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O Level

Chemistry

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540/1

CHEMISTRY

ORDINARY LEVEL

THEORY (ALTERNATIVE N)

(Two hours and a half)

Answer Question 1 *and any* **four** *other questions.*

Candidates are advised to spend not more than 50 *minutes in answering Question* 1.

Unless otherwise stated, equations must be given wherever possible and diagrams where they are helpful.

Names, not symbols, must be used in descriptive work for all reacting chemicals and for the products formed.

Mathematical tables are provided.

Essential working must be shown.

[H = 1; N = 14; O = 16; Na = 23; S = 32; Cl = 35·5; Cu = 64; Ba = 137. One gram-molecular weight of a gas occupies 22·4 litres at N.T.P.]

1 (*a*) (i) Name **two** harmful gaseous impurities often present in small quantities in the air of industrial towns.

(ii) Explain how nitrogen is returned to the soil as a result of thunderstorms.

(iii) Give **two** ways by which the rusting of iron can be prevented.

(*b*) State *Boyle's law* and *Charles' law.*

(*c*) Write equations for:

(i) the oxidation of ammonia by air in the presence of hot platinum;

(ii) a laboratory preparation of chlorine (**not** electrolysis);

(iii) the preparation of aluminium nitrate from aluminium oxide;

(iv) the action of heat on calcium bicarbonate solution.

(*d*) From the equation

$$2Na_2O_2 + 2H_2O \longrightarrow 4NaOH + O_2$$

calculate:

(i) the minimum weight of water required to react completely with 390 gm. of sodium peroxide;

(ii) the weight of hydrogen chloride in solution required to neutralise the sodium hydroxide formed in (i).

(*e*) Give the volumes, measured at N.T.P., occupied by 8 gm. of **each** of the following gases: (i) oxygen; (ii) hydrogen; (iii) nitrous oxide.

(*f*) 10 ml. of methane, CH_4, are exploded with 150 ml. of air (20% oxygen, 80% nitrogen). What will be the volume and composition of the resulting mixture of gases, all volumes being measured at 15° C. and 760 mm. pressure?

(*g*) Name, and give the formulae of, **two** acids and **two** bases each having an equivalent weight different from its molecular weight.

(*h*) (i) Give **one** reason why the collection of gases over mercury is not generally considered to be a convenient method.

(ii) Name **two** gases that cannot be collected over water and say how **each** can be collected, other than over mercury.

(iii) Name a substance whose solubility in water increases very much with rise of temperature.

(iv) Name **two** salts that are nearly insoluble in water.

2 (*a*) Describe the preparation and collection of a few gas jars of hydrogen sulphide. (A diagram is **not** required.)

(*b*) Describe what you would see and say what is formed when hydrogen sulphide is passed into: (i) concentrated nitric acid; (ii) sodium hydroxide solution. What does the reaction in (ii) show concerning the nature of hydrogen sulphide?

(*c*) When excess tin is heated in 1 litre of hydrogen sulphide until there is no further reaction, 1 litre of hydrogen is left and the tin gains 1·43 gm. in weight, forming a sulphide (SnS). Explain how the formula of hydrogen sulphide can be deduced from the above figures, given that the gaseous volumes are all measured at N.T.P.

3 (*a*) In preparing crystals of sodium sulphate, it is bad technique to evaporate the solution to dryness, or nearly to dryness, but to obtain a substantial sample of sodium chloride, it is better to evaporate to dryness. Explain why these two different techniques are necessary.

How would you obtain good crystals of sodium chloride from a concentrated solution?

(*b*) How would you prepare crystals of sodium nitrate, starting from sodium carbonate and dilute nitric acid?

Describe the action of heat on sodium nitrate crystals and name the products.

4 (*a*) Explain why a solution of sugar is a non-conductor of electricity but a solution of sodium chloride is a good conductor.

What is formed at each electrode when a current is passed through a solution of sodium chloride by means of carbon electrodes? Explain how you would demonstrate the presence of **each** product.

(*b*) A current of 2 amp. is passed for 2 hr. through

(i) a solution of copper sulphate (using copper electrodes), and

(ii) a dilute solution of sulphuric acid (using platinum electrodes), the two solutions being connected in series.

