Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2011

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

MONDAY, 20 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.

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

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 jogger moves at a constant speed of 2.5 m s^{-1}.
What distance does the jogger travel in 15 minutes?

(*b*) What is meant by *potential energy*?

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

(*d*) Candle wax melts at 65 ºC. What is this temperature on the Kelvin scale?

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

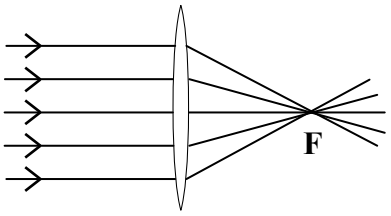

Figure 1

(*f*) Light is split into its component colours on passing through a glass triangular prism.
What name is given to this phenomenon?

(*g*) What are emitted from the surface of a metal during the photoelectric effect?

(*h*) **Figure 2** shows two similar waves combining together.
What type of interaction occurs?

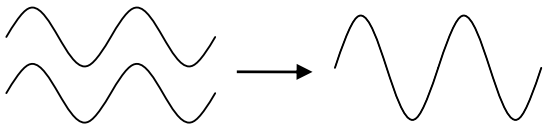
Figure 2

(*i*) Name the safety device found inside a standard 3-pin plug.

(*j*) An energy efficient lamp with a power rating of 28 W is connected to a 230 V supply.
Calculate the current drawn by the lamp.

(*k*) Calculate the number of units (kW h) used by a 2 kW electric toaster when it is turned on for 6 minutes.

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

(*m*) **Figure 3** shows two 5 μF capacitors connected in parallel.
What is the effective capacitance of the combined capacitors?

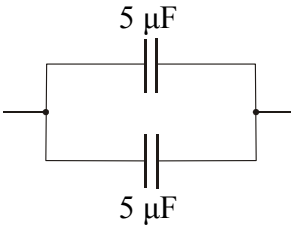

Figure 3

(*n*) Name the element commonly used to block nuclear radiation.

(*o*) What happens to the nucleus of an atom when it undergoes nuclear fission?

(11 × 6)

2. What is meant by the *kinetic energy* of a moving object?
Define (i) *weight*, (ii) *work*.

State **one** of Newton's laws of motion. (24)

Figure 4 shows a curling stone from a team event in the Winter Olympics. It is thrown along a frozen horizontal ice track to reach a target. During a practice session on an empty track, a curling stone of mass 18 kg is released with an initial velocity of 2 m s^{-1} and it eventually stops after moving 25 m.

Calculate

(iii) the weight of the curling stone
(iv) the initial kinetic energy of the curling stone
(v) the acceleration of the curling stone
(vi) the force on the curling stone as it slows down
(vii) the total work done on the curling stone. (30)

Figure 4

Team members use special brushes on the ice directly in front of the moving curling stone to smoothen the surface of the ice.

What effect does this have on the horizontal force acting on the curling stone?

Draw a diagram showing **two** forces acting on the moving curling stone. (12)

[acceleration due to gravity, g = 9.8 m s^{-2}]

3. **Figure 5** shows two plane mirrors found inside a periscope, a device which is based on the *laws of reflection*.

State the laws of reflection of light. (12)

Give **two** properties of the image formed by a plane mirror. (12)

Copy **Figure 5** into your answerbook and complete it to show the path of light through the periscope to the observer at **X**. (12)

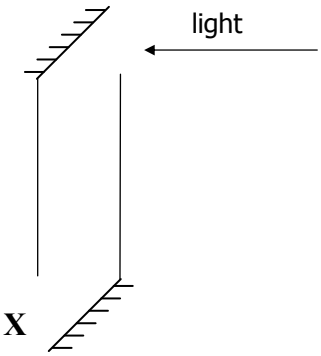

Figure 5

Figure 6 shows a pin placed 12 cm in front of a concave mirror of focal length 4 cm. **F** is its focus.

