



Coimisiún na Scrúduithe Stáit State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2026

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

WEDNESDAY, 17 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.

Do not hand this up.

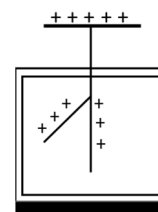
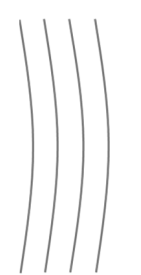
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SECTION I – PHYSICS

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



- (a) State the SI unit of energy.
- (b) Calculate the weight of a tiger with a mass of 265 kg.
[acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$]
- (c) State one difference between a scalar and a vector quantity.
- (d) Calculate the acceleration of an object of mass 18 kg when a force of 8.5 N is applied.
- (e) Pure aluminium metal melts at 660°C .
Convert this temperature to its value on the Kelvin scale.
- (f) The wavefronts shown diffract as they pass through the gap. Copy and complete the diagram to show this wave undergoing diffraction.
- (g) State one example of a longitudinal wave.
- (h) Name two regions of the electromagnetic spectrum.
- (i) State one common use for a concave mirror.
- (j) Calculate the focal length of a concave mirror with a radius of curvature of 10 cm.
- (k) What is observed as a negatively-charged rod approaches the cap of a positively charged electroscope?
- (l) State two effects of an electrical current.
- (m) Calculate the effective resistance of two 330Ω resistors connected in series.
- (n) Name the phenomenon that results in the release of electrons from the surface of a metal when light of a suitable frequency falls on it.
- (o) Sketch the magnetic field around a bar magnet.
- (p) State the principle on which the moving-coil galvanometer is based.
- (q) Name a device used to detect nuclear radiation.
- (r) State two types of nuclear reaction.



(11 × 6)

2. (a) A rider on an e-scooter maintains the maximum legal velocity of 20 kilometres per hour for 2 minutes on a road.



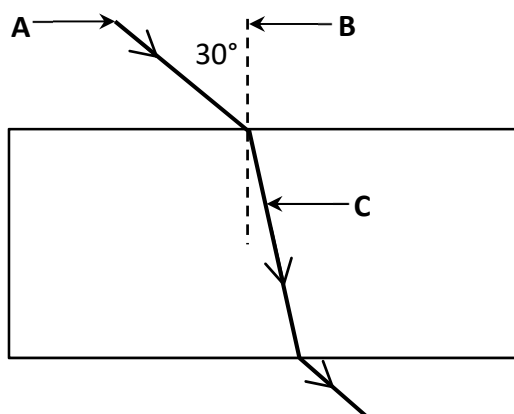
- (i) What is the meant by velocity?
- (ii) Convert 20 kilometres per hour to metres per second.
- (iii) Calculate the maximum distance travelled in the 2 minute interval.
- (iv) Calculate how long it would take, at this velocity, to travel 2.5 kilometres. (27)

- (b) The table shows the velocity of an e-scooter at constant time intervals along a road.

Time (s)	0.0	0.5	1.0	1.5	2.0	2.5
Velocity (m s^{-1})	0.0	0.8	1.6	2.4	3.2	4.0

- (i) Draw a graph on graph paper of velocity (y -axis) against time (x -axis).
- (ii) How does your graph show that the e-scooter is experiencing acceleration?
- (iii) Use your graph to estimate the time it takes for the e-scooter to reach a velocity of 3.0 m s^{-1} .
- (iv) Calculate the acceleration of the e-scooter.
- (v) State two factors which determine the maximum acceleration of an e-scooter. (39)

3. (a) The diagram below shows how a ray of light travels through a rectangular glass block.



(i) What is meant by the refraction of light?

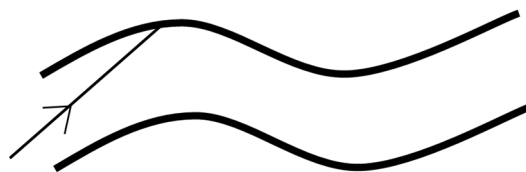
(ii) Identify **A**, **B** and **C**.

The light ray strikes the glass block at an angle of 30° and undergoes refraction as it travels from air to glass. The angle of refraction is 19.5° .

(iii) Calculate n , the refractive index of the glass block. (24)

- (b) The diagram shows a ray of monochromatic light entering a fibre optic cable.

