Coimisiún na Scrúduithe Stáit
State Examinations Commission

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Fisic agus Ceimic *Ardleibhéal*

Marking Scheme *Leaving Certificate Examination, 2003*

Physics and Chemistry *Higher Level*

Leaving Certificate Examination

2003

Physics & Chemistry

Higher Level

Marking Scheme

SECTION I – PHYSICS

Answer any three questions

1. Answer ***eleven*** of the following items(a), (b), (c), etc.
   (a) 2×3 (b) 2×3 (c) 2×3 (d) 2×3 (e) 2×3 (f) 2×3 (g) 2×3
   (h) 2×3 (i) 2×3 (j) 2×3 (k) 2×3 (l) 2×3 (m) 2×3 (n) 2×3 (o) 2×3

2. Define 2×3, 6 State 3×3 Explain 3×3 Describe 6×3
   Calculate (i) 3×3 (ii) 3×3

3. State 4×3 Describe 6×3 Draw 3×3 Find 4×3 Use 5×3

4. State 2×3 Draw 3×3 Explain 2×3 Plot 4×3

   Explain 3×3 Calculate 4×3 How 3 How 6 Give 3

5. (a) Define 2×3 Give 2×3 Describe 4×3 Calculate 4×3

   (b) State 2×3 Describe 3×3 Calculate 3×3 Give 2×3

6. ***Answer any two of the following parts.*** Each part carries 33 marks.

   (a) Give 2×3 Use 3×3 Calculate 6×3

   (b) Explain 4×3 Describe 3×3 Calculate 4×3

   (c) (i)Name 2×3 What 6 (ii)What 2×3 Explain 3×3 (iii)What 6

   (d) Explain 3×3 Describe 4×3 Write 4×3

NOTE: All questions will carry the same number of marks.
However, one additional mark will be given to each of the first two questions in each Section for which the highest marks are obtained by the candidate.

SECTION II - CHEMISTRY

Answer any three questions

7. Answer ***eleven*** of the following items(a), (b), (c), etc.
(a) 2×3 (b) 2×3 (c) 2×3 (d) 2×3 (e) 2×3 (f) 2×3 (g) 2×3 (h) 2×3
(i) 2×3 (j) 2×3 (k) 2×3 (l) 2×3 (m) 2×3 (n) 2×3 (o) 2×3

8. (a) Define 4×3 Sketch 3 Identify 2×3
(b) Explain 4×3 Calculate 4×3
(c) What 2×3 Give 6 Explain 3×3

9. (a) State 2×3 What 2×3 Calculate 7×3
(b) Write 3×3 (i) State 2×3 Describe 4×3 (ii) Write 2×3

10. Define 3×3 Identify 4×3 Write 2x3 (i) Express 2×3
(ii) Calculate 3×3 (iii) Calculate 3×3 Explain 5×3

11 Explain 4×3 (i) 4×3 (ii) 6 3×3 (iii) 3×6 (iv) 3×3

12. ***Answer any three of the following parts***. Each part carries 22 marks

(a) Define 4×3 Identify 2×3 2×2

(b) State 2×3 Write 2×3 Calculate 2×3 2×2

(c) Describe 2×3 Sketch 3×3 State 3 Explain 2×2

(d) Define 2×3 Calculate 4×3 2×2

NOTE: All questions will carry the same number of marks.
However, one additional mark will be given to each of the first two questions in each Section for which the highest marks are obtained by the candidate.