What is the distance of the image of the pin from the concave mirror? (12)

Give **one** use of a concave mirror. (6)

Give **two** differences between this image formed in the concave mirror and an image of an object formed when using a periscope. (12)

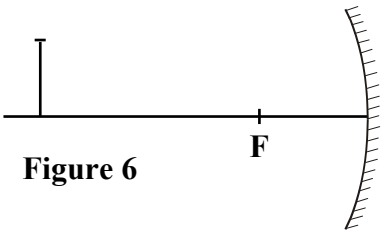

Figure 6

4. Explain the terms (i) *heat*, (ii) *temperature*.
The kelvin is the SI unit used to measure temperature.
What is the significance of the temperature zero on the Kelvin scale? (15)
A mercury thermometer is a common type of laboratory thermometer.
Name **one** other type of thermometer.
Describe an experiment to calibrate an unmarked mercury thermometer.
Give **one** disadvantage of a mercury thermometer. (24)
What is meant by a *thermometric property*?
Give **one** example of a thermometric property. (15)
A temperature θ on the Celsius scale is calculated using the equation:

$$\frac{\theta}{100} = \frac{X_\theta - X_0}{X_{100} - X_0}$$

What do the symbols (i) X_θ, (ii) X_{100}, represent? (12)

5. (*a*) Copper is a good <u>electrical conductor</u>.
Explain the underlined term.
The following terms are used in stating *Ohm's law*:

potential difference	current	temperature	proportional

Using these terms, copy and complete the following statement of Ohm's law:
"The . . . . . through a conductor is . . . . . to the . . . . . between its ends at constant . . . . . ." (15)

Figure 7 shows a circuit with two lamps each of resistance 3 Ω connected in series to a 12 V battery.
Calculate
(i) the effective resistance of the circuit
(ii) the current in the circuit.

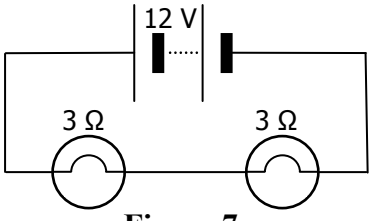

Figure 7

Draw a circuit diagram to show how to connect the two lamps in parallel. (18)

(*b*) "Many devices plugged into a mains supply use a transformer."
Name **one** device which uses a transformer.
Give **one** difference between a mains supply and a battery. (12)

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

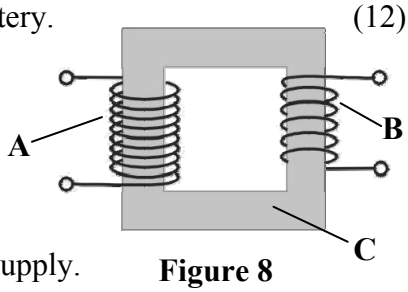

Figure 8

Part **A** has 345 turns and is connected to a 230 V a.c. supply.
If the output voltage is 30 V, calculate the number of turns needed on part **B**.
Why does a transformer become warm during use? (21)

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

(*a*) State the *principle of conservation of momentum*. (12)

In **Figure 9** a girl of mass 30 kg, standing still on a smooth horizontal surface, catches her dog of mass 12 kg moving horizontally through the air towards her at a velocity of 2 m s^{-1}.

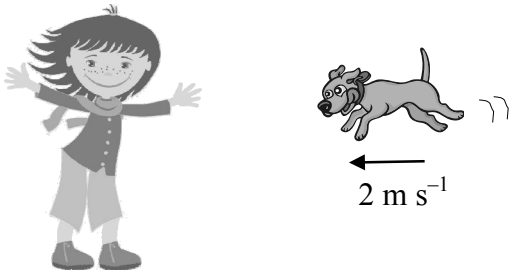

Figure 9

Why has the girl no momentum before she catches the dog?

Calculate

(i) the momentum of the dog before the girl catches the dog

(ii) the velocity of the girl after she catches the dog. (21)

(*b*) **Figure 10** shows part of the electromagnetic spectrum which classifies regions of waves.

