Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scéim Mharcála

Fisic agus Ceimic

Scrúdú na hArdteistiméireachta 2006

Gnáthleibhéal

Marking Scheme

Physics & Chemistry

Leaving Certificate Examination 2006

Ordinary Level

General Guidelines

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

1. In many instances only key words are given, words must appear in the correct context in the candidate's answer in order to merit the assigned marks.

2. Marks shown in brackets represent marks awarded for partial answers as indicated in the scheme.

3. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.

4. 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.

5. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.

6. The context and the manner in which the question is asked and the number of marks assigned to the answer in the examination paper determine the detail required in any question. Therefore, in any instance, it may vary from year to year.

7. Where indicated deduct 1 mark for incorrect/no units.

Question 1

(a) **What is meant by potential energy?**

energy due to // stored // example …3

position // energy // …3

[equation …6]

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

$F = ma$ / $F = 950 \times 6$ …3

5700 (N) …3

(c) **Calculate the work done when a force of 5 N moves an object a distance of 3 m.**

$W = F \times d$ / $W = 5 \times 3$ …3

15 (J) …3

(d) ***What is meant by an ideal gas?***

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

always / exactly / at all temperatures and pressures …3

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

shaving (make-up) mirror / searchlights / floodlights /

torch / headlights / dentist / microscope etc. any one …6

(f) **How would you show that white light is a mixture of colours?**

pass the light through …3

a prism / diffraction grating / spectrometer …3

[example …3]

(g) **The diagram shows waves passing through a narrow opening. Name the phenomenon that takes place.**

diffraction …6

[bending / spreading …3]

(h) **Copy and complete the following statement: "In the photoelectric effect . . . . . are released from the surface of a metal when . . . . . falls on it."**

electrons / charged particles / rays …3

radiation (light) …3

(i) **Fig. 2 shows a 2 μF capacitor connected in parallel with a 6 μF capacitor. Calculate the effective capacitance of the combined capacitors.**

$C = C_1 + C_2$ / $C = 2 + 6$ …3

8 (μF) …3

(j) **State Ohm's law.**

voltage (V) // current (I) // resistance (R) ...3

α I / RI // V ÷ R // V ÷ I …3

(k) **Calculate the number of units (kW h) used by a 2 kW electric fire left on for 3 hours.**

2 × 3 …3

6 (kW h) …3

(l) **Draw a diagram showing the magnetic field pattern due to a current flowing in a straight conductor.**

conductor showing current …3

circles (with arrows) …3

(m) **State one of the laws of electromagnetic induction.**

emf / current …3

α change of magnetic flux / opposes the change …3

(n) **Who discovered the equation $E = mc^2$?**

Einstein …6

(o) **Explain the term nuclear fission.**

nuclei / atoms / elements …3

split up …3

[example …3]

Question 2

***(a)* Define (i) velocity**

rate of change // change of displacement // speed // $s \div$ …3

of displacement // w.r.t. time // in a given direction // t …3

(ii) acceleration.

rate of change / change in velocity (speed) / $\underline{v - u}$ …3

of velocity (speed) / w.r.t. time / t …3

[$F = ma$ / units …3]

An ostrich starting from rest reaches a speed of 18 m s^{-1} in 3 seconds.
Calculate (i) the acceleration of the ostrich

$a = (v - u) \div t$ / $a = (18 - 0) \div 3$ …6

6 (m s^{-2}) …3

(ii) the distance covered by the ostrich in 3 second

$s = ut + \frac{1}{2}at^2$ / $s = 0 + \frac{1}{2}(6)(3)^2$ …6

27 (m) …3

(iii) the time taken for the ostrich to cover 20 m.

$20 = 0 + \frac{1}{2}\square t^2$ / 2.6 (s) …3

***(b)* State the principle of the conservation of momentum.**

momentum before / $m_1u_1 + m_2u_2$ // total …6

equals / = // momentum …3

momentum after / = $m_1v_1 + m_2v_2$ // remains constant …3

[in a closed system …3]

Sphere B is at rest and sphere A is approaching it with a velocity of 5 m s^{-1}.
The mass of each sphere is 2 kg. After the collision both spheres move in the same direction and the velocity of sphere A is 1.5 m s^{-1}. Calculate
(i) the momentum of sphere A before the collision

$p = m \times v$ / $p = 2 \times 5$ …3

10 (kg m s^{-1}) …3

(ii) the velocity of sphere B after the collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ / (2) (5) + 0 = (2)(1.5) + (2) v_2 …3

3.5 (m s^{-1}) …3

(iii) the momentum of sphere B after the collision.