SECTION I - PHYSICS

QUESTION 1

Any eleven parts

(a) $W = mgh$ / $W = (100)(9.8)(15)$ … 3

$W = 14{,}700$ … 3

(b) when A exerts a force on B / to every action … 3

B exerts an equal but opposite force on A /
there is an equal but opposite reaction … 3

(c) the separation (splitting, spreading) of light … 3
into its constituent colours (different wavelengths) … 3
[good diagram … 2×3]

(d) $W = VQ$ / $30 = V \times 2.5$ … 3

$V = 12$ … 3

(e) A = compression … 3
B = rarefaction … 3
[reverse order … 3 only]

(f) current carrying conductor in a magnetic field … 3
experiences a force (moves) … 3

(g) two parallel conductors / 1 metre apart / in a vacuum /
exert a force of 2×10^{-7} N/m … 2×3
any two … (3)

QUESTION 1 (continued)

(h)	100 / $X_\theta - X_0$ ÷ / $X_{100} - X_0$	…	2×3
	any two	…	(3)
	[T - … 3 273 … 3]		
	[100 / $X_{100} - X_0$ ÷ $X_\theta - X_0$ … 3]		
(i)	total	…	3
	internal reflection	…	3
(j)	infrared ultraviolet X-rays gamma	…	2×3
	[all in reverse order / 3 consecutively correct … 3]		
(k)	small current / low voltage and high current	…	3
	heating effect of electric current / $P \propto I^2$	…	3
(l)	emission of electrons	…	3
	when electromagnetic radiation (light)of suitable frequency		
	falls on the metal /UV light shines on zinc / light on sodium	…	3
(m)	positive charge on the sphere close to the charged rod	…	3
	negative charge on opposite side of the sphere	…	3
(n)	light (small) nuclei join	…	3
	to form a heavier (larger) nucleus	…	3
(o)	loss in mass	…	3
	converted to energy / $E = mc^2$	…	3

½

QUESTION 2

Define (2×3, 6)			
(i) *(momentum)*	mass	…	3
	× velocity	…	3
(ii) *(kinetic energy)*	energy due to motion / ½ mv^2	…	6
State (3×3)	no external forces / closed system	…	3
(PCM)	momentum before = / $m_1u_1 + m_2u_2 =$	…	3
	momentum after / $m_1v_1 + m_2v_2$	…	3
Explain (3×3)	spacecraft expels gases with a certain momentum	…	3
	the spacecraft gains the same momentum	…	3
	in the opposite direction	…	3
	[diagram / if momentum is not mentioned … 6 max]		
Describe (6×3)			
App:	2 trolleys, timing device, means of joining (separating) **any two**	…	3
Method:	correct arrangement shown (stated)	…	3
	measure the mass of both trolleys	…	3
	give push (release the spring)	…	3
	explain how to measure velocity	…	3
	explain how the result verifies P.C.M. / $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	…	3

QUESTION 2 (continued)

Calculate (i) (3×3)

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ … 3

$(0.16)(2.5) + (0.16)(0) = (0.16)\,v + (0.16)(2.4)$ … 3

$v = 0.1 \text{ m s}^{-1}$ … 3

incorrect / no units (-1)

(ii) (3×3) E_k initially $\frac{1}{2}(0.16)(2.5)^2 / 0.5$ … 3

E_k finally $\frac{1}{2}(0.16)(0.1)^2 + \frac{1}{2}(0.16)(2.4)^2 / 0.46$ … 3

E_k lost 0.04 J … 3

incorrect / no units (-1)

QUESTION 3

State (4×3) *(laws of refraction)*

I	incident ray (angle), refracted ray (angle) and normal	…	3
	are in the same plane	…	3
II	sin ***i*** ∝ / sin ***i*** =	…	3
	sin ***r*** / constant sin ***r***	…	3

Describe (6×3)

I	*Apparatus:*	glass block, pins (ray), paper	...	3
	Method:	correct arrangement shown (stated)	…	3
		incident and emergent ray defined	...	3
		draw normal and refracted ray (shown / stated)	...	3
		measure correct ***i*** and ***r***	...	3
		refractive index = sin ***i*** / sin ***r***		
		(slope of graph of sin ***i*** vs sin ***r***)	...	3
II	*Apparatus:*	glass block, powder, travelling microscope	...	(3)
	Method:	correct arrangement shown (stated)	…	(3)
		mark on paper, focus microscope		
		and read the scale (x)	...	(3)
		glass block over mark & read scale(y)	...	(3)
		powder on block & read scale (z)	...	(3)
		refractive index = $\frac{\text{real depth (z-x)}}{\text{apparent depth (z-y)}}$	...	(3)

