AN ROINN OIDEACHAIS 2963

LEAVING CERTIFICATE EXAMINATION, 1997

PHYSICS AND CHEMISTRY — HIGHER LEVEL

THURSDAY, 19 JUNE — AFTERNOON 2.00 to 5.00

Six questions to be answered. Answer any **three** questions from Section I and any **three** from Section II. All the questions carry equal marks.

SECTION I – PHYSICS (200 marks)

1. Answer **eleven** of the following items *(a)*, *(b)*, *(c)*, *(d)* etc. All the items carry equal marks.

(a) State *Newton's second law of motion.*

(b) Calculate the amount of work done in the acceleration of a body of mass 4 kg from rest to a velocity of 6 m s^{-1}.

(c) State the *principle of conservation of energy.*

(d) In what way does the *objective lens* of an astronomical telescope differ from that of a compound microscope?

(e) **Fig. 1** is a diagram representing the electromagnetic spectrum. Name the <u>two</u> types of radiation represented by the regions labelled **A** and **B**. [The black band is the visible region.]

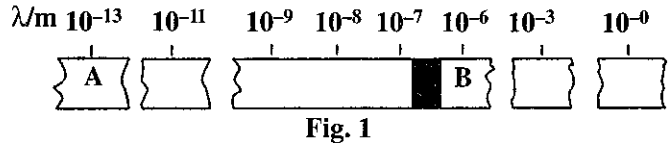


Fig. 1

(f) **Fig. 2** shows a ray of light passing along an optical fibre by internal reflection. State the condition necessary for this to happen.

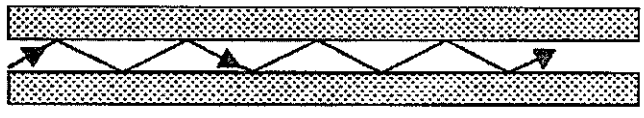


Fig. 2

(g) What is meant by a *thermometric property*?

(h) What readings are taken when using a constant volume gas thermometer?

(i) Give an example of electrical conduction where *Ohm's law* does <u>not</u> hold.

(j) Define the *unit of current* i.e. the ampere.

(k) A current of 4 A is maintained through an electric lamp of resistance 60 ohms for 10 seconds. How many joules of energy are used?

(l) Give an expression for *Coloumb's law of force* between electric charges.

(m) Mention <u>two</u> precautions which should be taken when dealing with radioactive substances.

(n) What is meant by *nuclear fission*?

(o) Give <u>two</u> properties of beta particles. (11 x 6)

2. Define *weight.* (3)

State *Newton's law of gravitation.* (6)

A student performed a laboratory experiment to measure **g**, the acceleration due to gravity.

(i) Draw a labelled diagram showing the apparatus which the student might have used in this experiment. (9)

(ii) State the measurements which the student would have made in the experiment. (6)

(iii) Explain how a value for **g** may be calculated from the measurements taken. (6)

(iv) Give <u>two</u> precautions which should be taken to ensure a more accurate result. (6)

A ball is thrown vertically upwards with an initial speed of 14 m s^{-1}. Calculate:

(i) the maximum height reached. (9)

(ii) the velocity of the ball after 0.8 seconds. (6)

(iii) the <u>times</u> at which the ball was at a height of 8.4 metres. (15)

3. ***(a)*** State the *laws of refraction of light.* (6)

Describe a laboratory experiment to measure the focal length of a <u>converging</u> (convex) lens. (12)

A converging lens of focal length 20 cm produces a real image which is 4 times the size of the object. Calculate the position of the object. (12)

(b) Explain the terms <u>monochromatic light</u>, <u>diffraction</u> and <u>interference</u>. (18)

A student carried out an experiment to measure the wavelength of monochromatic light.

(i) Sketch and label a diagram showing the apparatus/method which you would use in this experiment. (9)

(ii) Give the equation used to calculate your result, explaining each symbol. (9)

4. ***(a)*** State <u>four</u> of the basic assumptions of the kinetic theory of gases. (12)

In terms of the kinetic theory, what is the relationship between the temperature of a gas and the average kinetic energy of its molecules? (6)

Outline an experiment in support of the kinetic theory of gases. (12)

(b) State *Boyle's law.* (6)

In an experiment to demonstrate Boyle's law, the following data was obtained.

