Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2009

CHEMISTRY - ORDINARY LEVEL

TUESDAY, 16 JUNE – AFTERNOON 2.00 TO 5.00

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400 MARKS

Answer **eight** questions in all

These **must** include at least **two** questions from **Section A**

All questions carry equal marks (50)

Information

Relative atomic masses: H = 1, C = 12, O = 16

Molar volume at s.t.p. = 22.4 litres

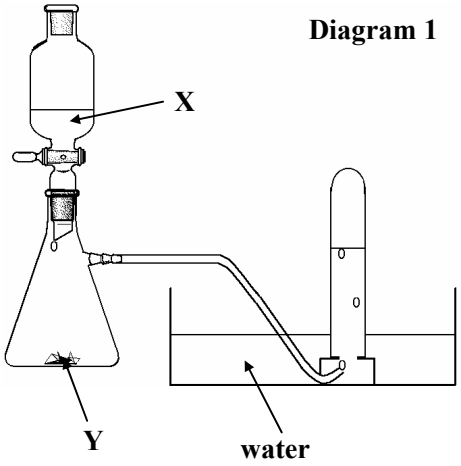
Avogadro constant = 6×10^{23} mol^{-1}

Section A

Answer at least <u>two</u> questions from this section [see page 1 for full instructions].

1. Diagram 1 shows an apparatus used for the preparation and collection of ethyne gas (C_2H_2).

Diagram 1



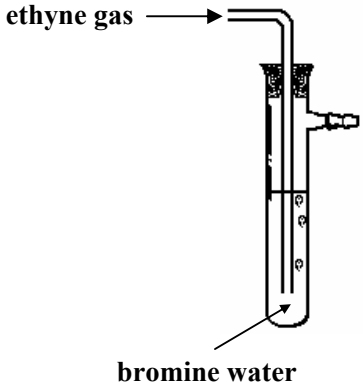
(*a*) Name the homologous series to which ethyne belongs. (5)

(*b*) Identify the liquid **X** and the solid **Y**.

Describe the appearance of the solid **Y**. (15)

(*c*) Diagram 2 shows ethyne gas being bubbled through bromine water in a test tube.

Diagram 2



What change would you expect to observe in the appearance of the bromine water?

What explanation would you give for this observation? (12)

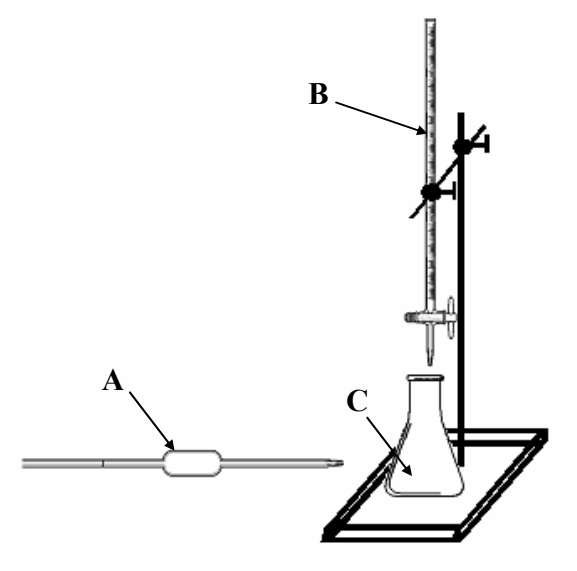
(*d*) What is observed when a sample of ethyne gas is burned in air? (6)

(*e*) When ethyne gas (commonly known as acetylene) is mixed with another gas in suitable proportions, the mixture burns with a very hot flame.

Identify the gas that is mixed with ethyne.

What use is made of the very hot flame? (12)

2. To prepare a pure sample of sodium chloride (common salt) in the school laboratory, the exact volume of a solution of hydrochloric acid (**HCl**), required to neutralise 25.0 cm^3 of a 0.10 M solution of sodium hydroxide (**NaOH**), was found by carrying out a number of titrations. The pieces of equipment used in carrying out these titrations are shown in the diagram on the right.



