Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2016

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*) State the *principle of conservation of energy*.

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

(*c*) **Figure 1** shows a soccer ball of mass of 445 g.
What is its mass expressed in kilograms (kg)?

Figure 1

(*d*) A smartphone has a mass of 0.143 kg.
Calculate the weight of the phone.
[acceleration due to gravity, g = 9.8 m s^{-2}]

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

(*f*) **Figure 2** shows a waveform.
What term is given to the distance marked **X**?

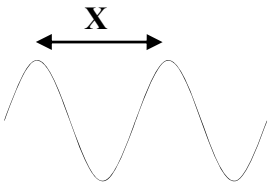

Figure 2

(*g*) What is meant by the dispersion of white light?

(*h*) Copper which is used in electrical wiring has a melting point of 1085 °C.
What is its melting point on the Kelvin scale?

(*i*) Copy and complete the following statement about how electric charges interact.
'Two positive charges ……. but a positive charge and a ……. charge attract.'

(*j*) Copy **Figure 3** that shows an isolated positively-charged conductor and sketch the electric field pattern around it.

Figure 3

(*k*) What is the replaceable safety component found inside a three-pin plug?

(*l*) How could you detect a magnetic field?

(*m*) **Figure 4** shows two 15 Ω resistors connected in parallel.
What is the value of their combined effective resistance?

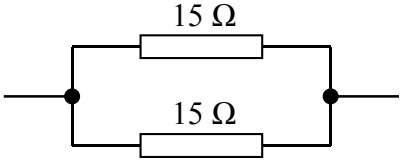

Figure 4

(*n*) Give one difference between nuclear fission and nuclear fusion.

(*o*) What is meant by the *half-life* of a radioactive substance?

(11 × 6)

2. (*a*) Define (i) momentum, (ii) kinetic energy, of a moving object. (12)

Figure 5 shows two snooker balls each of mass 0.15 kg on a smooth horizontal table. Ball **A** is moving at a velocity of 0.8 m s^{-1} towards stationary ball **B**. After the collision ball **A** continues to move in the same direction as before but it now has a speed of 0.3 m s^{-1}.

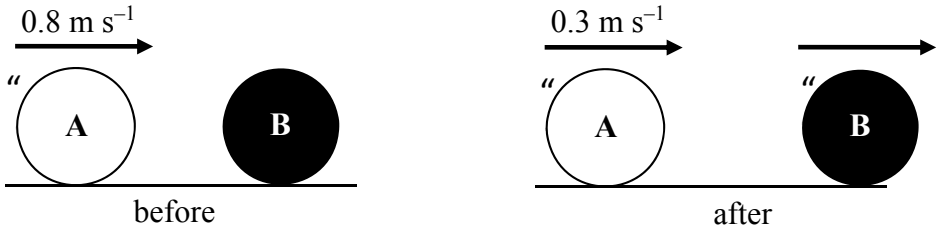

Figure 5

Calculate

(iii) the initial momentum of snooker ball **A**

(iv) the velocity of snooker ball **B** after the collision

(v) the kinetic energy of ball **A** after the collision. (21)

(*b*) Give **two** factors that affect the gravitational attraction between the sun and a planet. (12)

Describe with the aid of a labelled diagram an experiment to measure the acceleration due to gravity, *g*.

Give one precaution necessary to ensure an accurate result. (21)

3. (*a*) What is meant by the *refraction of light*?

Give one difference between the conditions for refracting and reflecting light. (12)

(*b*) **Figure 6** shows the path of a ray of light through a triangular prism.

(i) Name the phenomenon that occurs at **X**.

(ii) What is meant by the *critical angle*? (12)

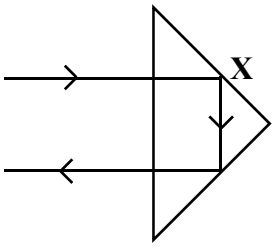

Figure 6

(*c*) Real images can be formed by lenses.

(i) Explain the underlined term.

