Name: _________________________
Class: _______________

Useful Data: Atomic numbers and relative atomic masses are shown in the periodic table printed below.

### PERIODIC TABLE

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</tr>
</tbody>
</table>

Key: $a$, $b$ = relative atomic mass symbol, atomic number

**Marks Grid [ For Examiner’s use only ]**

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Section A</th>
<th>Section B</th>
<th>Theory Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
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<tr>
<td>Actual Mark</td>
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</table>

Theory Paper: 85%  Practical: 15%  Final Score: 100%
SECTION A – Answer ALL questions. This section carries 60 marks.

1 Place each of the following substances near the best description.

<table>
<thead>
<tr>
<th>Description</th>
<th>Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A dark grey solid that turns into a violet vapour when heated</td>
<td>Calcium chloride</td>
</tr>
<tr>
<td>A metal that reacts with dilute sulfuric acid to produce hydrogen</td>
<td>Zinc</td>
</tr>
<tr>
<td>A pure covalent liquid at room temperature</td>
<td>Diamond</td>
</tr>
<tr>
<td>A monobasic acid</td>
<td>Hydrochloric acid</td>
</tr>
<tr>
<td>An ionic solid at room temperature</td>
<td>Hydrogen chloride</td>
</tr>
<tr>
<td>A gaseous non-metallic element</td>
<td>Iodine</td>
</tr>
<tr>
<td>A compound which is a covalent gas at room temperature</td>
<td>Copper</td>
</tr>
<tr>
<td>A metal that does not react with dilute hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>A substance made of carbon atoms only</td>
<td></td>
</tr>
<tr>
<td>An acid that produces sulfate salts when it reacts with bases</td>
<td></td>
</tr>
</tbody>
</table>

2a. This question is about compounds that contain oxygen. Fill in the table below by writing the chemical formula of each substance and the type of oxide you would expect it to be. Choose from **acidic, basic, neutral or amphotheric**.

<table>
<thead>
<tr>
<th>Chemical formula</th>
<th>water</th>
<th>sulfur dioxide</th>
<th>aluminium oxide</th>
<th>sodium oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of oxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Complete and balance the following equation:

\[ \text{__SO}_2 + \text{__H}_2\text{O} \rightarrow \]
A laboratory analyst wants to obtain a solvent from a dilute copper (II) sulfate solution. She sets up the following apparatus:

a. (i) The separation technique that she is using above is called ________________________. [1]

(ii) The missing labels in the diagrams are:

A ________________________________
B________________________________
C________________________________
D________________________________ [4]

(iii) Name the solvent in the mixture that the analyst is using.

_______________________________________________________________________ [1]

b. (i) Describe how the solvent can be obtained from the mixture using the above apparatus.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________ [2]

(ii) Mention one improvement that the analyst could make to the above experiment setup.
Give a reason.

_______________________________________________________________________
_______________________________________________________________________ [2]
Water, hydrochloric acid and sodium hydride are all compounds that contain hydrogen. To form each of these three compounds, hydrogen needs to react in different ways.

a. (i) Draw a dot-and-cross diagram showing all electron shells to represent the bonding in the compound water.

(atomic numbers: oxygen 8; hydrogen 1)

(ii) The type of bonding between oxygen and hydrogen atoms in water is called _______________ bonding.

b. Consider the following ionization equations:

\[ \text{HCl} \rightarrow \text{H}^+ + \text{Cl}^- \]
\[ \text{NaH} \rightarrow \text{Na}^+ + \text{H}^- \]

(i) Use these equations to help you explain how hydrogen atoms react differently when forming hydrochloric acid and sodium hydride.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

(ii) What type of bonding do these two compounds exhibit?

_______________________________________________________________________

(iii) Draw complete diagrams of an \( \text{H}^+ \) particle and an \( \text{H}^- \) particle.
During an experiment to study the rusting of iron, a student sets up the apparatus shown below. He places an iron nail in each of the boiling tubes and leaves them standing for a week. Then he checks each nail for any sign of rusting.

State, giving reasons, whether you expect the iron nail in each of the 5 boiling tubes shown above to rust or not.

A
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

B
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

C
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

D
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

E
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
6 A sample of water taken from a reservoir was found to contain high levels of suspended particles, common salt, hardness and some bacterial contamination. It was declared unfit for drinking.

a. (i) Name a process by which suspended particles could be removed from a sample of the water.  
_______________________________________________________________________ [1]

(ii) What process is used to reduce the salt content in water but not remove it completely?  
_______________________________________________________________________ [1]

b. (i) Give the chemical name of a compound that might be responsible for:
• Temporary hardness __________________________________________________________________________ [1]
• Permanent hardness __________________________________________________________________________ [1]

(ii) Suggest a simple way by which only temporary hardness can be removed from a sample of water.  
_______________________________________________________________________ [1]

(iii) Suggest two ways by which permanent hardness can be removed from a sample of water.  
_______________________________________________________________________  
_______________________________________________________________________ [2]

(iv) Name one advantage and one disadvantage of hard water.  
_______________________________________________________________________  
_______________________________________________________________________ [2]

c. What chemical is added to water in order to kill bacteria and make it safe for drinking?  
_______________________________________________________________________ [1]
7a. Jane, a chemistry student, wants to prepare a sample of hydrogen gas in the lab and collect it over water.