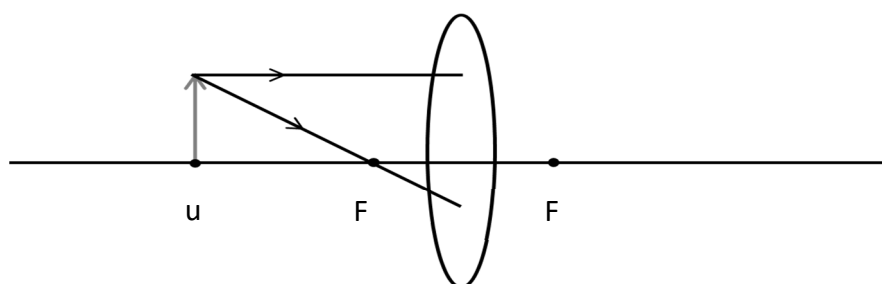
(i) Copy and complete the diagram to show how light is transmitted along an optical fibre.



(ii) Name the phenomenon that allows light to travel through an optical fibre without escaping.

(iii) State one use of an optical fibre. (18)

- (c) The diagram below shows two rays travelling towards a converging (convex) lens.



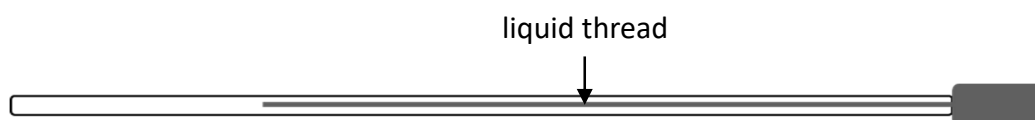
(i) Copy and complete the diagram to show the paths of the rays of light after they strike the converging lens.

A converging lens has focal length f of 2 cm. An object u is placed 6 cm in front of the lens.

(ii) Calculate the image distance, v .

(iii) Calculate the magnification, m . (24)

4. (a) A temperature scale can be defined in terms of changes of a physical property such as the length of an enclosed liquid as in a laboratory thermometer.



- (i) What term is used to describe a physical property that changes measurably with temperature?
 - (ii) State another example of a physical property that changes measurably with temperature.
 - (iii) State the two fixed points used to establish the Celsius temperature scale on a laboratory thermometer.
 - (iv) Describe an experiment to locate these fixed points on an unmarked laboratory thermometer. (27)
- (b) The following table shows the data obtained in an experiment to establish the calibration curve of a thermometer.

Temperature (°C)	0	20	40	60	80	100
Length (mm)	20	48	76	104	132	160

- (i) Draw a graph on graph paper of length (y -axis) against temperature (x -axis).
- (ii) Use your graph to estimate the length of the liquid thread of the liquid at 56°C .
- (iii) Calculate the change in length of the thread for every degree change in the temperature.

Some laboratory thermometers contain the liquid metal mercury (**Hg**).

- (iv) State two reasons why mercury is suitable for use in a thermometer. (39)

5. (a) A mains powered television is rated at 0.091 kW when in use and 0.0005 kW when in standby mode.



- (i) What replaceable safety device inside a three-pin plug is used to connect to a mains supply?
- (ii) State two energy conversions that take place when the television is switched on.
- (iii) Calculate the number of kilowatt hours (kW h) consumed by the television when used for 3 hours each day.

For the remainder of each day (21 hours) the television is in standby mode.

- (iv) Calculate the total number of kilowatt hours (kW h) consumed by the television in one day.
- (v) Calculate the total cost of running the television for 28 days if the cost per kW h is 35 cent.

(33)

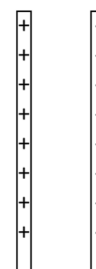
- (b) The following terms are used in expressing Coulomb's law of electrical forces:

distance inversely product square two

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

"The force between charged particles is directly proportional to the of the charges and is proportional to the of the between the charges."

The diagram shows the plates of a charged parallel-plate capacitor.