Pressure/kPa	100	120	140	160	180	200
Volume/cm^3	53	43	38	33	29	25

(i) Plot a graph of **P** against **1/V** and explain how the graph verifies Boyle's law. (18)

(ii) Draw a labelled diagram of the apparatus which you would use for this experiment. (12)

5. *(a)* Describe an experiment to demonstrate the magnetic effect of an electric current. (12)

Draw a labelled diagram of **either** a dynamo **or** a d.c. motor and explain how it works. (21)

(b) Define *capacitance*. (3)

Give an expression for the effective capacitance of <u>two</u> capacitors connected in series. (6)

Fig. 3 shows two capacitors of capacitance 4 μF and 6 μF connected in series with a 9 V battery.

Calculate

(i) the total capacitance. (6)

(ii) the total charge on the capacitors. (9)

(iii) the potential difference across the 4 μF capacitor. (9)

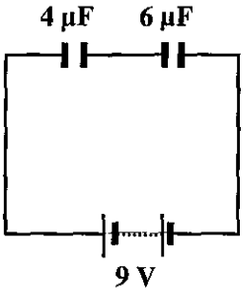


Fig. 3

6. Answer <u>two</u> of the following, *(a)*, *(b)*, *(c)* and *(d)*. Each part carries 33 marks.

(a) What is the *photoelectric effect*? Give an explanation for the effect. (15)

To demonstrate the photoelectric effect an ultra-violet lamp and a negatively charged gold leaf electroscope with a clean zinc plate were used, as shown in **Fig. 4**. When the lamp directly illuminates the zinc plate the separation of the leaves reduces.

Explain why the leaves do not collapse when

(i) the zinc plate is shielded from the lamp by a piece of ordinary glass. (6)

(ii) the electroscope is positively charged. (6)

Calculate the energy of a photon of ultra-violet radiation which has a wavelength of 3.0×10^{-7} m. (6)

[Speed of light = 3×10^8 m s^{-1}; h = 6.6×10^{-34} J s]

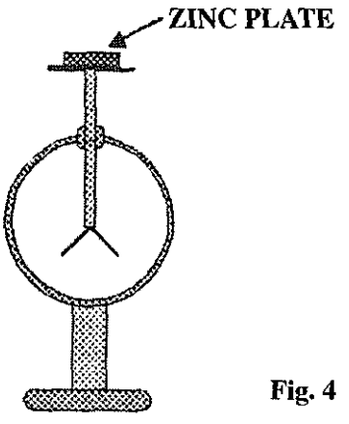


Fig. 4

(b) Define *momentum*. (3)

State the *principle of conservation of momentum*. (6)

Describe a laboratory experiment to verify the principle. (18)

How may the principle of conservation of momentum be applied to a collision between a tennis ball and a racquet? (6)

(c) What is meant by (i) *mass-energy conservation*, (ii) *half-life*. (12)

Uranium-235 has a half-life of 8×10^8 years and decays by alpha emission.

(i) Write an equation to represent the loss of one alpha particle. (9)

(ii) Calculate the fraction of a sample of uranium-235 which would remain undecayed after 3.2×10^9 years. (9)

(iii) Give one practical use of uranium. (3)

(d) State the *laws of electromagnetic induction*. (12)

Describe an experiment to illustrate <u>one</u> of these laws. (12)

Fig. 5 represents a transformer with a primary coil of 100 turns and a secondary of 4000 turns. The primary is connected across a 220 volt a.c. supply. Calculate the voltage across the secondary, assuming that there is no energy loss in the transformer. (9)

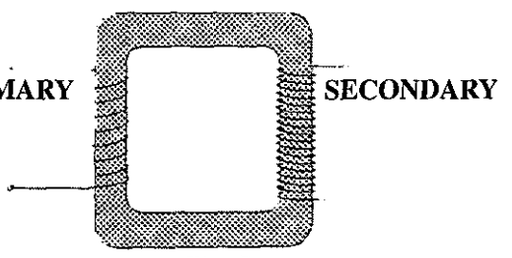


Fig. 5

SECTION II – CHEMISTRY (200 marks)

7. Answer eleven of the following items *(a)*, *(b)*, *(c)*, *(d)* etc. All the items carry equal marks.

(a) Identify the atom or ion represented by each of the following structures:

(i) $1s^2 2s^2 2p^6 3s^2 3p^4$

(ii) $[1s^2 2s^2 2p^6 3s^2 3p^6]^{2-}$

(b) Sketch the shape of the following molecules:

BeH_2 H_2O

(c) What is meant by an *atomic orbital*? Indicate the shape of a p-orbital.

