Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION 2009

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

MONDAY, 15 JUNE – MORNING 9:30 TO 12:30

Six questions to be answered.
Answer any **three** questions from **Section I** and any **three** questions 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*), etc. All the items carry equal marks.
Keep your answers short.

(*a*) A cyclist moves at a constant speed of 10 m s^{-1}.
What distance does the cyclist travel in 5 minutes?

(*b*) What is meant by *acceleration*?

(*c*) In the equation $g = \frac{GM}{r^2}$ what does *G* represent?

(*d*) Give **one** example of a thermometric property.

(*e*) **Figure 1** shows rays of light passing through a lens and meeting at the focus **F**.
What type of lens is shown?

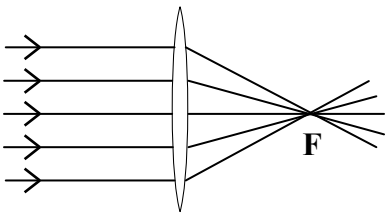


Figure 1

(*f*) How would you show the *dispersion* of white light?

(*g*) **Figure 2** shows a waveform.
What name is given to the number of waves passing a fixed point every second?

Figure 2

(*h*) What happens when light waves with the same wavelength meet?

(*i*) Copy and complete the following statement of *Coulomb's law*:

"The force between two point charges is proportional to the . . . . . of the charges and inversely proportional to the square of the . . . . . between them."

(*j*) Calculate the number of units (kW h) used by a 3 kW electric immersion heater in 30 minutes.

(*k*) What is the purpose of a fuse in a 3-pin plug?

(*l*) **Figure 3** shows an energy efficient lamp with a power rating of 11 W when connected to a 230 V source.
Calculate the current drawn by the lamp.

Figure 3

(*m*) State the principle on which the moving-coil galvanometer is based.

(*n*) Iodine–131 has a half-life of 8 days.
What fraction of a sample of iodine–131 remains after 16 days?

(*o*) What type of nuclear reaction occurs in a nuclear power plant? (11 × 6)

2. State the *principle of conservation of energy*.
Define (i) *weight*, (ii) *work*.
Give the unit of work.

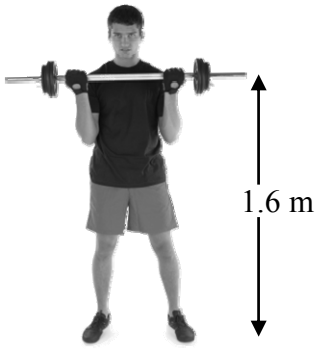


Figure 4

Figure 4 shows a weightlifter who has lifted a barbell of mass 50 kg to a height of 1.6 m above the ground.
The work done by the weightlifter is stored as energy in the barbell.
Name this form of energy.

Explain why no work is done by the weightlifter on the barbell if he holds it steady. (30)

Calculate:

(iii) the weight of the barbell;

(iv) the work done in lifting the barbell;

(v) the energy lost by the weightlifter in lifting the barbell. (18)

The weightlifter then drops the barbell.
State the energy change which occurs as the barbell is falling.
Calculate the velocity of the barbell as it strikes the ground. (18)
[acceleration due to gravity, g = 9.8 m s^{-2}]

3. What is meant by the reflection of light?
A plane mirror is a flat highly reflective surface.
Give **one** use of a plane mirror. (12)

A *law of reflection of light* states that the angle of incidence equals the angle of reflection.
Describe an experiment to verify this law using a plane mirror.
Give **one** precaution to ensure a more accurate result. (21)

Figure 5 shows a pin **O** placed 8 cm in front of a concave mirror of focal length 4 cm.

Draw a ray diagram to show the formation of the image.
Find the distance of the image from the concave mirror. (18)

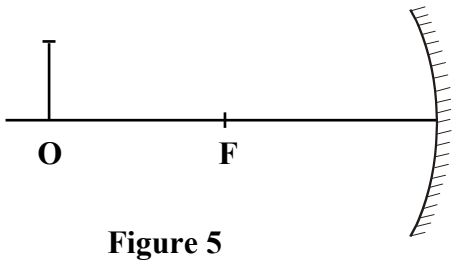


Figure 5

Give **two** differences between this image formed in the concave mirror with an image formed in a plane mirror.

