Coimisiún na Scrúduithe Stáit
State Examinations Commission

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Fisic agus Ceimic *Gnáthleibhéal*

Marking Scheme *Leaving Certificate Examination, 2004*

Physics and Chemistry *Ordinary level*

Leaving Certificate Examination

2004

Physics & Chemistry Ordinary Level

Marking Scheme

- **Six** questions to be answered.
- Answer any **three** questions from **Section I** and any **three** questions from **Section II.**
- All 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 by the candidate.

In considering this marking scheme the following points should be noted:

1. In many instances only key words are given, words that must appear in the **correct context** in the candidate's answer in order to merit the assigned marks.
2. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.
3. Answers that are separated by a double solidus, //, are answers which are mutually exclusive. A partial answer from one side of the // may not be taken in conjunction with a partial answer from the other side.
4. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.
5. The detail required in any answer is determined by the context and manner in which the question is asked and by the number of marks assigned to the answer in the examination paper. Therefore, in any instance, it may vary from year to year.
6. For lack of units, or incorrect units, one mark is deducted, when indicated.
7. Each time an arithmetical slip occurs in a calculation one mark is deducted.

QUESTION 1

Answer any eleven parts

(a) State the principle of conservation of energy

Energy cannot be created // total energy … 3
or destroyed / it can only be changed from one form to another
// is constant … 3

(b) A cyclist increases her velocity from 5 m s^{-1} to 8 m s^{-1} in 6 seconds. What is her acceleration?

$v = u + at$ / $8 = 5 + a(6)$ / 3 ($m\ s^{-1}$) … 3
0.5 / ½ … 3

(c) What is the value of absolute zero on the absolute scale?

– / minus … 3
273 … 3

(d) What is meant by a thermometric property?

(property) that changes … 3
with temperature / heat … 3
[example … 3 only]

(e) Give <u>one</u> use of total internal reflection.

optical fibres / reflectors / endoscopes / diamonds / binoculars etc. … 6

(f) What is meant by the diffraction of a wave?

bending / spreading (stated / implied) … 3
obstacle / narrow opening … 3
[diagram … 6]

(g) Give <u>one</u> example of a longitudinal wave

sound / ultrasonic / compression waves on a spring etc. … 6
[radio waves … 0]

(h) What is the name given to (i) height X, (ii) length Y?

(i) X = amplitude / maximum displacement / crest … 3
(ii) Y=wavelength … 3

(i) What is the purpose of a fuse in an electric circuit?

protects // prevents // melts / blows … 3
an appliance // a fire // if the current is too large … 3
[safety device … 6]

(j) Complete the statement

repel … 3
negative … 3

QUESTION 1 (continued)

(k) State a law of electromagnetic induction

emf / current	…	3
∝ rate of change of magnetic flux / opposes the change	…	3

(l) Calculate the effective capacitance of the two capacitors.

$C = C_1 + C_2$ / $C = 3 + 4$	…	3
7 (μF) / 1/C = 7/12	…	3

(m) Give <u>one</u> use of a gold leaf electroscope

detect charge / conductor or insulator / identify type of charge / indicate size of p.d./ detect ionising ability of radioactive particles etc.	…	6

(n) In the equation $E = mc^2$, what does c represent?

speed / constant	…	3
of light	…	3

(o) What is nuclear fusion?

nuclei / atoms / elements	…	3
join	…	3

[example / energy released … 3 only]

QUESTION 2

Define (i) acceleration, (ii) weight ***4×3***

(i) rate of change // change in velocity // $\frac{v-u}{t}$ … 3
of velocity (speed) // w.r.t. time // t … 3
[$F = ma$ / units … 3 only]

(ii) pull / force / attraction // measure of // m … 3
of the earth // how heavy a body is // $\times g$ …. 3
[show the difference between mass and weight … 3]

Describe an experiment to measure the acceleration due to gravity, g. ***7×3***

Apparatus pendulum, string, ruler, timer, cork, stand //
electromagnet, ball, ruler, timer, stand **any four** … 4×3
[one item missing (–1)]

Method correct arrangement of apparatus (shown / described)
set the pendulum swinging // release the ball
measure the length // height
time the oscillations // ball to fall
correct equation **any three** … 3×3

Give <u>one</u> precaution you should take to get an accurate result. ***3***

repeat //
small angle // lowest value of t
length /distance not too small
motion in one plane // reset the timer etc. **any one** … 3

