



Coimisiún na Scrúduithe Stáit State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2025

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

WEDNESDAY, 18 JUNE – MORNING, 9:30 to 12:30

Six questions to be answered.

Answer at least **two** questions from Section I, at least **two** questions from Section II and **any two other** questions.

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.

N.B. Relevant data are listed in the *Formulae and Tables* booklet, which is available from the superintendent.

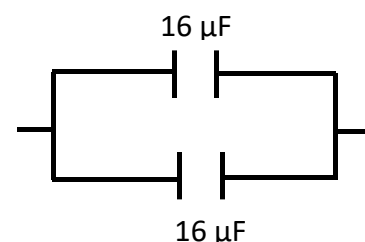
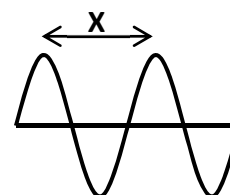
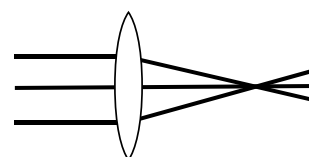
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SECTION I – PHYSICS

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

- (a) Calculate the weight of a small dog with a mass of 5 kg.
[acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$]
- (b) Calculate the work done when a force of 150 N moves an object 3.5 m in the direction of the force.
- (c) The image shows a sign with a speed limit of 30 km/h.
State the speed limit in metres per second.
- (d) State Newton's third law of motion.
- (e) State the lower fixed point on the Celsius temperature scale.
- (f) What is meant by a thermometric property?
- (g) What is meant by refraction?
- (h) The image on the right shows parallel light rays passing through a glass lens. State the name of this type of lens.
- (i) State **one** application of total internal reflection.
- (j) What term is given to the distance marked **X** on the waveform shown?
- (k) State **one** difference between a transverse wave and a longitudinal wave.
- (l) Sketch a diagram to show the diffraction of plane waves after passing through a narrow gap.
- (m) Name any **two** terminals found inside a three-pin plug.
- (n) What is the purpose of a transformer?
- (o) State **one** way to increase the capacitance of a parallel plate capacitor.
- (p) Two $16 \mu\text{F}$ capacitors connected in parallel are shown.
Calculate the effective capacitance of the combined capacitors.
- (q) State what each letter in Einstein's equation $E = mc^2$ stands for.
- (r) State **one** difference between nuclear *fission* and nuclear *fusion*.



(11 × 6)

2. (a) Define (i) velocity and (ii) acceleration.

(iii) What is meant by potential energy?

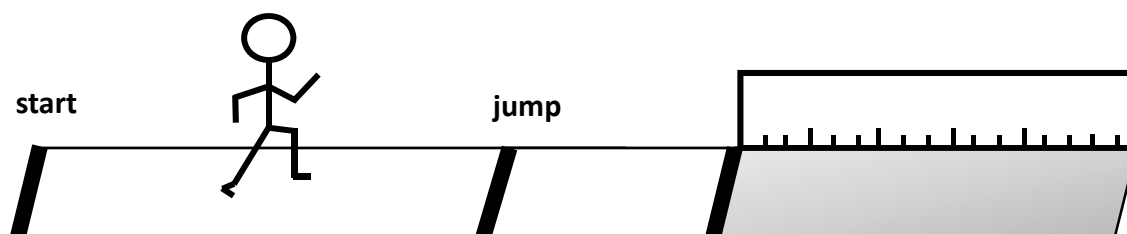
Kinetic energy (K.E.) can be calculated using the equation below:

$$\text{K.E.} = \frac{1}{2}mv^2$$

- (iv) Identify **two** factors (variables) which change the kinetic energy of a moving object.

(24)

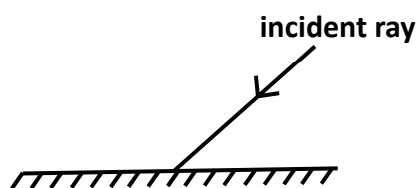
- (b) The diagram below shows an athlete of mass 68 kg taking part in a long jump. During the run towards the point labelled 'jump' the athlete accelerates from a constant velocity of 6.1 m s^{-1} to 7.3 m s^{-1} in 2.0 seconds.