(i) Describe an experiment she could do to reach her target. Your answer should include:
- The names of 2 substances that could be reacted safely together to produce hydrogen [2]
- A balanced chemical equation showing how these 2 substances react [2]
- The practical steps of the experiment (method) [3]
- A labelled diagram of the apparatus she should use [5]
- Any observations she would make during the experiment [2]

(ii) What property of hydrogen makes it suitable for collecting over water? [1]

(iii) Describe a chemical test to confirm the presence of hydrogen gas and also an important safety procedure to be applied during this test. [2]

b. Hydrogen gas can be collected in a variety of ways.

(i) Name one advantage of collecting hydrogen gas over water. [1]

(ii) Name two other methods by which hydrogen gas can also be collected. [2]
During a science fair Trevor, a chemistry student decides to set up a cool experiment. He places a raw chicken egg in a beaker full of vinegar and leaves it for about two days. He notices that the eggshell reacts with the weak acid in vinegar to produce bubbles and a fizzy sound. After two days, the shell dissolves completely leaving only a thin membrane to hold the egg contents together. John finds out from a chemistry website that most of the eggshell is made of calcium carbonate.

a. (i) What gas was produced from the reaction of vinegar and calcium carbonate in the egg?  
(ii) What is the chemical name of the acid found in vinegar?  
(iii) What is the difference between a weak and a strong acid?  
(iv) What chemical test could Trevor do to show that the acid in vinegar is a weak acid?

b. Trevor decides to repeat the same experiment but using dilute hydrochloric acid instead of vinegar.
(i) Do you expect the eggshell to dissolve slower or quicker than with vinegar? Give a reason for your answer.  
(ii) Write a balanced chemical equation to show the reaction between dilute hydrochloric acid and calcium carbonate.  
(iii) Give two suggestions about what Trevor could do to make this reaction go faster.

c. Trevor decides to repeat the same experiment using dilute sulfuric acid. He notices that the reaction slows down quickly and stops. The eggshell does not dissolve completely as before. John looks up the reaction and finds that the chemical equation is:
\[ \text{CaCO}_3(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{CaSO}_4(s) + \text{H}_2\text{O}(g) + \text{CO}_2(g) \]
Explain why the reaction stops after a short time even though sulfuric acid is a strong acid.

d. Trevor then decides to prepare a sample of calcium carbonate in the laboratory. He uses the precipitation method since calcium carbonate is insoluble in water.
(i) Give the names of 2 water-soluble salts that when reacted will produce a precipitate of calcium carbonate as well as another soluble salt.  
(ii) Write a balanced chemical equation for the reaction between these 2 salts.  
(iii) What simple process can be used to separate the calcium carbonate powder formed from the solution in which it is suspended?
Nitrogen is needed by plants to grow, develop and reproduce. However, most plants can only take up nitrogen in the form of water-soluble compounds from the soil. Artificial fertilizers provide water-soluble nitrogen that can be used by farmers to grow food crops more efficiently.

A farmer discovers 3 different artificial fertilizers on sale. These contain:

A. Potassium nitrate..................$\text{KNO}_3$
B. Ammonium phosphate.........$(\text{NH}_4)_3\text{PO}_4$
C. Ammonium nitrate...............$\text{NH}_4\text{NO}_3$

The farmer needs you to help him buy the fertilizer with the highest amount of nitrogen in it.

a. (i) Work out the formula mass of each of the three compounds A, B and C. Show your working. [3]

(ii) Calculate the percentage mass of nitrogen present in each of the three compounds. [6]

(iii) From your answer, state which of the 3 compounds has the highest percentage mass of nitrogen. [1]

b. (i) State one advantage of using artificial fertilizers. [1]

(ii) State one disadvantage resulting from the use of artificial fertilizers. [1]

c. Natural (organic) fertilizers such as cow manure are considered more eco-friendly.

(i) Explain why organic fertilizers are considered eco-friendly. [1]

(ii) State two disadvantages associated with the use of organic fertilizers such as cow manure. [2]

d. One of the fertilizers, potassium nitrate, can be prepared in the laboratory from dilute nitric acid.

(i) Give the name of a suitable substance that can be safely reacted with dilute nitric acid in order to prepare a sample of potassium nitrate. [1]

(ii) Write a balanced chemical equation to show the reaction between dilute nitric acid and the substance you chose in question d. (i). [2]

(iii) Name a chemical that could be used to determine the point when exact neutralization of the nitric acid and the other substance occurs. [1]

(iv) What processes can be used to obtain crystals of potassium nitrate from the resulting solution? [1]