(ii) What is the purpose of a lens in a camera? (12)

(*d*) (i) Copy **Figure 7** and complete it to show the formation of the image of object **O** by using any **two** rays.

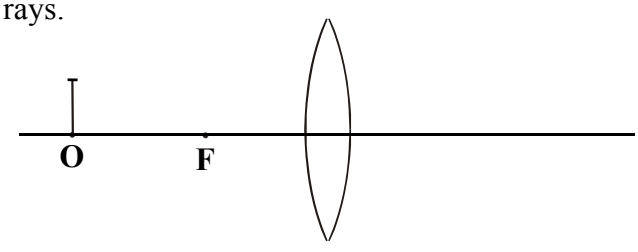

Figure 7

The position of **O** is 14 cm from the lens that has a focal length of 7 cm.

(ii) Find the image distance from the lens.

(iii) Compare the sizes of the object and the image.

(iv) Is the image inverted relative to **O**?

(v) Where should the object be placed to form a magnified, real image? (30)

4. In the seventeenth century, the Irish scientist, Robert Boyle, investigated the relationship between pressure and volume of a gas.

State *Boyle's law*.
Describe an experiment to investigate Boyle's law. (24)

Figure 8

Figure 8 shows a deflated balloon and an aerosol can containing compressed air at a pressure of 400 kPa.
If 300 cm^3 of compressed air from the can were released into the balloon, which was then sealed, calculate the final volume of the balloon at a pressure of 100 kPa at the same temperature. (9)

In the eighteenth century, the French scientist, Jacques Charles, investigated the relationship between volume and temperature of a gas.
State *Charles's law*. (9)

Both of these gas laws were later explained by the *kinetic theory of gases*.
Give **two** assumptions of the kinetic theory of gases.
What is meant by the *ideal gas*?
One mole of the ideal gas at standard pressure occupies 22.4 litres at 0 °C (273 K).
State the volume theoretically occupied by the gas at a temperature of –273 °C (0 K). (24)

5. (*a*) The following terms are used to state *Ohm's law*:

proportional **constant** **current** **potential difference**

Using the terms above copy and complete the following statement of Ohm's law.
'The ……in a conductor is directly ……to the ……between its ends at a …… temperature.' (12)

A student collected the data below to investigate Ohm's law using a metallic conductor.

potential difference (V)	0	1	2	3	4	5	6
current (A)	0	0.05	0.10	0.15	0.20	0.25	0.30

Draw a graph (on graph paper) of current (*y*-axis) against potential difference (*x*-axis).
Do you think that the data shows that the metallic conductor obeys Ohm's law?
Give a reason for your answer. (21)

(*b*) **Figure 9** shows a vacuum cleaner rated at 1300 W and connected to a 230 V a.c. supply.

Figure 9

State an energy change that takes place during its use.

Calculate the current drawn by the vacuum cleaner at full power. (12)

The vacuum cleaner was used at full power for a total of 2.5 hours in one week.
(i) How many units (kW h) were used?
(ii) If the cost of each unit was 20 cent, calculate the cost involved. (12)

Explain why electrical power is transmitted over long distances at high voltages.
Name the device that can change the voltage of an a.c. supply. (9)

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

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

Figure 10 is a velocity-time graph for a horse in a race.
The horse starts from rest and reaches a velocity of 16.5 m s^{-1} in 5.5 seconds and maintains this velocity for the rest of the race.
The horse passes the finishing post 30 seconds after starting the race.

(iii) How long does it take the horse to complete the part of the race run at constant velocity?

(iv) Use the graph to estimate the velocity of the horse after 2.5 seconds.

