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LEAVING CERTIFICATE EXAMINATION, 2000

PHYSICS AND CHEMISTRY — HIGHER LEVEL

MONDAY, 19 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 energy.*

(*b*) An athlete of mass 60 kg leaves a starting block with an acceleration of 5 m s^{-2}. What force is required to produce this acceleration?

(*c*) A missile travelling with a velocity of 10 m s^{-1} has a kinetic energy of 10 kJ. Calculate the mass of the missile.

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

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

(*f*) Calculate the work done when a crane raises a mass of 85 kg through a vertical height of 12 m. [g = 9.8 m/s^2.]

(*g*) For a given mass of gas state the relationship (i) between pressure and volume at constant temperature, (ii) between volume and temperature at constant pressure.

(*h*) **Fig. 1** shows an object **O** placed inside the focus of a concave mirror. Copy the diagram and indicate the position of the image. (**F** is the focus.)

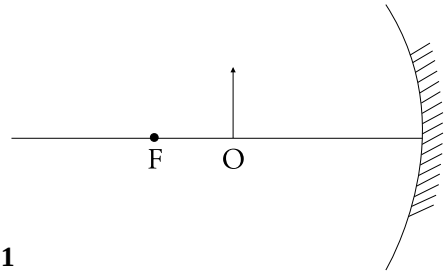

Fig. 1

(*i*) State a condition necessary for the occurrence of interference between waves.

(*j*) State *Faraday's law of electromagnetic induction.*

(*k*) **Fig. 2** shows a charged parallel plate capacitor. If the distance between the plates is increased what effect will this have on the voltage between the plates?

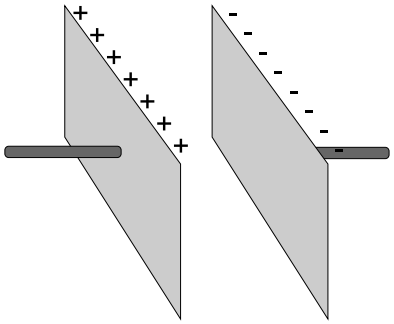

Fig. 2

(*l*) Suggest a reason why neutrons may penetrate the nucleus more easily than protons, in nuclear reactions.

(*m*) Complete the following nuclear equation

$$^{11}_{5}\mathbf{B} + {}^{4}_{2}\mathbf{He} \rightarrow {}^{1}_{1}\mathbf{H} +$$

(*n*) When a spectrum of white light is formed using a prism, which colour is (i) deviated least, (ii) deviated most?

(*o*) **Fig. 3** shows a simple a.c. generator.

Give the functions of the parts labelled **A** and **B**.

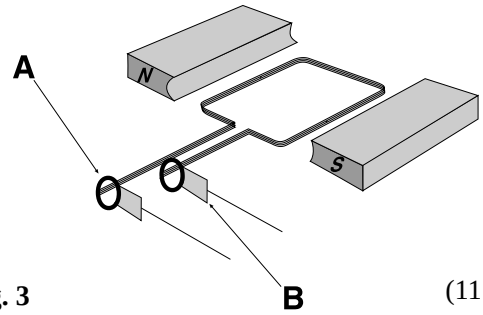

Fig. 3

(11 x 6)

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

Given that the acceleration due to gravity at the moon's surface is 1.6 m s^{-2} and that the moon's radius is 1.74 x 10^6 m, calculate the mass of the moon. (12)

Describe an experiment to determine the value of *g*, the acceleration due to gravity. State two precautions which you would take to ensure the accuracy of your result. (24)

A person stands on the edge of a cliff which is 20 m above a beach and throws a stone vertically upwards with an initial velocity of 15 m s^{-1}. Calculate

(i) the maximum height reached by the stone, (9)

(ii) the total time taken for the stone to reach the beach. (15)
[*g* = 9.8 m s^{-2}; *G* = 6.67 x 10^{-11} N m^2 kg^{-2}.]

3. Explain the terms (i) refraction, (ii) critical angle. (12)

In an experiment to verify Snell's law, a student placed a glass block on a sheet of paper. The following readings were obtained for the angles of incidence (*i*) and refraction (*r*):

***i* /degrees**	20	30	40	50	60	70
***r* /degrees**	13.5	20	26	31.5	36	40

Draw a suitable graph on graph paper and explain how this verifies Snell's law. (18)

From the graph determine a value for the refractive index of the glass. (9)

Describe the experimental procedure by which the above readings may have been obtained. (15)

Use a diagram to show how a prism may be used to reflect light through (i) 90º, (ii) 180º. (12)

4. (*a*) Define the unit of current, i.e. *the ampere*. (6)

Describe, with the aid of a labelled diagram, an experiment to show that the heat produced by the current in a metallic conductor in a given time is proportional to the square of the current, assuming that the resistance of the conductor is constant. (18)

Calculate the energy produced when a current of 5 A flows in a 100 Ω resistor for 10 minutes. (9)

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

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

A circuit consisting of a 9 V battery and 3 resistors is set up as in **Fig. 4.** The ammeter reads 0.9 A.