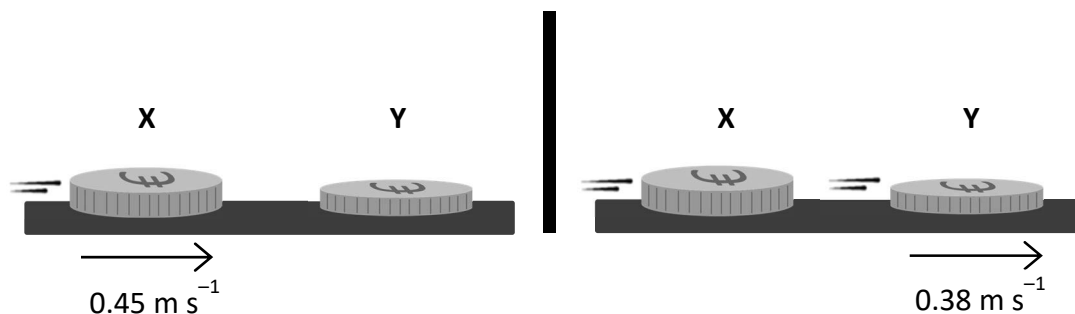


- (ii) Copy the diagram into your answerbook showing the electric field between the plates and its direction.
- (iii) What happens to the electric field between the plates when they are discharged?
- (iv) State three factors which affect the capacitance of a parallel-plate capacitor.

(33)

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

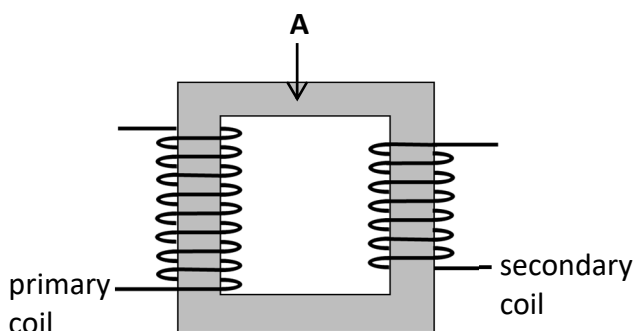
- (a) A coin, **X**, of mass 24 g moving at a velocity of 0.45 m s^{-1} slides along a smooth horizontal table top. It collides with a smaller coin, **Y**, of mass 16 g which is stationary. After the collision both coins move off in the same direction with coin **Y** moving at 0.38 m s^{-1} .



- What is meant by momentum?
- State the principle of conservation of momentum.
- Calculate the momentum of coin **X** *before* the collision.
- Calculate the velocity of coin **X** *after* the collision.
- Why does coin **Y** not contribute to the total momentum before the collision? (33)

- (b) An electrical transformer is based on the principle of electromagnetic induction and is used with a.c. voltage sources.

- What is meant by a.c. voltage?
- Explain the term electromagnetic induction.
- Identify the part labelled **A** on the electrical transformer shown.



A transformer with 4900 turns on its primary coil is connected to a 1000 V a.c. source.

- Calculate the number of turns on the secondary coil when the output voltage is 230 V a.c.
- Why are high voltages used to transmit electrical power over long distances? (33)

- (c) Many discoveries about the nature of matter are based on the study of gases and their properties. Consider the descriptions in the table below.

Letter	Description
A	type of motion to describe the random motion of gaseous particles
B	a gas law relating the pressure and volume of a gas
C	a value kept constant when applying the gas laws
D	a gas law relating the volume and absolute temperature of a gas
E	a gas obeying all gas laws at all values of pressure and temperature
F	the temperature scale which includes an absolute zero value
G	effect on the pressure of a gas after doubling the volume
H	effect on the absolute temperature of a gas after doubling its volume

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

Boyle

Brownian

Charles

doubling

halving

ideal

Kelvin

mass

The kinetic theory of gases makes predictions about the particle nature of gases.

- (ii) State two assumptions of the kinetic theory of gases. (33)

- (d) In 1977 the Voyager 2 space probe was launched on an initial trajectory to pass Uranus and Neptune and in 2026 continues to send back data from interstellar space.

Voyager 2 is powered using the energy released during the decay of plutonium-238 which is a radioactive isotope with a half-life of 88 years.



- (i) What is meant by the half-life of a radioactive isotope?
- (ii) How many years since the launch of Voyager 2?
- (iii) Does Voyager 2 currently have more than 50% of its power source remaining? State a reason for your answer.

During the radioactive decay of plutonium-238 a stream of alpha-particles is emitted.

