# Coimisiún na Scrúduithe Stáit
# State Examinations Commission

## LEAVING CERTIFICATE EXAMINATION, 2014

## PHYSICS AND CHEMISTRY – ORDINARY LEVEL

**MONDAY, 16 JUNE – MORNING, 9:30 to 12:30**

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**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.

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**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 **one** of *Newton's laws of motion*.

(*b*) Calculate the work done when a trolley is pushed 2 m across a floor with a force of 30 N.

(*c*) In the equation $F = \frac{G m_1 m_2}{d^2}$, what does $d$ represent?

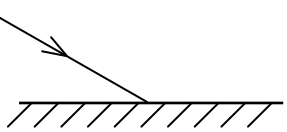

**Figure 1**

(*d*) **Figure 1** shows a ray of light approaching a mirror.
Copy the diagram to show the path of the ray after striking the mirror.

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

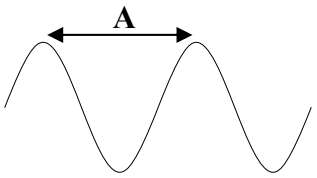


**Figure 2**

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

(*g*) What name is given to the random motion of smoke particles suspended in air or of pollen grains suspended in water?

(*h*) Give **two** assumptions of the kinetic theory of gases.

(*i*) Copy and complete the following statement about electric charges.
"Two negative charges ……. but a negative charge and a ……. charge attract."

(*j*) **Figure 3** shows an isolated positively-charged conductor.
Sketch the electric field pattern around the conductor.

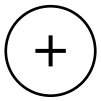


**Figure 3**

(*k*) **Figure 4** shows the inside of an electric plug.
What is the purpose of the fuse?

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

(*m*) An electric food mixer, rated at 550 W, is used continuously for fifteen minutes.
Calculate the number of units (kW h) used.

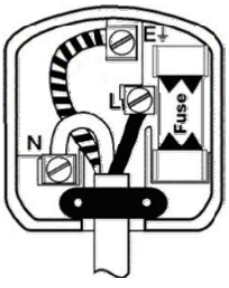


**Figure 4**

(*n*) Name the type of nuclear reaction where a large nucleus splits into two smaller nuclei.

(*o*) In Einstein's famous $E = mc^2$ equation, what does $c$ represent?

(11 × 6)

**2.** State the principle of *conservation of energy*.
Give the SI unit of

(i) mass,

(ii) weight. (12)

Describe with the aid of a labelled diagram an experiment to measure the acceleration due to gravity, *g*.
Give **one** precaution to ensure an accurate result. (24)

During a spell of freezing weather a helicopter was sent to drop bales of hay to stranded animals on a farm.

**Figure 5** shows the helicopter hovering 70 m above the ground releasing a bale of hay of mass 20 kg. The bale was thrown with an initial downward velocity of 2 m $s^{-1}$.

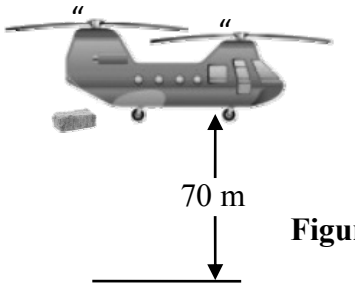

**Figure 5**

Calculate

(iii) the weight of the bale of hay,

(iv) the potential energy lost by the bale of hay in its fall,

(v) the downward velocity of the bale of hay 3 seconds after it left the helicopter. (18)

What energy conversion took place as the bale of hay was falling?

Explain why the bale of hay may not land vertically below where it was released if the helicopter was moving forward. (12)

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

**3.** What is meant by the *refraction of light*? (6)

Copy and complete the following statement of *Snell's law* of the refraction of light.
"The sine of the angle of . . . . . is . . . . . to the sine of the angle of . . . . . ." (12)

A student recorded the following data when investigating Snell's law using a glass block placed on a sheet of paper and a ray of light, as shown in **Figure 6**.