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

Microwaves	**A**	Light	**B**	X-rays

Figure 10

Name each of the regions labelled (i) **A**, (ii) **B**. (12)

Give **one** use of the electromagnetic waves found at **B**. (6)

Describe how you could detect the electromagnetic waves found at **A**. (9)

(*c*) What is an *electric field*? (6)

Figure 11 shows a pair of isolated and equal opposite charges.

Figure 11

Copy the diagram and sketch the electric field pattern around the charges. (9)

The force between the two charges is 0.80 N.

Is this an attractive or a repulsive force? Give a reason for your answer.

What is the value of this force if one of the charges is doubled?

What is the effect on the force if the distance between the charges is increased? (18)

(*d*) All radioactive isotopes decay with a certain half-life and emit nuclear radiation.

Explain the underlined terms. (12)

List the **three** types of nuclear radiation. (9)

What fraction of a radioactive isotope will remain after a period of time equal to four half-lives? (6)

Give **one** use of a radioactive isotope. (6)

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 a *p-orbital*.

(*b*) How many (i) protons, (ii) neutrons, are in an atom of $^{11}_{5}\mathbf{B}$?

(*c*) What is meant by the *ground state* of an electron in an atom?

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

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

(*f*) The relative atomic mass of helium gas (**He**) is 4.
Calculate the number of atoms in 16 g of helium gas.

(*g*) Calculate the percentage of nitrogen by mass in ammonium chloride (**NH_4Cl**).
[H = 1; N = 14; Cl = 35.5]

(*h*) Define an acid in terms of the Brønsted-Lowry theory.

(*i*) What is the **pH** of a **0.03 M** solution of hydrochloric acid (**HCl**)?

(*j*) What is meant by an *exothermic reaction*?

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

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

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

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

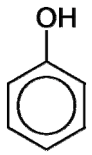

Figure 12

(*n*) Name a hydrocarbon extracted from crude oil.

(*o*) Why is the compound shown in **Figure 12** classified as an aromatic alcohol? (11 × 6)

8. The element fluorine is located in a group on the right hand side of the periodic table.

Name an element found in (i) the same group, (ii) the same period, as fluorine.

Give a common property of the elements found in this group. (18)

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

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

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

Name another type of bond formed by fluorine in its compounds. (24)

Fluorine is the element with the highest <u>first ionisation energy</u> in its group.

Explain the underlined term.

Using the electronic configuration of neon, explain why neon has a higher first ionisation energy value than fluorine.

Explain why first ionisation energy values decrease down a group in the periodic table. (24)

9. (*a*) Define *oxidation* in terms of electron transfer.

As well as oxidation, name the other process which occurs during an oxidation reaction. (12)

Identify the substance oxidised in the following reaction:

$$\mathbf{CuSO_{4(aq)} + Mg_{(s)} \longrightarrow Cu_{(s)} + MgSO_{4(aq)}}$$

What would you see happening during this reaction? (12)

Copy and complete the following reaction:

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

Identify the oxidising agent in this reaction. (9)

(*b*) Each of the following elements combines with oxygen to form a stable oxide:

calcium (**Ca**) sulfur (**S**) sodium (**Na**)

Give the name and chemical formula of an oxide formed by each element. (15)

From these oxides, identify

(i) an acidic oxide, (ii) a basic oxide. (9)

How would you show that an oxide is acidic? (9)

10. In a titration experiment, a <u>standard solution</u> of hydrochloric acid (**HCl**) was used to find the concentration of a potassium hydroxide (**KOH**) solution.

Explain the underlined term. (6)

Figure 13 shows some items of equipment used.

(i) Name each of the items labelled **A** and **B**. (12)

(ii) Describe the procedure for preparing and filling **B**. (9)

(iii) State **one** precaution required when taking a reading of the volume of the liquid in **B**. (6)

(iv) Name one piece of safety equipment that should be worn during a titration experiment. (6)

(v) Name the item of equipment where the liquids mix together during the titration. (6)

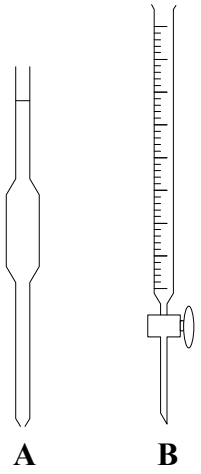

Figure 13

In the titration, the end-point was reached when 22.5 cm^3 of **0.16 M** hydrochloric acid solution reacted with 20.0 cm^3 of the potassium hydroxide solution.

