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LEAVING CERTIFICATE EXAMINATION, 2001

PHYSICS AND CHEMISTRY — HIGHER LEVEL

MONDAY, 18 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*) Define *weight*.

(*b*) A stone of mass 0.12 kg is thrown from a catapult with a kinetic energy of 24 J. What is the initial velocity of the stone?

(*c*) Write an expression for the relationship between temperature on the Celsius scale and temperature on the Absolute (Kelvin) scale.

(*d*) Name the thermometric property on which the constant volume gas thermometer is based.

(*e*) A ray of light AB is incident normally on a 45° right-angled glass prism as shown in **Fig. 1.** Copy the diagram and complete the path of the ray through the prism. (Critical angle for the glass is 42°.)

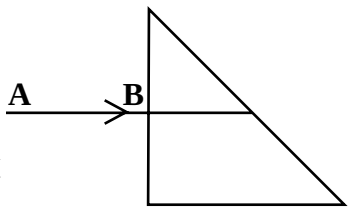

Fig. 1

(*f*) Why are convex mirrors, rather than concave mirrors, used as security mirrors, e.g. in shops?

(*g*) Sketch the magnetic field due to a current flowing in a solenoid.

(*h*) **Fig. 2** shows a pear-shaped conductor on an insulated stand. Copy the diagram and show how the charge is distributed over the conductor when it is charged positively.

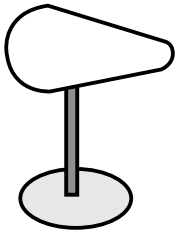

Fig. 2

(*i*) State which of the following types of electromagnetic radiation has (i) the longest wavelength, (ii) the highest frequency.

radio waves **X-rays** **microwaves** **ultraviolet rays**

(*j*) Calculate the effective resistance of the arrangement of resistors shown in **Fig. 3.**

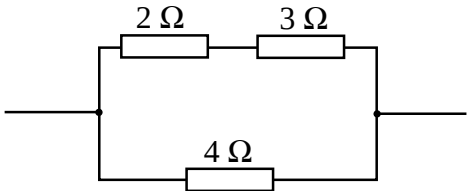

Fig. 3

(*k*) Sketch a graph to show the current-voltage relationship for a metal.

(*l*) Calculate the frequency of a photon of energy 6.4×10^{-19} J. (**Planck constant**, $\boldsymbol{h = 6.6 \times 10^{-34}}$ **J s.**)

(*m*) A piece of fuse wire has a resistance of 0.1 Ω. A current of 13 A melts the wire in 0.2 s. How much energy is converted to heat?

(*n*) Give <u>two</u> uses of radioactive isotopes.

(*o*) Explain what is meant by the *half-life* of a radioactive isotope.

(11×6)

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

Define (i) acceleration, (ii) the unit of force, i.e. *the newton.* (12)

In an experiment to verify Newton's second law, a force F was applied to a body and the acceleration a of the body was measured. This was repeated a number of times for different values of the applied force. The values of a and the corresponding values of F are given in the following table.

F/N	0.05	0.15	0.25	0.35	0.45	0.55	0.65
a/m s^{-2}	0.14	0.38	0.72	0.98	1.2	1.5	1.8

Draw a suitable graph on graph paper and hence determine the mass of the body. (21)

Describe how the above experiment could be carried out in the laboratory. Your account should include details of the measurements taken. (15)

For each measurement, the body started from rest and travelled a distance of 90 cm. Calculate the time taken by the body to travel this distance when its acceleration was 1.5 m s^{-2}. (12)

3. State the *laws of refraction of light.* (12)

Distinguish between a real image and a virtual image. (6)

Describe, with the aid of a labelled diagram, a laboratory experiment to measure the focal length of a converging (convex) lens. State <u>one</u> precaution necessary for an accurate result. (18)

The image formed in a diverging (concave) lens of focal length 20 cm is one quarter the height of the object. Find the distance of the object from the lens. State the nature of the image. (15)

Use a ray diagram to show how the final image is formed by an astronomical telescope in normal adjustment and describe the image formed. (15)

4. (*a*) State *Boyle's law.* (6)

Describe an experiment to verify Boyle's law. (18)

A gas cylinder has a volume of 0.04 m^3 and contains air at a pressure of 2×10^6 Pa. Assuming that the temperature remains constant calculate:

(i) the equivalent volume of air at atmospheric pressure (1×10^5 Pa);

(ii) the volume of air, at atmospheric pressure, which escapes from the cylinder when it is opened to the atmosphere. (12)

(*b*) Explain the term *ideal gas.* (6)

State <u>two</u> assumptions of the *kinetic theory of gases.* (6)

How is temperature of a gas explained in terms of the kinetic theory? (6)

Calculate the number of moles in 0.02 m^3 of an ideal gas at a temperature of 300 K and a pressure of 1×10^5 Pa. (12)

(Universal gas constant, R = 8.3 J mol^{-1} K^{-1}.)