Angle **A** .....38º
Angle **B** .....24º

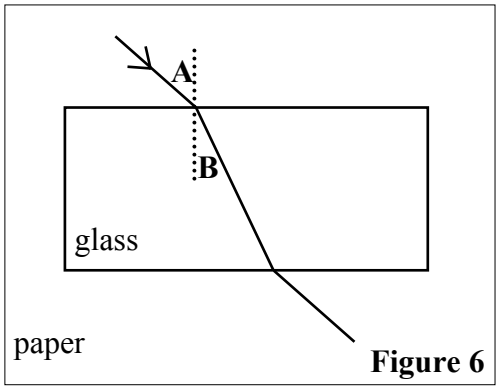

**Figure 6**

Describe how the student could follow and record the path of the light ray through the glass block.

Use the data above to calculate the refractive index of the glass. (18)

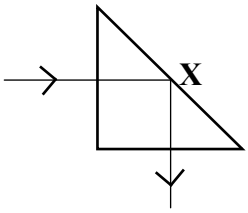

**Figure 7**

**Figure 7** shows the path of a ray of light through a triangular prism.

Name the phenomenon that occurs at **X**.

What is meant by the *critical angle* of a substance? (12)

The human eye forms an image which is real and inverted.

What is meant by a real image? (6)

Copy **Figure 8** and complete it to show the formation of a real, inverted image of **O** using any **two** rays. (12)

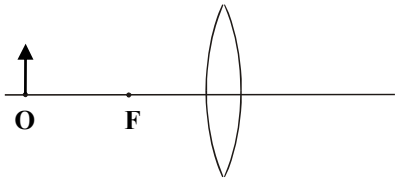

**Figure 8**

**4.** (*a*) The temperature of an object can be measured using the Kelvin scale or the Celsius scale.
What is meant by the *temperature* of an object? (6)

What is the significance of
(i) absolute zero on the Kelvin scale,
(ii) 100º on the Celsius scale?

Convert 100º on the Celsius scale to its value on the Kelvin scale. (18)

A thermometer is based on a *thermometric property*.
What is meant by a thermometric property?
Give **one** example of a thermometric property. (9)

(*b*) Using the terms: **mass**, **volume**, **pressure** and **temperature**, copy and complete the following statement of *Boyle's law*.

"The . . . . . of a fixed . . . . . of gas is inversely proportional to the . . . . . at constant. . . . . " (12)

The air inside a car tyre had a volume of 11 litres at a pressure of 340 kPa.
The tyre suddenly burst.
Use Boyle's law to calculate the new volume of the air released from the tyre when it burst.
Assume the atmospheric pressure is 100 kPa.

How do cold tyre pressures compare with warm tyre pressures? (21)

**5.** (*a*) **Figure 9** shows two ways of connecting a 2 Ω resistor with a 6 Ω resistor.
What term is given to the arrangement of resistors in (i) **A**, (ii) **B**? (12)

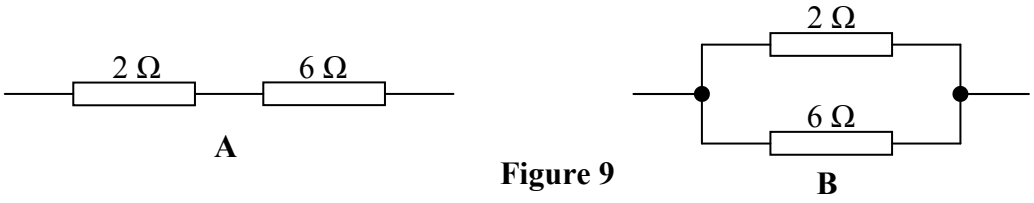


**Figure 9**

Each arrangement can be replaced by a single resistor.
What would the value of this resistor be for arrangement (iii) **A**, (iv) **B**? (12)

State *Ohm's law*.

