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LEAVING CERTIFICATE EXAMINATION, 1999

PHYSICS AND CHEMISTRY — HIGHER LEVEL

MONDAY, 21 JUNE — MORNING 9.30 to 12.30

Six questions to be answered. Answer any **three** questions from Section I and any **three** from Section II. All the questions carry equal marks. However, in each Section, one additional mark will be given to each of the first two questions for which the highest marks are obtained.

SECTION I – PHYSICS (200 marks)

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

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

(*b*) Write down the values of 0 °C and 100 °C on the absolute scale.

(*c*) Write the following in order of *increasing* wavelength:

red light **blue light** **green light.**

(*d*) Sketch a graph to show the relationship between voltage and current for acidified water being electrolysed at low voltage, using inert electrodes.

(*e*) An object is thrown vertically upwards with an initial velocity of 40 m s^{-1}. What is its velocity after 2.5 seconds? [$g = 9.8$ m s^{-2}.]

(*f*) In a gas, collisions between the molecules may be assumed to be perfectly elastic. Explain what is meant by this statement.

(*g*) Sketch the electric field created by two equal adjacent positive point charges.

(*h*) Diffraction occurs when waves are incident on a narrow slit as in **Fig. 1.** Mention two ways by which the extent of the diffraction could be increased.

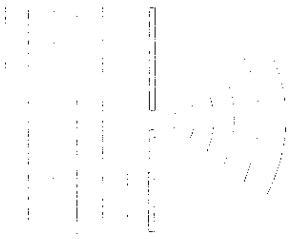

Fig. 1

(*i*) Explain how a fuse protects an electrical circuit.

(*j*) Give <u>two</u> advantages of nuclear fusion as a source of energy.

(*k*) Which has the greater power, a 220 volt motor drawing 0.25 amperes or a 24 volt motor drawing 2.5 amperes?

(*l*) What is the relationship between g, the acceleration due to gravity, and G, the universal constant of gravitation?

(*m*) A radioactive isotope has a half-life of 18 hours. After what period of time will one-eighth of a given sample of the isotope remain?

(*n*) What is meant by the dispersion of light?

(*o*) **Fig. 2** shows a solenoid through which a current is flowing in the direction shown. Copy the diagram and sketch the magnetic field pattern.

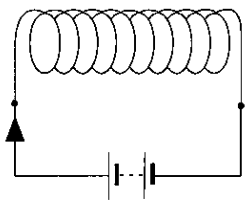

Fig. 2

(11x6)

2. State *Newton's laws of motion.* (18)

Describe a laboratory experiment to show that the acceleration of a body of constant mass is proportional to the resultant force acting on it.

State <u>one</u> precaution necessary for an accurate result. (24)

A missile of mass 5 kg travelling with a speed of 200 m s^{-1} penetrates into a wooden block to a depth of 0.03 metres.

Calculate: (i) the acceleration of the missile in coming to rest

(ii) the average resistive force exerted on the missile. (18)

Briefly describe an everyday example of Newton's third law. (6)

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

Outline a laboratory experiment to measure the focal length of a concave mirror. (12)

A pencil, 15 cm high, is held perpendicular to the principal axis of a concave mirror. The pencil is 87 cm from the mirror and its image is found 29 cm from the mirror. Calculate the focal length of the mirror.

What is the magnification and height of the image? (15)

(*b*) Define the terms (i) refractive index, (ii) critical angle.

State the relationship between these terms. (15)

Fig. 3 shows a beam of light travelling through water at a speed of 2.25 x 10^8 m s^{-1} . Given that the speed of light in air is 3 x 10^8 m s^{-1}, calculate

(i) the refractive index of the water,

(ii) the maximum value of the angle θ which will allow light to escape into the air. (18)

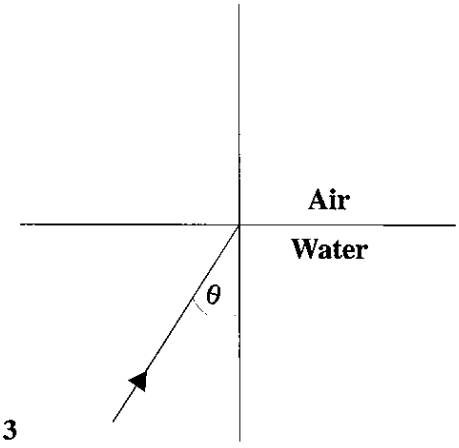

Fig. 3

4. (*a*) State the basic principles involved in establishing a scale of temperature. (9)

Give an expression to define temperature on the Celsius scale. (9)

The mercury level in an uncalibrated mercury-in-glass thermometer was found to be 4 cm from the bulb when the thermometer was placed in melting ice, and 20 cm from the bulb when it was placed in steam above pure boiling water. Where will the mercury level be found at -5 °C? (15)

(*b*) State *Charles' law.* (6)

Explain what is meant by an ideal gas and write down the equation of state for **n** moles of an ideal gas. (12)