Give **one** use of a concave mirror. (15)

4. (*a*) Water is boiling in a kettle. What is the temperature of boiling water when using (i) the Celsius scale, (ii) the Kelvin scale? (12)

The following terms are used in stating *Charles' law*:

volume	pressure	temperature	gas

Using these terms, copy and complete the following statement of Charles' law:
"The . . . . . of a fixed mass of . . . . . is proportional to the absolute . . . . . at constant . . . . . ." (9)

Figure 6

Figure 6 shows a balloon containing 200 cm^3 of helium gas at 280 K.
The balloon is then placed in a flask of liquid nitrogen at a temperature of 70 K.
Calculate the new volume of the balloon when it is in the flask. (12)

(*b*) State **two** assumptions of the *kinetic theory of gases*. (12)
What is *Brownian motion*? (9)
Describe an experiment to show Brownian motion. (12)

5. (*a*) A straight wire carrying a current is surrounded by a magnetic field.
How can this magnetic field be detected?
Sketch the shape of this magnetic field.
Name **one** other effect of an electric current. (18)

Figure 7 shows a circuit with a 10 Ω resistor and a 5 Ω resistor in series connected to a battery. The current in the circuit is 0.4 A.

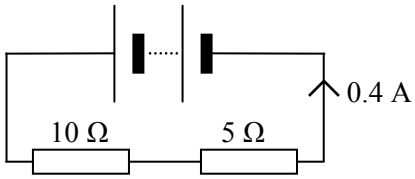


Figure 7

Calculate:
(i) the effective resistance of the two resistors;
(ii) the voltage (potential difference) across the 5 Ω resistor. (15)

(*b*) A transformer is used to change a.c. voltages. What does a.c. represent?
Name **one** device which uses a transformer.
Why does an electricity supply company transmit electrical power at high voltages? (15)

Figure 8 shows a transformer.
Identify the parts labelled **A**, **B** and **C**. (9)

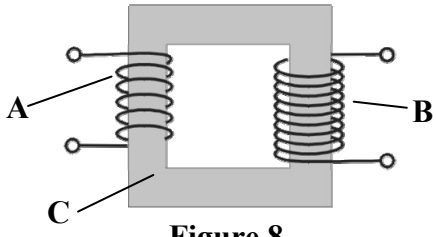


Figure 8

Part **A** is connected to a 300 V a.c. supply and has 600 turns.
If the output voltage is 1200 V, calculate the number of turns needed on part **B**. (9)

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

(*a*) Define *momentum*.

State the *principle of conservation of momentum*. (15)

In **Figure 9,** a bowling ball of mass 4 kg moves with a velocity of 8 m s^{-1} on a smooth bowling alley. The ball strikes a stationary bowling pin of mass 1.5 kg. After the collision they both move in the same direction and the bowling ball moves with a velocity of 3 m s^{-1}.

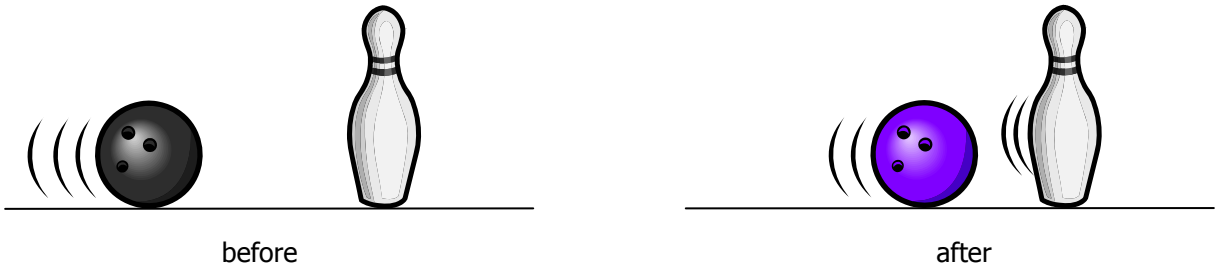


Figure 9

Calculate:

(i) the momentum of the bowling ball before the collision;

(ii) the momentum of the bowling pin after the collision. (18)

(*b*) Ultraviolet radiation is a region of the electromagnetic spectrum.

Name **two** other regions of the electromagnetic spectrum. (12)

Give **one** property common to all regions of the electromagnetic spectrum. (6)

Figure 10 shows a piece of zinc on a negatively charged gold leaf electroscope.

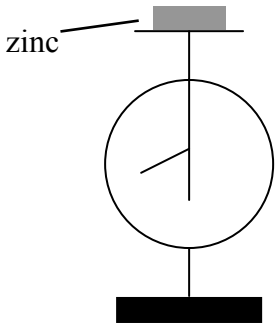


Figure 10

When ultraviolet radiation is shone on the zinc, the gold leaf drops.

Name this phenomenon.

Explain why the leaf drops. (15)

(*c*) **Figure 11** shows the two charged plates of a parallel plate capacitor.

Copy the diagram and show the direction of the electric field between the plates.