Complete the statement of Newton's law of gravitation. ***3×3***

product, square, distance ... *3×3*
[correct words, wrong order … 2×3]

Calculate (i) the weight of the package ***3***

$W = mg$ / $W = 5 \times 9.8$ / 49 N … 3

(ii) the velocity of the package after 5 seconds ***3×3***

$v = u + gt$ / $v = 3 + (9.8)(5)$ … 2×3
$= 52$ (m s^{-1}) … 3

(iii) the distance that the package falls from the helicopter in 5 seconds ***2×3***

$s = ut + \frac{1}{2}at^2$ / $v^2 = u^2 + 2as$ / $s = 3(5) + \frac{1}{2}(9.8)(5)^2$ /
$(52)^2 = (3)^2 + 2(9.8)s$ … 3
137.5 (m) / answer consistent with formula used … 3

(iv) the height of the package above the ground after 5 seconds ***3***

62.5 (m) / answer consistent with distance in (iii) … 3

QUESTION 3

(a) What is meant by (i) real image, (ii) magnified image? ***2×6***

(i) formed on a screen / inverted / rays converging /appropriate diagram / correct location for lens / correct location for mirror / correct example **any one** … 6

[formed / seen … 3, on a screen … 3]

(ii) bigger … 6

State <u>two</u> properties of the image formed by a plane mirror. ***2×3***

virtual / laterally inverted / erect / same size as object / as far behind as object is in front ($u = v$) / behind the mirror **any two** … 2×3

Experiment to verify that the angle of incidence is equal to the angle of reflection. ***5×3***

Apparatus: mirror, ray box / pins … 2×3

Procedure: correct arrangement of apparatus
mirror perpendicular to the page / mark back of mirror / precaution
mark incident ray
mark reflected ray
draw normal
measure angles **any three** … 3×3

(b) ***State the laws of refraction of light*** ***4×3***

I incident ray, normal, refracted ray … 3
on the same plane … 3

II $\sin i$ … 3
$\propto \sin r$ … 3

Complete the diagram to show the formation of the image by the lens ***3×3***

One ray correct to lens … 3
Correct refraction … 3
2nd ray correct … 3

Is the image real or virtual? Give a reason for your answer. ***6,3***

Real image / consistent with the diagram … 6
inverted / converging rays / formed on a screen consistent with diagram … 3

Give <u>one</u> use of a converging lens **3**

Spectacles / microscope / telescope / binoculars etc **any one** ... 3

QUESTION 4

(a) ***State Boyle's law*** ***3×3***

fixed mass /
constant temperature /
pressure // pV // p_1V_1
inversely proportional to volume ($\propto$ 1/V) // $= k$ // $= p_2V_2$ **any three** … 3×3

Describe, with the aid of a labelled diagram, an experiment to verify Boyle's law ***6×3***

Apparatus: pressure gauge // J-tube
pump / plunger // mercury
enclosed volume of air **any two** … 2×3
[any one omitted / no labels … 3 only]

Procedure: increase / read pressure (p)
read volume (V)
vary // repeat
pressure // different values
valid precaution **any four** … 4×3

What is meant by an ideal gas? ***2×3***

obeys Boyle's law / obeys gas laws / satisfies K.T. assumptions … 3
always / exactly / at all temperatures / at all pressures … 3

(b) Give <u>two</u> assumptions of the kinetic theory of gases ***6, 3***

large no. of particles / elastic collisions / rapid motion /
negligible volume / random motion / straight line motion /
negligible duration of collisions / temperature depends on K.E. etc.

1st assumption … 6
2nd assumption … 3

What is Brownian motion? ***2×3***

molecules / particles … 3
motion … 3

Describe an experiment to show Brownian motion ***3×3, 6***

Apparatus: smoke cell / lamp / microscope **any two** … 2×3

Procedure: fill cell with smoke / shine light from side /
focus microscope **any one** … 3

Observe: describe what is observed … 6

What does Brownian motion tell you about the nature of gases ***3***

particles of gas in motion … 3

QUESTION 5

State the principle on which the moving coil galvanometer is based. ***3×3***

current / conductor / coil … 3
in a magnetic field … 3
experiences a force / moves … 3

Describe an experiment to demonstrate this principle. ***5×3***

Apparatus: magnet, conductor, battery / power source … 2×3
[any two … 3]