- (iv) Describe the structure of an alpha particle.
- (v) How could a stream of alpha particles be deflected?
- (vi) State two other types of nuclear radiation. (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) Draw the shape of
 - (i) an s orbital,
 - (ii) a p orbital.
- (b) Identify two elements with the same group number as krypton (**Kr**).
- (c) Copy and complete the following statement:
 "Allotropes are different forms of the same"
- (d) State two characteristic properties of transition metal compounds.
- (e) Carbon-14 is a naturally occurring radioactive isotope used in archaeology.
 Explain the term isotope.
- (f) State two possible shapes of a molecule with the general formula **AB₂**.
- (g) Calculate the volume occupied by 2.5 moles of argon gas at s.t.p.
 [molar volume at s.t.p. = 22.4 litres]
- (h) Calculate the percentage by mass of oxygen in hydrogen peroxide (**H₂O₂**).
 [**H** = 1, **O** = 16]
- (i) A hot air balloon contains 1.5×10^5 moles of nitrogen gas.
 How many molecules of nitrogen does it contain?
 [Avogadro constant = $6 \times 10^{23} \text{ mol}^{-1}$]
- (j) State the role of a catalyst in a chemical reaction.
- (k) What is a hydrocarbon?
- (l) Balance the following equation:



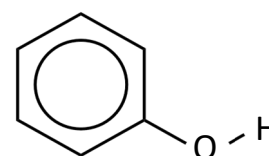
- (m) Calculate the pH of 0.018 M solution of nitric acid (**HNO₃**).
- (n) Identify two gases produced when acidified water undergoes electrolysis.
- (o) List the following elements in their order in the electrochemical series.

zinc (**Zn**)

copper (**Cu**)

potassium (**K**)

- (p) How many electrons are present in the triple bond between the two carbon atoms in ethyne (**C₂H₂**)?
- (q) Copy the structural formula for phenol and circle the hydroxyl group.
- (r) State one use for ethanoic acid.



(11 × 6)

8. All known elements are arranged on the periodic table by increasing atomic number. The location of elements can be used to predict trends in their structure and properties.

(a) You should use the information found on pages 79, 80 and 81 of the *Formulae and Tables* booklet when answering this question.

Element	lithium (Li)	chlorine (Cl)
Atomic number	S	V
Group number	T	W
Period number	2	X
First ionisation energy (kJ mol^{-1})	520	Y
Electronegativity	U	Z

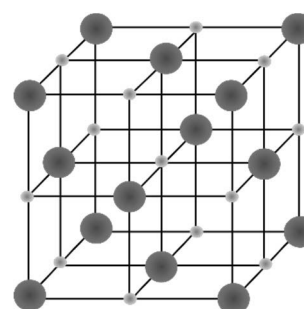
- Identify the values **S**, **T** and **U** for the element lithium (**Li**) shown in the table above.
- Identify the values **V**, **W**, **X**, **Y** and **Z** for the element chlorine (**Cl**) shown in the table above.
- What do elements in the same group have in common?
- Write the electronic configuration for an atom of chlorine (**Cl**).
- What is meant by the first ionisation energy of an atom of an element?
- State a reason why there is a large difference in first ionisation energy between lithium and chlorine.

(36)

(b) The type of bonding in a compound is related to the electronegativity values of the elements it contains.

- Use electronegativity values to show that the bonding in lithium chloride (**LiCl**) is ionic.
- Draw a dot and cross diagram to show the arrangement of the valence electrons in **LiCl**.

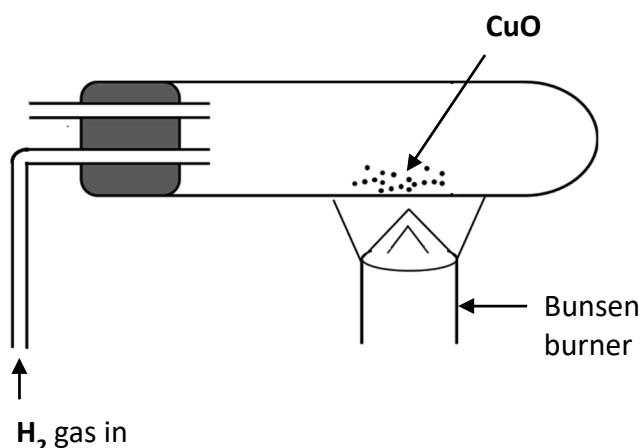
The arrangement of ions in a crystal of lithium chloride is shown.



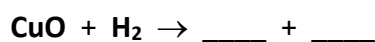
- What is the maximum number of chloride ions that can surround (as its nearest neighbours) a lithium ion in the crystal?
- State two conditions in which lithium chloride crystals conduct electricity.
- What type of bonding exists between the atoms in a sample of pure lithium?