(*a*) Name the pieces of equipment **A**, **B** and **C**. (9)

(*b*) How would you have used **A** to measure 25.0 cm^3 of the sodium hydroxide solution and to transfer the solution into **C**? (9)

(*c*) Name a suitable indicator for the titration and state the colour change at the end point. (9)

(*d*) What is the correct procedure for reading the level of the hydrochloric acid solution in **B**? (6)

(*e*) If the exact volume of the hydrochloric acid solution required to neutralise 25.0 cm^3 of the 0.10 M solution of sodium hydroxide was 22.5 cm^3, calculate the molarity of the hydrochloric acid solution.
The equation for the reaction involved in the titrations is

$$\mathbf{HCl + NaOH \rightarrow NaCl + H_2O}$$ (9)

(*f*) Describe the further steps needed to obtain a pure sample of sodium chloride. (8)

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3. The volume of oxygen released by hydrogen peroxide solution, in the presence of granular manganese(IV) oxide (**MnO_2**), was measured at one minute intervals until the reaction was complete.
The data obtained are shown in the following table.

Time / minutes	0	1	2	3	4	5	6	7
Volume / cm^3	0	38	56	67	74	78	80	80

(*a*) What term is used to describe the function of the manganese(IV) oxide in this reaction? (5)

(*b*) Draw a diagram of a suitable apparatus for carrying out this experiment. (12)

(*c*) On graph paper, plot a graph of the volume of oxygen produced (*y*-axis) against time (*x*-axis). (15)

(*d*) Find from your graph the average rate of oxygen production in cm^3 per minute during the first three minutes of the reaction. (6)

(*e*) How would the reaction rate have been affected

(*i*) if the reaction had been carried out at a higher temperature,

(*ii*) if the granules of manganese(IV) oxide had been ground to a fine powder? (12)

Section B

[See page 1 for instructions regarding the number of questions to be answered.]

4. Answer **eight** of the following items (a), (b), (c), etc. (50)

(*a*) What are the three states of matter?

(*b*) The Greek philosopher Empedocles (pictured on the right) suggested there were four "elements". One of these "elements" was earth. Name **two** of the other three "elements" according to the Greeks.

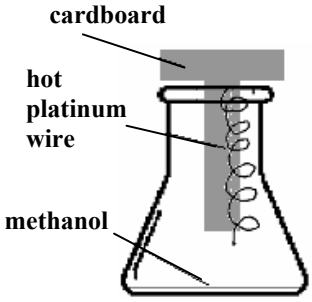
(*c*) State the function of (*i*) chlorination, (*ii*) fluoridation, in water treatment.

(*d*) Explain why atomic radius decreases across a period in the periodic table.

(*e*) Define *electronegativity*.

(*f*) Balance the combustion equation: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

(*g*) What term describes a chemical reaction for which the value of ΔH is negative?



(*h*) The diagram on the right shows a hot platinum wire inserted in a heated flask over warm methanol. First the platinum wire glows, then there is a flash or flames and a popping sound and then all this repeats. What is the function of the hot platinum wire?

(*i*) The pH values of three solutions are 4, 9 and 6. Arrange these pH values in order of increasing acidity.

(*j*) Write the equilibrium constant (K_c) expression for the following reaction.

$$H_2 + I_2 \rightleftharpoons 2HI$$

(k) Answer part **A** *or* part **B**.

A What are the two main stages in the manufacture of oxygen from air?

or

B What happens in the process known as galvanising? Why is it carried out?

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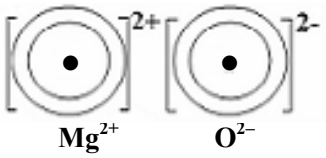
5. (*a*) Define *atomic number*. (8)

In 1913, atomic numbers were introduced by the young English scientist pictured on the right. Two years later he was killed in action at Gallipoli during World War I. Who was he? (6)

(*b*) What is an *ionic bond*? (6)

The diagram on the right is an incomplete illustration of the ionic bond between magnesium and oxygen.

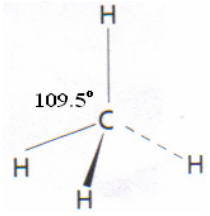


How many protons are there (*i*) in the nucleus of the magnesium ion,
(*ii*) in the nucleus of the oxide ion?

Copy the diagram into your answer book.
Use dots and crosses to show the electrons present in each of the four shells. (12)

Give any **two** characteristic properties of ionic compounds. (6)

(*c*) The diagram on the right shows the methane molecule in which all four bond angles are identical.



What term is used to describe the shape of this molecule?

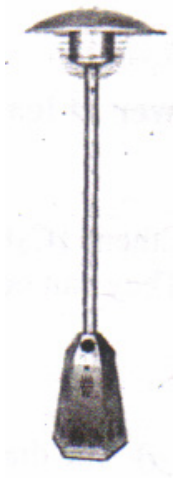
What type of bonds are present in the molecule?

