Read the instructions on the ANSWER SHEET and fill in your NAME, SCHOOL and OTHER INFORMATION.
Use a pencil. Do NOT use a coloured pencil or a pen.
Rub out any mistakes completely.
You MUST record your answers on the ANSWER SHEET.
Mark only ONE answer for each question.
Your score will be the number of correct answers.
Marks are NOT deducted for incorrect answers.
Use the information provided to choose the BEST answer from the four possible options.
On your ANSWER SHEET fill in the oval that matches your answer.
You may use a calculator and a ruler.

STUDENT’S NAME:
1. The flow chart distinguishes between some classes of stars.

Sirius is a white star which has a surface temperature of 10 000 °C. Its spectrum has hydrogen but no strong metallic lines.

What class of star is Sirius?

(A) A Class  
(B) B Class  
(C) F Class  
(D) O Class
2. In order to X-ray the digestive system, it is necessary to swallow a dense and very insoluble substance which will not react with the chemicals (mainly water and hydrochloric acid) in the stomach.

Information about some substances is given in the table.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Density (g/cm³)</th>
<th>Solubility in water (g/100 mL)</th>
<th>Reaction to hydrochloric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>caesium carbonate</td>
<td>4.0</td>
<td>$2.6 \times 10^{17}$</td>
<td>reacts to form carbon dioxide</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>3.9</td>
<td>$9.9 \times 10^{-18}$</td>
<td>reacts to form iron (III) chloride</td>
</tr>
<tr>
<td>barium sulfate</td>
<td>4.5</td>
<td>$2.5 \times 10^{-4}$</td>
<td>does not react</td>
</tr>
<tr>
<td>magnesium sulfate</td>
<td>2.7</td>
<td>$3.6 \times 10^{-1}$</td>
<td>does not react</td>
</tr>
</tbody>
</table>

Which substance shown would be most suitable for use when X-raying the digestive system?

(A) caesium carbonate
(B) iron(III) hydroxide
(C) barium sulfate
(D) magnesium sulfate

3. A scientist wanted to investigate the effects of two types of antibiotics, X and Y, on the growth of the bacterium, E. coli. He grew five cultures of the bacterium in a growth medium placed on separate Petri dishes like the one shown.

Information about the preparation of the five dishes is shown in the table.

<table>
<thead>
<tr>
<th>Petri Dish</th>
<th>Experimental Condition</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of growth medium in dish (mL)</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>20</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Type of antibiotic added to dish</td>
<td>X *</td>
<td>X *</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Amount of antibiotic added to dish (mL)</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Temperature at which dish is kept (°C)</td>
<td>30</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Which two dishes should he use to compare the effects of X and Y on the growth of the bacteria?

(A) I and III
(B) II and V
(C) III and IV
(D) IV and V
4. Serial dilution is a procedure used to make a very dilute solution. The procedure for diluting a solution of copper sulfate is shown.

A student estimated that there were 1,000,000 particles of the dissolved substance in the initial solution.

How many dilutions would she have to perform to obtain a solution with approximately 100 particles of the dissolved substance?

(A) 3  (B) 4  (C) 5  (D) 6
5. Reports about science experiments often include:

- a title
- an introduction
- an aim
- a method of how the experiment was to be carried out
- results (what was observed)
- a discussion of the results
- a conclusion

A student wrote a report containing a number of points.

1) "Which liquid is the most viscous?"
2) The viscosity of the liquid is how ‘thick’ it is. The more viscous the liquid, the slower the marble will pass through it.
3) To determine the most viscous: honey, oil or water.
4) Set up three identical jars filled with the different liquids.
5) Drop a marble in each jar at the same time and record the marble’s position after one second.
6) ![Images of jars with different liquids]

<table>
<thead>
<tr>
<th>time = 0 seconds</th>
<th>time = 1 second</th>
</tr>
</thead>
<tbody>
<tr>
<td>honey</td>
<td>honey</td>
</tr>
<tr>
<td>oil</td>
<td>oil</td>
</tr>
<tr>
<td>water</td>
<td>water</td>
</tr>
</tbody>
</table>

7) The marble in the honey was near the top of the jar while the marble in the water was at the bottom of the jar.
8) Water was the most viscous liquid tested.

Which points are the student’s results?

