AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1996

PHYSICS AND CHEMISTRY — HIGHER LEVEL 2274

THURSDAY, 13 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) Write an expression for *Newton's law of gravitation.*

(b) A stone travelling at 8 m s^{-1} has kinetic energy of 64 J. Calculate the mass of the stone.

(c) Define the *newton.*

(d) Convert –203 °C to the Kelvin scale.

(e) Give <u>two</u> assumptions of the kinetic theory of gases.

(f) Define *the unit of work*, i.e. the joule.

(g) Complete the statement:

"White light may be dispersed using a .....or a .....".

(h) Complete the statement:

"The image produced by the object shown in **Fig. 1** may be described as .....

and.....

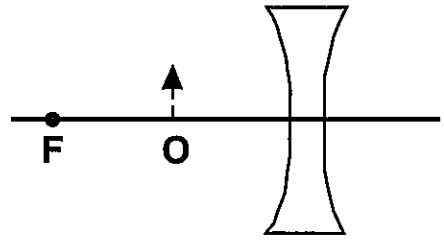

Fig. 1

(i) How may infrared radiation be detected in the laboratory?

(j) State Lenz's law of electromagnetic induction.

(k) Mention <u>one</u> way in which energy losses may occur in a transformer.

(l) State <u>two</u> methods by which a body can be electrically charged.

(m) State <u>two</u> properties of gamma rays.

(n) After 8 years, 1/16th of a sample of a radioactive substance remains undecayed. What is the half-life of the substance?

(o) How may a galvanometer be converted to work as **either** (i) an ammeter **or** (ii) a voltmeter. (11 x 6)

2. Define **(i)** velocity, **(ii)** force.

State *Newton's second law of motion.* (15)

In an experiment to verify Newton's second law, using a trolley, a force **F** was applied to a body and the acceleration **a** was measured. The experiment was repeated for a series of different forces and the following results were obtained.

Force/N	0.2	0.25	0.3	0.35	0.4	0.5
Acceleration/m s^{-2}	0.55	0.7	0.8	1.0	1.1	1.3

(a) Draw a suitable graph (on graph paper) and explain how it verifies Newton's second law. (18)

(b) From the graph determine the mass of the trolley. (9)

(c) Describe how the above experiment could be carried out in the laboratory to verify Newton's law. (24)

3. **(a)** Give two differences between longitudinal and transverse waves. Mention an everyday example of each type of wave. (18)

(b) Explain the terms diffraction and interference of waves. What condition must be fulfilled in order that waves meeting at a point constructively interfere.

Describe, with the aid of a diagram, how the wavelength of light may be measured in the laboratory using an interference method. (36)

(c) Calculate the value of the angle of refraction **r**, as shown in **Fig. 2**, if the speed of light in the glass is 2 x 10^8 m s^{-1} and speed of light in air is 3 x 10^8 m s^{-1}. (12)

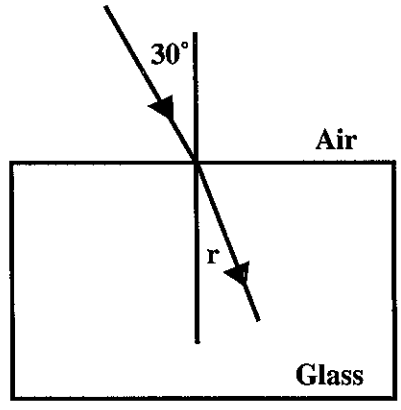

Fig. 2

4. *(a)* State *Coulomb's law* of force between electrical charges. (6)

Describe a laboratory experiment to demonstrate an electrical field pattern. (12)

If two spheres with charges of + 4 x 10^{-6} C and – 8 x 10^{-6} C are placed with their centres 500 mm apart, calculate the force between them, given that the constant k = 0.08. What would be the effect of moving the spheres so that they were 1000 mm apart? (15)

(b) Define the term *capacitance.* (6)

Outline an experiment to investigate how the capacitance of a parallel plate capacitor changes with the distance between the plates. (12)

Fig. 3 shows an arrangement of capacitors attached to a 6 V power supply.

Calculate:

(i) the total capacitance of the circuit,

(ii) the total charge stored,

(iii) the potential difference across the 4 μF capacitor. (15)

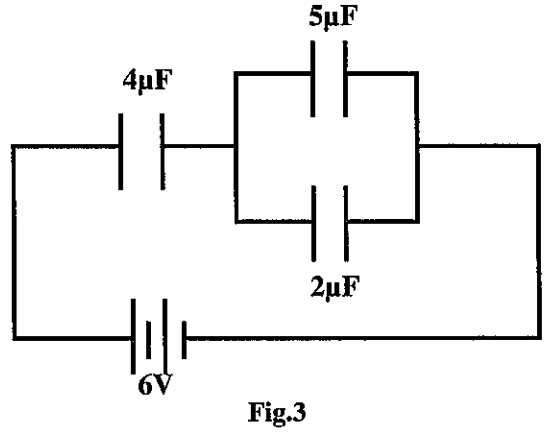

Fig.3

5. *(a)* Distinguish between nuclear fission and nuclear fusion. (6)

Complete the following nuclear reaction equation:

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{a}_{b}\mathrm{Z} + {}^{93}_{37}\mathrm{Rb} + 2{}^{1}_{0}\mathrm{n}$$

replacing **a**, b and Z with the appropriate numbers and symbol. (9)
(Refer to the Periodic Table of elements, p. 44 of Mathematical Tables).

