

FORM 3

CHEMISTRY

TIME: 1h 30min

Name: _____

Class: _____

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

PERIODIC TABLE

PERIODIC TABLE

1	2																	3	4	5	6	7	0	
																								4 He 2
7 Li 3	9 Be 4											11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10							
23 Na 11	24 Mg 12											27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18							
39 K 19	40 Ca 20	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	63.5 Cu 29	65 Zn 30	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36							
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	99 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54							
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	210 Po 84	210 At 85	222 Rn 86							
223 Fr 87																								

Key

a

relative atomic mass

Key

relative atomic mass
symbol
atomic number

Marks Grid [For Examiner's use only][illegible]

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.

water	oxygen	sulfuric acid	hydrogen chloride
calcium chloride	zinc	diamond	iodine
	hydrochloric acid	copper	

<i>Description</i>	<i>Substance</i>
A dark grey solid that turns into a violet vapour when heated	
A metal that reacts with dilute sulfuric acid to produce hydrogen	
A pure covalent liquid at room temperature	
A monobasic acid	
An ionic solid at room temperature	
A gaseous non-metallic element	
A compound which is a covalent gas at room temperature	
A metal that does not react with dilute hydrochloric acid	
A substance made of carbon atoms only	
An acid that produces sulfate salts when it reacts with bases	

[10]

- 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 amphoteric**.

	water	sulfur dioxide	aluminium oxide	sodium oxide
<i>Chemical formula</i>				
<i>Type of oxide</i>				

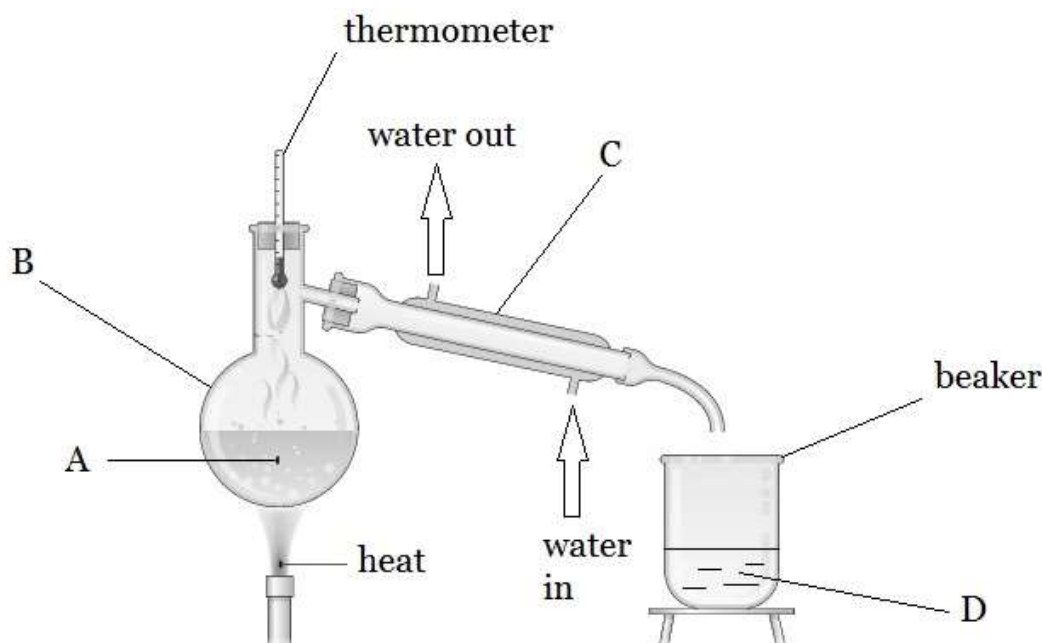
[8]

- b. Complete and balance the following equation:



[2]

- 3 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]

4 Water, hydrochloric acid and sodium hydride are all compounds that contain hydrogen. In 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)

[2]

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

[1]

- b. Consider the following ionization equations:



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

[2]