In (i), calculate the changes in weight of the cathode and anode, stating whether a gain or a loss. In (ii), calculate the volumes at N.T.P. of the gases liberated at the cathode and anode. Name the gases.

[1 faraday (96,500 coulombs) discharges 1 gm. equivalent of an ion.]

5 (*a*) What do you understand by *an oxidising agent*?

You are provided with a solution of a chemical *X* which is thought to be an oxidising agent. Describe, with all the necessary practical details, **two** tests that you could apply to the solution and explain how the results of the tests would justify your calling *X* an oxidising agent.

(*b*) Given a solution of ferric sulphate, how would you obtain (i) ferrous sulphate solution; (ii) ferric oxide?

6 Describe in detail how you would prepare:

(i) pure zinc oxide, from granulated zinc; (ii) pure calcium hydroxide, from solid calcium chloride.

How do zinc oxide and calcium hydroxide react with (iii) hydrochloric acid, and (iv) sodium hydroxide solution? If there is no reaction, say so.

Give **two** quite different uses for calcium hydroxide.

How would you distinguish between zinc oxide and aluminium oxide?

7 (*a*) A solution contains hydrochloric acid and sulphuric acid. When 50 ml. of the solution were treated with excess barium chloride solution, a precipitate weighing 10·0 gm. was obtained. Calculate the weight of sulphuric acid present in 1 litre of the solution.

When 100 ml. of the solution were treated with excess magnesium ribbon, 4·00 litres of hydrogen (measured at N.T.P.) were liberated. Calculate the weight of hydrogen chloride present in 1 litre of the solution.

(*b*) State clearly **three** ways in which a physical change differs from a chemical change and say to which class the following belong:

(i) the obtaining of oxygen and nitrogen from liquid air;

(ii) the conversion of rhombic sulphur (Sα) to prismatic sulphur (needles or Sβ);

(iii) the formation of ammonia by sparking nitrogen and hydrogen;

(iv) the formation of violet fumes on heating iodine.

8 Outline the commercial synthesis of ammonia from its elements, stating briefly how the nitrogen and hydrogen are obtained on a large scale.

Describe carefully how you would carry out, in **each** case, **one** experiment to demonstrate **two** of the following facts:

(i) ammonia gas is a basic anhydride;

(ii) ammonia gas can act as a reducing agent;

(iii) ammonia gas will burn in oxygen.

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CHEMISTRY

ORDINARY LEVEL

THEORY (ALTERNATIVE T)

(*Two hours and a half*)

Answer Question **1** *and any* **four** *other questions.*

Candidates are advised to spend not more than 50 *minutes in answering Question* 1.

Unless otherwise stated, equations must be given wherever possible and diagrams where they are helpful.

Names, not symbols, must be used in descriptive work for all —reacting chemicals and for the products formed.

Mathematical tables are provided.

Essential working must be shown.

[H = 1; C = 12; O = 16; S = 32; Fe = 56; Pb = 207. One gram-molecular weight of a gas occupies 22·4 litres at N.T.P.]

1 (*a*) Give the names of: (i) **three** gases, other than oxygen and nitrogen, that are present in the atmosphere, (ii) **two** compounds that, when dissolved in water, make the water hard.

(*b*) Write equations for the action of heat on: (i) sodium bicarbonate; (ii) lead carbonate; (iii) lead nitrate; (iv) ferric hydroxide.

(*c*) Mention **two natural** processes by which atmospheric nitrogen is converted into nitrogen compounds.

(*d*) State (i) *Boyle's law*, (ii) *the law of constant composition.*

(*e*) Calculate the simplest formula of a compound containing, by weight, 53·8 % of iron and 46·2 % of sulphur.

(*f*) State briefly why each of the following statements is false.

(i) 'If 112·5 gm. of an element combine with 16 gm. of oxygen, the atomic weight of the element must be 112·5.'

(ii) 'Isotopes are atoms of different elements having the same atomic weight.'

(iii) 'Rusting is the combination of iron with the combined oxygen in water.'

(*g*) Define or explain the meaning of the following terms:

diffusion, *molecule*, *saturated solution*.

(*h*) $Pb(NO_3)_2 + H_2SO_4 = PbSO_4 + 2HNO_3$.