- (i) Calculate the average acceleration of the athlete.
- (ii) Calculate the force produced by the athlete during the acceleration.
- (iii) Calculate the change in kinetic energy of the athlete during the acceleration. (24)
- (c) (i) Describe an experiment to measure the acceleration due to gravity, g .
You should include a labelled diagram in your answer.
- (ii) State **one** precaution to ensure an accurate result. (18)

3. (a) The diagram shows an incident ray of light striking a plane mirror.

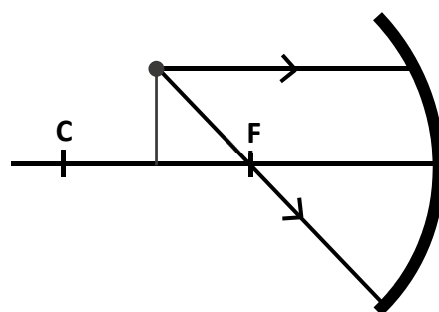
- (i) What is meant by the underlined term?
- (ii) State the laws of reflection of light.
- (iii) Copy and complete the diagram showing the location of the normal **and** the path of the reflected ray.



(24)

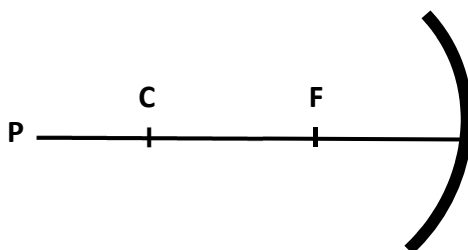
- (b) A pin placed in front of a concave mirror at a position between the focus, **F**, and the centre of curvature, **C**, forms a magnified image.

- (i) What is meant by the underlined term?
- (ii) Copy and complete the diagram to show how the **two** rays are reflected by the mirror forming an image of the head of the pin.
- (iii) Is the image formed *real* or *virtual*?
State a reason for your answer.
- (iv) Calculate the focal length of the mirror given that its radius of curvature is 15 cm.



(30)

- (c) The location of an object along the principal axis, **P**, affects the type of image formed. Copy the diagram below into your answerbook.



- (i) Draw an **X** on the principal axis to show where the object must be placed to form an image of equal height.
- (ii) Draw a **Y** on the principal axis to show where the object could be placed to form a virtual image.

(12)

4. (a) (i) Name the Irish scientist who has a gas law named in recognition of his work on the relationship between the pressure and the volume of a gas.
- (ii) State the gas law associated with this work.
- (iii) What term describes the gas which obeys the gas laws at all pressures and temperatures?



(24)

- (b) The following data were recorded during an experiment to investigate the relationship between the pressure and the volume of the gas in an apparatus kept at 0 °C.

Volume (Litres)	1.0	2.0	3.0	4.0	5.0	6.0
Pressure (kPa)	900	450	300	220	180	160

- (i) Convert 0 °C to its value on the Kelvin scale.
- (ii) Draw a graph, on graph paper, of pressure (y-axis) against volume (x-axis).
- (iii) Use your graph to estimate the pressure of this gas when it occupies a volume of 3.5 litres. (30)
- (c) In 1827 Robert Brown observed that pollen grains suspended in water moved in rapid random motion.
- (i) State **one** assumption of the kinetic theory of gases.
- (ii) How do Robert Brown's observations provide evidence for the kinetic theory? (12)

5. (a) The image shows a pair of point charges.

(i) Is the force between the charges *attractive* or *repulsive*?
State a reason for your answer.



(ii) Copy the diagram and show the electric field pattern around the charges.

The force between the two-point charges is 0.40 N.

(iii) What will happen to the size of the force if the size of **both** charges is doubled?

(iv) What will happen to the size of the force if the distance between the charges is doubled?

(27)

(b) The following terms are used in stating Ohm's law:

**potential difference
(voltage)**

constant

conductor

current

(i) Copy and complete the following statement of Ohm's law in your answerbook:

"The in a is directly proportional to the
between its ends at a temperature."

The diagram shows a 5 Ω and a 10 Ω resistor in a circuit with a 12 V supply.

(ii) What term describes this arrangement of resistors?