Give the name *or* molecular formula of any other simple molecule and draw the shape of its molecules *or* give the term that describes the shape. (12)

6. (*a*) Explain what is meant by *fractionation* in the oil refining process. (5)
Select any **two** of the fractions below and state **one** common use of each of the chosen fractions. (12)

light gasoline **naphtha** **kerosene** **gas oil**

(*b*) LPG is obtained from a gaseous fraction (refinery gas). LPG consists mainly of propane (C_3H_8) and butane (C_4H_{10}) with small amounts of mercaptans added. LPG is widely used in gas-burning appliances e.g. domestic gas cookers and patio heaters. The diagram on the right shows a common type of patio heater.



(*i*) What do the letters LPG stand for? (6)
(*ii*) Draw the structure of **one** of the two isomeric forms of C_4H_{10}. (6)
(*iii*) Why are mercaptans added to LPG? (6)
(*iv*) Why is the use of patio heaters being discouraged by environmentalists? (6)

(*c*) Give **one** advantage and **one** disadvantage of using hydrogen as a fuel.
State **one** industrial use of hydrogen other than its use as a fuel. (9)

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7. Answer the questions below with reference to the organic compounds **A**, **B**, **C** and **D**.

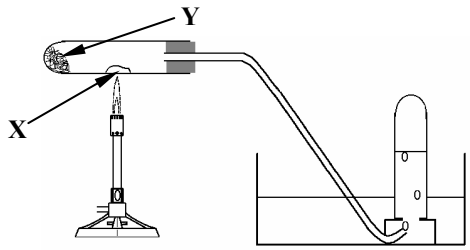
CH_2CH_2	CH_3CH_2OH	CH_3COOH	C_6H_6
A	**B**	**C**	**D**

(*a*) Which **one** of the compounds **A**, **B**, **C** or **D** has no planar carbon atom? (8)

(*b*) Name the compounds **A**, **B**, **C** and **D**. (12)

(*c*) What type of reaction is involved in the conversion of **B** to **C**?
Name the common flavouring agent that consists of a 6% (v/v) solution of **C**. (6)

(*d*) The conversion of **B** to **A** is carried out in the school laboratory using the apparatus shown on the right.



(*i*) Identify the substance **X**.
Describe the appearance of this substance.

(*ii*) How is compound **B** held at position **Y** in the test tube?

(*iii*) Why should the delivery tube be removed from the trough of water before heating is stopped? (15)

(*e*) The usual representation of the structure of compound **D** is shown in the diagram on the right.

What term is used for organic compounds that contain this structure?

What serious health hazard is associated with compound **D**? (9)

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8. In the case of any **four** of the following, describe simple experiments, one in each case,

(*a*) to separate the indicators in a mixture of indicators by chromatography (diagram required),

(*b*) to measure the pH of an aqueous solution,

(*c*) to show the presence of potassium in potassium chloride using a flame test,

(*d*) to test for the presence of sulfate ions in aqueous solution,

(*e*) to show that water is a polar liquid whereas cyclohexane is non-polar (diagram required). (4 × 12 + 2)

9. (*a*) What is meant by *hardness* in water? (5)

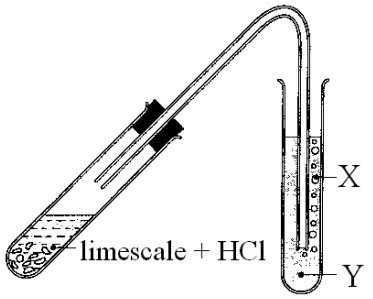
The following names/terms all relate to hardness in water.

calcium sulfate **temporary** **permanent** **ion exchange** **calcium hydrogencarbonate**

Write in your answer book the name/term corresponding to each of the numbers 1 to 5 in the statements below.

Dissolved **1** causes **2** hardness which is removed when water is boiled.
Dissolved **3** causes **4** hardness which is *not* removed when water is boiled.
Both forms of hardness are removed by **5** . (15)

The diagram shows a test tube containing limescale (scraped from the inside of a kettle) and dilute hydrochloric acid (**HCl**). As the gas **X** produced by the reaction is bubbled through solution **Y**, the solution becomes milky (cloudy). Identify the gas **X** and liquid **Y**. (6)



(*b*) In an experiment to measure the concentration of suspended solids in a water sample, a volume of 200 cm^3 of the water was found to contain 0.02 g of suspended solids.
Find the concentration of suspended solids in parts per million (ppm). (12)

Outline how the mass of suspended solids was obtained in the experiment. (12)

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10. Answer any **two** of the parts (a), (b) and (c).