5. (*a*) Describe an experiment to demonstrate the principle on which the moving-coil galvanometer is based. (15)

A galvanometer with an internal resistance of 50 Ω is fully deflected by a current of 4 mA. Calculate the value of the shunt resistance needed to convert the galvanometer to an ammeter capable of measuring currents up to 6 A. (12)

Explain why an ammeter should have a very small resistance. (6)

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

Fig. 4 shows a simple a.c. generator. Name the parts labelled **A**, **B** and **C** and give the function of <u>two</u> of these parts. (15)

Sketch a graph showing how the voltage generated by the a.c. generator varies with time. (6)

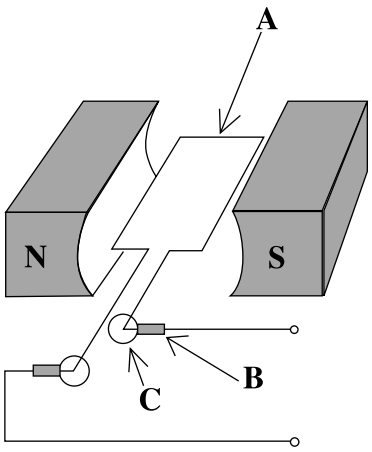

Fig. 4

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

(*a*) Describe a laboratory experiment to verify the *principle of conservation of momentum*. State <u>one</u> precaution that should be taken to ensure an accurate result. (21)

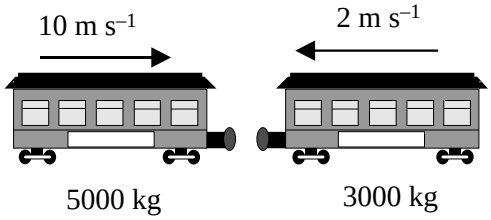

Fig. 5

Fig. 5 shows a railway carriage of mass 5000 kg moving with a velocity of 10 m s^{-1} in the direction shown. It collides with another carriage of mass 3000 kg moving in the opposite direction with a velocity of 2 m s^{-1}. After the collision both carriages move together. Calculate their initial velocity after the collision. (12)

(*b*) When a beam of monochromatic light is passed through Young's slits an interference pattern is formed on a screen. The bright and dark bands formed on the screen are due to constructive and destructive interference. Explain, with the aid of diagrams, the difference between the underlined terms. (12)

In a Young's slits experiment, light of wavelength 590 nm gave 5 fringes on the screen. The distance from the first fringe to the fifth was 4.8 mm. Given that the distance from the slits to the screen was 0.8 m calculate the distance between the slits. (15)

How would the interference pattern have been different if the slits had been closer together? (6)

(*c*) Define (i) nuclear fission, (ii) nuclear fusion. (12)

State the changes, if any, that occur in the atomic number and the mass number of a radioactive nucleus when it emits (i) an alpha particle, (ii) a beta particle. (12)

Calculate the number of α-particles and the number of β-particles emitted in the radioactive decay of $^{226}_{88}\mathbf{Ra}$ to $^{214}_{83}\mathbf{Bi}$. (9)
(Refer to Mathematics Tables, p. 44.)

(*d*) State two of the factors that determine the capacitance of a parallel plate capacitor. (6)

Fig. 6 shows two capacitors connected in series with a 30 V power supply. The charge on each capacitor is the same. Calculate:

(i) the total capacitance of the circuit;

(ii) the charge on each capacitor;

(iii) the potential difference across the 5 μF capacitor. (21)

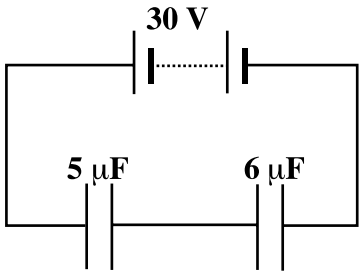

Fig. 6

Give an example of a device that contains a capacitor and state the function of the capacitor. (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*) Define a *mole* of a substance.

