Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2013

PHYSICS AND CHEMISTRY – ORDINARY LEVEL

MONDAY, 17 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 ride-on lawnmower.
If it is driven at 2.2 m s^{-1} what length of lawn does it cut every 15 seconds?

Figure 1

(*b*) A car has a mass of 950 kg. What force is needed to give it an acceleration of 6 m s^{-2} ?

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

(*d*) State *Boyle's law*.

(*e*) **Figure 2** shows rays of light approaching a lens.
Copy the diagram to show the path of the rays after passing through the lens.

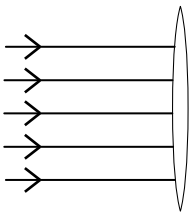

Figure 2

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

(*g*) What name is given to the effect where electrons are emitted from the surface of a metal when light of high frequency is shone on it?

(*h*) State **one** way to *increase* the capacitance of a parallel-plate capacitor.

(*i*) Give **two** items needed to make an electromagnet.

(*j*) A security system with a power rating of 46 W is connected to a 230 V supply.
Calculate the current drawn by the system.

(*k*) Calculate the number of units of electricity (kW h) used by a 2 kW grill in 3 minutes.

(*l*) Why does a conductor that is carrying a current move in a magnetic field?

(*m*) **Figure 3** shows a 4 μF capacitor connected in parallel with an 8 μF capacitor.
What is the effective capacitance of this arrangement?

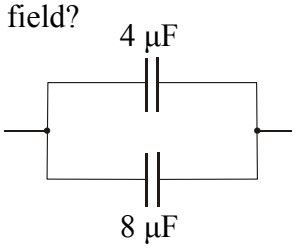

Figure 3

(*n*) Name a chemical element commonly used to shield nuclear radiations.

(*o*) What happens to the nuclei during a nuclear fusion reaction?

(11 × 6)

2. (*a*) Define (i) *velocity*, (ii) *acceleration*. (12)

Figure 4

Figure 4 shows a walrus which is a large sea-based mammal found in the Arctic.
A walrus starting from rest accelerates to a velocity of 9 m s^{-1} in 18 seconds.

Calculate

(i) the acceleration of the walrus

(ii) the distance covered by the walrus in the 18 seconds

(iii) the time taken by the walrus to move the first 25 m. (21)

(*b*) Define *work*.

Give the unit of work. (9)

Figure 5

Figure 5 shows a 0.25 m high platform used by a 65 kg student while doing a personal fitness test. The student steps on and off the platform 208 times during the test.

Calculate

(i) the weight of the student

(ii) the work done by the student each time he steps on to the platform

(iii) the total work done by the student during the test. (15)

Give **one** example of an energy conversion during the test.

Sketch a diagram showing **two** forces that act on the student when he is standing still on the step. (9)

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

3. State the *laws of reflection of light*. (12)

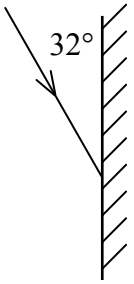

Figure 6

Figure 6 shows a ray of light striking a plane mirror at an angle of 32º.

What is the *angle of incidence* of the ray?

Give **two** properties of the image formed by a plane mirror. (18)

Describe an experiment to measure the focal length of a concave mirror. (15)

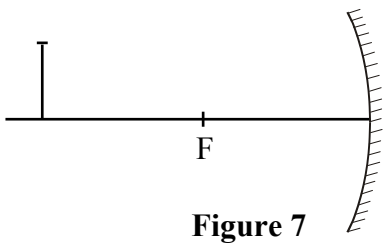

Figure 7

Figure 7 shows a pin placed 16 cm in front of a concave mirror of focal length 8 cm.

What distance is the image of the pin from the concave mirror? (9)

Give **one** use of (i) a plane mirror, (ii) a concave mirror. (12)

4. What is meant by a *thermometric property*?

Some laboratory thermometers contain mercury.

State the thermometric property on which the mercury thermometer is based. (12)

Name **one** other type of thermometer used in a laboratory and state the thermometric property on which it is based. (12)

A student carried out an activity to calibrate an unmarked mercury thermometer to measure temperatures on the Celsius scale.

(i) What are the **two** *fixed points* on the Celsius scale?

(ii) After marking the fixed points, what must the student then do to be able to use the thermometer to measure temperatures on the Celsius scale? (18)

Give **two** reasons why mercury is suitable for use in a thermometer.