Calculate the current flowing through **A** when it is connected to a 12 V battery. (12)

(*b*) Why is electrical power transmitted at high voltages over long distances? (6)

A transformer produces a different output *a.c.* voltage compared to its input *a.c.* voltage.
What does *a.c.* stand for?
Give **one** example of a device in the home that uses a transformer. (9)

A transformer produces an output voltage of 11.5 V when connected to a 230 V supply.
If the primary coil has 460 turns, calculate the number of turns on the secondary coil.

What is the principle on which the transformer is based? (15)

**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 large suitcase of mass 20 kg moving on a smooth surface in a straight line at a constant velocity of 0.8 m $s^{-1}$ towards a smaller stationary suitcase of mass 10 kg.

After the collision the smaller suitcase moves with a velocity of 1.2 m $s^{-1}$.

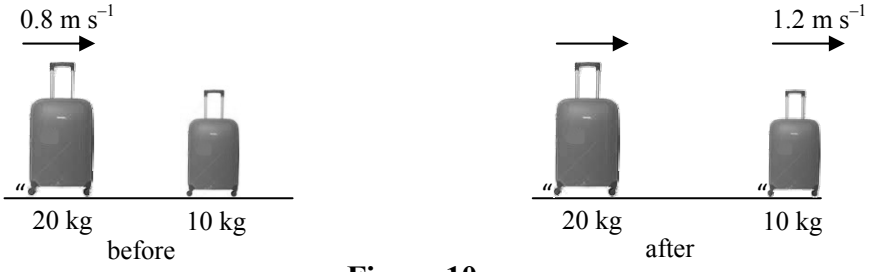


**Figure 10**

Calculate

(i) the initial momentum of the larger suitcase,

(ii) the velocity of the larger suitcase after the collision,

(iii) the kinetic energy of the smaller suitcase after the collision. (21)

(*b*) Consider the descriptions in the table:

| | |
|---|---|
| **A** | Radiation detected by a heat sensor |
| **B** | A group of waves with a common speed of $3 \times 10^8$ m $s^{-1}$ |
| **C** | A wave in which particles of the medium vibrate parallel to the direction in which the wave travels |
| **D** | Formation of a new wave when two waves with a similar frequency meet |
| **E** | Release of electrons from a metal surface when light shines on the metal |
| **F** | Separation of white light into its component colours |
| **G** | Spreading out of waves around an obstacle |

In your answerbook match each term below with its description (**A**, **B**, **C**, **D**, **E**, **F** or **G**).

| | | |
|---|---|---|
| **longitudinal wave** | **photoelectric effect** | **diffraction** |
| **infrared radiation** | **electromagnetic spectrum** | **dispersion** |
| **interference** | | |

(27)

Identify **one** type of electromagnetic radiation that would be suitable to demonstrate the phenomenon described in **E**. (6)

(*c*) Define *capacitance*. (6)

**Figure 11** shows two charged plates of a parallel-plate capacitor.

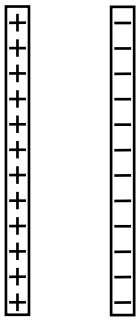

**Figure 11**

Copy the diagram and show the electric field pattern between the plates. (6)

What happens to the negative charges when the plates are connected by a piece of wire? (6)

State how the capacitance of this capacitor will change when

(i) the distance between the plates is *decreased*,

(ii) the common area between the plates is *decreased*. (9)

**Figure 12** shows a tablet device which uses technology based on the principle of the parallel-plate capacitor.

**Figure 12**

Give a reason why a user cannot interact with the tablet when wearing a regular glove.

Give **one** other example of a device that uses a capacitor. (6)

(*d*) Every radioactive isotope has a different half-life.
Explain the underlined terms. (12)

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

Positively-charged particles are emitted during alpha-decay.
Which type of nuclear decay emits negatively-charged particles?

Give **one** way to deflect charged nuclear radiations. (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** is a photograph of a neon sign. In the periodic table of the elements what is the *group number* of the element neon (**Ne**)?


**Figure 13**

(*b*) Copy and complete the following statement about allotropes.
"Allotropes are different …… forms of the same ……."