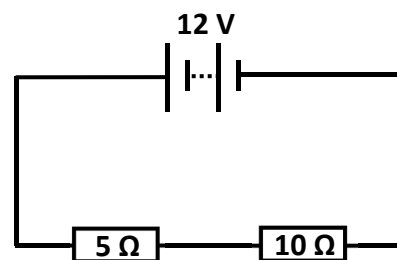
(iii) How could the current in the circuit be measured?

(iv) State the SI unit of electrical current.

(v) Calculate the combined resistance of the two resistors.

(vi) Calculate the current in the circuit.

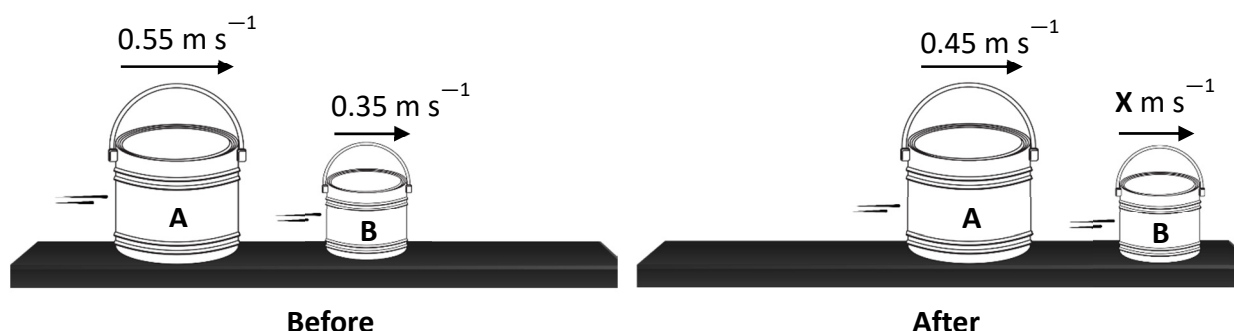
(vii) Calculate the power generated in the circuit.



(39)

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

- (a) (i) What is meant by momentum?
(ii) State the principle of conservation of momentum.



Paint can **A** of mass 9.0 kg slides towards paint can **B** of mass 6.0 kg . Both cans are moving in the same direction along a smooth floor. **A** has an initial velocity of 0.55 m s^{-1} and **B** has an initial velocity of 0.35 m s^{-1} . The velocity of **A** after the collision is 0.45 m s^{-1} .

(iii) Calculate the momentum of can **A** before the cans collide.

(iv) Calculate the momentum of can **B** before the cans collide.

After the cans collide they continue to move in the same direction.

(v) Calculate the momentum of can **A** after the collision.

(vi) Calculate the velocity, **X**, of can **B** after the collision. (33)

- (b) An air fryer uses the heating effect of an electric current to prepare a range of foods.

(i) State **two** other effects of an electrical current.

The table below indicates the electrical energy converted over a six-minute period by an air fryer.



Time (minutes)	0	1	2	3	4	5	6
Energy (kJ)	0	150	300	450	600	750	900

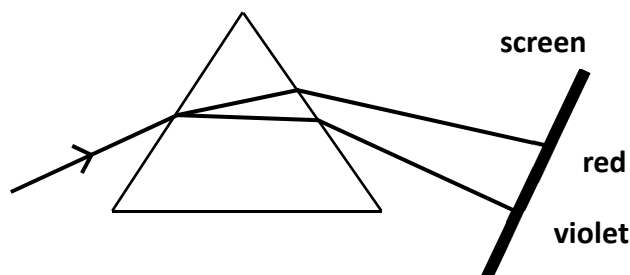
(ii) Draw a graph, on graph paper, of energy (y-axis) against time (x-axis).

(iii) How many joules of electrical energy are converted during each minute?