State how the capacitance of the capacitor will change if:

(i) the distance between the plates is increased;

(ii) the common area between the plates is decreased. (18)

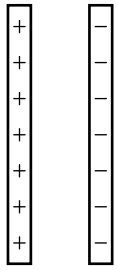


Figure 11

Figure 12 shows how two capacitors can be combined with a battery.
In diagram **A** the capacitors are arranged in series.
How are the capacitors arranged in diagram **B**?

Calculate the effective capacitance of the two 10 μF capacitors
(i) in diagram A, (ii) in diagram B. (15)

diagram **A**

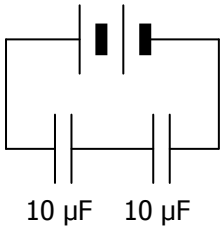


diagram **B**

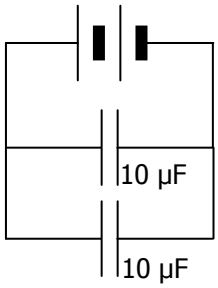


Figure 12

(*d*) What is *radioactivity*?

In beta (β) radiation, negatively charged particles are emitted.
Which type of nuclear radiation emits positively charged particles? (12)

List **two** uses of radioactive substances. (12)

Give **two** precautions when using radioactive substances. (9)

SECTION II – CHEMISTRY (200 marks)

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

(*a*) Sketch an *s-orbital*.

(*b*) How many (i) protons, (ii) neutrons, are there in $^{9}_{4}\text{Be}$?

(*c*) Define *electronegativity*.

(*d*) Copy and complete the statement: "Isotopes of an element have the same number of . . . . . and different numbers of . . . . . ."

(*e*) Give **one** example of an ionic compound.

(*f*) The relative molecular mass of hydrogen gas ($\mathbf{H_2}$) is 2.
Calculate the number of molecules in 18 g of hydrogen gas.
[Avogadro constant = 6.0×10^{23} mol^{-1}]

(*g*) Calculate the percentage of oxygen by mass in calcium carbonate ($\mathbf{CaCO_3}$).
[Ca = 40; C = 12; O=16]

(*h*) Define *electrolysis*.

(*i*) What is the **pH** of a **0.05 M** solution of hydrochloric acid (**HCl**)?

(*j*) Which **one** of the following oxides is acidic?
MgO **CO** **NO_2**

(*k*) Give **one** characteristic property common to transition elements.

(*l*) Copy, complete and balance the following reaction:

$$\mathbf{Na_2SO_3 + HCl \longrightarrow NaCl + \_\_\_\_\_ + H_2O}$$

(*m*) List the following elements in order of **decreasing** chemical activity:
copper **calcium** **iron**

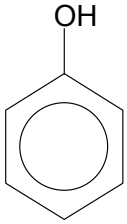


Figure 13

(*n*) What is a *hydrocarbon*?

(*o*) Why is the compound shown in **Figure 13** classified as *aromatic*? (11 × 6)

8. A neutron is a subatomic particle found in the nucleus of an atom.

Name **one** other particle found in the nucleus of an atom.

Give **one** difference between these two particles. (12)

Give the electronic (s,p) configuration of an atom of chlorine.

State the type of bond formed when two atoms of chlorine combine.

Explain, with the aid of a diagram, how this bond is formed.

Give **one** property of a substance with this type of bond. (24)

Fluorine and chlorine are elements found in the same group of the periodic table.

Explain the underlined terms. (12)

Name **one** other element in this group. (6)

What is meant by *ionisation energy*? (6)

Explain why the first ionisation energies decrease down a group. (6)

(Refer to Mathematics Tables, p.44 – 46)

9. (*a*) In a redox reaction, oxidation and reduction occur.

Explain the underlined words in terms of electron transfer. (12)

Identify the substance oxidised in the following reaction: (6)

$$\mathbf{Mg + F_2 \longrightarrow MgF_2}$$

Copy and complete the following reaction:

$$\mathbf{CuO + H_2 \longrightarrow \_\_\_ + \_\_\_}$$

Identify the oxidising agent in this reaction. (15)

(*b*) Using the Brønsted-Lowry theory, define (i) an acid, (ii) a base.

What is a meant by a *strong acid*? (15)

Identify **two** acids and **two** bases in the following reaction:

$$\mathbf{NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-}$$

Give **one** example of an acid-base pair in this reaction. (18)

10. **Figure 14** shows glassware used during a titration to find the concentration of a potassium hydroxide (**KOH**) solution.