(vi) How was the 'end-point' identified? (6)

(vii) Copy and complete the equation for the titration reaction: (6)

$$\mathbf{HCl + KOH \longrightarrow \underline{\quad\quad} + \underline{\quad\quad}}$$

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

11. Ethyne (acetylene) ($\mathbf{C_2H_2}$) is the first member of a <u>homologous series</u> of <u>hydrocarbons</u>.

Explain the underlined terms. (12)

Name the homologous series of which ethyne is a member. (6)

Sketch the structural formula of ethyne. (6)

Name **one** other homologous series of hydrocarbons.
What is the first member of this series? (12)

Figure 14 shows part of the apparatus used to prepare a sample of ethyne gas.

Name the liquid **X** and the solid **Y**. (12)

What is observed when a sample of ethyne gas

(i) is burned in air

(ii) is tested with a bromine water solution? (12)

Ethyne gas burns at a very high temperature with excess oxygen.
Give an application of this process. (6)

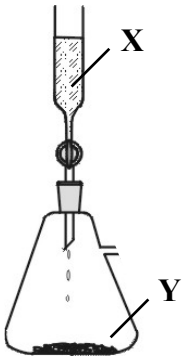

Figure 14

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

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

Describe the appearance of sodium and chlorine at room temperature.

Sodium and chlorine react together to form sodium chloride as follows:

$$\mathbf{2Na + Cl_2 \longrightarrow 2NaCl}$$

Give **one** use of sodium chloride. (15)

34.5 g of sodium was used in this reaction, calculate

(i) the number of moles of sodium used

(ii) the mass of sodium chloride produced. (18)

[Na = 23; Cl = 35.5]

(*b*) **Figure 15** shows carbon dioxide ($\mathbf{CO_2}$) gas being prepared.

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

Describe a test to show when the gas jar is full of carbon dioxide. (6)

What is observed when carbon dioxide is bubbled through a solution of blue litmus?

What does this tell you about carbon dioxide?

Give **one** commercial use for carbon dioxide. (15)

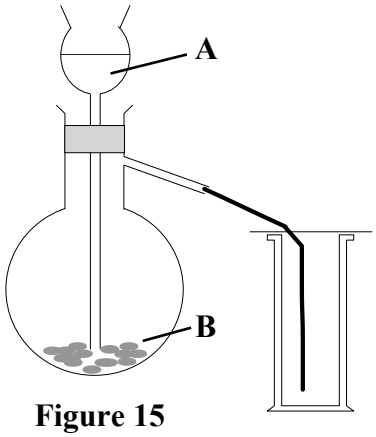

Figure 15

(*c*) What is meant by *electrolysis*? (9)

Figure 16 shows an apparatus used to demonstrate the electrolysis of water.

Name a suitable metal used for the electrodes.

Why is a small amount of sulfuric acid usually added to the water? (9)

Name (i) gas **A**, (ii) gas **B**.

Describe a test to identify gas **A**.

Explain why one of the gases is produced at twice the rate of the other. (15)

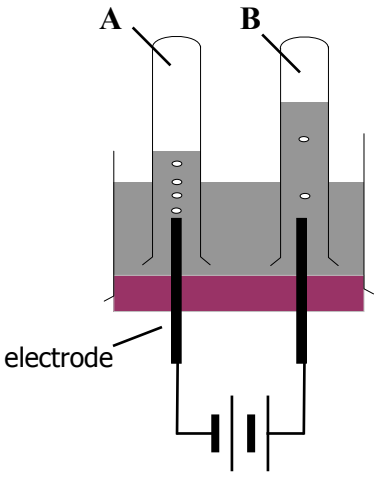

Figure 16

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