P = (2) (3.5) / 7 (kg m s^{-1}) …3

What type of energy is lost by sphere A in the collision?

kinetic / heat / sound …6

Question 3

State the laws of refraction of light.

I incident ray, normal, refracted ray …3

on the same plane …3

II sin *i* …3

α sin r …3

[sin *i* ÷ sin *r* …3]

Copy the diagram and label (i) the angle of incidence *i*, (ii) the angle of refraction *r*.

first angle correct …6

second angle correct …3

[correct rays indicated …3]

Describe an experiment to show how a ray of light passes through a glass block.

draw the outline of the glass block

mark incident ray

mark emergent ray

remove the glass block

draw the incident ray

draw the emergent ray

join the incident and emergent rays 1st correct point …6

two additional points …2×3

Calculate the refractive index of the glass.

n = sin i ÷ sin r / = (sin 30^o) ÷ (sin 19^o) / = (0.5) ÷ (0.3256) …6

1.5 …3

Name the type of lens shown.

convex / converging …3

Copy and complete the diagram showing the paths of the rays after they pass through the lens.

show rays bending as they pass through the lens …3

show rays meeting at a point …3

Give one use of this type of lens.

camera / telescope / microscope / spectacles etc **any one** …6

[use of curved mirror …3]

Draw a ray diagram showing how a lens can form a magnified image.

lens …3

object …3

two correct rays …3

Question 4

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

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

Describe an experiment to verify Boyle's law.

Apparatus: pressure gauge // J tube
pump / plunger // mercury
enclosed volume of air any two …2×3

Method: correct arrangement
read pressure (p)
read volume (V)
vary pressure
repeat (for different values) // any valid precaution any three …3×3

The balloon contains 2 m^3 of helium gas when the pressure is 100 kPa. The balloon reaches a height where the pressure is 50 kPa. Calculate the volume of the balloon at this height.

$p_1V_1 = p_2V_2$ / $100 \times 2 = 50 \times V_2$ …3
4 (m^3) …3
[1 m^3 …3]

What happens to the volume of the balloon as it continues to rise?

increases 3

***(b)* "Two <u>fixed points</u> and a <u>thermometric property</u> are needed to set up a temperature scale." Explain the underlined terms.**

freezing and boiling points …3

changes …3
with temperature (heat) …3

What are the values of the fixed points on the Celsius scale?

0^oC …3
100^oC …3

Give <u>one</u> example of a thermometric property.

length / emf (voltage) / colour / volume / pressure/ resistance etc. any one …6

Describe an experiment to mark the position of the lower fixed point on a mercury thermometer.

Apparatus: mercury thermometer / beaker / ice any two …2×3

Method: place thermometer in ice
wait until mercury has stopped moving
mark the position of the mercury any two …2×3
[steam point …(−3)]

Question 5

(*a*) Copy and complete the following statement of *Coulomb's law*:
"The force between two point charges is directly proportional to the . . . . . of the charges and inversely proportional to the . . . . . of the . . . . . between them."
product
square
distance 1st correct …6
remaining two …2×3

Draw a labelled diagram of a gold leaf electroscope.
cap / leaves / case / metal rod / insulating plug 1st correct ..6
two additional parts …3
[no labels (−1)]

Give <u>one</u> use for a gold leaf electroscope.
detect charge / show size (type) of the charge / measure p.d. /
test if an object is an insulator or conductor etc. …6

Name a suitable material for the handle. What will be observed as the charged disc brought close to an uncharged electroscope?
any named insulator e.g wood / plastic etc.
leaves will separate (rise) 1st correct …6
2nd correct …3

(b) "An electric current is a flow of charge in a circuit." Give <u>two</u> ways of increasing the current in a circuit.
reduce the resistance / adjust the rheostat
increase the p.d. 1st correct …6
2nd correct …3

Name a device used to measure electric current.
ammeter …3

In diagram A the resistors are arranged *in series*.
How are the resistors arranged in diagram B?
parallel …9

Calculate the effective resistance of the combined resistors.
one correct equation / substitution …6
(i) **A** $R = R_1 + R_2$ / $R = 6 + 12$
(ii) **B** $1/R = !/R_1 + 1/R_2$ / $1/R = 1/6 + 1/12$

18 (ohms) …3
4 (ohms) …3
[18 (ohms) only …6]

