Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2010

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

MONDAY, 21 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.

Figure 1

(*a*) The mass of a suitcase is 5 kg.
What is the weight of the suitcase when it is placed on the hook of a newton balance as shown in **Figure 1**?
[acceleration due to gravity, g = 9.8 m s^{-2}]

(*b*) What is the unit of *work*?

(*c*) Water freezes at 0 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**.

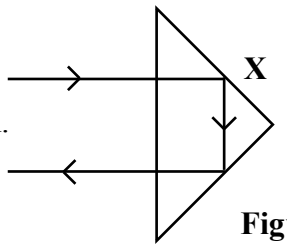

Figure 2

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

(*g*) Which **one** of the following types of radiation has the highest frequency?
radio waves **blue light** **ultraviolet light** **red light**

(*h*) During the photoelectric effect, what is released from the surface of a metal?

(*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?

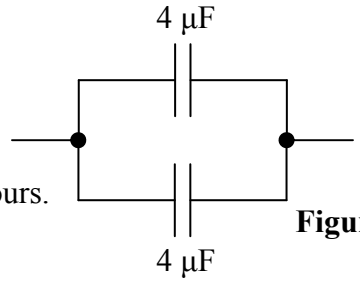

Figure 3

(*j*) **Figure 3** shows two 4 μF capacitors connected in parallel.
What is the effective capacitance of the combined capacitors?

(*k*) A television, rated at 200 W, is left on continuously for four hours.
Calculate the number of units (kW h) used.

(*l*) What is the advantage of transmitting electricity at a high voltage?

(*m*) What would you use to detect the presence of a magnetic field?

(*n*) A sample of a radioactive isotope has a half-life of 3 days.
What fraction of the sample will remain after 9 days?

(*o*) Give **one** difference between *nuclear fission* and *nuclear fusion*. (11 × 6)

2. Define (i) *velocity*, (ii) *acceleration*.
State the *principle of conservation of momentum*. (24)

Bumper cars are a popular attraction in amusement parks.
A bumper car starts from rest on a smooth horizontal surface and reaches a velocity of 2 m s^{-1} in 4 seconds.

Calculate:

(iii) the acceleration of the bumper car
(iv) the distance travelled by the bumper car in the first 4 seconds. (12)

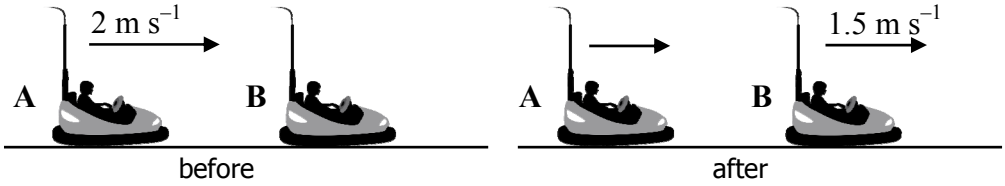

Figure 4

Figure 4 shows bumper car **A** of total mass 250 kg moving on a smooth horizontal surface at velocity of 2 m s^{-1}.
Bumper car **A** collides into a stationary bumper car **B** of total mass 200 kg.
After the collision bumper car **B** moves off with a velocity of 1.5 m s^{-1}.

Calculate:

(v) the momentum of bumper car **A** *before* the collision
(vi) the momentum of bumper car **A** *after* the collision
(vii) the velocity of bumper car **A** *after* the collision. (21)

What is meant by *kinetic energy*?
Explain why the kinetic energy of bumper car **B** changes during the collision. (9)

3. Refraction occurs when light travels from one medium to another.
Explain each of the underlined terms.
State **one** of the *laws of refraction of light*. (18)

Figure 5 shows a ray of light incident at 80º approaching a beaker containing cooking oil.
If the angle of refraction is 42º, calculate the refractive index of the cooking oil. (9)

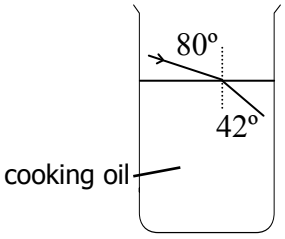

Figure 5

Lenses make use of the refraction of light.
Name **two** devices that use lenses. (6)