Calculate:

(i) the resistance of **R**; (12)

(ii) the potential difference across the 6 Ω resistor and the current flowing through it. (9)

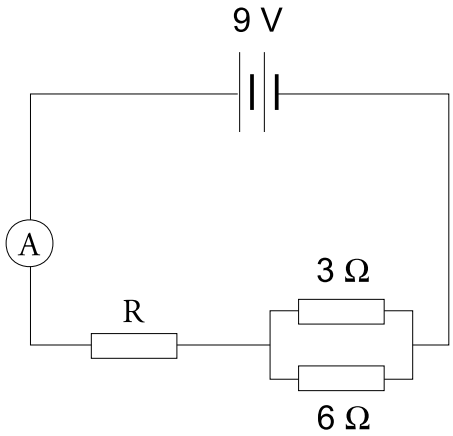

Fig. 4

5. (*a*) State *Coulomb's law of force* between electric charges. (6)

Describe an experiment to demonstrate an electric field pattern. (12)

Two equal electric charges are 5 cm apart and repel each other with a force of 2.4×10^{-6} N. Calculate the force if

(i) the size of each charge is doubled;

(ii) the distance between the charges is doubled. (15)

(*b*) When a freshly cleaned piece of zinc is placed on the cap of a negatively charged electroscope and illuminated with ultraviolet radiation, the leaves of the electroscope collapse.

Explain why the zinc must be freshly cleaned and why the leaves collapse. (15)

Explain why the leaves do not collapse when

(i) the zinc is illuminated with infrared radiation;

(ii) the zinc is covered with a piece of ordinary glass;

(iii) the electroscope is charged positively rather than negatively. (18)

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

(*a*) Distinguish between longitudinal and transverse waves. (6)

Explain, with the help of a diagram, the terms: wavelength, frequency and velocity, as they apply to waves. (15)

Calculate the wavelength of radio waves of frequency 2.0×10^{15} Hz which have a speed in air of 3×10^{8} m s^{-1}. (6)

Name <u>two</u> other radiations which have the same speed in air as radio waves. (6)

(*b*) Explain the terms (i) thermometric property, (ii) ideal gas. (12)

Draw a labelled diagram of a constant volume gas thermometer. (12)

Explain why it is necessary to have a standard thermometer.

Why is the constant volume gas thermometer used as a standard thermometer? (9)

(*c*) Explain the terms (i) radioactivity, (ii) radioisotope. (12)

Describe an experiment to compare the relative ionising ability of alpha and beta particles. (15)

What do you understand by "background radiation"? State *one* source of this radiation. (6)

(*d*) Explain the physical principles involved in each of the following:

(i) a crackling sound is sometimes heard when dry hair is combed; (6)

(ii) electrical systems normally contain fuses; (9)

(iii) magnets with curved poles are often used in moving–coil meters; (9)

(iv) the efficiency of a transformer is improved by laminating its core. (9)

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

(*b*) State *two* factors on which the value of the ionisation energy of an element depends.

(*c*) What is meant by the *principal quantum number* of an electron?

(*d*) Write down the structural formula of 2-chloropropene.

(*e*) What is the meaning of the term *catalyst*?

(*f*) Calculate the percentage by mass of nitrogen in ammonium nitrate ($\mathbf{NH_4NO_3}$).

[H = 1; N =14; O = 16.]

(*g*) Name one metallic element whose salts give a lilac coloured Bunsen burner flame.

(*h*) Arrange the following metals in order of decreasing chemical reactivity in the electrochemical series:

Mg Na Cu Fe.

(*i*) Complete and balance the equation

$$\mathbf{Ca + H_2O \rightarrow}$$

(*j*) Give the chemical formula of an ester.

(*k*) What is meant by the *heat of formation* of a compound?

(*l*) State <u>two</u> chemical properties of phenol.

(*m*) Write down an expression to show the relationship between the frequencies of lines in a spectrum and the energy levels in atoms.

(*n*) Give a brief description of a test for an unsaturated hydrocarbon.