(i) Explain the underlined terms. (12)

(ii) Identify the pieces of glassware labelled **A**, **B** and **C**. (9)

(iii) Give **one** safety precaution required when filling **A**. (6)

(iv) State **one** precaution required when reading the level of liquid in **B**. (3)

(v) Why is an indicator used during a titration? (6)

(vi) Explain why deionised water is added to **C** during the titration. (6)

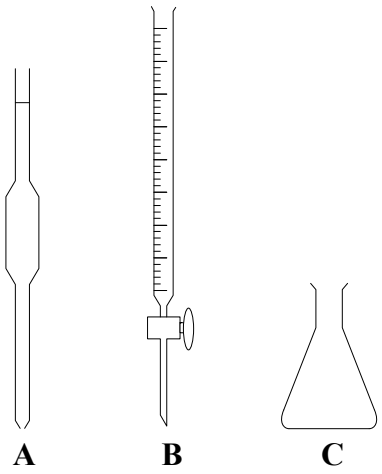


Figure 14

It was found that 21.5 cm^3 of **1.5 M** hydrochloric acid (**HCl**) solution reacted with 25 cm^3 of the potassium hydroxide (**KOH**) solution.

(vii) Copy and complete the equation for the reaction that takes place in this titration: (6)

$$\mathbf{HCl + KOH \longrightarrow \_\_\_\_ + \_\_\_\_}$$

(viii) Calculate the molarity of the potassium hydroxide solution. (9)

(ix) Name the salt produced in this experiment. (3)

(x) Explain how a sample of the salt can be separated from the solution. (6)

11. Methanol (**CH_3OH**) is the first member of a *homologous series*.

(i) What is a homologous series? (6)

(ii) Name the homologous series to which methanol belongs. (6)

(iii) Name **one** other member of this homologous series. (6)

(iv) Sketch the structural formula of methanol. (6)

Methanol burns in air according to the following reaction:

$$\mathbf{2CH_3OH + 3O_2 \longrightarrow 2CO_2 + 4H_2O} \qquad \mathbf{\Delta H = -1450\ kJ\ mol^{-1}}$$

(v) Is this reaction *exothermic* or *endothermic*? Give a reason for your answer. (9)

(vi) Describe an experiment to detect one of the products when methanol burns. (9)

Methanol can be oxidised to form methanoic (formic) acid.

(vii) Sketch the structural formula of methanoic acid. (6)

(viii) What is observed when methanoic acid reacts

(*a*) with litmus solution;

(*b*) with magnesium? (12)

(ix) Methanol and methanoic acid react to form an ester. Give one property of an ester. (6)

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

(*a*) Define a *mole* of a substance. (6)

Describe the appearance of carbon and oxygen at room temperature. (9)

Carbon and oxygen react together to form carbon dioxide as follows:

$$\mathbf{C + O_2 \longrightarrow CO_2}$$

If 36 g of carbon were used in this reaction, calculate:

(i) the number of moles of carbon used;

(ii) the mass of carbon dioxide produced.

What environmental impact is caused by carbon dioxide in the atmosphere?

Name **one** major source that releases carbon dioxide into the atmosphere. (18)

[C=12; O= 16]

(*b*) **Figure 15** shows oxygen ($\mathbf{O_2}$) gas being prepared.

Name the liquid **A** and the solid **B**. (12)

What is the purpose of solid **B**? (9)

Describe a test for the presence of oxygen.

Give **one** commercial use for oxygen gas. (12)

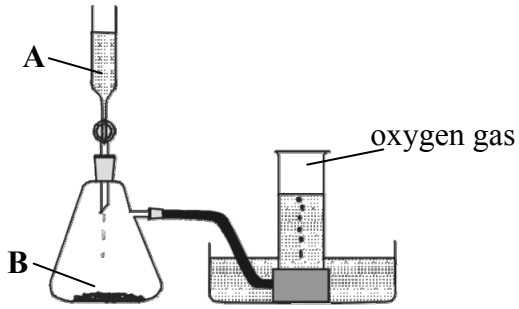
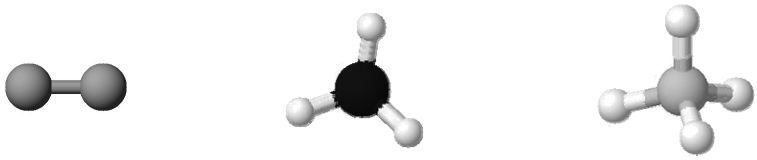


Figure 15

(*c*) **Figure 16** shows three molecular shapes from the *electron pair repulsion theory*.



A **B** **C**

Figure 16

Name each of the molecular shapes **A**, **B** and **C**. (9)

Give the bond angle (i) in molecule **A**; (ii) in molecule **B**. (6)

What is the molecular shape of methane ($\mathbf{CH_4}$)? (6)

Explain the molecular shape of $\mathbf{H_2O}$ using the electron pair repulsion theory. (12)

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