Describe an experiment to measure the focal length of a converging (convex) lens.
Give **one** way to improve the accuracy of your result. (18)

Figure 6 shows an object **O** placed 10 cm from a converging lens of focal length 5 cm.
Copy and complete the diagram to show the formation of the image by the lens.
Give **two** properties of the image observed. (15)

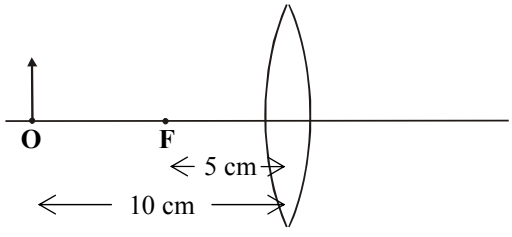

Figure 6

4. (*a*) State *Boyle's law*.
Describe an experiment to verify Boyle's law. (24)

Figure 7

In **Figure 7**, a tyre pump contains 180 cm^3 of air at a pressure of 100 kPa.
The outlet of the pump is blocked.
The handle on the pump is pushed down until the volume of air is reduced to 30 cm^3.
Calculate the new pressure of the air inside the pump. (9)

(*b*) The *kinetic theory* is used to explain the behaviour of gases.
Give **two** assumptions of the kinetic theory of gases. (12)


Figure 8

Figure 8 represents an ideal gas in a sealed balloon.
What is meant by the underlined term? (6)

(i) How does the velocity of the gas particles change as the balloon is warmed?
(ii) What is the effect of the gas particles on the walls of the balloon as the balloon is warmed?
(iii) Explain why the pressure of the gas increases as the volume of the balloon is reduced. (15)

5. **Figure 9** shows a positive and a negative charge at a fixed distance apart.
Copy the diagram and show the electric field between the two charges. (9)


Figure 9

'A current is a flow of electrical charges.'
Give **two** effects of an electric current. (12)
Describe how to demonstrate **one** of these effects. (12)

Figure 10 shows a wind-up torch containing a dynamo which is based on the principle of *electromagnetic induction*.
State **one** of the laws of electromagnetic induction.
Who discovered electromagnetic induction? (12)


Figure 10

As the handle is turned the bulb in the torch lights.
Explain why the bulb lights as the handle is turned. (9)
What energy change occurs in a wind-up torch? (6)
Name **one** other device based on the principle of electromagnetic induction. (6)

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

(*a*) The following terms are used in stating *Newton's law of universal gravitation*:

distance	**square**	**product**

Using these terms, copy and complete the following statement of Newton's law of universal gravitation:

"The force between two masses is directly proportional to the . . . . . of the masses and inversely proportional to the . . . . . of the . . . . . between them." (9)

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

(*b*) **Figure 11** shows a wavefront of monochromatic light approaching a narrow gap.
Explain the underlined term.
Name a source of monochromatic light. (12)

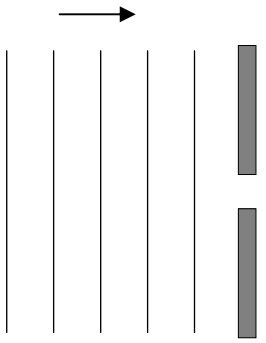

Figure 11

Copy the diagram and show the path of the wavefront after passing through the gap.

Name the phenomenon which occurs at the gap. (9)

This phenomenon can be used to measure the wavelength of monochromatic light in an experiment.

Give **two** measurements which need to be taken during the experiment. (12)

(*c*) State *Ohm's law*. (9)

Figure 12 shows an 8 Ω and a 12 Ω resistor connected in series with a battery.

The ammeter in the circuit gives a reading of 2.5 A.

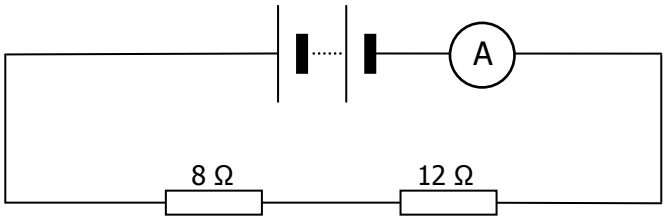

Figure 12

Calculate:

(i) the voltage (potential difference) across the 12 Ω resistor

(ii) the effective resistance of the circuit

(iii) the voltage across the battery. (18)

The ammeter is now placed between the two resistors.

