Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2012

PHYSICS AND CHEMISTRY – ORDINARY 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** 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*) **Figure 1** shows a racing bicycle of mass 8 kg.
What is the weight of the racing bicycle?
[acceleration due to gravity, g = 9.8 m s^{-2}]

Figure 1

(*b*) A person pushes a fridge 2 m across a kitchen floor with a force of 160 N.
Calculate the work done.

(*c*) Normal body temperature is 37 ºC. What is this temperature on the Kelvin scale?

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

(*e*) **Figure 2** shows a ray of light passing through a glass prism.
Name the phenomenon that occurs at **X**.

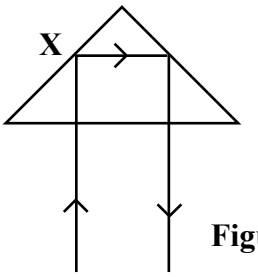

Figure 2

(*f*) Give **one** use for a concave mirror.

(*g*) Copy and complete the statement:
"When light is reflected, the angle of ……. equals the angle of ……."

(*h*) **Figure 3** shows an isolated positive point charge.
Sketch in your answerbook the electric field pattern around the charge.

Figure 3

(*i*) In the equation for *Coulomb's law*, $F = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{d^2}$, what does d represent?

(*j*) **Figure 4** shows a 4 Ω and a 12 Ω resistor connected together.
What is the effective resistance of the combined resistors?

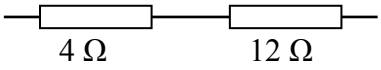

Figure 4

(*k*) A kettle, rated at 3000 W, is left on for five minutes.
Calculate the number of units (kW h) used.

(*l*) Why is electricity transmitted over long distances at high voltages?

(*m*) Name **one** device containing an electrical transformer.

(*n*) A sample of a radioactive isotope has a half-life of 15 minutes.
What fraction of the sample will remain after 60 minutes?

(*o*) State Einstein's famous equation of mass-energy conservation.

(11 × 6)

2. Define (i) *acceleration*, (ii) *kinetic energy*.
What is the SI unit of kinetic energy? (18)

Describe an experiment to measure the acceleration due to gravity, *g*.
Give **one** precaution to ensure an accurate result. (24)

Figure 5 shows an athlete of mass 65 kg running on a track. On the final length of the track, the athlete accelerates from a velocity of 6 m s^{-1} to 7 m s^{-1} in two seconds.

Figure 5

Calculate

(iii) the acceleration of the athlete

(iv) the net force produced by the athlete in accelerating

(v) the change in kinetic energy of the athlete on the final length of the track. (21)

What is the net force on the athlete when she is moving at a constant velocity? (3)

3. **Figure 6** shows a ray of light undergoing refraction as it enters and leaves a glass block.
State **one** of the *laws of refraction of light*. (6)

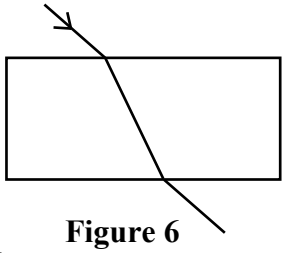

Figure 6

During an experiment to find the refractive index of the glass in the block the following data were recorded:

angle of incidence, *i*	**angle of refraction, *r***
35º	22º

Copy the diagram in **Figure 6** and mark (i) the angle of incidence, (ii) the angle of refraction.
Use the data to calculate the refractive index of the glass. (24)

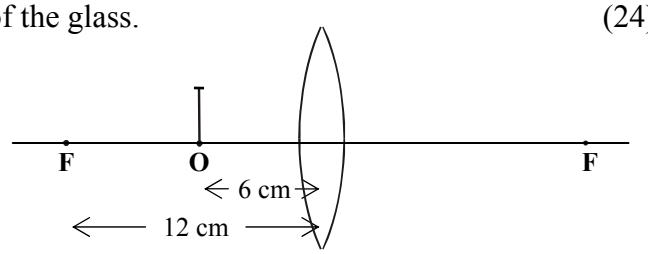

Figure 7

Figure 7 shows a pin **O** placed 6 cm from a converging (convex) lens of focal length 12 cm.