Calculate

(v) the acceleration of the horse in the first 5.5 seconds of the race

(vi) the distance covered in the first 5.5 seconds of the race. (21)

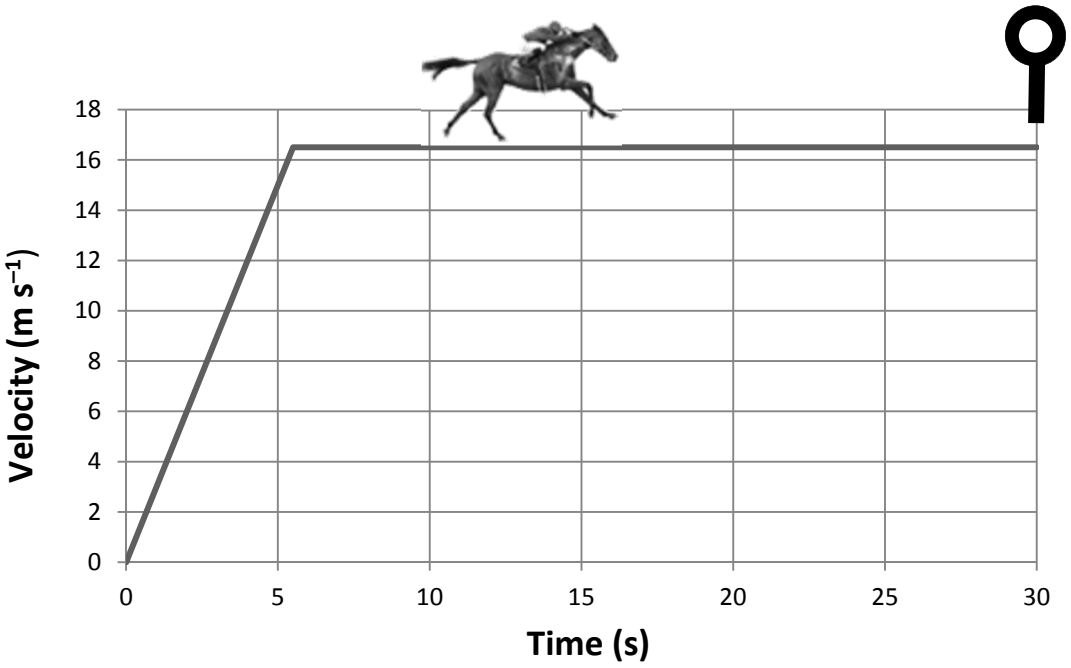

Figure 10

(*b*) Which part of an atom of a radioactive isotope is unstable? (6)

Give **two** uses for radioactive isotopes. (12)

During one type of radioactive decay negatively-charged particles are emitted.
Identify this type of radioactivity. (6)

Give **two** ways to deflect charged radiations from radioactive materials. (6)

Which type of radiation from radioactive materials cannot be deflected by these means? (3)

(*c*) Define *capacitance*.

State the SI unit of capacitance.

Which property of a capacitor allows it to be used in a flash light circuit of a camera? (15)

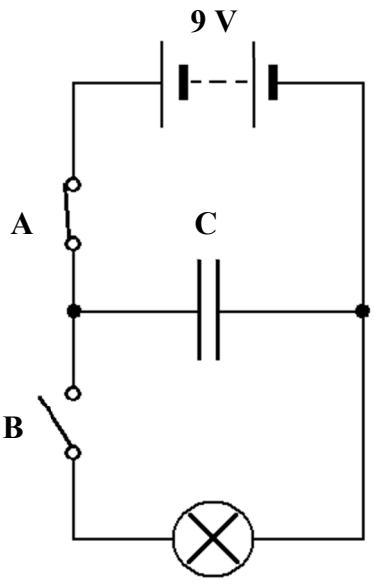

Figure 11

Figure 11 shows a circuit used to charge a parallel plate capacitor.

Copy the circuit and show the distribution of charges on the plates of the capacitor **C**.

What happens when switch **A** is then opened and switch **B** is closed? (12)

A capacitor connected to a 9 V battery has a charge of 1.5×10^{-6} C.

Calculate its capacitance. (6)

(*d*) In 1921 Albert Einstein, shown in **Figure 12**, was awarded the Nobel Prize in Physics for his explanation of the *photoelectric effect*.