Procedure: workable circuit … 3
allow current to flow … 3
conductor moves … 3

Name <u>three</u> parts of a moving coil galvanometer ***3×3***

core / coil / needle / spring / magnet / scale **any three** … 3×3

What does a.c. stand for? ***2×3***

alternating … 3
current … 3

(i) Name the parts of the transformer labelled A, B and C ***3×3***

A: primary … 3
B: secondary … 3
C: core … 3
[reverse order for A and B (−1),
correct words, wrong order …2×3, step down …3]

(ii) How many turns are required on part B to give an output of 6 V? ***3×3***

$N_s / N_p = V_s / V_p$ … 3
$N_s / 460 = 6 / 230$ … 3
12 (turns) … 3
[3 turns … 3]

Name <u>one</u> device that uses a transformer ***3***

battery charger / TV etc … 3

What is the advantage to the ESB in transmitting electricity at high voltages? ***2×3***

less heat / less energy / cheaper // more … 3
lost // efficient … 3
[advantage of a.c. over d.c. … 3]

QUESTION 6

Answer any <u>two</u> parts

(a) Define (i) kinetic energy, (ii) momentum. ***4×3***

(i) energy due to // work // example … 3
motion // done … 3
[½ mv^2 … 2×3]

(ii) mass … 3
× velocity (speed) … 3

Calculate (i) the initial kinetic energy of sphere A ***3×3***

E_k = ½ mv^2 … 3
= ½ (2)$(4)^2$ … 3
=16 J … 3

(ii) the momentum of sphere A before the collision ***2×3***

$p = mv$ / $p =$ 2 × 4 … 3
= 8 … 3

(iii) the momentum of sphere B after the collision ***2×3***

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ / 3 m s^{-1} … 3
6 (kg m s^{-1}) … 3

(b) Explain the term <u>spectrum</u> ***2×3***

band / range / spread … 3
of colours … 3

What happens to the light as it enters the prism at W? ***6***

dispersed / refracted / split up … 6

Name the invisible radiation on the screen at (i) region X, (ii) region Y. ***4×3***

(i) infra … 3
red … 3

(ii) ultra … 3
violet … 3
[reverse order … 2×3]

Describe how you would detect <u>one</u> of these invisible radiations. ***3×3***

thermometer (thermocouple) // fluorescent material //
Zn and electroscope and shine UV … 2×3
rise in temperature // glows // leaves collapse … 3

Question 6 (continued)

(c) ***State Ohm's law*** ***3×3***

voltage (V) … 3

∝ current (I) / = RI … 3

at constant temperature … 3

What is the unit of electric current? ***6***

Ampere / Amp / A … 6

Calculate(i) the total resistance of the circuit ***2×3***

$R = R_1 + R_2$ / R = 3 + 9 … 3

= 12 Ω … 3

(ii) the current in the circuit ***3×3***

$V = RI$ … 3

6 = 12 × I … 3

= 0.5 … 3

(iii) the potential difference (voltage) across the 9 Ω resistor ***3***

V = 9 × 0.5 / 4.5 V … 3

(d) ***Give <u>two</u> properties of gamma radiation*** ***2×6***

high energy / low ionising ability / very penetrating / short wavelength / invisible etc **any two** … 2×6

Name <u>two</u> other types of nuclear radiation. ***2×3***

alpha … 3

beta … 3

Give <u>two</u> uses of radioactive substances ***2×3***

medical / cancer / carbon dating/ detecting leaks etc **any two** … 2×3

What fraction of a sample of radon gas is left after 12 days? ***3×3***

½ / ½ / ½ // 1/8 … 3×3

QUESTION 7

Answer any eleven parts

(a) How many (i) protons, (ii) electrons, are there in the Li^+ ion?

(i) 3 … 3
(ii) 2 … 3
[value given in (ii) one less than (i) … 3]

(b) Which element is represented by the electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

Argon / element number 18 … 6

(c) Sketch an s-orbital

Spherical shape (shown / stated) … 6
[sketch of p-orbital … 3]

(d) Give one example of a molecular crystal

Iodine / sucrose / sulphur / ice / dry ice (solid carbon dioxide)/
organic solids etc. … 6
[ionic / covalent crystal … 3]

(e) Arrange the metals in order of <u>increasing</u> activity

Zinc, aluminium, sodium … 6
[any two in correct order / reverse order … 3]