(d) What is meant by *electronegativity*?

(e) What are the oxidation numbers of manganese in $KMnO_4$ and MnO_2?

(f) What is meant by the term the *catalyst*?

(g) Calculate the percentage of nitrogen, by mass, in ammonium chloride, NH_4Cl.

[H = 1; N = 14; Cl = 35]

(h) State *Hess's law.*

(i) Write down the structural formula of propanone (acetone).

(j) Give two properties usually associated with transition elements and/or their compounds.

(k) Identify the two species behaving as acids in the following system:

$$H_2SO_4 + 2HF \rightleftharpoons H_3SO_4^+ + HF_2^-$$

(l) Give the name and structural formula of the gaseous compound formed when calcium dicarbide reacts with water.

(m) Give two chemical properties of phenol.

(n) Arrange the following metals in order of decreasing chemical activity:

Zn Mg Cu Fe

(o) What is meant by an *amphoteric oxide*? (11 x 6)

8. *(a)* Distinguish clearly between mass number (A) and relative atomic mass (A_r). (12)

Using a mass spectrometer, it was found that lead consists of 25 % $^{204}_{82}Pb$, 23 % $^{207}_{82}Pb$ and 52 % $^{208}_{82}Pb$. Calculate the value for the relative atomic mass of lead. (12)

(b) What do you understand by *energy levels* in an atom? (6)

Explain, in terms of energy levels, why the spectra of atoms of elements consist of lines of definite frequency. (18)

(c) Define the *first ionisation energy of an element.* (6)

Explain why the first ionisation energy of sulphur is lower than that of both phosphorus and chlorine. (12)

9. Define *pH*.
What is the range of the pH scale? (9)

Calculate the pH of **(i)** a 0.01 M solution of **NaOH**; (ii) an aqueous solution containing 6.3 g of HNO_3 in 500 cm^3 of solution. (15)

The concentration of a hydrochloric acid solution was found by titration with a standard 0.1 M solution of sodium carbonate.

What is *a standard solution*? (6)

Describe how you would prepare 250 cm^3 of a standard solution of 0.1 M sodium carbonate. (15)

In the titration 24.0 cm^3 of the hydrochloric acid solution were required to neutralise 30.0 cm^3 of the 0.1 M sodium carbonate, using methylorange indicator.

(i) Write a balanced equation for the reaction involved. (6)

(ii) Name another suitable indicator for the titration. (6)

(iii) What is the concentration of the hydrochloric acid solution in moles per litre (dm^3). (9)

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

10. State *Faraday's first law of electrolysis.* (6)

Explain: (i) *oxidation*, (ii) *oxidising agent*, in terms of electron transfer. (12)

The apparatus shown in **Fig. 6** is used in the electrolysis of molten lead bromide.

Name the electrodes **R** and **S**. (6)

Name suitable material for the electrodes. (6)

Write balanced equations for the reactions that occur at **R** and **S**. (12)

If a current of 6 A was passed through the circuit for 3860 seconds, calculate:

(i) how many coloumbs of electricity were passed. (6)

(ii) the mass of lead deposited. (6)

(iii) the mass of bromine released. (6)

Give an industrial/commercial use of electrolysis. (6)

[F = 96 500 C mol^{-1}; Br = 80; Pb = 207].