What does the ammeter read in this new position? (6)

(*d*) 'Radioactivity is the spontaneous disintegration of unstable nuclei with the emission of one or more types of nuclear radiation.'

Explain the underlined terms. (9)

Figure 13 shows a beam from a radioactive sample passing between a pair of charged plates.

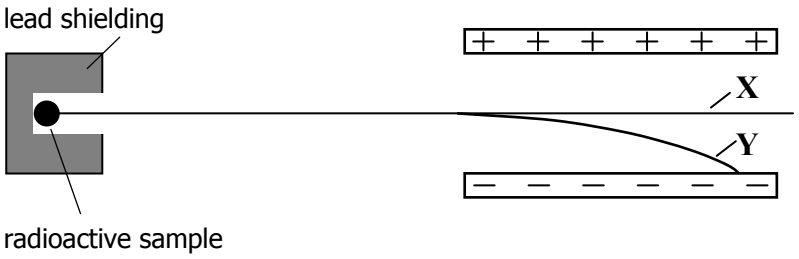

Figure 13

Name each one of the nuclear radiations, labelled **X** and **Y**. (9)

Give the structure of **Y**.

Give **one** use of radioactive substances. (15)

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 14** shows a sample of rock salt which contains the compound sodium chloride. What type of bonding exists in a crystal of sodium chloride?

Figure 14

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

(*c*) Which subatomic particle is located in an *orbital*?

(*d*) In the equation $E = hf$, what does f represent?

(*e*) Give **one** reason why the element fluorine has a large electronegativity value.

(*f*) Calculate the percentage of carbon by mass in carbon monoxide (**CO**).
[C=12; O=16]

(*g*) Give **one** property of a transition element.

(*h*) What would you use to show that dissolving ammonium chloride in water is an *endothermic* process?

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

$$\mathbf{CaCO_3 + HCl \rightarrow \_\_\_\_ + \_\_\_\_ + H_2O}$$

(*j*) What is the **pH** of a **0.02 M** solution of hydrochloric acid (**HCl**)?

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

lead **sodium** **silver**

(*l*) What is an *electrolyte*?

(*m*) The relative molecular mass of oxygen gas ($\mathbf{O_2}$) is 32.
Calculate the number of molecules in 64 g of oxygen gas.
[Avogadro constant = 6.0×10^{23} mol^{-1}]

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

(*o*) What structural feature do aromatic compounds have in common? (11 × 6)

8. A compound of the element boron is used in the manufacture of laboratory glassware.

Explain the underlined terms. (12)

Define (i) *mass number*, (ii) *relative atomic mass*. (12)

Copy the following table and complete it by filling in the missing numbers:

Atom	Atomic number	Mass number	Number of neutrons
$^{10}_{5}\mathbf{B}$			
$^{11}_{5}\mathbf{B}$			

(18)

What name is given to a set of atoms such as $^{10}_{5}\mathbf{B}$ and $^{11}_{5}\mathbf{B}$? (6)

A sample of boron consists of 20% $^{10}_{5}\mathbf{B}$ and 80% $^{11}_{5}\mathbf{B}$.

Calculate the relative atomic mass of this sample of boron. (12)

Give the electronic (*s, p*) configuration of an atom of boron. (6)

9. (*a*) Using the Brønsted-Lowry theory, define (i) an acid, (ii) a base. (12)

Weak acids only slightly dissociate in solution.

Give **one** example of a weak acid. (6)

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

$$\mathbf{HF + H_2O \rightleftharpoons F^- + H_3O^+}$$

Give **one** example of a conjugate acid-base pair in the above reaction. (15)

(*b*) Each one of the following elements reacts with hydrogen gas:

nitrogen **sulfur** **chlorine**

Give the name and chemical formula of the product formed in each reaction. (12)

From these products, identify (i) an acidic product, (ii) a basic product. (9)

For **one** of these products:

(iii) state its molecular shape,
(iv) sketch its shape, showing the position of the atoms. (12)

10. A student carried out a titration to standardise a solution of sodium hydroxide (**NaOH**).

Explain the underlined terms. (12)

Figure 15 shows some equipment which the student used.