(iv) Calculate the power rating (wattage) of this air fryer. (33)

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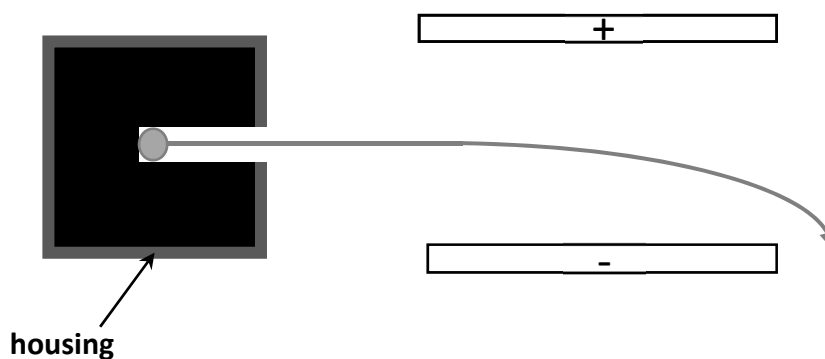
- (c) White light is a small part of the electromagnetic spectrum which can be detected by the human eye. A beam of white light is split into its component colours as it passes through a glass prism.



- (i) Name the phenomenon that is associated with the separation of white light into its component colours.
- (ii) State **one** property common to all parts of the electromagnetic spectrum.
- (iii) State **three** other component colours of white light.
- (iv) Identify the type of invisible radiation located just beyond the red visible light.
- (v) What is meant by the frequency of a wave motion?
- (vi) State the unit of frequency. (33)

- (d) (i) Explain what is meant by radioactivity.

The image shows the path of positively charged alpha-particles, emitted by a radioactive substance, as they pass through a pair of oppositely charged plates.



- (ii) State **two** other properties of alpha-particles.
- (iii) Suggest a suitable chemical element which could be used for the housing of the radioactive substance.
- (iv) Describe the path a beta-particle would take as it passes through the same oppositely charged plates. State a reason for your answer.

It is observed that gamma radiation passes through the oppositely charged plates undeflected.

- (v) State a reason for this observation. (33)

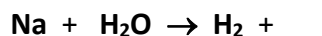
SECTION II – CHEMISTRY

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

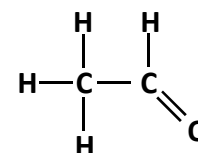
- (a) What type of atomic orbital is shown on the right?
- (b) Which element is represented by the electron configuration:
 $1s^2, 2s^2, 2p^6, 3s^2$?
- (c) State **one** property of a neutron.
- (d) State the name of **one** of the allotropes of the element carbon.
- (e) Identify an element with a lower electronegativity value than sodium (**Na**).
[Refer to *Formulae and Tables* booklet, page 81]
- (f) State an example of a substance that contains hydrogen bonds.
- (g) Select the **two** transition metals from the following list of elements:

aluminium boron chromium sulfur iron

- (h) How many molecules of oxygen are in 0.25 moles of oxygen gas (**O₂**)?
[Avogadro's constant = $6.0 \times 10^{23} \text{ mol}^{-1}$]
- (i) Copy, complete and balance the following equation:



- (j) What is meant by an amphoteric substance?
- (k) Draw the structural formula of **C₃H₆** (propene).
- (l) Calculate the pH of 0.1 M solution of nitric acid (**HNO₃**).
- (m) State the chemical formula of copper(I) oxide.
- (n) Calculate the percentage of hydrogen by mass in benzene (**C₆H₆**).
[H = 1; C = 12]
- (o) State Hess's law.
- (p) State **one** use for ethanoic (acetic) acid.
- (q) Which alcohol can undergo dehydration to form ethene (**C₂H₄**)?
- (r) Copy the structural formula of ethanal (acetaldehyde) and circle the exact location of the carbonyl group.



(11 × 6)

8. (a) What is meant by (i) the atomic number and (ii) the mass number of an atom of an element? (12)

(b) Pages 79 – 81 of the *Formulae and Tables* booklet may help answer the following questions.

Bromine (**Br**) is located in group 17 of the Periodic Table of the Elements. Bromine reacts with sodium (**Na**) to form the compound sodium bromide (**NaBr**).

(i) State the group number of sodium.

(ii) What type of chemical bond is present in sodium bromide?

(iii) State **two** properties of compounds with this type of chemical bond.

(iv) State a reason why bromine does not form compounds with elements in group 18.

(24)

(c) Bromine is a volatile coloured liquid which exists as molecules at room temperature.

Bromine (**Br**) atoms occur in two natural forms: $^{79}_{35}\text{Br}$ and $^{81}_{35}\text{Br}$.

(i) What is a molecule?