Copy and complete the diagram in **Figure 7** to show the formation of the image by the lens. (18)

Is this image *real* or *virtual*? Give a reason for your answer.
How does the size of the image compare with the size of the pin?
Give **one** use of a converging lens based on this property. (18)

4. (*a*) State *Boyle's law*. (9)

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

What is meant by an *ideal gas*? (6)

(*b*) The *kinetic theory* is used to explain the behaviour of gases.

State **two** assumptions of the kinetic theory of gases. (9)

What is *Brownian motion*? (6)

How would you demonstrate Brownian motion? (12)

What does Brownian motion tell you about the behaviour of gases? (6)

5. (*a*) **Figure 8** shows a toaster with a heating element of resistance 46 Ω connected across a potential difference (voltage) of 230 V.

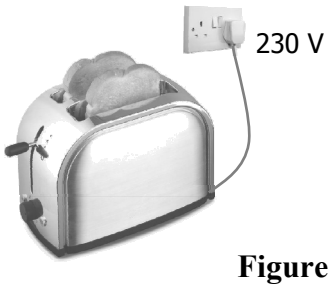

Figure 8

When a current flows through the circuit of the toaster, the toaster gets hot.

(i) Explain the underlined terms. (12)

(ii) Calculate the current in the element of the toaster. (9)

(iii) Why does the current in a toaster change when the toaster is in use? (6)

(iv) What is the purpose of the fuse in the plug of the toaster? (6)

(*b*) What is *electromagnetic induction*?

State **one** of the laws of electromagnetic induction. (15)

Figure 9 shows a galvanometer connected across the ends of a coil of wire.

When the string is cut, the bar magnet falls through the coil.

As the bar magnet enters the coil, the needle of the galvanometer deflects to the right.

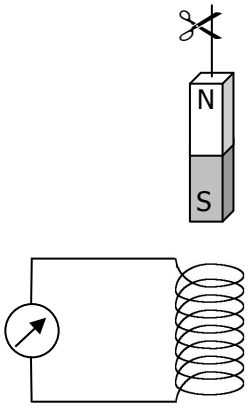

Figure 9

What does the galvanometer detect? (6)

In which direction does the needle of the galvanometer move as the bar magnet leaves the coil? (6)

Why would the needle show no deflection, if the bar magnet were stationary in the coil? (6)

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)

Figure 10 shows a shark of mass 12 kg moving in a straight line at a constant velocity of 1.1 m s^{-1} towards a stationary fish of mass 2.5 kg, which the shark swallows.

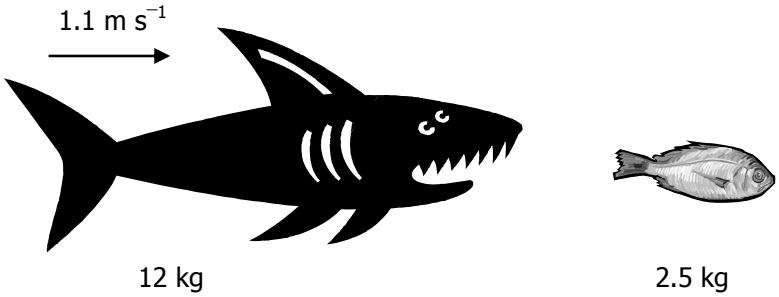

Figure 10

Calculate:

(i) the initial momentum of the shark

(ii) the velocity of the shark immediately after swallowing the fish. (15)

Why does a moving container ship stop its engines, when it is some distance away from its destination port? (6)

(*b*) Ultraviolet radiation is part of the electromagnetic spectrum.
Name **two** other radiations that are part of the electromagnetic spectrum. (12)

Figure 11 shows a piece of freshly cleaned zinc on the cap of a negatively charged electroscope.

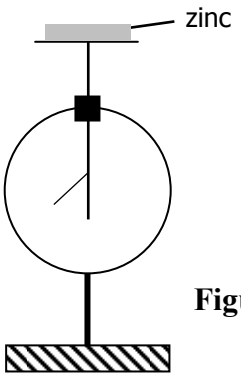

Figure 11

Describe how the electroscope was charged negatively. (9)

When ultraviolet radiation was shone on the zinc, the leaf in the electroscope dropped.
What is the name of this phenomenon?
Explain why the leaf dropped. (12)

(*c*) **Figure 12** shows a circuit used to charge a parallel plate capacitor.