(*b*) Identify <u>two</u> molecular crystals from the following:

diamond **dry ice** **sodium chloride** **iodine**

(*c*) Calculate the percentage of carbon, by mass, in propanone (acetone), $\mathbf{(CH_3)_2CO}$.

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

(*d*) Explain what is meant by the term *hydrolysis*.

(*e*) Name an element that exhibits variable valency and give its valencies.

(*f*) Give an example of a compound which has polar bonds but which is a non-polar molecule.

(*g*) An oxide of sulphur contains 50% by mass of oxygen. What is the formula of this oxide?

[O = 16; S = 32.]

(*h*) Name a chemical test <u>or</u> reagent that you would use to distinguish between an aldehyde and a ketone.

(*i*) Give the name and structural formula of the aromatic compound of molecular formula, $\mathbf{C_7H_8}$.

(*j*) Name <u>two</u> chemicals that may be used to prepare a sample of hydrogen peroxide.

(*k*) Define *heat of solution* of a substance.

(*l*) Identify the oxidising and the reducing agent in the following reaction:

$$\mathbf{2Ca + O_2 \rightarrow 2CaO}$$

(*m*) Suggest a suitable indicator for each of the following acid-base titrations:

(i) strong acid and strong base; (ii) strong acid and weak base.

(*n*) Copy, complete and balance the equation: $\mathbf{Mg + H_2SO_4 \rightarrow}$

(*o*) Distinguish between an *exothermic reaction* and an *endothermic reaction*.

(11×6)

8. Define the terms (i) first ionisation energy, (ii) atomic orbital, (iii) relative atomic mass. (18)

Fig. 7 shows a graph of first ionisation energy against atomic number for the elements hydrogen to neon.

Account for:

(i) the decrease in the first ionisation energy from **Be** to **B**; from **He** to **Ne**; and from **N** to **O**;

(ii) the increase in the first ionisation energy from **B** to **N**. (24)

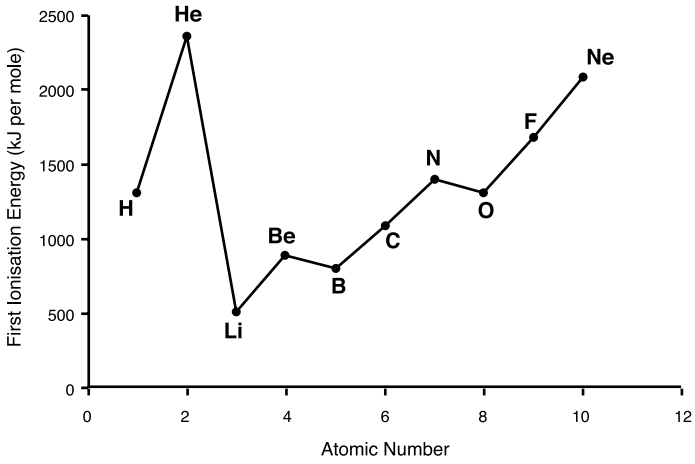

Fig. 7

Write the electronic configuration (s, p) of (i) the germanium atom (**Ge**), (ii) the fluoride ion ($\mathbf{F^-}$). (12)

(Refer to the Periodic Table of Elements given in the Mathematics Tables, p. 44.)

Using a mass spectrometer it was found that a sample of lead consisted of 24.1% of $^{206}_{82}\mathbf{Pb}$, 23.1% of $^{207}_{82}\mathbf{Pb}$ and 52.8% of $^{208}_{82}\mathbf{Pb}$. Calculate the relative atomic mass of this sample of lead. (12)

9. (*a*) Define (i) *heat of reaction*, (ii) *heat of formation*, of a substance. (12)

Methane reacts with chlorine to form tetrachloromethane according to the equation:

$$\mathbf{CH_{4(g)} + 4Cl_{2(g)} \rightarrow CCl_{4(l)} + 4HCl_{(g)}}$$

Calculate the heat of reaction of the above reaction using the following data:

$$\mathbf{C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)} \quad \Delta H = -74.9\ kJ\ mol^{-1}}$$
$$\mathbf{C_{(s)} + 2Cl_{2(g)} \rightarrow CCl_{4(l)} \quad \Delta H = -139.0\ kJ\ mol^{-1}}$$
$$\mathbf{H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} \quad \Delta H = -184.6\ kJ\ mol^{-1}}$$ (18)