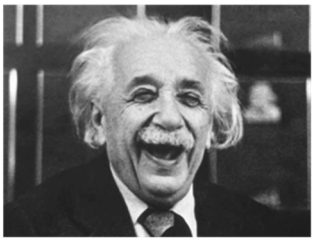

Figure 12

The effect can be demonstrated using the equipment shown in **Figure 13**.

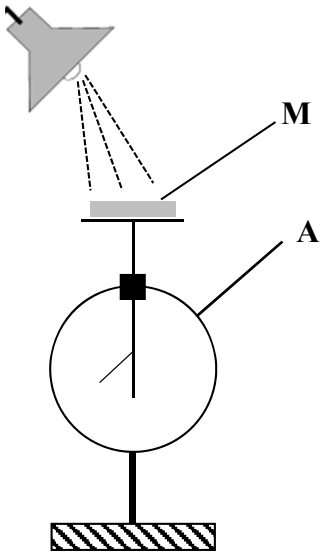

Figure 13

(i) Name the piece of apparatus labelled **A**.

(ii) Identify a suitable metal for **M**.

(iii) How is this metal prepared before use?

(iv) Why is ultraviolet radiation suitable as the light source?

(v) What is observed during this demonstration?

(vi) What does this tell you about the photoelectric effect?

(33)

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** is a photograph of a silicon chip. In the periodic table of the elements, what is the *group number* of the element silicon (**Si**)?

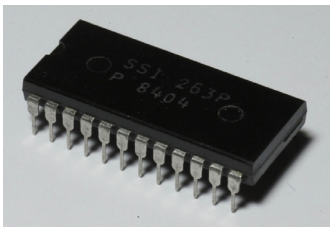

Figure 14

(*b*) Sketch the shape of a *p* orbital.

(*c*) What type of bond arises between two atoms when an electron is transferred from one atom to the other?

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

(*e*) How many (i) protons, (ii) neutrons, are there in an atom of argon, $^{40}_{18}\mathbf{Ar}$?

(*f*) Copy and complete the statement:
'Allotropes, e.g. diamond and graphite, are different …… forms of the same ……'

(*g*) What happens to limewater in the presence of carbon dioxide gas?

(*h*) Calculate the percentage of calcium by mass in calcium oxide (**CaO**).
[O = 16; **Ca = 40]**

(*i*) Copy, complete and balance the following equation.

$$\mathbf{Zn} + \underline{\quad\quad} \rightarrow \mathbf{ZnCl_2} + \mathbf{H_2}$$

Figure 15

(*j*) List the following metals in order of *increasing* activity:
aluminium sodium silver

(*k*) Calculate the number of atoms in the 9 moles of helium inside the balloons shown in **Figure 15**.
[Avogadro constant = 6.0×10^{23} mol^{-1}]

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

(*m*) Name the **two** gases produced when an electric current is passed through acidified water.

(*n*) Draw the structure of the benzene molecule.

(*o*) **Figure 16** shows the structural formula of methanoic acid which is found in ant stings.
Copy the structure and draw a circle around the acidic hydrogen.

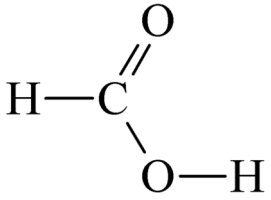

Figure 16

(11 × 6)

8. (*a*) Define (i) atomic number, (ii) mass number, of an element. (12)

State (iii) the atomic number of an atom of oxygen, $^{16}_{8}\mathbf{O}$.

Write the electron configuration (*s*, *p*) for an atom of oxygen. (12)

(*b*) The type of bonding in a compound is related to the electronegativity values of its component elements.

Define electronegativity.

Use electronegativity values (page 81 of the *Formulae and Tables* booklet) to explain why the bonding in a water molecule is **not** pure covalent. (12)

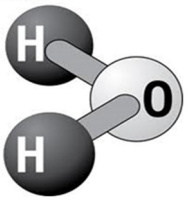

Figure 17

Figure 17 shows a representation of a single molecule of water.