(*o*) Give <u>two</u> essential features of acid-base indicators. (11 x 6)

8. Define (*a*) covalent bond, (*b*) polar covalent bond, (*c*) electronegativity. (15)

Use electronegativity values to predict the bonding in ammonia ($\mathbf{NH_3}$) and in phosphine ($\mathbf{PH_3}$). Describe their reaction, if any, with water. (15)

Explain why nitrogen has a higher electronegativity value than phosphorus. (6)

The following substances form crystalline solids:

graphite iodine sodium chloride.

In the case of each substance state

(i) the type of crystal present;

(ii) its solubility in non-polar solvents. (18)

Diamond and graphite are allotropes of carbon. Sketch their crystal structures. Compare their electrical conductivity and account for the difference by referring to their structures. (12)
(Refer to Mathematics Tables p. 46.)

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

Define the *heat of combustion* of a substance. (6)

Calculate the heat of combustion of propane given the following data:

$$\mathbf{C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} \quad \Delta H = -393\ kJ\ mol^{-1}}$$
$$\mathbf{H_{2\,(g)} + \tfrac{1}{2}O_{2\,(g)} \rightarrow H_2O_{(l)} \quad \Delta H = -286\ kJ\ mol^{-1}}$$
$$\mathbf{3C_{(s)} + 4H_{2\,(g)} \rightarrow C_3H_{8\,(g)} \quad \Delta H = -104\ kJ\ mol^{-1}}$$

(21)

(*b*) Classify each of the following oxides as basic, acidic, amphoteric or neutral:

aluminium oxide carbon monoxide sulphur dioxide iron(III) oxide.

(12)

Write balanced equations for the reactions between sodium hydroxide and (i) the amphoteric oxide, (ii) the acidic oxide.

Name the salts produced in each case. (18)

Give <u>one</u> use of sulphur dioxide. (3)

10. Define *relative molecular mass.* (6)

Two hydrocarbons have relative molecular masses of 26 and 78 and each contains 92.3% carbon and 7.7% hydrogen. Calculate the molecular formula of each compound and name them. [**C = 12, H = 1.**] (18)

Study the following reaction scheme and answer the questions which follow:

ethanol → ethanal → ethanoic acid.

(i) What is a homologous series? Name the homologous series to which each of the three named compounds belongs. (15)

(ii) Explain the term functional group. Write the functional group of each of the homologous series represented by the three compounds. (15)

(iii) Give the reaction conditions necessary to convert (a) ethanol to ethanal; (b) ethanal to ethanoic acid. (12)

11. Define (i) strong acid, (ii) conjugate acid-base pair. (12)

List the four species which may be described as bases in the following:

$$\mathbf{C_6H_5COOH + OH^- \rightarrow C_6H_5COO^- + H_2O}$$
$$\mathbf{H_2SO_4 + HCN \rightarrow HSO_4^- + H_2CN^+.}$$

(12)

Write down one conjugate acid-base pair from each of the two reactions. (6)

In a titration 25.0 cm^3 of a **0.15 M** sodium hydroxide solution neutralises 24.0 cm^3 of a sulphuric acid solution.

(i) Describe the correct washing procedures for the pipette and conical flask before starting the titration. (9)

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

(iii) Calculate the concentration of the sulphuric acid in moles per litre (dm^3). (9)

(iv) Define **pH** and calculate the **pH** of the **0.15 M** sodium hydroxide solution. (12)

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

(*a*) Define (i) reduction, and (ii) reducing agent, in terms of electron transfer.

Identify the substance reduced and the reducing agent in each of the following reactions

$$\mathbf{2Mg + CO_2 \rightarrow 2MgO + C}$$
$$\mathbf{2NO + O_2 \rightarrow 2NO_2.}$$

(*b*) Copper is both a d-block element and a transition element.

Explained the underlined terms.

Write down the electronic configurations (s, p etc) of (i) Cu^{+}, (ii) Cu^{2+}.

State which ion is the more stable and give a reason for your answer.

(*c*) 10.5 g of sodium hydrogencarbonate (**$NaHCO_3$**) were heated and completely decomposed forming sodium carbonate, carbon dioxide and water vapour.

(i) Write a balanced equation for the reaction.

(ii) How many moles of sodium hydrogencarbonate were heated?

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

(iv) Give an example of where sodium hydrogencarbonate is used in the food industry.

[H = 1; C = 12; O = 16; Na = 23; Avogadro's constant = 6×10^{23} mol^{-1}.]

(*d*) What is an electrolyte?

Draw a labelled diagram of the apparatus used in the electrolysis of acidified water using platinum electrodes.

Calculate the volume of oxygen collected at the cathode when a current of 1.3 A is passed through the acidified water for 10 minutes.

[Molar volume at STP = 22.4 litres (dm^3); 1 faraday = 96,500 C.]