Give the scientific reasons why (i) large amounts of energy may be produced by small quantities of fuel during nuclear reactions, (ii) nuclear fusion normally occurs at high temperatures only. (12)

Calculate the amount of energy released in a nuclear fission reactor when there is a loss of mass of 5 grammes. **($c = 3 \times 10^8$ m s^{-1})** (12)

(b) What is meant by the *photoelectric effect*?

Outline how the photoelectric effect may be demonstrated in the laboratory. (18)

Mention the historical significance of the discovery of the photoelectric effect. Give an everyday use of the photoelectric effect. (9)

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

(a) Draw ray diagrams to show how a concave mirror forms: **(i)** a real image, **(ii)** a virtual image. (15)

A pin of height 2 cm is placed 15 cm from a converging mirror of focal length 10 cm

(i) State the nature of the image formed. (6)

(ii) Calculate the magnification of the image and the height of the image. (12)

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

Describe an experiment to verify Boyle's law. Include all essential conditions in your description. (18)

A container of volume 0.5 litres holds a gas at a pressure of 4.5 atmospheres. Calculate the volume of gas that can be released from the can, at a pressure of 1.0 atmospheres, if the gas is allowed to expand at constant temperature. (9)

(c) Describe an experiment to confirm Ohm's law. (15)

Fig. 4 shows a circuit with a 12 volt power supply. If the ammeter is reading 1.43 A, calculate the value of resistor **X**. (12)

Name **two** types of conductors which do **not** obey Ohm's law. (6)

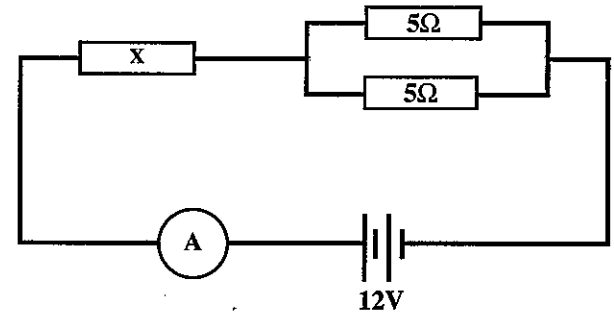

Fig. 4

(d) Explain the term *thermometric property* (6)

Draw a labelled diagram of a gas thermometer and outline how this thermometer can be calibrated in the laboratory. (18)

State:

(i) the principal use for a gas thermometer. (6)

(ii) the thermometric property on which the gas thermometer is based. (3)

SECTION II – CHEMISTRY (200 marks)

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

(a) How many (i) electrons (ii) neutrons are in the ion $^{24}_{12}Mg^{2+}$?

(b) Suggest a solvent in which iodine crystals are readily soluble, giving a reason for your choice.

(c) State the shape of each of the following molecules (i) BeH_2 (ii) BF_3.

(d) Complete and balance the equation $Na_2O + H_2O \longrightarrow$

(e) Calculate the number of molecules in 7.17 g of trichloromethane ($CHCl_3$)
(C = 12, H = 1, Cl = 35.5; Avogadro constant = 6×10^{23} mol^{-1}).

(f) Give the structural formula of 2-propanol.

(g) Arrange the following elements in order of increasing chemical reactivity:
calcium, copper, silver, sodium.

(h) Name a compound which is a reducing agent.

(i) Calculate the percentage aluminium, by mass, in aluminium oxide **(Al = 27, O = 16).**

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

(k) Explain the term *catalyst.*

(l) Name and describe the appearance of the compound PCl_3.

(m) Name the compound shown in **Fig. 5.**

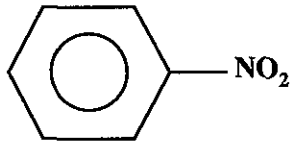

Fig. 5

(n) What is meant by a *homologous* series of compounds?

(o) Name one reagent used to test for aldehydes and ketones. (11 x 6)

8. *(a)* Define the *ionisation energy of an element.* (6)

The following table gives the first ionisation energies, in kJ mol^{-1}, of the elements in the second period of the Periodic Table.