Question 6

***(a)* Describe an experiment to measure the acceleration due to gravity, *g*.**

apparatus: pendulum /string / stand / cork / ruler / timer //
electromagnet / ball / stand / ruler / timer — 1st correct …6
two additional parts …2×3

method: arrangement of apparatus
set the pendulum swinging // release the ball
measure the length / height
time the oscillations // time for ball to fall
correct equation — any three …3×3

What do the symbols *G*, *M* and *r* stand for?
Gravitation constant
mass
distance / radius — 1st correct …6
remainder …2×3

***(b)* The diagram shows part of the electromagnetic spectrum in order of increasing <u>wavelength</u>. Explain the underlined term.**
distance …3
between two crests (troughs) …3

Give <u>two</u> properties common to all regions of the electromagnetic spectrum.
speed / reflection / refraction / polarisation / diffraction / interference, etc
1st correct …9
2nd correct …3

Name the regions labelled (i) A, (ii) B.
(i) ultra violet (ii) infra red — 1st correct …6
2nd correct …3

[reverse order …3]

How would you detect the radiation found at A?
causes substances to fluoresce / effects photographic plates /
causes sunburn / causes photoemission etc — any one …6

Question 6 (continued)

***(c)* What is meant by a.c.?**

alternating …3
current …3

The diagram shows a transformer which converts a 230 V a.c. supply into 4600 V a.c. Name the parts labelled A, B, C.

(i) **A** primary
(ii) **B** core/ frame / structure
(iii) **C** secondary 1st correct …6
remaining two …3

[coil for A / C…3]

If part A has 1500 turns calculate the number of turns on part C.

$N_s/N_p = V_s/V_p$ / $N_s/ 4600 = 1500 / 230$ …6
30 000 …3

Name <u>one</u> device that uses a transformer.

battery charger / TV etc …6

Why does a transformer become warm during use?

energy / eddy currents / heat etc. …3

***(d)* "<u>Ionisation</u> can be caused by the radiations emitted from <u>radioactive</u> substances." Explain the underlined terms.**

loss of // formation …3
electrons // of ions …3

decay (disintegration) …3
of nuclei (atoms) …3

Name the radiation emitted from radioactive substances which causes the greatest amount of ionisation? Give <u>one</u> other property of this radiation.

alpha
low penetrating power / helium nucleus / charge of +2 etc 1st correct …6
2nd correct …3

Give <u>two</u> uses for radioactive substances.

medical / cancer / carbon dating / detecting leaks / smoke detectors etc
1st correct …9
2nd correct …3

QUESTION 7

(a) What is an isotope?

same number of protons/ same atomic number/ atoms of the same element …3
different number of neutrons / different mass number …3
[reverse …3]

(*b*) Name the <u>two</u> elements found in a molecule of methane.

carbon …3
hydrogen …3

(*c*) In the equation $E = hf$, what does f represent?

frequency …6

***(d)* Name the type of bonding which exists between the particles in a salt crystal.**

ionic …6
[chemical …3]

(*e*) Define *electronegativity*.

attraction // EN difference …3
for electrons // > 1.7 …3
[determines the type of bond formed …3]

(*f*) Calculate the percentage of carbon by mass in methanol (CH_3OH).

$M_r = 12 + 4 + 16$ / $M_r = 32$ …3
% C = 37.5 …3

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

heat / energy // ΔH …3
taken in // negative …3

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

heat change …3
independent of the path …3

(*i*) Give <u>one</u> example of a *weak acid*.

vinegar / ethanoic (acetic) acid / carbonic acid / organic acid etc. …6
[definition / orange (lemon) juice …3]

(*j*) Calculate the pH of a 0.01 M solution of hydrochloric acid (HCl).

$pH = -\log_{10}[H^+]$ / $pH = -\log_{10}[0.01]$ …3
2 …3

(*k*) List the following elements in their order in the electrochemical series.

potassium zinc copper …6

[reverse / any one correct …3]

(*l*) Give <u>two</u> uses of *electrolysis*.

electroplating / extraction of metals / purification of metals /

anodising / manufacture of chemicals etc any two …2×3

(*m*) The relative molecular mass of oxygen gas (O_2) is 32.
Calculate the number of molecules in 64 g of oxygen gas.