Give **two** disadvantages of a mercury thermometer.

Pure silver melts at 962 ºC. What is this temperature on the Kelvin scale? (24)

5. (*a*) **Figure 8** shows a three-pin plug containing a fuse.

On which effect of an electric current is a fuse based?

Give **one** other effect of an electric current. (12)

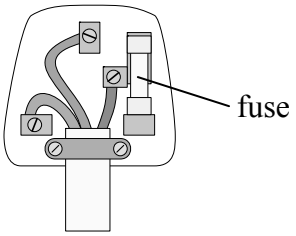

Figure 8

Figure 9 shows a circuit with two lamps each of resistance 3 Ω connected in *series* with a 9 V battery.

Calculate

(i) the effective resistance of the circuit

(ii) the current in the circuit.

Draw a circuit diagram in which the two lamps are connected in *parallel*.

Give **one** advantage of this parallel arrangement. (21)

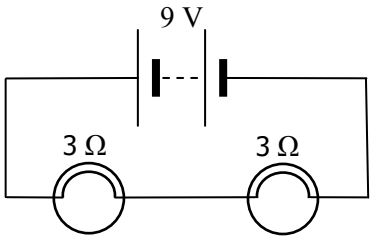

Figure 9

(*b*) Draw a labelled diagram of a gold-leaf electroscope. (12)

How would you use a positively-charged electroscope to confirm that a charged plastic rod is positively charged? (9)

Figure 10 shows a positively-charged rod held near two conducting spheres, **A** and **B**, which are in contact. Both spheres are on insulated stands.

When the spheres are moved apart by holding them by their stands, what charge remains on sphere **A**?

Give a reason for your answer. (12)

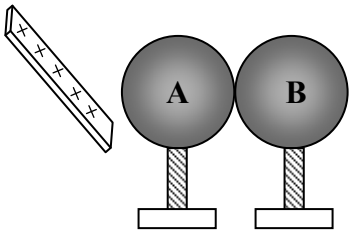

Figure 10

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 11 shows two wheelie bins on a smooth surface.

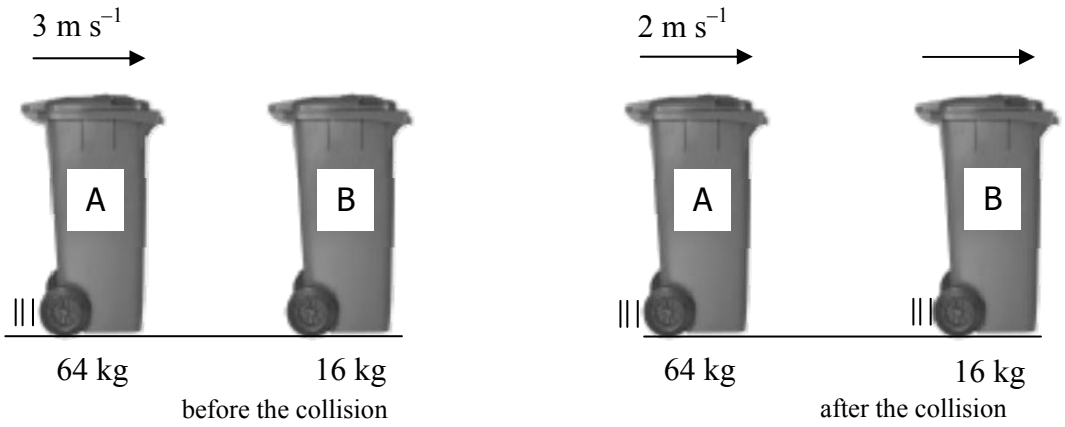

Figure 11

Wheelie bin **A** of total mass 64 kg sliding with a velocity of 3 m s^{-1} collides with an empty wheelie bin **B** of mass 16 kg which is at rest. After the collision both bins continue in the same direction with wheelie bin **A** now moving at 2 m s^{-1}.

Explain why wheelie bin **B** has zero momentum before the collision.

Calculate

(i) the momentum of wheelie bin **A** before the collision

(ii) the velocity of wheelie bin **B** after the collision. (21)

(*b*) State **two** assumptions of the kinetic theory of gases. (12)

How would you show *Brownian motion*? (15)

What information does Brownian motion give about the nature of gases? (6)

(*c*) **Figure 12** shows an interference pattern of bright and dark areas formed by light waves during an experiment to find the wavelength of a monochromatic light source.