(i) Name the glassware labelled **A** and **B**. (12)

(ii) What is the purpose of **C**? (6)

(iii) Describe how glassware **B** is prepared and used to give a 20 cm^3 portion of the sodium hydroxide solution. (9)

(iv) Name a suitable indicator for this titration. (6)

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

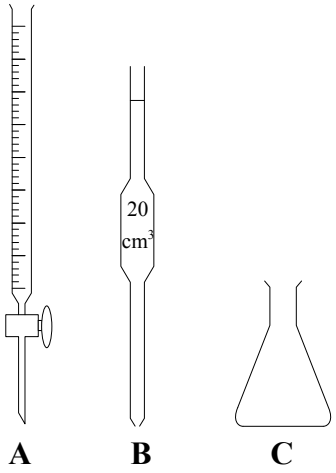

Figure 15

(vi) The student recorded that 20 cm^3 of sodium hydroxide (**NaOH**) solution was neutralised by 18.7 cm^3 of **1.5 M** hydrochloric acid (**HCl**) solution.

The chemical equation for this titration is:

$$\mathbf{HCl + NaOH \rightarrow NaCl + H_2O}$$

Calculate the molarity of the sodium hydroxide solution. (9)

11. Ethanol ($\mathbf{C_2H_5OH}$) can be produced by the hydration of ethene ($\mathbf{C_2H_4}$).

What is meant by the underlined term? (6)

Sketch the structural formula of (i) ethanol, (ii) ethene. (12)

Name the *homologous series* to which ethanol belongs.
What is the name of the first member of this homologous series? (9)

Explain why ethene is an *unsaturated* compound. (6)

Describe the physical appearance, at room temperature, of (iii) ethanol, (iv) sodium. (12)

Ethanol reacts with sodium according to the following chemical equation:

$$\mathbf{2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2} \qquad \mathbf{\Delta H = -270\ kJ\ mol^{-1}}$$

How would you show that the gas produced in the above reaction is hydrogen? (9)

Calculate:

(v) the quantity of energy released when 1 mole of ethanol reacts with 1 mole of sodium

(vi) the number of moles of hydrogen released when 4 moles of ethanol and 4 moles of sodium react. (12)

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

(*a*) Define a *mole* of a substance.
Hydrogen peroxide decomposes according to the following chemical equation:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

How could you make the hydrogen peroxide decompose faster? (12)
Describe a test to confirm that the gas produced is oxygen. (9)

If 17 g of hydrogen peroxide were used in this reaction, calculate:

(i) the number of moles of hydrogen peroxide used
(ii) the mass of water produced. (12)

[H=1; O=16]

(*b*) **Figure 16** shows sulfur dioxide (SO_2) being prepared and collected.

(i) Name the solid **A** and liquid **B**. (9)

(ii) What is the purpose of liquid **C**? (6)

(iii) Describe the colour change observed as a sample of litmus solution is added to a gas jar full of sulfur dioxide. (6)

(iv) State **one** physical property of sulfur dioxide. (6)

(v) Give **one** use of sulfur dioxide. (6)

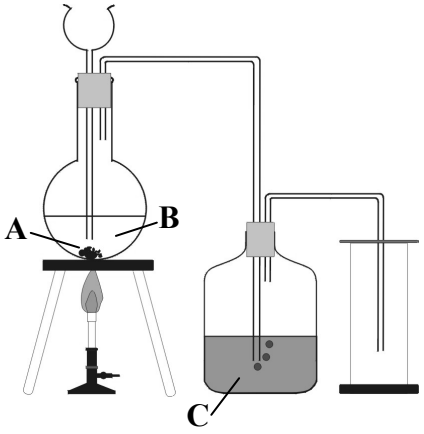

Figure 16

(*c*) Oxidation and reduction reactions occur in a car battery.
Define the underlined words in terms of electron transfer. (12)

Identify (i) the substance oxidised, (ii) the substance reduced, in the following reaction: (9)

$$PbO + H_2 \rightarrow Pb + H_2O$$

A clean iron nail is placed in a beaker containing a solution of copper sulfate.
Describe how the colour of the solution in the beaker changes. (6)

Copy and complete the following reaction which occurs in the beaker:

$$Fe + CuSO_4 \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$ (6)

Blank Page

Blank Page