(30)

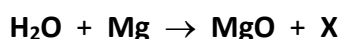
9. (a) A stream of hydrogen gas (H_2) passed over a heated sample of copper oxide (CuO) will cause the hydrogen gas to be oxidised.



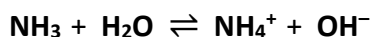
- (i) What other chemical process also occurs as the hydrogen is oxidised?
(ii) Copy and complete the equation for the reaction:



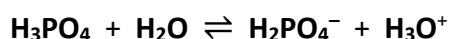
Steam (H_2O) reacts with magnesium (Mg) according to the following equation



- (iii) Identify substance **X**.
(iv) Is H_2O or Mg oxidised in this reaction? State a reason for your answer. (33)
- (b) (i) What is an acid according to the Brønsted-Lowry theory?
(ii) Identify the two acids in the following reaction:



- (iii) State one example of an acid-base conjugate pair in the above reaction.
(iv) Identify the two bases in the following reaction:



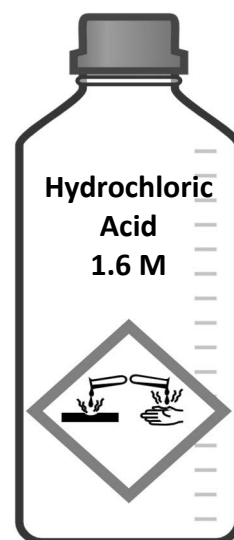
The two given reactions in part (b) show the amphoteric nature of water.

- (v) What is meant by the term amphoteric?
(vi) How do the equations show that water is amphoteric? (33)

10. (a) The diagram shows a standard solution of hydrochloric acid (**HCl**).

- (i) What is meant by the term standard solution?
- (ii) Identify the safety pictogram on the label.
- (iii) State two types of personal protective equipment to be worn when using this acid.

(15)

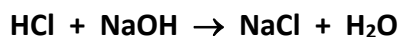


(b) Some of this acid was used in a titration with a solution of sodium hydroxide (**NaOH**). In preparation for the titration 20.0 cm³ of the solution of sodium hydroxide (**NaOH**) was accurately measured using a pipette and transferred into a conical flask.

- (i) Describe how the pipette was rinsed before use.
- (ii) Describe a procedure for accurately transferring 20.0 cm³ of **NaOH** to the conical flask.
- (iii) Explain why a conical flask is a suitable piece of glassware when reacting the solutions.
- (iv) What is the purpose of using an indicator in a titration?
- (v) Explain why a wash bottle is used to rinse the inside of the conical flask during the titration.

(27)

(c) The titration was completed when 19.8 cm³ of 1.6 M hydrochloric acid (**HCl**) reacted with 20.0 cm³ of the sodium hydroxide solution (**NaOH**). The reaction can be described by the following balanced chemical equation:



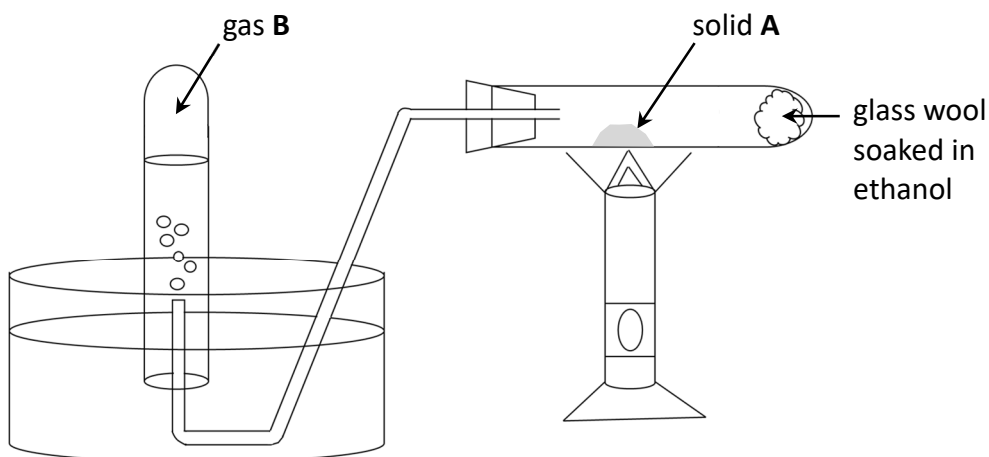
- (i) Name a suitable indicator for this titration.
- (ii) State the colour change observed at the end point.
- (iii) Calculate the concentration of the **NaOH** solution in moles per litre.
- (iv) Why should the titration be repeated a number of times?