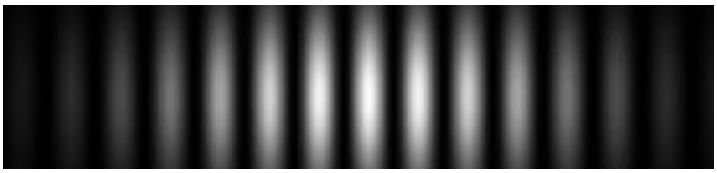

Figure 12

What is meant by the underlined term?

Name a source of monochromatic light.

Give **two** measurements that should be recorded during this experiment. (24)

Sketch diagram(s) to show how the light waves combine to form the interference pattern. (9)

(*d*) Marie Curie first isolated the element polonium, which exhibits radioactivity. Polonium–210 has a half-life of 138 days and is an alpha-particle emitter.

Explain the underlined terms. (12)

Give **one** property of an alpha particle. (6)

What fraction of a sample of polonium–210 will remain after a period of time equal to two half-lives (276 days)? (6)

Give **two** safety precautions used when handling radioactive sources. (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*) What is the maximum number of electrons that can occupy an atomic orbital?

(*b*) What are *isotopes* of an element?

(*c*) Give the chemical symbol of an element that is **more** electronegative than oxygen.

(*d*) Name a metal found free in nature.

(*e*) Which **one** of the following molecules has a dipole moment?

H_2 **HCl** **CH_4**

(*f*) The relative atomic mass of neon gas (**Ne**) is 20.
Calculate the number of atoms in 100 g of neon.
[Avogadro constant = 6.0×10^{23} mol^{-1}]

(*g*) Calculate the percentage of oxygen by mass in manganese dioxide (**MnO_2**).
[O = 16; Mn = 55]

(*h*) Give **one** property of transition elements.

(*i*) What is the **pH** of a **0.015 M** solution of hydrochloric acid (**HCl**)?

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

(*k*) State *Hess's law*.

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

$MgCO_3$ + HCl $\rightarrow$ $MgCl_2$ + _____ + ____

(*m*) List the following elements in order of **increasing** atomic size:

sodium **potassium** **lithium**

(*n*) Give **one** use for ethanoic (acetic) acid.

(*o*) What is the chemical formula of benzene?

(11×6)

8. (*a*) Sketch a diagram to show the arrangement of electrons in the main energy levels (shells) in *an atom* of chlorine. (6)

What is the chemical formula for a *molecule* of chlorine?

Sketch a diagram to show the arrangement of electrons in a *molecule* of chlorine.

State the shape of a molecule of chlorine. (18)

Chlorine is a gas at room temperature.

What does this tell you about the bonding *between* the molecules of chlorine at room temperature? (6)

(*b*) **Figure 13** shows the structure of a sodium chloride crystal. It consists of positively-charged particles and negatively-charged particles.

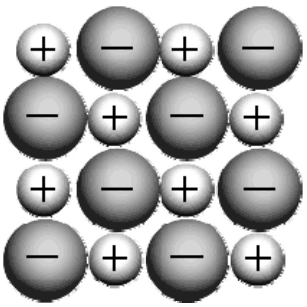

Figure 13

How does a neutral atom become a charged particle?

Name the positively-charged particles in sodium chloride.

The negatively-charged particles in a sodium chloride crystal are *larger* than the positively-charged particles.

Give a reason for this. (18)

Name the type of bonding in sodium chloride crystals.

Give **two** properties of substances that have this type of bonding. (18)

9. (*a*) Oxidation and reduction occur during the electrolysis of acidified water.

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

Figure 14 shows an apparatus used to demonstrate the electrolysis of acidified water.

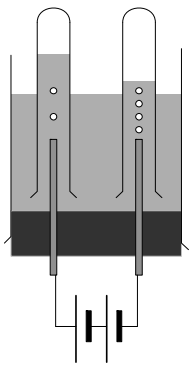

Figure 14

Name an element that can be used for the electrodes. (6)

Name the **two** gases produced during the process.

How would you confirm the identity of **each** of these gases? (15)

(*b*) Define (i) an acid, (ii) a base, in terms of the Brønsted-Lowry theory. (12)

Identify (iii) **two** acids, (iv) **one** acid-base conjugate pair in the following reaction:

$$\mathbf{HCN + H_2O \rightleftharpoons H_3O^+ + CN^-}$$

(15)

What is meant by an *amphoteric* substance? (6)

10. A standard solution of hydrochloric acid was used in a titration experiment to determine the concentration of a potassium hydroxide solution.