Li	Be	B	C	N	O	F	Ne
519	900	799	1090	1400	1310	1680	2080

(i) Explain the factors which account for the trend in ionisation energies across the period. (12)

(ii) Explain why the values for boron and oxygen are exceptional. (12)

(b) Define the terms: **(i)** relative atomic mass, **(ii)** isotope. (12)

Write down the electronic configuration of (i) silicon, (ii) argon.
(Refer to the Periodic Table of elements, p. 44 of Mathematics Tables). (12)

A sample of lead was found to contain the three isotopes $^{206}_{82}Pb$, $^{207}_{82}Pb$, $^{208}_{82}Pb$ in the proportions 24.1 %, 23.1 % and 52.8 % respectively.
Calculate the relative atomic mass of the sample. (12)

9. Write down the structural formula of each of the following compounds:

Propane	Ethyne	Ethanal	Methanoic Acid
A	**B**	**C**	**D**

(12)

(i) **A** reacts with chlorine gas forming several products. Give the reaction conditions required and state the type of reaction involved. Write a balanced equation for the formation of *one* of these products. (15)

(ii) Describe how compound **C** may be prepared in the laboratory. State a precaution necessary to get a fairly pure sample of **C**. (18)

(iii) Show, using equations, how **D** may be converted to:

(*a*) a named salt, (*b*) a named ester. (15)

(iv) Outline a laboratory test to distinguish **A** from **B**. (6)

10. *(a)* Define **(i)** strong acid, **(ii)** conjugate acid-base pair. (12)

Identify the conjugate pairs in the following reactions

$$\mathbf{H_2F^+ + H_2O \rightleftharpoons HF + H_3O^+}$$

$$\mathbf{C_2H_5COOH + OH^- \rightleftharpoons C_2H_5COO^- + H_2O}$$ (12)

How would you classify the conjugate base of a strong acid? (6)

(b) In a titration, 20 cm^3 of 0.2 M sulphuric acid neutralises 25 cm^3 of a solution of sodium hydroxide.

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

(ii) Suggest a suitable indicator for the titration. (6)

(iii) Calculate the concentration of the sodium hydroxide in moles per litre (dm^3).

How many grammes of sodium hydroxide are used to make 1 litre (dm^3) of this solution? **(Na = 23, O = 16, H = 1)**. (15)

(iv) Calculate the pH of 0.02 M sulphuric acid. (9)

11. *(a)* State *Hess's law.* (6)

Define the *heat of combustion* of a compound. (12)

Calculate the heat of combustion of methanoic acid from the following data:

$$\mathbf{C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}} \qquad \mathbf{\Delta H = -394\ kJ\ mol^{-1}.}$$

$$\mathbf{H_{2(g)} + {}^1/_2O_{2(g)} \longrightarrow H_2O_{(l)}} \qquad \mathbf{\Delta H = -285\ kJ\ mol^{-1}.}$$

$$\mathbf{C_{(s)} + H_{2(g)} + O_{2(g)} \longrightarrow HCOOH_{(l)}} \qquad \mathbf{\Delta H = -412\ kJ\ mol^{-1}.}$$ (21)

(b) For *two* of the following elements, write down the name and formula of a hydride:

Na S N.

For each hydride selected:

(i) state its appearance at room temperature. (6)

(ii) Write a balanced equation for the reaction of each hydride with water – state whether the resulting solution is acidic, basic or neutral. (12)

Outline how ONE of the hydrides could be prepared in the laboratory. (9)

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

(a) Explain the terms:
(i) electronegativity; **(ii)** polar covalent bond.

How are electronegativity values used to predict the type of bonds formed between elements?

Fig. 6 shows the boiling point for two series of hydrides. Explain why the boiling point of water is higher than might be expected.

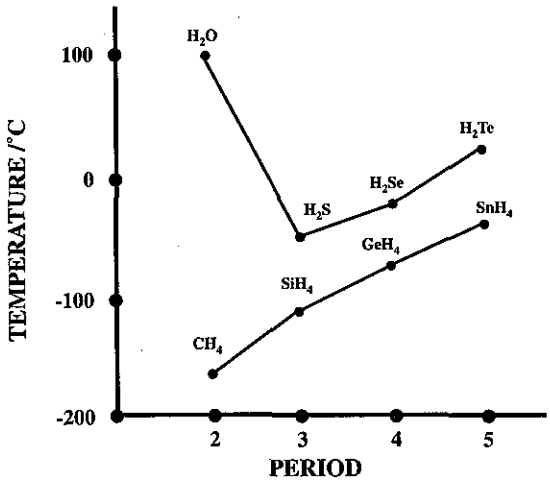

Fig. 6

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

Calculate the volume of chlorine released at STP when a current of 2 A flows for 10 minutes through molten calcium chloride.
(Molar volume at STP = 22.4 litres (dm^3); F = 96 500 C).

(c) Write the structural formula of:

(i) phenol

(ii) bromobenzene

(iii) ethyl benzoate.

Describe an experiment to confirm that phenol behaves as a weak acid.

(d) Define the *mole*.

5.08 g of copper reacts as follows:

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$$

(i) How many moles of copper were used?

(ii) Find the mass of water produced during the reaction.

(iii) Calculate the number of <u>molecules</u> of SO_2 that were made.
[H = 1; O = 16, Cu = 63.5; Avogadro constant = 6 x 10^{23} mol^{-1}]