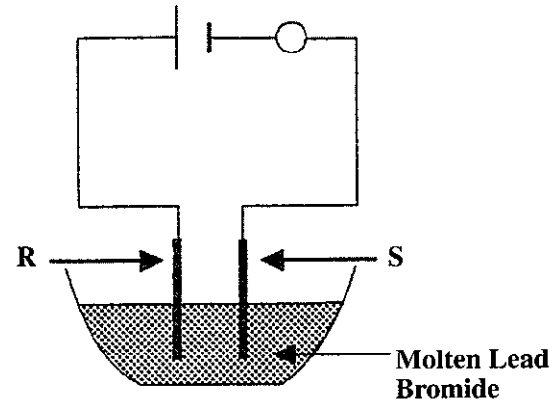
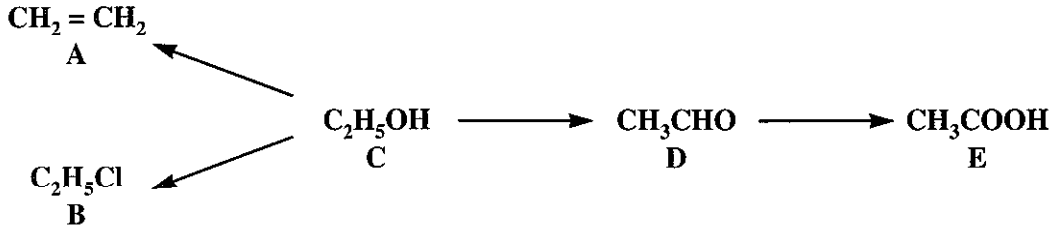


Fig. 6

11. Study the reaction scheme below and answer the questions which follow:



(i) Name the compounds **A, B, C, D** and **E** in the above reaction scheme. (12)

(ii) Give the structural formula for compound **E** and name the homologous series to which it belongs. (6)

(iii) Outline a laboratory test to distinguish compound **D** from compound **E**. (9)

(iv) Write an equation for the reaction of compound **D** with phenylhydrazine. (9)

(v) What type of compound is formed when compound **C** reacts with compound **E**? Name the products of this reaction. (9)

Describe, with the aid of a labelled diagram, the experimental procedure, by which compound **C** may be converted to compound **A.** (21)

12. Answer any three of the following, *(a)*, *(b)*, *(c)*, *(d)*. Each part carries 22 marks.

(a) Distinguish between a covalent bond and an ionic bond.

Sodium chloride and iodine are crystalline solids at room temperature. Iodine exists as a covalent crystal while sodium chloride exists as an ionic crystal. In the case of each of the above give the structural units present and the solubility of the compounds in polar and non-polar solvents.

(b) Define a *mole* of a substance.

5 g of calcium carbonate were heated and completely decomposed, forming calcium oxide and carbon dioxide according to the equation:

$$CaCO_3 = CaO + CO_2$$

(i) How many moles of calcium carbonate were heated?

(ii) What mass of calcium oxide was formed?

(iii) How many molecules of carbon dioxide were produced?

[C = 12; O = 16; Ca = 40; Avogadro constant = 6×10^{23} mol^{-1}]

(c) Define *the heat of formation of a compound.*

Calculate the heat change for the reaction:

$$3C_{(s)} + 4H_{2(g)} \longrightarrow C_3H_{8(g)}$$

from the following data:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -393 \text{ kJ mol}^{-1}$$
$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} \qquad \Delta H = -572 \text{ kJ mol}^{-1}$$
$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)} \qquad \Delta H = -2211 \text{ kJ mol}^{-1}.$$

(d) (i) **Fig. 7** shows a laboratory preparation of dry sulphur dioxide.

Name the solid **A** and the liquid **B**.

Write a balanced equation for the preparation.

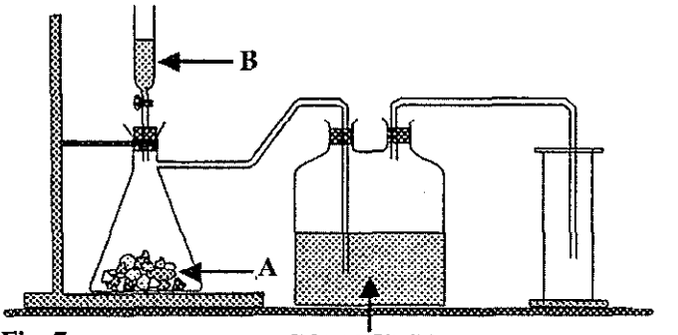


Fig. 7

(ii) Select from the following list:

CO_2 NH_3 CH_4 SO_2

the substance which in each case is:

(i) the main constituent of natural gas.

(ii) an acidic oxide which makes a large contribution to acid rain.

(iii) released, in large quantities, by the burning of fossil fuels and is a major cause of the greenhouse effect.

(iv) an alkaline gas.