Given that 50 ml. of 2N (M) sulphuric acid are added to an excess of lead nitrate solution, calculate the weight of leap sulphate precipitated.

(*j*) Name **two** metals whose oxides are reduced when heated in a stream of hydrogen and **two** metals whose oxides cannot be reduced in this way. Arrange the four metals you have named in order of decreasing metallic reactivity.

2 (*a*) Give an account of the manufacture of sulphuric acid from sulphur by the contact process.

(*b*) Describe **two** reactions in which sulphuric acid behaves as an oxidising agent and **one** reaction in which it behaves as a dehydrating agent.

3 (*a*) Dilute sulphuric acid is electrolysed in a beaker, using copper electrodes. Answer the following questions about this electrolysis.

(i) Give the formulae of **all** the ions present in the solution before electrolysis starts.

(ii) Give the formula (e) of any new ion (or ions) which will be present in the solution after electrolysis has been taking place for a few minutes.

(iii) Draw a simple diagram to indicate the direction of migration of the ions mentioned in (i) and (ii), and also the direction of flow of electrons in the circuit outside the beaker.

(iv) What changes, if any, would you **observe** at the anode, at the cathode, and in the solution?

(v) Explain the chemical change occurring at the anode (positive electrode).

(*b*) Draw a labelled diagram of the apparatus you would use to electroplate a small object with a coating of a metal such as nickel or silver.

Do you think it would be possible to electroplate an object with magnesium? Give briefly the reasons for your answer.

4 (*a*) 'Non-metallic elements of valency n usually form with hydrogen compounds of formula XH_n. These compounds, called hydrides, are generally covalent and gaseous. They vary from being very soluble to insoluble in water and may be acidic, basic or neutral in character.'

Illustrate these statements by reference to the simple hydrides of chlorine, sulphur, nitrogen and carbon.

(*b*) Aluminium forms the compounds $AlCl_3$ and Al_2S_3 with chlorine and sulphur. These compounds react with water as indicated by the following equations

$$AlCl_3 + 3H_2O = Al(OH)_3 + 3HCl,$$
$$Al_2S_3 + 6H_2O = 2Al(OH)_3 + 3H_2S.$$

(i) Write formulae for the compounds you would expect aluminium to form with nitrogen and with carbon.

(ii) Write equations for the reactions you would expect when the compounds in (i) are treated with water.

(iii) Suggest simple qualitative experiments by which you would attempt to confirm your expectations in (ii).

5 For **each** of the following, name the reagents used, give the conditions of reaction and write the equations:

(*a*) the preparation of oxygen from hydrogen peroxide,

(*b*) the conversion of ethylene into ethane,

(*c*) the preparation of concentrated nitric acid from a nitrate,

(*d*) the preparation of ethylene from ethanol (ethyl alcohol),

(*e*) the liberation of hydrogen from ethanol.

Diagrams, and details of collection and purification of products are **not** required.

6 (*a*) Crystals of naphthalene melt on heating to give liquid naphthalene and the liquid boils at a higher temperature to give gaseous naphthalene. Describe, in terms of naphthalene molecules, the differences between the solid, liquid and gaseous states.

(*b*) Explain the following facts.

(i) Sulphur will not conduct electricity in the solid or the liquid state.

(ii) Copper will conduct electricity in both the solid and liquid states.

(iii) Sodium chloride will not conduct electricity in the solid state but will conduct electricity when molten.

(iv) Pure liquid hydrogen chloride and a solution of hydrogen chloride in toluene are non-conductors but a solution of hydrogen chloride in water will conduct electricity.

7 It is found that 4 gm. of oxygen, 7 gm. of the gaseous compound butylene and 10·5 gm. of the gaseous element krypton all occupy the same volume at the same temperature and pressure.

(i) What fraction of a gram-molecule is 4 gm. of oxygen?

(ii) Calculate the molecular weights of butylene and krypton.

(iii) The empirical (simplest) formula of butylene is CH_2. What is its molecular formula?

(iv) The atomic weight of krypton is 84. What is the atomicity of krypton?

(v) Write a possible structural formula for butylene.

(vi) Give the name and structural formula of another compound having the empirical formula CH_2.

(vii) Write the equation for the burning of butylene in oxygen to give carbon dioxide and water.