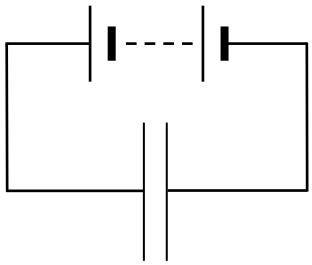

Figure 12

Copy the circuit and show the distribution of charges on the plates of the capacitor. (12)

Give **one** way to change the capacitance of a parallel plate capacitor. (6)

Calculate the effective capacitance of two 3 μF capacitors when they are connected (i) in series, (ii) in parallel. (12)

Give **one** use of a capacitor. (3)

(*d*) 'Alpha particles, a type of nuclear radiation, were used to examine the structure of the atom during experiments in the early twentieth century.'

Give **two** properties of an alpha particle. (12)

Name **two** other types of nuclear radiation. (12)

Give **two** other uses of nuclear radiation. (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*) **Figure 13** shows a block of the element gold.
What is meant by the underlined term?

Figure 13

(*b*) Give **one** property of a proton.

(*c*) How many neutrons are in an atom of beryllium, $^{9}_{4}\mathbf{Be}$?

(*d*) What is emitted when an electron in an atom returns to the ground state?

(*e*) Copy and complete the statement:
"Allotropes are different ……. forms of the same ……."

(*f*) Calculate the percentage of sulfur by mass in sulfur dioxide (**SO_2**).
[O=16; S=32]

(*g*) Give **one** property common to transition elements.

(*h*) What happens during electrolysis of acidified water?

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

$CaCO_3$ + **HCl** → ____ + ____ + **H_2O**

(*j*) What is the **pH** of a **0.035 M** solution of nitric acid (**HNO_3**)?

(*k*) List the following metals in order of *increasing* activity:

zinc **potassium** **silver**

(*l*) Give **one** example of an *amphoteric oxide*.

(*m*) Calculate the number of molecules in 3 moles of ammonia gas.
[Avogadro constant = 6.0×10^{23} mol^{-1}]

(*n*) Give an example of an *alkene*.

(*o*) Identify the aromatic compound shown in **Figure 14**.

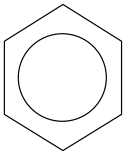

Figure 14

(11 × 6)

8. (*a*) What is an *atomic orbital*? (6)

Sketch the shape of (i) an *s* orbital, (ii) a *p* orbital. (12)

Give the electronic (*s*, *p*) configuration of an atom of sodium. (12)

(*b*) Name **two** types of chemical bond that are formed when atoms combine. (12)

Use a diagram to show the formation of the bond formed when:

(i) two atoms of chlorine combine

(ii) an atom of chlorine combines with an atom of sodium. (12)

(*c*) Electronegativity is a measure of the attraction of an atom of an element for a shared pair of electrons.

Identify the element in the periodic table with the highest electronegativity value.

Why is the element, argon, not given an electronegativity value? (12)

(Refer to *formulae and tables* booklet, p. 81.)

9. (*a*) Ethanoic acid is a <u>weak acid</u> found in vinegar.

What is meant by the underlined term?

Give **one** example of a *strong* acid. (12)

Identify **one** acid and **one** base in the following reaction:

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

Give **one** example of a conjugate acid-base pair in this reaction. (21)

(*b*) In reacting with oxygen, magnesium is <u>oxidised</u> and the oxygen is <u>reduced</u>.

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

Give the balanced chemical equation for this reaction. (6)

A sample of black copper oxide reacts with hydrogen gas.

Copy and complete the chemical equation for this reaction:

$$CuO + H_2 \rightarrow \_\_\_\_ + \_\_\_\_$$

State (i) the substance oxidised, (ii) the substance reduced, in the reaction.

What colour change will be observed during the reaction? (15)

10. A student carried out an experiment, using a solution of hydrochloric acid (**HCl**), to determine the concentration of a sodium hydroxide (**NaOH**) solution.