Draw (3×3)	object inside the focus	…	3
	one correct ray	…	3
	second ray and image	…	3

QUESTION 3 (continued)

Find (4×3)

	$v = 3u$	…	3
	$1/f = 1/u + 1/v$ / $1/12 = 1/u - 1/3u$	…	3
	$2/3u = 1/12$	…	3
	$u = 8$ cm	…	3

incorrect / no units (-1)

Use (5×3) two converging lenses
show focal lengths of lenses
formation of intermediate image
I_1 at or inside f_e
consistent rays from I_1 to I_2 … 5×3

QUESTION 4

State (2×3)

(Ohm's law) at constant temperature … 3

$V \propto I$ / $V = RI$, R constant … 3

V / V	0.5	1.5	2.5	3.5	4.5	5.5	6.5
I / A	0.03	0.09	0.15	0.21	0.26	0.33	0.38

Draw (3×3)

power supply (battery), ammeter, voltmeter,
rheostat, metallic conductor … 2×3

[**any two** … 3]

correct arrangement … 3

Explain (2×3)

explain how to vary V / I … 3

read I and V … 3

Plot (4×3)

axes labelled correctly
plot 5-7 points correctly
one relevant straight line
good distribution (best fit) … 4×3

[graph paper not used … deduct 2x3]

Explain (3×3)

straight line
through the origin
shows that $V \propto I$ /
verifies Ohm's law (if correct at start) … 3×3

Calculate (4×3)

	equation for the slope	…	3
	two points on the line	…	3
	resistance (16 – 17) ohms	…	2×3

incorrect / no units (–1)

[calculate resistance from average …6 only]

How (3)	immerse in a beaker of water (non-conducting liquid / ice / a flow of cold water)/ blow cold air	…	3

How (6)	non-linear (stated / implied)	…	6
	[reference to resistance … 3]		

Give (3)	use a small current/more accurate ammeter (voltmeter) etc.	…	3

QUESTION 5

(a) Define (2×3)

(capacitance)	ratio of charge	…	3
	to potential (voltage, p.d.)	…	3

[$C = Q/V$ … 3 ; explain the three terms … 3]

Give (2×3)

	distance between the plates		
	common area		
	permittivity (dielectric) **any two**	…	2×3

Describe (4×3)

Apparatus:	parallel plates, detector	…	3
Method:	correct arrangement	…	3
	increase (decrease) distance (area) (permittivity)	…	3
Result:	divergence of leaves increases (decreases)		
	capacitance decreases (increases)	…	3

Calculate (4×3)

(i) $C = C_1 + C_2$ / $C = 4 + 2$ / $C = 6$ … 3

$1/C = 1/C_1 + 1/C_2$ / $1/C = 1/9 + 1/6$ … 3

$C = 3.6\ \mu F$ … 3

incorrect / no units (–1)

[$5 \div 18$ / 10.3 μF … 2×3 max]

(ii) $Q = 2.16 \times 10^{-5}$ C … 3

incorrect / no units (–1)

QUESTION 5 (continued)

(b) State (2×3)

(*Faraday's law)* induced emf (current) proportional to … 3

rate of change of flux … 3

Describe (3×3)

Apparatus: coil, galvanometer, magnet … 3

Method: move magnet relative to coil … 3

Result: deflection in the galvanometer … 3

[Lenz's law … deduct 3]

Calculate (3×3)

$V_{in} / V_{out} = N_p / N_s$ … 3

$230 / V_{out} = 4000 / 200$ … 3

$V_o = 11.5$ V … 3

incorrect / no units (–1)

Give (2×3) use an iron core

laminate the core

use thick wires (wires of low resistance)

tightly wound coils etc.

