life is the time taken for the count to drop to half its value. The half-life of protactinium is 70 seconds.

Explain whether the graph confirms this. Show your working on the graph or in this space.

[1]

[Total: 10]



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