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

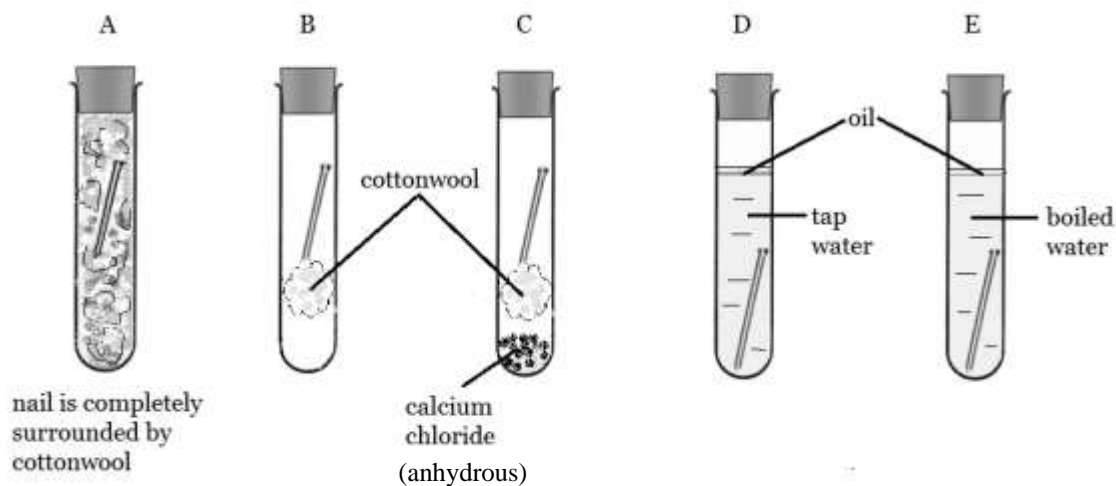
[1]

- (iii) Draw complete diagrams of an H^+ particle and an H^- particle.

H^+	H^-
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[4]

- 5 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** _____

 _____ [2]
- B** _____

 _____ [2]
- C** _____

 _____ [2]
- D** _____

 _____ [2]
- E** _____

 _____ [2]

- 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]

SECTION B – Answer TWO questions only on the foolscap provided.
This section carries 40 marks.

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.

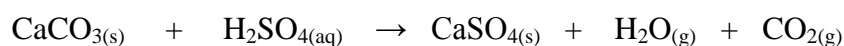
(i) Name **one** advantage of collecting hydrogen gas over water. [1]

(ii) Name **two** other methods by which hydrogen gas can also be collected. [2]

- 8 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? [1]
- (ii) What is the chemical name of the acid found in vinegar? [1]
- (iii) What is the difference between a weak and a strong acid? [2]
- (iv) What chemical test could Trevor do to show that the acid in vinegar is a weak acid? [2]
- 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. [2]
 - (ii) Write a balanced chemical equation to show the reaction between dilute hydrochloric acid and calcium carbonate. [2]
 - (iii) Give **two** suggestions about what Trevor could do to make this reaction go faster. [2]
- 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:



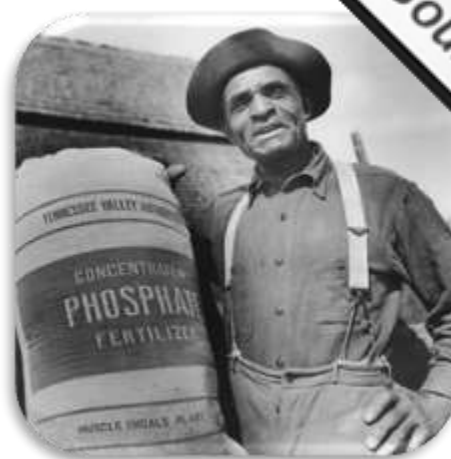
Explain why the reaction stops after a short time even though sulfuric acid is a strong acid. [3]

- 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. [2]
 - (ii) Write a balanced chemical equation for the reaction between these 2 salts. [2]
 - (iii) What simple process can be used to separate the calcium carbonate powder formed from the solution in which it is suspended? [1]

- 9 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..... KNO_3
- B. Ammonium phosphate..... $(\text{NH}_4)_3\text{PO}_4$
- C. Ammonium nitrate..... NH_4NO_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]