(24)

11. (a) Ethanol ($\text{C}_2\text{H}_5\text{OH}$) is the second member of its homologous series.

- (i) Name the homologous series to which ethanol belongs.
- (ii) Draw the molecular structure of ethanol showing all atoms and all bonds.
- (iii) State the IUPAC name of the first member of the same homologous series.

The diagram below shows the apparatus used to convert ethanol to an unsaturated hydrocarbon containing two carbon atoms.



- (iv) Identify solid **A**.
- (v) Identify gas **B**.
- (vi) What is meant by the term unsaturated hydrocarbon?
- (vii) Describe a test to show that gas **B** is unsaturated. Your answer should include all apparatus used and observations made. (36)

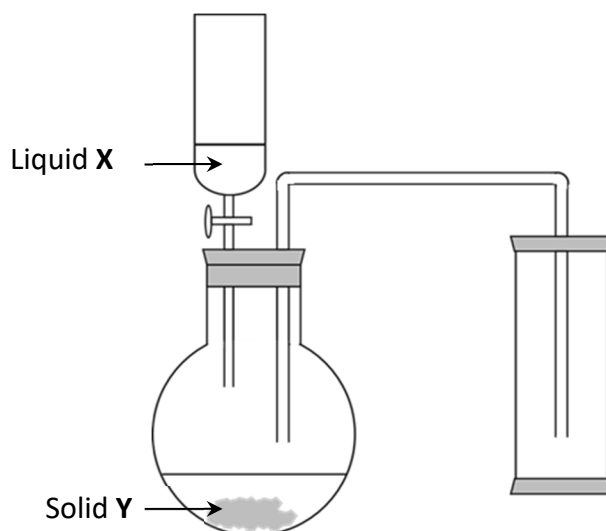
(b) The combustion of sulfur can be described using the following balanced chemical equation:



- (i) What is meant by the heat of combustion (ΔH) of a substance?
- (ii) Is this reaction *exothermic* or *endothermic*? Explain your answer.
- (iii) Calculate the heat change when 20 moles of sulfur (**S**) are reacted with oxygen.
- (iv) Why should the amount of **SO**₂ released into the atmosphere be limited? (30)

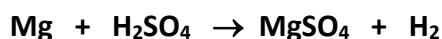
12. Answer any **two** of the following parts (a), (b), (c). Each part carries 33 marks.

(a) Carbon dioxide (**CO₂**) can be prepared and collected using a laboratory set up as shown.



- (i) Identify liquid **X**.
- (ii) Identify solid **Y**.
- (iii) What does this method of collection tell you about the density of **CO₂** compared to the density of air?
- (iv) Describe a test to verify that the gas jar is full of **CO₂**.
- (v) Describe a chemical test to verify that **CO₂** is an acidic gas. (33)

(b) Magnesium (**Mg**) metal reacts with sulfuric acid (**H₂SO₄**) according to the following balanced chemical equation:



- (i) What is meant by a mole of a substance?
- (ii) State the mass of one mole of magnesium.
- (iii) How many moles of magnesium atoms are present in 120 g of the metal?
- (iv) Calculate the mass of **MgSO₄** produced when 120 g of magnesium fully react.
- (v) How many molecules of **H₂** gas are produced when 120 g of magnesium fully react?

[**H** = 1, **O** = 16, **Mg** = 24, **S** = 32, Avogadro constant = $6.0 \times 10^{23} \text{ mol}^{-1}$]

(33)

This question continues on the next page

(c) Some chemical elements react with oxygen to form stable compounds known as oxides.

(i) State the formula of the oxides **U**, **V** and **W** in the table below.

(ii) State the names of the oxides **X**, **Y** and **Z** in the table below.

	sodium (Na)	calcium (Ca)	carbon (C)	aluminium (Al)
formula of oxide	U	V	CO	W
name of oxide	X	calcium oxide	Y	Z

Water (**H₂O**) is the only oxide found naturally on earth in the three states of matter.

(iii) State the shape of the **H₂O** molecule.

(iv) Draw a diagram of a **H₂O** molecule showing the arrangement of bonding pairs and lone pairs of electrons.

(v) What type of intermolecular forces exist between molecules of water in its solid state?

(33)

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Leaving Certificate Examination – Ordinary Level

Physics and Chemistry

Wednesday, 17 June

Morning, 9:30 – 12:30