(viii) If 10 ml. of butylene are burnt according to your equation, calculate the volume of oxygen used and the volume of carbon dioxide formed (all volumes at the same temperature and pressure).

8 (*a*) Name the raw materials used in the manufacture of iron and give an account of the chemical reactions taking place in the blast furnace. (No diagram is required.)

(*b*) What elements, other than iron, are present in (i) mild steel, (ii) stainless steel?

(*c*) For **each** of **two** of the following alloys, (i) name the metals present in the alloy, and (ii) give **one** reason why the alloy is used in preference to the pure metals it contains.

Brass, solder, type-metal, duralumin.

9 (*a*) Name **three** gases that can be prepared by the action of a dilute acid on a solid **compound**. For **each** gas, name the acid and solid compound used, and write an equation for the reaction.

If you found, on carrying out one of these preparations, that the reaction was too slow, suggest **two** ways, other than the use of a catalyst, by which you could make it faster.

(*b*) Dilute sulphuric acid was added to an excess of granulated zinc. It was noticed that hydrogen was evolved very slowly at first. The rate of evolution of gas increased rapidly for about two minutes and then gradually decreased until the reaction stopped. Attempt to explain these observations.

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CHEMISTRY

ORDINARY LEVEL

(ALT. N. AND T.)

PRACTICAL A

(Two hours)

Answer **all** *the questions.*

Read the questions carefully and follow the instructions.

N.B. *In Question* 1, *all burette readings and the capacity of the pipette must be recorded,* **but no account of experimental procedure is required. All essential working must be shown;** *if a slide rule is used, a statement to this effect must be made.*

Mathematical tables are provided.

In Questions 2 *and* 3, *credit will be given for good observations precisely recorded, and for well-drawn inferences.*

Candidates using semi-micro methods in Questions 2 *and* 3 *should modify the instructions as appropriate to the size of apparatus and the techniques they are using.*

[H = 1; C = 12; N = 14; O = 16; Na = 23.]

1 **B 1** is a solution containing 7·20 gm. of sodium carbonate, Na_2CO_3, per litre.

B 2 is a solution of nitric acid.

Put the acid into the burette and titrate 20 ml. (or 25 ml.) portions of the alkali. Name the indicator used.

Calculate:

(*a*) the normality (or molarity) of the solution **B 2**;

(*b*) the number of grams of nitrate ion in 1 litre of **B 2.**

The equation for the reaction may be written as

$$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$$

or as

$$2Na^+ + CO_3^{2-} + 2H^+ + 2NO_3^- \rightarrow 2Na^+ + 2NO_3^- + H_2O + CO_2.$$

2 (*a*) Place approximately $\frac{1}{2}$ gm. of **B 3** in a test tube and add about 1 in. in depth of 1:1 hydrochloric acid. Identify the gas evolved.

Warm until there is no further reaction, filter *while still hot* into a clean test tube. Leave to cool.

Describe all that you observe while heating and cooling.

(*b*) Filter the cold mixture left in the final test tube in (*a*).

(i) Pour hot water over the residue and cool the washings.

(ii) Filter the cool solution from (i) and to the filtrate add a little potassium iodide solution; boil then cool.

Describe all that you observe in (i) and (ii).

3 The mixture **B 4** contains a sodium salt and a salt of another metal. Identify the other metal and the two acid radicals present.

State clearly how you obtain your solutions. (Solution tests should be given, where appropriate).

B (A)

PRACTICAL CHEMISTRY INSTRUCTIONS

PRACTICAL A

ORDINARY LEVEL

(ALT. N. AND T.)

PAPER 540/2, 542/2

In addition to the fittings and substances ordinarily contained in a chemical laboratory and to the substances

enumerated below, candidates will require a burette to hold 50 ml. and a pipette [20 ml. or 25 ml.]. **All candidates at a Centre should have pipettes of the same size.**

The following substances are to be provided locally.

1 A solution of sodium carbonate containing approximately 7·2 gm. per litre (Na_2CO_3), labelled **B 1**. Allow each candidate 150 ml.

2 A solution of nitric acid containing approximately 7 gm. per litre (HNO_3), labelled **B 2**. Allow each candidate 150 ml.