Figure 15 shows the laboratory glassware **A**, **B**, and **C** used.

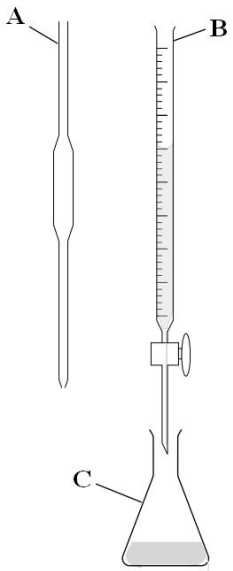

Figure 15

(i) Name **A**, **B** and **C**. (18)

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

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

(iv) Name **one** item of safety equipment that should be used. (6)

The equation for the reaction is

$$\mathbf{HCl + KOH \rightarrow KCl + H_2O}$$

The end point was reached when 24.7 cm^3 of 0.12 M hydrochloric acid solution reacted with 20.0 cm^3 of the potassium hydroxide solution.

(v) Name a suitable indicator for use in this experiment. (6)

(vi) State the colour of the named indicator in flask **C** at the end point of the titration. (6)

(vii) Calculate the concentration of the potassium hydroxide solution. (9)

(viii) How could the accuracy of the experiment be improved? (6)

11. In **Figure 16** a <u>butane</u> lighter is used to ignite the <u>methane</u> gas in a Bunsen burner.

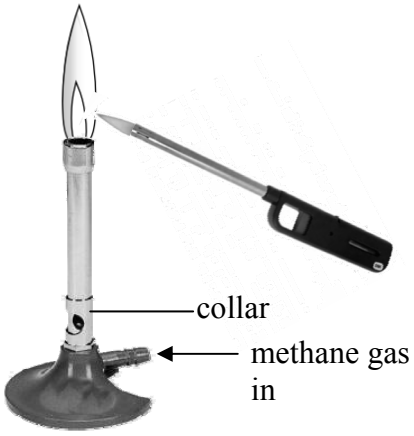

Figure 16

(*a*) What is the purpose of the collar on a Bunsen burner? (6)

(*b*) To which homologous series do **both** methane and butane belong? (6)

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

Give **two** sources of methane ($\mathbf{CH_4}$).

Butane is a *saturated* hydrocarbon.
What does this tell you about its structure?

Sketch the molecular structure of butane ($\mathbf{C_4H_{10}}$). (21)

(*c*) In a Bunsen burner methane burns according to the following equation:

$$\mathbf{CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O} \qquad \mathbf{\Delta \mathit{H} = -895\ kJ\ mol^{-1}}$$

What is meant by the *heat of combustion* of a substance?
How much energy is released when 0.05 moles of methane are burned? (18)

(*d*) Carbon dioxide gas is produced during the combustion of hydrocarbons.
Describe a test for carbon dioxide. (9)

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

(*a*) Ethanol reacts with sodium according to the following equation:

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$$

Describe the appearance of (i) ethanol, (ii) sodium, at room temperature. (12)

If 69 g of ethanol are used in the reaction, calculate

(i) the number of moles of ethanol used

(ii) the mass of sodium needed to react with the ethanol

(iii) the number of moles of hydrogen produced. (21)

[H = 1; C = 12; O = 16; Na = 23]

(*b*) There are three subatomic particles: protons, neutrons and electrons.

Copy and complete the following table, filling in the missing information, in your answerbook. (18)

	Location in atom	**Mass**	**Charge**
Proton	nucleus		+1
Neutron			
Electron		1/1836	

The atomic number of a fluorine (**F**) atom is 9 and its mass number is 19.
How many (i) protons, (ii) neutrons, are there in the fluorine atom?

Write the electronic (*s*, *p*) configuration for a fluorine atom. (15)

(*c*) What is the *electrochemical series*? (9)

The following list shows three elements in order of their positions in the electrochemical series:

potassium **magnesium** **copper**

Explain why the elements are in this order by considering their reaction (if any) with water. (12)

Name **one** element that is *below* copper in the electrochemical series. (6)

Copy and complete the following equation: (6)

$$CuSO_4 + Mg \longrightarrow \_\_\_\_\_ + \_\_\_\_\_$$

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