(f) Name one oxide which is a major cause of atmospheric pollution

oxide of … 3
carbon / nitrogen / sulfur … 3

(g) What is meant by an amphoteric oxide?

acts as an acid … 3
or a base … 3
[example … 3]

(h) Copy, complete and balance the equation:

$CaCl_2$ / H_2 … 3
$Ca + 2HCl \rightarrow CaCl_2 + H_2$ … 3

(i) Give an example of a weak acid.

vinegar / ethanoic acid / acetic acid / carbonic acid etc. … 6
[definition of weak acid … 3]

(j) Calculate the percentage of nitrogen by mass in ammonia (NH_3)

M_r of NH_3 = 17 … 3
82% … 3
[rain / definition … 3]

(k) State Hess's law

heat change … 3
*i*ndependent of path … 3

Question 7 (continued)

(l) Name two gases produced when acidified water undergoes electrolysis

hydrogen … 3
oxygen … 3

(m) Calculate the number of molecules in 22 g of ethanal

(22g) = ½ a mole … 3
3×10^{23} … 3

(n) Name the compound

phenol … 6
[benzene / aromatic alcohol / benzoic acid … 3]

(o) Give the molecular formula for benzene

C_6 // CH … 3
H_6 // C_6H_6 … 3

QUESTION 8

(a) Explain the terms (i) mass number, (ii) isotope ***4×3***

(i) number of protons … 3
and neutrons … 3

(ii) same number of protons / same atomic number /
atoms of the same element … 3
different no. of neutrons / different mass number … 3
[example … 3]

(iii) State the number of neutrons in each of these isotopes ***2×6***

38 neutrons … 6
40 neutrons … 6
[difference of two … 3]

(iv) calculate the relative atomic mass of gallium ***3×3***

60×69 / 4140 … 3
40×71 / 2840 … 3
69.8 … 3

(b) What is meant by (i) covalent bond, (ii) ionic bond? ***4×3***

(i) sharing … 3
of electrons … 3
[EN difference < 1.7 / example … 3]

(ii) transfer // attraction … 3
of electrons // between ions … 3
[EN difference >1.7 / example … 3]
[correct but in reverse (–1)]

Give <u>one</u> property of ionic compounds. ***3***

solid / crystalline / high m.p. / high b.p. / good conductors of electricity
in molten state or in solution etc. … 3

Using electronegativity values, explain why (iii) sodium chloride is an ionic compound; (iv) hydrogen chloride is a polar covalent molecule ***4×3***

(iii) EN difference … 3
greater than … 3
1.7 … 3
(iv) less than … 3
[correct but in reverse (–1)]

State the type <u>and</u> size of charge of the chloride ion in sodium chloride. ***6***

Cl^- … 6
[minus … 3, one … 3]

QUESTION 9

What is meant by the molarity of a substance? ***2×3***

moles / concentration / M_r expressed in grams … 3

per litre … 3

Explain why an indicator is used during a titration. ***2×3***

show / change colour … 3

end-point / point of neutralisation … 3

(i) Draw a labelled diagram of the apparatus used in a titration **… 6, 2×3**

burette / flask / beaker / pipette / stand / funnel / white tile / pipette filler

1st correct … 6

any two … 2×3

(ii) Name a suitable indicator for this experiment ***6***

named indicator … 6

[use of an indicator … 3]

(iii) Describe how the volume of sulfuric acid required for neutralisation was found. **6,3**

add acid until colour change // read at end-point // three accurate titres … 6

adjust (read) to zero / read volume/ subtract readings //

// rough titration / average titres … 3

(iv) State <u>two</u> precautions taken to ensure an accurate result ***2×6***

add acid slowly (drop wise) / white tile / swirl flask / wash sides of flask /

read bottom of meniscus / three accurate titres / rinse apparatus with water /

rinse burette (pipette) with acid (base) **any two** … 2×6

(v) Copy, complete and balance the equation for the reaction: ***2×3***

$Na_2SO_4 + 2H_2O$ … 2×3

[Na_2SO_4 / $2H_2O$ … 3]

(vi) Calculate the molarity of the sodium hydroxide solution. ***3×3***

$\frac{M_1 \times V_1}{n_1}$ / $\frac{0.1 \times 18.5}{1}$ … 3

$\frac{M_2 \times V_2}{n_2}$ / $\frac{M_2 \times 25}{2}$ … 3

0.15 (M) … 3

QUESTION 10

(a) Define heat of formation ***2×3***

heat change … 3

one mole is formed (from its elements) … 3

Explain why the reaction is exothermic. ***2×3***

heat // ΔH … 3

given off // minus … 3

Calculate(i) the quantity of heat released in the combustion of 6 moles of hydrogen ***3×3***