3 Methyl orange, or screened methyl orange, or other suitable indicator.

[*Note.* The solutions need not contain exactly 7·2 gm. of sodium carbonate and 7 gm. of nitric acid per litre, but they should not appreciably differ from these quantities. Their actual concentrations must be accurately known and **must be stated on the form supplied**. The candidates will assume the concentrations stated, and the Examiner will make the necessary correction.

The Examiner will be obliged if the Chemistry teacher will perform the titration in the first question and enter the results on the report form **which must be returned with the scripts**. Unless this is done at the same time as the candidates' own titrations, candidates may be unavoidably penalised.]

4 An intimate mixture, in about equal proportions by weight, of powdered ferric oxide and powdered lead carbonate, labelled **B 3**.

5 An intimate mixture, in about equal proportions by weight, of powdered sodium chloride and zinc nitrate, labelled **B 4**.

B 3 and **B 4** may conveniently be given out on squares of stiff paper, or on watch glasses, appropriately labelled.

Allow about a teaspoonful of each.

[*Caution.* If mixed too early, **B 4** may deliquesce. If necessary, store in an air-tight vessel.]

6 1:1 hydrochloric acid and potassium iodide solution should be readily available to all candidates.

N.B. In all cases more material may be issued if required, without penalty, but this should not be necessary.

In order to check the suitability of apparatus and material the teacher responsible for preparing the examination is allowed to consult the question paper ten days before the paper is worked.. The question paper must then be **replaced in the envelope, re-sealed and kept under lock and key with other question papers until the day of the examination.**

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CHEMISTRY

ORDINARY LEVEL

(ALT. N AND T.)

ALTERNATIVE-TO-PRACTICAL TEST

(*One hour and a half*)

Answer the whole of Question 1 *and any* **two** *other questions. Throughout this paper, marks will be given mainly for details which show you have carried out experiments in the laboratory. Mathematical tables are provided.*

1 (*a*) For **each** of the following substances, state: (i) its colour, (ii) whether it is soluble, sparingly soluble or insoluble in water, (iii) its effect, if any, on moist red or blue litmus.

Calcium sulphate, ferric oxide, ammonia, phosphorus pentoxide.

(*b*) 6 gm. of anhydrous sodium hydrogen sulphate are dissolved in a solution containing 6 gm. of anhydrous sodium carbonate. You are provided with normal (molar) solutions of sodium hydroxide and hydrochloric acid. Which of these would be needed to make the above mixture neutral, and how many millilitres will be required? Answer to the nearest millilitre.

[H = 1; C = 12; O = 16; Na = 23; S = 32; Cl = 35·5.]

(*c*) Liquid sulphur dioxide is commonly available in the laboratory in strong glass bottles, under pressure. The density of the liquid is 1·43 gm. per ml. What volume of gaseous sulphur dioxide will be obtained at N.T.P. from 1 litre of the liquid? [O = 16, S = 32. The gram-molecular weight of a gas occupies 22·4 litres at N.T.P.]

2 Describe what you would see, and explain what happens, in the following experiments.

(*a*) A gas jar half-full of nitric oxide is standing over water. A slow stream of oxygen bubbles is allowed to pass up into the gas jar for a few minutes.

(*b*) An electric discharge from an induction coil is passed between platinum wire electrodes in a closed glass globe containing air.

(*c*) Ferrous sulphate solution is shaken up in a gas jar of nitric oxide, after which the jar is opened under water.

3 Four reagent bottles A, B, C and D, have carelessly been left unstoppered for several days.

(i) Bottle A originally contained a colourless liquid. A white suspension can now be seen, but the volume of the liquid has not changed appreciably.

(ii) Bottle B originally contained a colourless liquid. The volume of liquid is now greater than before.

(iii) Bottle C originally contained a white solid. The solid is now partly immersed in a colourless liquid.

(iv) Bottle D contained a colourless liquid and is now empty.

Suggest the identity of the original contents of bottles A, B, C and D, explain what has happened and give **one** useful application of the effects described for any **two** of the bottles.

4 Draw diagrams of the following pieces of apparatus and give **one** example of the use of **each.**

(*a*) A desiccator, (*b*) a separating funnel, (*c*) a drying tower.