Helium is contained in a vessel of volume 8.0 x 10^{-4} m^3 at a temperature of 300 K. If the pressure of the gas is 200 kPa, calculate the mass of helium present.
(Universal Gas Constant = 8.3 J mol^{-1} K^{-1}; molar mass of helium = 4 x 10^{-3} kg.) (15)

5. (*a*) Explain the term *capacitance.*

Define the unit of potential difference, *i.e.* the volt. (12)

Describe, with the aid of a labelled diagram, an experiment to show that the capacitance of a parallel-plate capacitor depends on the distance between the plates of the capacitor. (12)

Calculate the charge on a 1000 μF capacitor when the potential difference across it is 6 V. (9)

(*b*) State the basic principle upon which the moving-coil galvanometer is based. (6)

Fig. 4 shows a moving-coil galvanometer. Name the parts labelled **A**, **B** and **C** and give the function of **A** and **C**. (15)

A galvanometer has a resistance of 50 Ω and gives a full scale deflection with a current of 10 mA. Calculate the value of the shunt resistance needed to convert the instrument to an ammeter capable of measuring currents up to 2 amperes. (12)

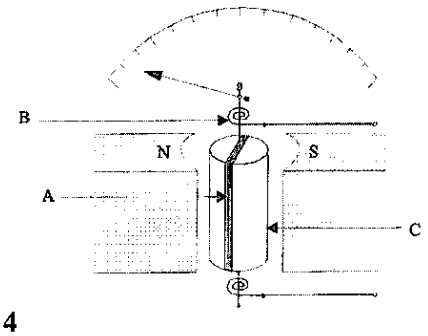

Fig. 4

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

(*a*) State *Faraday's law of electromagnetic induction* and describe an experiment by which it may be demonstrated. (15)

Fig. 5 shows a transformer. Calculate the current which flows in a resistance of 3 ohms connected to the secondary coil of 60 turns, if the primary coil has 1200 turns and is connected to a 240 V a.c. supply. (12)

Explain the causes of heating in the core of a transformer. (6)

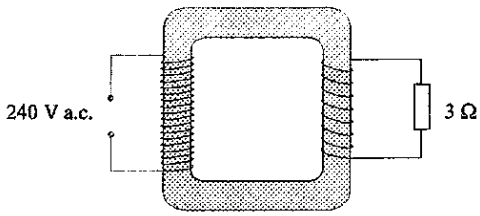

Fig. 5

(*b*) Explain the nature of alpha, beta and gamma radiation. (6)

Describe an experiment to show that beta particles have a greater penetrating ability than alpha particles. (15)

State <u>two</u> precautions you should take when performing an experiment using radioactive materials. (6)

The uranium isotope $^{238}_{92}U$ decays to an isotope of thorium (Th) by emitting an alpha particle. Write an equation for this nuclear transformation. (6)

(*c*) State the law of conservation of energy. (6)

A body of mass m is at a height h above ground level. If it falls a distance x ($x < h$), show that the loss in potential energy is equal to the gain in kinetic energy. (15)

A ball of mass 0.5 kg falls from a height of 45 metres. Calculate its kinetic energy just before it strikes the ground. ($g = 9.8$ m s^{-2}.) (12)

(*d*) <u>Interference</u> occurs when waves from two <u>coherent</u> sources meet. Explain the underlined terms. (12)

Describe in detail how you would measure the wavelength of the light from a sodium lamp (assumed to be monochromatic). (15)

What would be the effect on the image separation if light of shorter wavelength was used? (6)

SECTION II – CHEMISTRY (200 marks)

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

(*a*) State <u>two</u> characteristic properties of the transition elements.

(*b*) What is meant by *heat of solution*?

(*c*) Give <u>one</u> difference between aliphatic compounds and aromatic compounds.

(*d*) Calculate the percentage by mass of hydrogen in ethanoic acid (acetic acid). **[H = 1; C = 12; O = 16.]**

(*e*) What is (i) the conjugate acid of ammonia, (ii) the conjugate base of nitric acid?

(*f*) Write the name and structural formula for any homologue of ethyne (acetylene).

(*g*) Complete and balance the following equation

$$Al_2O_{3(s)} + HCl_{(aq.)} \longrightarrow$$

(*h*) Which of the following metals will <u>not</u> liberate hydrogen from dilute hydrochloric acid: aluminium, silver, zinc, magnesium?

(*i*) Calculate the **pH** of a **0.01 M** sulphuric acid solution, assuming it to be a strong acid.

(*j*) Give one chemical test to distinguish between an aldehyde and a ketone.

(*k*) Write down the structural formula for methylbenzene (toluene).

(*l*) Define the *relative atomic mass* of an element.

(*m*) Name two chemicals which can be used together in the preparation of sulphur dioxide in the laboratory.

(*n*) How many molecules are there in 56 g of nitrogen gas?
[N = 14; Avogadro constant = 6×10^{23} mol^{-1}.]