State <u>one</u> condition necessary for this reaction to occur and give <u>one</u> use for tetrachloromethane. (6)

(*b*) Place the elements copper, calcium, silver and potassium in order of *decreasing* chemical reactivity. (6)

Explain how this order is justified on the basis of the reaction, if any, of the metals (i) with water, (ii) with dilute hydrochloric acid. (18)

Explain what is observed when a piece of zinc is immersed in a solution containing copper(II) ions. (6)

10. (*a*) Explain what is meant by a conjugate acid-base pair in terms of the Bronsted-Lowry theory. (6)

Two acids dissociate in water as follows:

$$H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$$

$$CH_3COOH + H_2O \rightarrow H_3O^+ + CH_3COO^-$$

Explain why sulphuric acid is considered a strong acid but ethanoic acid (acetic acid) is described as a weak acid. (12)

Give the formulae for the conjugate bases of (i) HSO_4^-, (ii) H_2O. (6)

(*b*) What is meant by **pH**? (6)

Calculate the **pH** of (i) an aqueous solution containing 0.049 g of H_2SO_4 in 500 cm^3 of solution, (ii) a **0.33 M** solution of **KOH**. (15)

[H = 1; O = 16; S = 32; K = 39.]

(*c*) A student was asked to measure the concentration of a solution of calcium hydroxide **($Ca(OH)_2$)** and found that 25 cm^3 of the solution was neutralised by 19.6 cm^3 of a **0.05 M** hydrochloric acid solution.

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

Calculate the concentration of the calcium hydroxide solution in moles per litre (dm^3). How many grams of calcium hydroxide were required to make one litre of this solution? (15)

[H = 1; O = 16; Ca = 40.]

11. Explain the terms (i) homologous series, (ii) functional group. (12)

A sample of ethyne (acetylene) gas was prepared using the apparatus shown in **Fig. 8**.

(i) State the homologous series to which ethyne belongs and write its structural formula. Give the main use for ethyne. (18)

(ii) Identify **X** and **Y** and write a balanced equation for the reaction involved in the preparation of ethyne. (12)

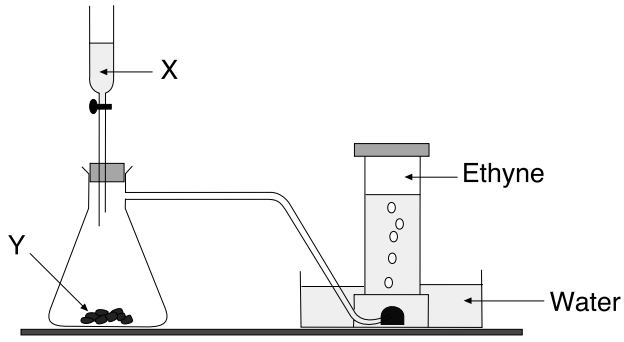

Fig. 8

(iii) Outline a laboratory test to show that ethyne is an unsaturated compound. (6)

(iv) State the conditions under which ethyne is converted into ethanal (acetaldehyde). (9)

(v) Write an equation for the reaction of ethanal (acetaldehyde) with phenylhydrazine. (9)

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

(*a*) State *Faraday's laws of electrolysis.*

Draw a labelled diagram to show the electrolysis of molten lead(II) bromide.

Name the products formed.

(*b*) Give the names or formulae of the products formed when water reacts with each of the following compounds:

(i) an oxide of a Group I metal;

(ii) a hydride of a Group II metal;

(iii) a chloride of phosphorus.

In the case of (ii) write a balanced equation for its reaction with water.

(*c*) Outline the *electron pair repulsion theory.*

Sketch the shape of two of the following molecules:

BeH_2 **BF_3** **CH_4**

In each case state:

(i) the number of bond pairs;

(ii) the number of lone pairs;

(iii) the bond angle.

(*d*) The formulae of two organic compounds are:

A **B**

(i) Name each of the compounds **A** and **B**.

(ii) Both compounds act as acids when reacted with sodium hydroxide. Write a balanced equation to show this reaction for either **A** or **B**. Name the products formed.

(iii) Give one use for each of the compounds **A** and **B**.

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