(*c*) Sketch the shape of a *p*-orbital.

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

(*e*) Why is sodium metal very reactive?

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

(*g*) Name the chemical used to test for the presence of carbon dioxide (**$CO_2$**) gas.

(*h*) Calculate the percentage of carbon by mass in benzene (**$C_6H_6$**).
**[H=1**; **C=12]**

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

$$\mathbf{HCl} + \_\_\_\_ \rightarrow \mathbf{ZnCl_2} + \_\_\_\_$$

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

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

(*l*) Calculate the number of molecules in 4 moles of water.
**[Avogadro constant = $6.0 \times 10^{23}$ $mol^{-1}$]**

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

(*n*) What is the functional group in ethanol (**$C_2H_5OH$**)?

(*o*) What structural feature do aromatic compounds have?

$(11 \times 6)$

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

State (iii) the atomic number, (iv) the number of neutrons, in an atom of fluorine, $^{19}_{9}\mathbf{F}$.

Write the electron configuration (*s*, *p*) for a fluorine atom. (12)

Chemical bonding determines the properties of substances.
Use a diagram to show how two atoms of fluorine bond together *covalently*. (12)

(*b*) Electronegativity values (page 81 of the *Formulae and Tables* booklet) are used to predict polarity of a covalent bond.
Classify the bonding in ammonia (**$NH_3$**) as pure covalent or polar covalent.

Give a reason why the boiling point of ammonia (–33 ºC) is much higher than the boiling point of fluorine (–188 ºC). (15)

**Figure 14** shows the arrangement of the outer electrons in a molecule of ammonia.

How many (i) bond pairs, (ii) lone pairs, of electrons are there in the outer shell of the nitrogen atom in an ammonia molecule?

The number of bond pairs and lone pairs of electrons in the outer shell of the central atom in a covalent molecule can be used to work out the shape of a molecule.

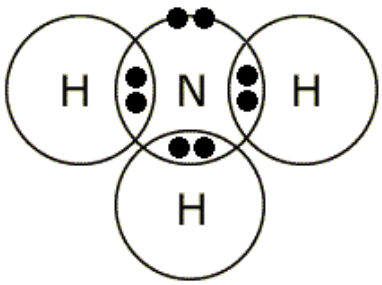


**Figure 14**

What is the shape of an ammonia molecule? (15)

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

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

$$\mathbf{NH_3 + H_2S \rightleftharpoons NH_4^+ + HS^-}$$

Define **pH**.

What is the pH of a 0.035 M solution of nitric acid (**$HNO_3$**)? (12)

(*b*) Explain (i) oxidation, (ii) reduction, in terms of electron transfer. (12)

Oxidation and reduction are used to extract zinc metal from its oxide.

Identify (iii) the substance oxidised, (iv) the oxidising agent, in the following reaction. (9)

$$\mathbf{ZnO + C \rightarrow Zn + CO}$$

Name the electrical process used to extract aluminium from its oxide.

Why is electricity usually used to extract aluminium from its oxide? (12)

**10.** An acid-base titration was carried out to find the concentration of a solution of sodium hydroxide (**NaOH**) using a standard solution of hydrochloric acid (**HCl**).

(*a*) What is a *standard solution*? (6)

(*b*) (i) Name the piece of glassware used to transfer exactly 20 $cm^3$ of the sodium hydroxide solution to a conical flask.

(ii) Give the **two** liquids used to rinse this piece of glassware before use. (15)

(*c*) A few drops of another liquid were also added to the conical flask.

(i) What was the purpose of this liquid?

(ii) Suggest a suitable liquid for this purpose. (12)

(*d*) (i) Sketch the piece of glassware used to add the hydrochloric acid solution to the conical flask.

(ii) During the titration what should have been done with the conical flask as the hydrochloric acid solution was being added? (12)

(*e*) What safety equipment should have been worn throughout this activity? (6)

(*f*) The balanced equation for the titration reaction is as follows:

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

To neutralise 20 $cm^3$ of the sodium hydroxide solution, 24.8 $cm^3$ of 0.13 M hydrochloric acid was added to the conical flask.