(*a*) **Le Châtelier**, **Rutherford**, **Arrhenius**, **Dalton** and **Marie Curie** all made important contributions to scientific knowledge. In your answer book match the names of these scientists with the letters **A – E** that correspond in the table below to their contribution to scientific knowledge. (5 x 5)

A	*Stated that matter consists of tiny, indivisible particles called atoms.*
B	*Stated that chemical reactions at equilibrium oppose applied stresses.*
C	*Discovered the nucleus of the atom.*
D	*Isolated the radioactive elements, polonium and radium.*
E	*Defined an acid as a substance that produces hydrogen ions in aqueous solution.*

(*b*) The French scientist, pictured on the right, discovered radioactivity while experimenting with uranium salts.

(*i*) Name the French scientist. (4)

(*ii*) What is *radioactivity*? (6)

(*iii*) Name one type of radiation emitted by radioactive substances. Describe its penetrating ability in air, and state its charge, if any. (9)

(*iv*) Give an example of a radioactive isotope and state **one** of its uses. (6)

(*c*) (*i*) Define *relative atomic mass* (A_r). (7)

(*ii*) The molecular formula of glucose is $\mathbf{C_6H_{12}O_6}$ and its relative molecular mass is 180. What is the empirical formula for glucose? (6)

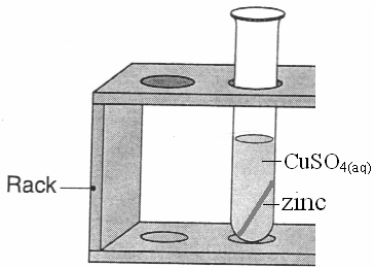
(*iii*) Calculate the percentage by mass of carbon in glucose. (6)

(*iv*) Another organic compound **B** has the same empirical formula as glucose but its relative molecular mass is 60. What is the molecular formula of **B**? (6)

11. Answer any **two** of the parts (*a*), (*b*) and (*c*).

(*a*) Define *reduction* in terms of electron transfer. (4)

The diagram shows a piece of zinc in copper sulfate solution. Initially the zinc is silver-grey and the solution is blue. A reaction takes place which may be represented by the following equation.



$$\mathbf{Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu}$$

(*i*) Which species has been reduced?
How many electrons were transferred in the reduction? (6)

(*ii*) State any **two** changes you would observe as the reaction proceeds. (9)

(*iii*) Metals can be listed in the order of their ability to be oxidised. What is this list called? (6)

(*b*) (*i*) State *Boyle's law*. (7)

(*ii*) A sample of carbon dioxide gas has a volume of 12230 cm^3 at a temperature of 298 K and a pressure of 2×10^5 Pa. Use the combined gas law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

to calculate the volume occupied by the gas at a temperature of 273 K and a pressure of 1×10^5 Pa. (9)

(*iii*) Taking the values 273 K and 1×10^5 Pa in (*ii*) as standard temperature and pressure, how many moles of gas are in the sample? (6)

(*iv*) How many molecules are in the sample? (3)

(*c*) Answer part **A** *or* part **B**.

A Oxides of carbon, nitrogen and sulfur are atmospheric pollutants.

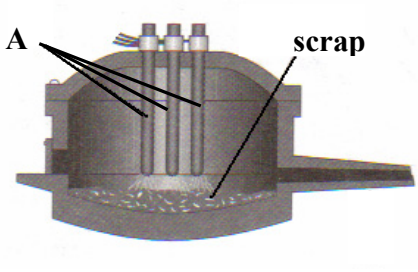
(*i*) Give the name *or* formula of an oxide of carbon other than carbon dioxide. State **one** harmful effect of this oxide. (7)

(*ii*) Give the name *or* formula of **one** oxide of nitrogen and **one** oxide of sulfur. In the case of the oxide of sulfur, how would you show that it is an acidic oxide? (9)

(*iii*) Some gaseous acidic oxides combine with moisture in the atmosphere to produce acid rain. Give **two** examples of damage caused by acid rain. (9)

or

B Steel, an alloy of iron, is extracted from scrap (containing iron and/or steel) in a special furnace which is illustrated in the diagram on the right.



(*i*) Name the process involved. (7)

(*ii*) From what material are the electrodes **A** made? (6)

(*iii*) Name the non-metallic element present in steel at concentrations generally less that 1.7%. (6)

(*iv*) Give any **two** uses of steel. (6)

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