any two … 2×3

QUESTION 6

Answer any two parts

(a) Give (2×3) $F \propto (=) / GM_1M_2 / 1/d^2$ … 2×3

[any two … 3 only]

Use (3×3) $F = GMm/d^2$ … 3

$F = m \times g$ … 3

$mg = GMm/r^2$ … 3

Calculate (6×3)

(i) $r = (6.38 \times 10^6) + (5.74 \times 10^5) / 6.954 \times 10^6$ … 3

$$g = \frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{(6.954 \times 10^6)^2}$$ … 2×3

$g = 8.25 \text{ m s}^{-2}$ … 3

incorrect / no units (–1)

(ii) $W = mg \; / \; W = 80 \times 8.25$ … 3

$W = 660 \text{ N}$ … 3

incorrect / no units (–1)

[accept $W = 784$ N for $g = 9.8$]

QUESTION 6 (continued)

(b) Explain (4×3)

(i) (ideal gas)

obeys Boyle's law (gas laws)(satisfies K.T. assumptions) … 3

always (exactly)(at all temperatures and pressures) … 3

(ii) *(Brownian movement)*

constant (continuous) motion of particles (molecules) … 3

in a fluid (liquid or gas) … 3

Describe (3×3)

microscope, smoke cell(cell and light source) ... 3

correct arrangement … 3

observation ... 3

Calculate (4×3)

$PV = nRT$ … 3

$(150 \times 10^3)(1.2 \times 10^{-3}) = 0.07\ (8.3)T$ … 3

$T = 310$ … 3

$^{o}C = 37$ … 3

(c) (i)	**Name (2×3)**	diffraction / light spreads out	…	3
		interference	…	3
	What (6)	light is a wave	…	6
	(ii) What (2×3)	bright and dark	…	3
		fringes / spots	…	3
	Explain (3×3)	two waves meet	…	3
		interfere constructively / bright	…	3
		interfere destructively / dark	…	3
		[no diagram –3]		
(iii)	**What (6)**	wavelength	…	6
(d) Explain (3×3)				
(radioactive)		the decay (disintegration) of nuclei / unstable	…	3
		with the emission of radiation (alpha/gamma/energy)	…	3
(beta particle)		electron / $^{0}_{-1}e$	…	3
Describe (4×3)				
	Apparatus	detector, beta source	…	3
	Method	correct arrangement	…	3
		vary distance / detect track	…	3
	Result	count changes accordingly / measure length of track	…	3
		[cloud chamber … 4×3; penetrating power … deduct 3]		
Write (4×3)		$^{14}_{6}C$	…	3
		$^{14}_{7}N$	…	3
		$^{0}_{-1}e$ / $^{0}_{-1}\beta$	…	3
		correct order	…	3

SECTION II – CHEMISTRY

QUESTION 7

(a)	(i)	20 neutrons	…	3
	(ii)	18 electrons	…	3
(b)	named solvent e.g. hexane, cyclohexane, benxene, toluene etc. [non-polar solvent … 3 only]		…	6
(c)	attraction an atom (element) has		…	3
	for a shared pair of electrons		…	3
(d)	h = Planck's constant		…	3
	f = frequency		…	3
(e)	the decomposition of a substance		…	3
	by water		…	3
(f)	specifies the energy level		…	3
	of an electron		…	3
(g)	graphite, diamond, quartz, carborundum etc.	**any two**	…	2×3
(h)	complete:	$Ca(OH)_2 + H_2$	…	3
	Balance:	$Ca + 2H_2O$	…	3
(i)	nickel		…	3
	manganese		…	3

QUESTION 7 (continued)

(j) M_r of $CaCO_3$ = 100 … 3

40 … 3

(k) heat change … 3

when a reaction takes place according to a given chemical equation / when the number of moles indicated in the balanced equation react completely … 3

(l) Mg Zn Fe Cu … 2×3

[all in reverse order / 3 consecutively correct … 3]