(ii) Which **two** sub-atomic particles are identical in number in both forms of the bromine atoms?

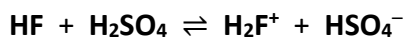
Analysis of a sample of bromine atoms concluded that 50.7% of the atoms were $^{79}_{35}\text{Br}$ and the rest were $^{81}_{35}\text{Br}$.

(iii) Calculate the percentage of $^{81}_{35}\text{Br}$ present in the sample.

(iv) Calculate the relative atomic mass of bromine.

(30)

9. (a) (i) What is meant by a Brønsted-Lowry acid?
(ii) Identify the **two** acids in the following equation:

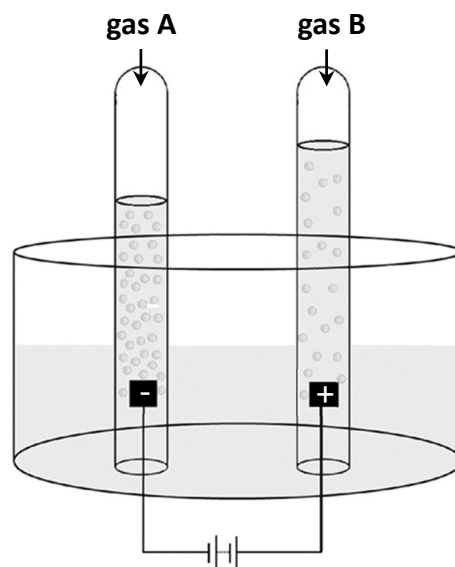


- (iii) What is meant by an acid-base conjugate pair?
(iv) According to the above equation which substance along with **H₂SO₄** would form a conjugate pair?
(v) What term describes an acid which fully dissociates in water? (24)

- (b) Both oxidation and reduction occur during the process of the electrolysis of acidified water.
(i) Explain reduction in terms of electron transfer.

The image on the right shows an apparatus that can be used to carry out electrolysis of acidified water using inert electrodes.

- (ii) Suggest a suitable material for use as the inert electrodes.
(iii) Identify the electrolyte used during this process.
(iv) Name **gas A** and **gas B**.
(v) Describe a test to identify **gas A**.



(42)

10. Exactly 25.0 cm³ of a solution of potassium hydroxide (**KOH**) was delivered by **A** into **B** in preparation for a titration.

- (a) (i) Identify the pieces of glassware labelled **A** and **B**.
 (ii) How was **A** prepared for use?
 (iii) Name the piece of laboratory apparatus used to fill **A**. (15)

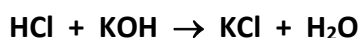
(b) A burette was prepared and filled with a solution of hydrochloric acid (**HCl**).

- (i) State **one** safety precaution that should be taken when filling a burette.
 (ii) State **one** precaution to ensure an accurate reading is taken from the burette.

A white tile was placed under **B** and a few drops of another solution **Z** added.

- (iii) What was the purpose of the white tile?
 (iv) What type of solution is **Z**?
 (v) State the purpose of **Z**. (24)

(c) The equation for the reaction between hydrochloric acid (**HCl**) and potassium hydroxide (**KOH**) is:



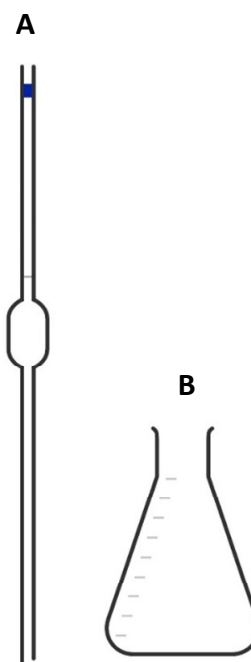
A student recorded the following data from the burette containing the acid, **HCl**.

Volume of HCl in burette	Titration 1	Titration 2
at start	0.0 cm ³	19.7 cm ³
at end	19.7 cm ³	39.1 cm ³

- (i) Explain why the results of **Titration 2** would be more accurate than the results of **Titration 1**.
 (ii) What volume of acid was used during **Titration 2**?

The volume of 0.18 M hydrochloric acid used in **Titration 2** neutralised 25 cm³ of the potassium hydroxide solution.