Copy the diagram into your answerbook and show the location of

(i) a partial negative charge

(ii) a partial positive charge.

State the shape of a molecule of water. (12)

(*c*) **Figure 18** shows two views of water bulging on the surface of a coin.

What causes the water to hold together as shown?

Why does water have a particularly high boiling point compared to other substances with molecules of a similar size?

Is water a good solvent for pure covalent substances?

Explain your answer. (18)

Figure 18

9. (*a*) What is (i) an acid, (ii) a base, according to the Brønsted-Lowry theory? (12)

Identify (iii) **two** bases, (iv) one acid-base pair, in the following equation. (9)

$$\mathbf{CH_3COO^- + HCl \rightleftharpoons CH_3COOH + Cl^-}$$

Define pH.

Calculate the pH of a 0.025 M solution of nitric acid ($\mathbf{HNO_3}$). (12)

(*b*) Define reduction, in terms of electron transfer.

What other chemical process always occurs at the same time as reduction? (12)

Identify the substance reduced in the following reaction. (6)

$$\mathbf{CuO + H_2 \rightarrow Cu + H_2O}$$

What would you observe during this reaction? (6)

Name the electrical process used to extract metals form their ores.

At which electrode does reduction occur during this process? (9)

10. Using the glassware shown in **Figure 19**, a hydrochloric acid (**HCl**) solution of known concentration was added to a 25 cm^3 volume of sodium hydroxide (**NaOH**) solution to which a few drops of indicator had been added.

The equation for the reaction that occurred is:

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

The *end point* was reached when 19.6 cm^3 of 0.18 M hydrochloric acid solution reacted with the sodium hydroxide solution.

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

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

(*c*) Explain the term end point. (3)

(*d*) How was the end point detected? (3)

(*e*) How was **A** rinsed for use in this experiment? (9)

(*f*) Give one precaution when taking a reading from **B**. (3)

(*g*) **C** should be rinsed only with deionised or distilled water before use in this experiment.
Why is tap-water **not** suitable for rinsing **C**? (6)

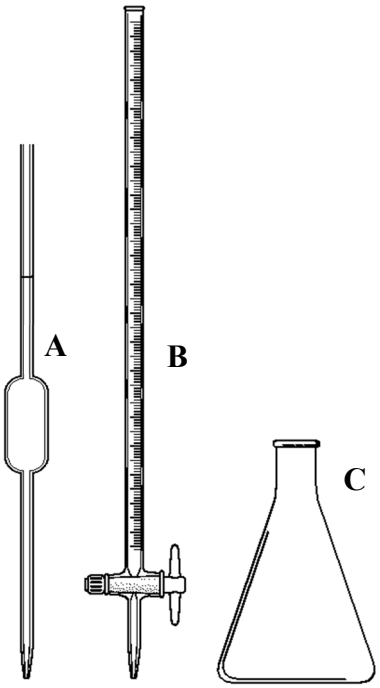

Figure 19

(*h*) Calculate the concentration of the sodium hydroxide solution used. (9)

The procedure was then repeated using the same quantities of acid and base but this time without the indicator.

(*i*) Explain how sodium chloride crystals can be separated from the reaction mixture in the conical flask. (6)

(*j*) Give **two** safety precautions when carrying out these experiments. (12)

11. (*a*) **Figure 20** shows a polythene plastic bag which is manufactured from the *hydrocarbon* gas ethene (**C_2H_4**).

Explain the term hydrocarbon.

Give one natural source of hydrocarbons. (12)


Figure 20

Ethane (**C_2H_6**) is another hydrocarbon gas whose molecules also contain two carbon atoms.

What is the structural difference between an ethene molecule and an ethane molecule?

Describe a chemical test which can confirm this structural difference. (12)

(*b*) **Figure 21** shows part of a laboratory set up for the production and collection of ethene gas by passing vaporised ethanol over a solid **C**.

Identify solid **C**.