(A) 4 and 5
(B) 5 and 6
(C) 6 and 7
(D) 7 and 8

END OF PAPER
ACKNOWLEDGMENT

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THE FOLLOWING YEAR LEVELS SHOULD SIT THIS PAPER:

Australia  Year 9
Brunei  Form 4
Hong Kong  Form 3
Indian Subcontinent¹  Class 9
Indonesia  Year 10
Malaysia  Form 3
Middle East²  Class 9
New Zealand/Pacific³  Year 10
Singapore  Secondary 2
Southern Africa⁴  Grade 9

¹ Indian Subcontinent Region: India, Sri Lanka, Nepal, Bhutan and Bangladesh.
² Middle East Region: United Arab Emirates, Qatar, Kuwait, Saudi Arabia, Egypt, Bahrain, Oman, Turkey, Lebanon, Tunisia, Morocco, Libya, Algeria and Jordan.
³ Pacific Region: Vanuatu, Papua New Guinea and Fiji.
⁴ Southern Africa Region: South Africa, Botswana, Lesotho, Swaziland, Zimbabwe and Namibia.
TO ANSWER THE QUESTIONS

Example:
Ari added cordial to water to make a jug of drink. What will be the volume of the drink in the jug?

(A) 50 mL
(B) 150 mL
(C) 200 mL
(D) 250 mL

The answer is 250 mL, so you would fill in the oval D, as shown.

USE A PENCIL
DO NOT USE A COLOURED PENCIL OR PEN

START

1
2
3
4
5
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>KEY</th>
<th>KEY REASONING</th>
<th>LEVEL OF DIFFICULTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Sirius does not have strong metallic lines but has strong hydrogen lines. The temperature is irrelevant to this question.</td>
<td>Easy</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>In order to X-ray the digestive system, it is necessary to swallow a dense and very insoluble substance. From the table, barium sulfate has the highest density and lowest solubility; it also does not react with hydrochloric acid. Only the last two chemicals do not react with hydrochloric acid, so answers A and B are wrong. Magnesium sulfate is less dense and more soluble than barium sulfate, so D is wrong.</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>To compare the effect of the two types of antibiotics on the growth of bacterium, <em>E. coli</em>, the scientist needs to make sure that all other possible variables were kept the same except for the antibiotic used. This only happens in petri dishes II and V.</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>Each dilution reduces the concentration by a factor of 10. Therefore to reduce 1 000 000 to 100 we have to divide 1 000 000 four times by 10.</td>
<td>Medium/Hard</td>
</tr>
<tr>
<td>5</td>
<td>C</td>
<td>Results are ‘observations’ made using our five senses, particularly sight. We can see the marbles above the jars at time = 0 s, and we can see the jars with the marbles in them at t = 1 s, at different positions within the liquids. So point 6 and point 7 of the report are observations. Note that which liquid is the most or least viscous is an inference which is based on observations. It itself is not an observation.</td>
<td>Medium/Hard</td>
</tr>
</tbody>
</table>

**LEGEND**

Level of difficulty refers to the expected level of difficulty for the question.

- **Easy**: more than 70% of candidates will choose the correct option.
- **Medium**: about 50–70% of candidates will choose the correct option.
- **Medium/Hard**: about 30–50% of candidates will choose the correct option.
- **Hard**: less than 30% of candidates will choose the correct option.
1 A Sirius does not have strong metallic lines but has strong hydrogen lines. The temperature is irrelevant to this question. Easy

\[
\rho_{\text{Sirius}} = \rho_{\text{Sun}} \times \left( \frac{m_{\text{Sirius}}}{m_{\text{Sun}}} \right) = 1 \times \left( \frac{10}{11} \right) = 0.909
\]

2 C

In order to X-ray the digestive system, it is necessary to swallow a dense and very insoluble substance. From the table, barium sulfate has the highest density and lowest solubility; it also does not react with hydrochloric acid. Only the last two chemicals do not react with hydrochloric acid, so answers A and B are wrong. Magnesium sulfate is less dense and more soluble than barium sulfate, so D is wrong.

3 B

To compare the effect of the two types of antibiotics on the growth of bacterium, *E. coli*, the scientist needs to make sure that all other possible variables were kept the same except for the antibiotic used. This only happens in petri dishes II and V.

4 B Each dilution reduces the concentration by a factor of 10. Therefore to reduce 1 000 000 to 100 we have to divide 1 000 000 four times by 10.

5 C

Results are 'observations' made using our five senses, particularly sight. We can see the marbles above the jars at time = 0 s, and we can see the jars with the marbles in them at t = 1 s, at different positions within the liquids. So point 6 and point 7 of the report are observations. Note that which liquid is the most or least viscous is an inference which is based on observations. It itself is not an observation.