(*o*) Write the chemical formula of (i) an acidic oxide, (ii) an amphoteric oxide. (11x6)

8. (*a*) Explain the terms (i) energy level, (ii) atomic orbital. (12)

Compare protons and electrons under the headings (i) mass, (ii) charge. (6)

Identify the ions represented by each of the following structures
(i) $[1s^2\ 2s^2\ 2p^6]^{2-}$, (ii) $[1s^2\ 2s^2\ 2p^6]^{-}$. (6)

What is the meaning of the relationship $E_2 - E_1 = hf$? (9)

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

What are the trends in first ionisation energies in the Periodic Table (i) from lithium to neon, (ii) from lithium to potassium? State the factors which influence these trends. (15)

List the exceptions to the general trend in (i) above and explain why these exceptions occur. (12)

9. (*a*) Chlorine is a gas at room temperature but exists as a solid below –103 °C.
State the type of crystal formed by solid chlorine. (6)

Write the formula of the simplest chloride of (i) carbon, (ii) phosphorus and describe the appearances of these chlorides at room temperature. (12)

Draw diagrams showing the shapes of the two compounds and justify their shapes using the electron pair repulsion theory. (15)

(*b*) State *Faraday's laws of electrolysis.* (12)

Describe the electrolysis of molten calcium chloride using inert electrodes. Write equations for the reactions which occur at the anode and cathode. At which electrode does reduction take place? (21)

10. Distinguish between the terms *hydrolysis* and *dehydration.* (12)

Describe, using a labelled diagram of the apparatus, how you would prepare and collect a sample of ethene in the laboratory. Write a balanced equation for the reaction involved in the preparation. (24)

8.28 g of ethanol, $\mathbf{C_2H_5OH}$, burns in air, producing carbon dioxide and water vapour.

(i) How many moles of ethanol does 8.28 g represent? (6)

(ii) What volume of oxygen at STP is used up in the combustion of ethanol? (12)

(iii) How many molecules of carbon dioxide are produced? (6)

(iv) What mass of water vapour is produced? (6)

[H = 1; C = 12; O = 16; molar volume at STP = 22.4 litres (dm^3); Avogadro constant = 6 x 10^{23} mol^{-1}.]

11. Anhydrous sodium carbonate is a primary standard. In an experiment to standardise a solution of hydrochloric acid a standard solution of sodium carbonate was used.

(i) Explain the underlined terms (12)

(ii) Why is it necessary to standardise a hydrochloric acid solution? (9)

(iii) Describe how you would make up accurately 250 cm^3 of **0.1 M** sodium carbonate solution. (18)

(iv) Write a balanced equation for the reaction involved. Name a suitable indicator for the titration and state its colour change at the end point. (12)

(v) The following table shows the readings obtained when 25.0 cm^3 portions of **0.1 M** sodium carbonate were titrated with the hydrochloric acid solution.

Titration	First	Second	Third
Initial Reading/cm^3	0.0	25.0	0.0
Final Reading/cm^3	24.6	48.3	23.3

Calculate the molarity of the hydrochloric acid solution. How many grams of hydrogen chloride were used to make 1 litre (dm^3) of this solution? (15)

[H = 1; C = 12; O= 16; Cl = 35.5.]

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

(*a*) Explain what is meant by an *endothermic reaction* and give an example.

What is the *heat of formation of a compound*?

Given the following data:

$$H_{2\,(g)} + \tfrac{1}{2}O_{2\,(g)} \longrightarrow H_2O_{(l)} \qquad \Delta H = -286 \text{ kJ mol}^{-1}$$

$$C_2H_{6\,(g)} + 3\tfrac{1}{2}O_{2\,(g)} \longrightarrow 2CO_{2\,(g)} + 3H_2O_{(l)} \qquad \Delta H = -1560 \text{ kJ mol}^{-1}$$

$$C_2H_{4\,(g)} + 3O_{2\,(g)} \longrightarrow 2CO_{2\,(g)} + 2H_2O_{(l)} \qquad \Delta H = -1410 \text{ kJ mol}^{-1},$$

calculate the heat change for the reaction.

$$C_2H_{4\,(g)} + H_{2\,(g)} \longrightarrow C_2H_{6\,(g)}.$$

(*b*) Use equations to illustrate each of the following:

(i) the chlorination of methane,

(ii) the oxidation of ethanal (acetaldehyde),

(iii) the formation of an ester, *e.g.* ethyl ethanoate (ethyl acetate).

(*c*) Phenol behaves as a weak acid. Illustrate by means of an equation how phenol behaves, in water, as an acid.

Outline the preparation of phenol in the laboratory.

(*d*) Distinguish between a *polar* and a *non-polar* compound.

The electronegativity value of hydrogen is 2.1. Using this value, predict the type of bond it forms with (i) phosphorus, (ii) fluorine.

(Refer to Mathematical Tables page 46.)

"The water molecule has an overall dipole moment while the carbon dioxide molecule has zero dipole moment."

What does this statement tell us about the shapes of both molecules? Explain your answer.