Explain how the ethanol
(i) is held at the end of the test tube
(ii) is then vaporised. (18)

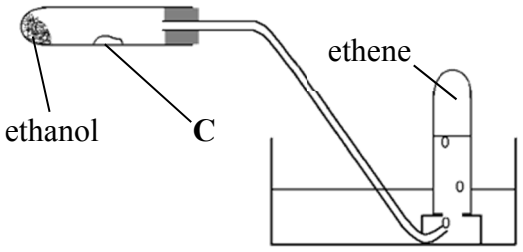

Figure 21

(*c*) Ethene burns exothermically in oxygen to form two compounds.

What is meant by an exothermic reaction?
Identify the **two** compounds formed.

What type of flame is observed when a test tube of ethene is tested with a glowing wooden splint? (24)

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

(*a*) Methane reacts with steam under certain conditions to form hydrogen according to the following equation:

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

Give one commercial use for hydrogen.
What is meant by a mole of a substance? (12)

When 32 g of methane is used in the reaction, calculate
(i) the number of moles of methane used
(ii) the mass of hydrogen produced
(iii) the volume occupied at s.t.p. by the hydrogen gas produced. (21)
[H = 1; **C = 12**; **molar volume at s.t.p. is 22.4 litres]**

(*b*) Oxygen gas is prepared in the laboratory by the addition of a liquid **A** to solid **B** as shown in **Figure 22**.

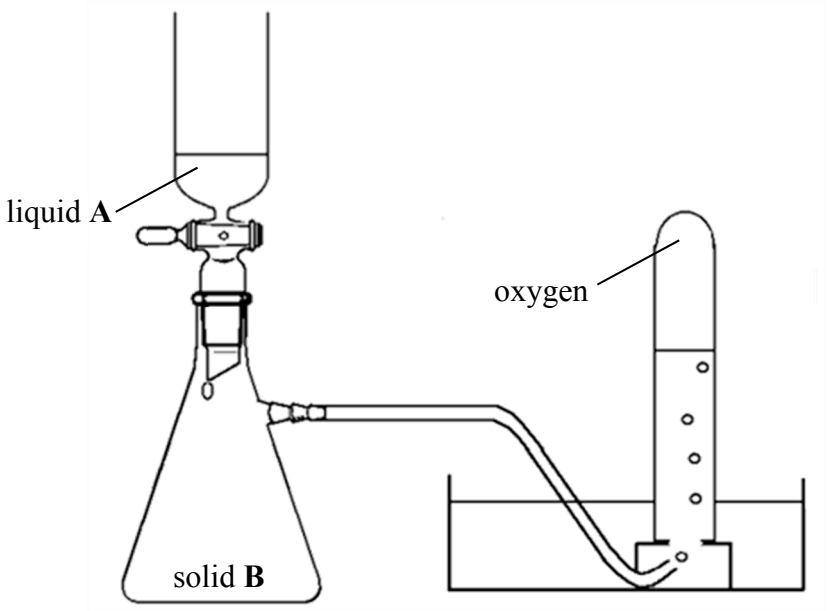

Figure 22

(i) Give the names or formulae of **A** and **B**. (12)
(ii) Describe the appearance of solid **B**. (6)
(iii) What is the purpose of solid **B** in this chemical reaction? (6)
(iv) Describe how a glowing splint is used to detect the presence of oxygen gas. (6)
(v) Give one commercial use for oxygen gas. (3)

(*c*) Consider the descriptions in the table.

A	A substance capable of acting as an acid or as a base in a reaction
B	An element in group 18 of the periodic table
C	A group of very reactive elements
D	A substance which does **not** cause litmus solutions to change colour
E	A binary compound containing the eighth element in the periodic table
F	A subatomic particle found in the nucleus of every atom
G	A subatomic particle with a negative charge

In your answerbook match each term below with its description (**A** to **G** above).

proton	**electron**	**alkali metals**
amphoteric	**neutral**	**oxide**
noble gas		

(27)

What are *isotopes* of an element? (6)

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