(1 mole) = 286 … 3

= 6 × 286 … 3

= 1716 (kJ) … 3

(ii) the number of moles of oxygen used in the combustion of 6 moles of hydrogen ***2×3***

1 mole H_2 requires ½ mole O_2 … 3

(6 moles H_2) 3 … 3

(iii) the number of moles of hydrogen required to release 1430 kJ of energy ***2×3***

(1 mole) = 286 … 3

1430 ÷ 286 / 5 … 3

(b) Explain oxidation and reduction in terms of electron transfer ***2×6***

loss (of electrons) … 6

gain (of electrons) … 6

[reverse order (–1)]

Identify (i) the substance oxidised, (ii) the oxidising agent ***6, 3***

(i) Ca

(ii) F / F_2 **1st correct** … 6

2nd correct … 3

[reverse order (–1)]

Copy and complete the reaction of copper oxide with hydrogen gas ***2×3***

Cu … 3

H_2O … 3

Name (iii) the substance oxidised, (iv) the substance reduced ***2×3***

(i) H_2 … 3

(ii) Cu / CuO … 3

[reverse order (–1)]

QUESTION 11

Identify the homologous series to which methane belongs ***6***

Alkanes … 6

Name <u>two</u> other members of this homologous series ***4×3***

Ethane / propane / butane / pentane etc **1st correct** … 3×3

2nd correct … 3

Give one <u>use</u> for methane gas ***6***

Fuel / heat / energy source etc. … 6

Give the structural formula of (i) ethene, (ii) ethanol ***4×3***

(i) C == C … 3

H's attached … 3

(ii) C – C – OH … 3

H's attached … 3

Describe, with the aid of a labelled diagram, an experiment to produce ethene from ethanol ***6×3***

Apparatus: test-tube, trough, gas jar, Bunsen **any three** … 3×3

[no diagram … deduct 3]

Method: alcohol and glass wool in test tube

Al_2O_3 / catalyst

sealed tube

heat

collect gas in gas jar **any three** … 3×3

What happens to the solution in the test tube? ***2×3***

changes // becomes … 3

colour // colourless … 3

What does this tell you about the structure of ethene? ***6***

unsaturated / double bonds … 6

[saturated … 3]

QUESTION 12

(a) ***Name the gas being produced*** ***6***

carbon dioxide … 6

Name liquid A and solid B ***2×6***

(A) acid … 6

(B) suitable carbonate / hydrogen carbonate … 6

[reverse order … 9]

Give <u>two</u> uses of the gas produced ***2×3***

Fire extinguishers / special effects / fizzy drinks / refrigerant etc. **any two** … 2×3

Describe a test to find out if the gas is acidic or basic ***3×3***

Named indicator … 3

Give colour change … 3

Conclusion (consistent with the colour change) … 3

(b) Define (i) an acid, (ii) a base, in terms of the Bronsted-Lowry theory. ***4×3***

(i) proton // pH between 0 – 7 // low pH … 3

donor // … 3

[example … 3]

(ii) proton // pH between 7 – 14 // high pH … 3

acceptor// … 3

[example … 3]

[reverse order (–1)]

Identify (iii) <u>two</u> acids, (iv) <u>two</u> bases and (v) <u>one</u> acid-base pair ***5×3***

(iii) H_2O, NH_4^+ … 2×3

(iv) NH_3, OH^- … 2×3

[reverse order (–1)]

(v) NH_3, NH_4^+ // H_2O, OH^- … 3

Name the scale used to compare the acidity of substances ***6***

pH … 6

Question 12 (continued)

(c) Draw a diagram to show the arrangement of electrons in ammonia. ***2×3***

Show 1 lone pair … 3
Show 3 bond pairs … 3

Complete table ***2×6, 3***

Molecule	Number of bond pairs	Number of lone pairs	Shape
NH_3	3	1	
BF_3	3		
H_2O		2	V-shaped / planar

1st two correct … 2×6
remainder … 3

Sketch the shape of any <u>two</u> of the molecules in the table, showing the positions of the atoms in each case. ***4×3***

Any two correct shapes showing correct position of atoms

1st correct … 9
2nd correct … 3