(i) Calculate the concentration of the sodium hydroxide solution.

(ii) Give **one** everyday use for **NaCl**. (15)

**11.** **Figure 15** shows an oil refinery where crude oil is used as a source of alkanes.

**Figure 15**

Which elements are found in an alkane? (12)

Name or give the formula of the first member of the alkanes. (6)

Give **one** major use for this alkane. (6)

Alkenes are another family of organic compounds that contain the same elements as the alkanes. Alkenes are described as <u>unsaturated compounds</u> while alkanes are saturated.

What is meant by the underlined term? (6)

Draw the structural formula for ethene (**$C_2H_4$**). (6)

Describe, with the aid of a diagram, an experiment to produce ethene gas from ethanol. (18)

**Figure 16** shows a sample of ethene gas being bubbled through a test tube containing a solution of bromine (**$Br_2$**).

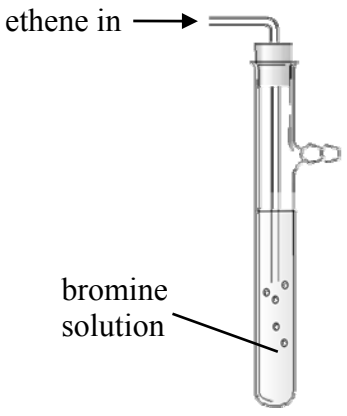


**Figure 16**

Describe the appearance of a solution of bromine.

What is observed as the ethene is bubbled through the bromine?

How will this test confirm that the gas bubbled through is an alkene and not an alkane? (12)

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

(*a*) **Figure 17** shows a piece of coal, a major component of which is the element carbon. Coal often contains small quantities of sulfur in the form of iron sulfide (**FeS**).

**Figure 17**

Name the **two** oxides of carbon that can be produced when coal is burned.

Which **one** of these oxides is acidic?

What poisonous gas with a choking smell is produced when coal containing sulfur is burned?

What effect, if any, does this gas have on the colour of a piece of damp blue litmus paper? (21)

The equation for the reaction between iron and sulfur is as follows:

$$\mathbf{Fe + S \rightarrow FeS}$$

When 84 g of iron reacted with sulfur according to the equation above, calculate

(i) the number of moles of iron used,

(ii) the mass of iron sulfide produced. (12)

**[S = 32**; **Fe = 56]**

(*b*) **Figure 18** shows an arrangement for the preparation of oxygen gas using a liquid **A** and a solid black catalyst **B**.

Name (i) liquid **A**, (ii) catalyst **B**. (12)

What is the purpose of a catalyst? (6)

Describe a test for oxygen gas. (6)

Identify the second product of this reaction. (3)

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

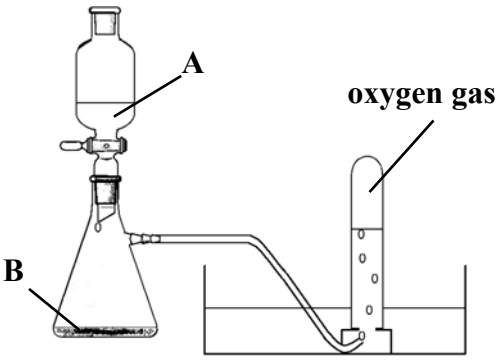


**Figure 18**

(*c*) Define the *heat of combustion* of a substance.

State *Hess's law*.

What is meant by an *exothermic* reaction? (18)

Octane ($\mathbf{C_8H_{18}}$) burns in air according to the equation:

$$\mathbf{2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O} \qquad \mathbf{\Delta H = -10\ 940\ kJ}$$

Is this reaction *exothermic* or *endothermic*? Explain your answer.

Calculate the heat of combustion of octane ($\mathbf{C_8H_{18}}$). (15)

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