(m) alters (changes) the rate … 3

of a reaction / is not used up in the reaction … 3

(n) functional group … 3

two alkyl groups (one hydrogen and one alkyl group) … 3

(o) nitro … 3

benzene / phenyl … 3

[$C_6H_5NO_2$ … 3]

QUESTION 8

(a) **Define (4×3)**

(i) *(atomic number)*

number of protons … 3
in the nucleus (atom) … 3

(ii)*(atomic orbital)*

region (space) around the nucleus … 3
where electrons are most likely to be found … 3

[path the electron takes around the nucleus … 3]

Sketch (3) dumb-bell shape … 3

Identify (2×3)

Silicon … 3
sodium ion (Na^+) … 3

(b) **Explain (4×3)**

(i) *(R.A.M.)*

mass of an atom … 3
compared with $\frac{1}{12}$ th of the mass of the carbon atom … 3

(ii)*(isotope)*

atoms of the same element / with same atomic number … 3
that have different mass numbers
(atomic mass / no. of neutron) … 3

Calculate (4×3)

80 × 20 (1600) … 3

10 × 21 (210) 10 × 22 (220) … 3

2030 … 3

20.3 … 3

(c) What (2×3)

(1^{st} I.E.)

energy required to remove the first (most loosely bound) (outermost) electron … 3

from a neutral (isolated) (gaseous) atom … 3

Give (6)

increase in atomic radius

screening effect of inner electrons **any one** … 6

Explain (3×3)

(K lower 1^{st} I.E. than Ca)

outer electron in K (Ca) farther from (closer to) the nucleus /
larger (smaller) atomic radius /
lower (higher) number of protons in the nucleus (nuclear charge)/
full sub-shell in Ca and more energy required (extra stability) /
not full sub-shell in K and less energy required (less stable) /

(K higher 2^{nd} I.E. than Ca)

electron removed from full (half-full) shell (sublevel)

full shell requires more energy (is more stable) /
(half-full sublevel requires less energy (is less stable))

any one … 2×3

2^{nd} correct … 3

QUESTION 9

(a) State (2×3)

(Hess's law) heat for a reaction … 3
independent of the path followed … 3

What (2×3) heat change when one mole … 3
(heat of comb) burned in oxygen (completely)(excess) … 3

Calculate (7×3)

$6C + 6O_2 \rightarrow 6CO_2 \quad \Delta H = -2358$ … 3
$3H_2 + 1½O_2 \rightarrow 3H_2O \quad \Delta H = -858$ … 3
$C_6H_6 \rightarrow 6C + 3H_2 \quad \Delta H = -49$ … 3

$C_6H_6 + 7½O_2 \rightarrow$ … 3

$6CO_2 + 3H_2O$ … 3

$\Delta H = -3265$ kJ mol^{-1} … 2×3
incorrect / no units (–1)

(b) Write (3×3) Na_2O Al_2O_3 FeO (Fe_2O_3) … 3×3

(i) State (2×3) basic amphoteric basic (amphoteric)
any two … 2×3

Describe (4×3)
Sodium(aluminium) oxide white / crystalline / solid

FeO (Fe_2O_3) black (brown, red) /powder / solid

any two properties for any two compounds … 4×3

(ii) Write (2×3)

$Na_2O + 2HCl \rightarrow 2NaCl + H_2O$
$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
$FeO + 2HCl \rightarrow FeCl_2 + H_2O$
$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

any one complete /LHS … 3
balanced / RHS … 3

QUESTION 10

Define (3×3)

(i) *(base)* proton acceptor … 3

(ii) *(conj pair)* acid and a base / two species … 3
which differ by a proton … 3
[example … 3 only]

Identify (4×3)

NH_3 OH^- … 2×3

OH^- $C_2H_5COO^-$ … 2×3

Write (2×3) NH_3 , NH_4^+ / H_2O , OH^- … 3

OH^- , H_2O / C_2H_5COOH , $C_2H_5COO^-$ … 3

(i) Express (2×3)