Figure 15 shows some of the glassware which the student used.

(i) What name is given to this type of experiment? (6)

(ii) Identify the glassware **A** and the glassware **B**. (12)

(iii) Describe how glassware **A** is used to give 20 cm^3 of the sodium hydroxide solution. (9)

(iv) Explain why an indicator is used during this experiment. (6)

(v) Give **two** safety precautions that the student should have followed while carrying out this experiment. (12)

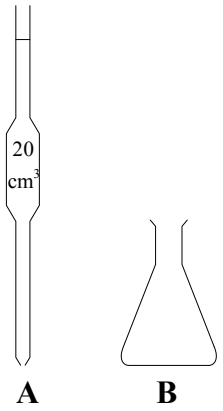

Figure 15

The student recorded the following data:

Concentration of **HCl** solution	=	1.15 M
Volume of **NaOH** solution used	=	20 cm^3
Volume of **HCl** used	=	22.9 cm^3

(vi) Copy, complete and balance the chemical equation for this experiment:

HCl + NaOH → ____ + ____ (6)

(vii) Use the data to calculate the concentration of the sodium hydroxide solution. (9)

(viii) How could the student improve the accuracy of the experiment? (6)

11. **Figure 16** shows a cylinder containing butane (C_4H_{10}), which is the fourth member of a homologous series of hydrocarbons.

(i) What is meant by the underlined term? (6)

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

(iii) State the first member of this homologous series. (6)

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

(v) Explain why butane is a *saturated* compound. (6)

(vi) Give **one** everyday use for butane. (6)

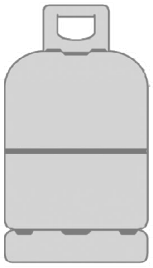

Figure 16

Butane burns in air according to the following chemical equation:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O \qquad \Delta H = -5750 \text{ kJ}$$

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

(viii) What is meant by the *heat of combustion* of a substance? (6)

(ix) Calculate the heat of combustion of butane. (6)

(x) How would you detect the presence of carbon dioxide? (9)

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

(*a*) The mole is an SI unit.
Define the *mole* of a substance. (6)
Magnesium reacts with bromine according to the following chemical equation:

$$\mathbf{Mg + Br_2 \rightarrow MgBr_2}$$

Describe the appearance of (i) magnesium, (ii) bromine, at room temperature.
Give **one** use of magnesium. (15)

If 48 g of magnesium were used in this reaction, calculate:
(i) the number of moles of magnesium used
(ii) the mass of magnesium bromide produced. (12)
[Mg = 24; Br = 80]

(*b*) Hydrogen peroxide is used in the laboratory preparation of oxygen as shown in **Figure 17**.

(i) What is the molecular formula for hydrogen peroxide? (3)

(ii) Describe the appearance of hydrogen peroxide at room temperature. (6)

(iii) Identify solid **A**. (6)

(iv) What is the purpose of solid **A**? (6)

(v) Describe a test for oxygen. (6)

(vi) Give **one** commercial use for oxygen. (6)

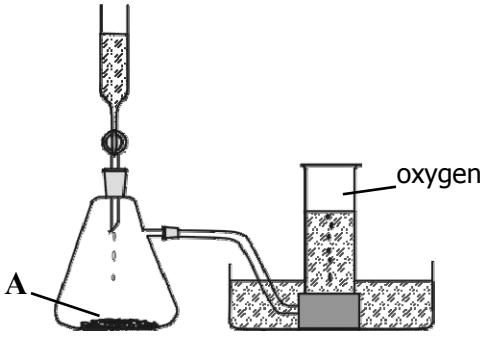

Figure 17

(*c*) The shape of a molecule can be determined by using the number of lone pairs of electrons and the number of bonding pairs of electrons in the molecule.
What is meant by a 'lone pair of electrons'? (6)

Sketch a diagram to show the arrangement of bonding pairs and lone pairs in a molecule of water (**H_2O**). (9)

Copy and complete the following table: (18)

molecule	**number of bonding pairs**	**number of lone pairs**	**shape of molecule**
NH_3		1	
CH_4	4		
BeH_2			linear

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