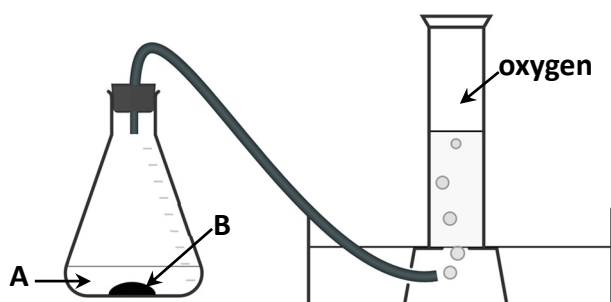
- (iii) Calculate the concentration of the potassium hydroxide solution.
 (iv) Name a technique that can be used to separate the salt, **KCl**, from the water. (27)



11. (a) Natural gas consists of a mixture of component hydrocarbon gases including methane, ethane, propane and butane which are all alkanes.
- (i) Explain the underlined terms.
 - (ii) Name the component with one carbon atom.
 - (iii) Draw the structural formula of the component named in (ii).
 - (iv) How many extra hydrogen atoms are found in a molecule of butane when compared to a molecule of propane? (21)
- (b) (i) What is meant by the term unsaturated?
- (ii) Name an unsaturated hydrocarbon with **two** carbon atoms.
 - (iii) Describe how you would test a hydrocarbon for unsaturation. (21)
- (c) The heat of formation of carbon dioxide is represented by the following equation:
- $$\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} \quad \Delta H = -393 \text{ kJ mol}^{-1}$$
- (i) What is meant by the heat of formation?
 - (ii) Is this reaction *exothermic* or *endothermic*? State a reason for your answer.
 - (iii) Calculate the heat change involved when 15 moles of carbon dioxide are formed. (24)

12. Answer **any two** of the following parts (a), (b), (c). Each part carries 33 marks.

- (a) The diagram below shows a set up for the preparation and collection of oxygen (O_2) gas by the decomposition of liquid **A** in the presence of a solid catalyst **B**.



- (i) Identify **A** and **B**.
- (ii) Explain the role of a catalyst in a chemical reaction.
- (iii) Describe a test to verify that the gas collected is oxygen.
- (iv) State **one** use for oxygen gas. (33)

- (b) Consider the following descriptions of quantities in various areas in chemistry:

Letter	Description
A	number of electrons in a single neutral atom of hydrogen
B	total number of electrons in a $1s^2, 2s^2, 2p^3$ configuration
C	number of electrons present in the triple bond in ethyne (C_2H_2)
D	number of lone pairs of electrons on the central atom of a BF_3 molecule
E	total number of hydrogen atoms around carbon in methane
F	total number of types of sub-atomic particles in an atom of helium (He)
G	number of electrons present in a molecule of hydrogen (H_2)

- (i) In your answerbook match each term to its description (**A, B, C**, etc.) in the table.

zero	one	two	three
four	six	seven	

- (ii) Sketch a diagram showing the arrangement of atoms in one molecule of BF_3 .
- (iii) State the bond angle in BF_3 . (33)

This question continues on the next page

- (c) (i) What is meant by s.t.p.?

Concrete blocks are formed from the reaction between cement and other natural materials.

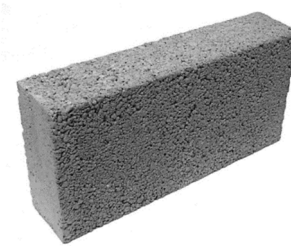
During the manufacture of cement, calcium carbonate (**CaCO₃**) decomposes, when heated, to produce calcium oxide (**CaO**) according to the equation:



- (ii) Calculate the mass of one mole of **CaCO₃**.
(iii) How many moles of **CaCO₃** are present in 500 g?
(iv) Calculate the mass of **CaO** produced when 500 g of **CaCO₃** decomposes.
(v) What volume of **CO₂** is produced at s.t.p. when 500 g of **CaCO₃** decompose?

[**C** = 12, **O** = 16, **Ca** = 40, volume at s.t.p. = 22.4 litres]

(33)



Acknowledgements

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Leaving Certificate Examination – Ordinary Level

Physics and Chemistry

Wednesday, 18 June

Morning, 9:30 – 12:30