M_r of NaOH = 40 / conc (g/l) = 0.09 × 40 … 3

3.6 … 3

(ii) Calculate (3×3)

$pH = -log\,[H^+]$ / $pOH = -log\,[OH^-]$ / $pOH = -log\,[0.09]$
any one … 3

$pOH =$ 1.1 … 3

pH = 12.9 … 3

(iii) Calculate (3×3)

$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$ … 3

$\frac{M_1 \times 9}{1} = \frac{0.09 \times 20}{2}$ … 3

$M = 0.1$ … 3

Explain (5×3)

(i) easier to detect … 3
colour change (end-point) … 3

(ii) to determine the approximate
end-point/ point of neutralisation / volume of acid added … 3

(iii) all chemicals / no chemicals / reaction is … 3
reacts / remain on the sides / complete … 3

QUESTION 11

Explain (4×3)

(i) *(h. series)*	successive members differ / group of compound with	…	3
	by CH_2 / same general formula (functional group)	…	3
(ii) *(fun. gp.)*	atom (group of atoms) which determine / reactive part	…	3
	the chemical properties / of a molecule	…	3
	[correct example … 3]		

(i) (4×3)

Identify	X = ethanol	…	3
	Y = conc. sulphuric acid	…	3
Write	$C_2H_5OH \rightarrow$	…	3
	$C_2H_4 + H_2O$	…	3

(ii) (6, 3×3)

Name	X = alcohols	…	6
Draw	– C – OH	…	3
	remainder correct	…	3
Name	hydroxyl / OH	…	3

(iii) (3×6)

What	addition / bromination	…	6
Give	bromine water (bromine in 1,1,1-trichloroethane)	…	6
Explain	decolourises / clear	…	6

(iv) (3×3)

Name	butene	…	3
Give	any two correct properties	…	2×3

QUESTION 12

Answer any three parts

(a) Define (4×3)

(i) *(ox. agent)* gain … 3
of electrons … 3

(ii) *(red. agent)* loss … 3
of electrons … 3

Identify (2×3, 2×2)

(ox. agent) O_2 … 3
Cl_2 … 3

(red. agent) Ca … 2
KBr / Br^- … 2

(b) State (2×3) *(Faraday's Law)*

mass of element liberated (deposited) … 3
∝ charge (Q)(I×t) (quantity of electricity) / = *zIt* / = *zQ* … 3

[2nd law … 3 max]

Write (2×3) $2Cl^- \rightarrow Cl_2 + 2e^-$ equation … 3
balanced … 3

Calculate (2×3 2×2)

2F (2 × 96 500) produces 1 mole (22.4 litres) of Cl_2 … 3

$Q = I \times t$ / Q = 0.25 × 720 … 3

Q = 180 (180 / 193 000) … 2

vol of Cl_2 = 0.02 litres … 2
incorrect / no units (–1)

(c) Describe (2×3)

pairs of electrons repel each other	…	3
lp:lp > lp:bp > bp:bp	…	3

Sketch (3×3)

three correct shapes with central atom and Hs correct and bond angle / shape stated	…	3×3

State (3)

107^0	…	3

Explain (2×2)

different number of lone pairs	…	2
refer to lp:bp (lp:lp) repulsion	…	2

(d) Define (2×3) *(mole)*

molecular mass / amount of substance	…	3
expressed in grams / which contains same no. of particles as there are in 12 g of carbon (the Avogadro number of particles)	…	3

Calculate (4×3, 2×2)

(i) $n = m / M_r$ (1.65 ÷ 31)	…	3
= 0.053	…	3
(ii) 1 mole P requires 1.5 moles Cl_2 / correct ratio	…	3
0.080	…	3
(iii) 1 mole PCl_3 contains 6×10^{23} molecules	…	2
3.18×10^{22}	…	2