2 moles …3

12×10^{23} molecules …3

(*n*) Give <u>one</u> example of a neutral oxide.

carbon / nitrogen // dinitrogen …3

monoxide // oxide …3

(*o*) Give <u>one</u> example of an aromatic compound.

benzene / methylbenzene (toluene) / phenol / benzoic acid /

benzaldehyde etc. any one …6

Question 8

Sketch the shape of (i) an s-orbital, (ii) a p-orbital.
(i) spherical shape (shown / stated)

(ii) dumb-bell shape (shown / stated) 1st correct …9

2nd correct …3

[reverse …6]

Name <u>two</u> other subatomic particles.
proton

neutron 1st correct …9

2nd correct …3

Give the electronic (s, p) configuration of (i) neon, (ii) chlorine.
(i) $1s^2$

$2s^2\ 2p^6$

(ii) $1s^2\ 2s^2$

$2p^6\ 3s^2\ 3p^5$ 1st correct …6

2nd correct …3

[any two parts correct …2×3]

Will the element neon form a bond with other elements?
Give <u>one</u> reason for your answer.
No …3

it has a full outer shell / all valencies are satisfied / stable / inert gas / noble gas …3

Name the type of bond in a molecule of chlorine.
covalent …3

Give <u>two</u> properties of this type of bond.
liquids or gases / poor conductors of heat / poor conductors of electricity /

insoluble in water / slower reactions / shares electrons / weak bond etc.1st correct …6

2nd correct …3

Draw a diagram showing how this bond is formed in a molecule of chlorine.
two atoms …3

one pair of shared electrons / single bond …3

Give (i) the formula for the chloride of carbon
(ii)the shape of a molecule of the chloride of carbon.
(i) CCl_4

(ii) tetrahedral 1st correct …6

2nd correct …3

Question 9

Define (i) a base, (ii) a conjugate acid-base pair, using the Brønsted-Lowry theory.

(i) proton // pH between 7 - 14 // high pH …6
acceptor …3
[example not in the question …3]

(ii) acid and a base (two species) which differ by a proton /
example not in the question …3

Identify <u>two</u> bases and <u>one</u> acid-base pair in the following reaction:

bases: H_2O and HSO_4

conjugate pairs: H_2SO_4 and HSO_4 / H_2O and H_3O^+ 1st correct …9
2nd correct …6
3rd correct …3

Water is an <u>amphoteric</u> substance. Explain the underlined term.

acts as an acid …3

or a base …3

Give the chemical formula for an oxide of each of these elements.

sodium magnesium sulphur

Na_2O / Na_2O_2

MgO

SO_2 / SO_3 1st correct …6
remaining two …3

From these oxides, name (i) an acidic oxide, (ii) a basic oxide.

(i) SO_2 / SO_3

(ii) Na_2O / Na_2O_2 / MgO 1st correct …9
2nd correct …3

[reverse order …6]

Describe a test to find out if an oxide is acidic or basic.

add indicator

observe colour change 1st correct …6
2nd correct …3

Question 10

In a titration, a student used a <u>standard solution</u> of hydrochloric acid (HCl) to find the <u>concentration</u> of a potassium hydroxide (KOH) solution. Explain the underlined terms.

s. solution: molarity / concentration
known
conc: amount / moles / grams present — 1st correct …6
remainder …2×3

Name the pieces of glassware labelled (i) A, (ii) B.
burette / tap funnel
pipette — 1st correct …9
2nd correct …3
[reverse order …6]

Describe the procedure used in preparing A to hold the acid.
place in (retort) stand / wash with water / wash with acid /
close the tap / fill (using a funnel) etc — 1st correct …6
2nd correct …3

Explain how 20 cm^3 portions of the potassium hydroxide solution can be accurately measured out.
pipette filler / fill pipette with base / no air bubbles /
meniscus / level with the mark /
allow base to run into flask /
don't blow out the last drop etc. — 1st correct …6
2nd correct …3

Why is an indicator used in a titration?
show end-point / show point of neutralisation etc …3

Name a suitable indicator for this titration.
a named indicator …6

Give <u>one</u> precaution taken to improve the accuracy of the titration.
add the acid slowly (drop-wise) / white tile /
swirl the flask / read bottom of the meniscus /
wash sides of flask / three accurate titrations /
rinse pipette with water (base) — any one …6
[rough titre …3]

Calculate the molarity of the potassium hydroxide solution.

$\frac{V_1 \times M_1}{n_1}$ / $\frac{17.5 \times 0.15}{1}$ …3

$\frac{V_2 \times M_2}{n_2}$ / $\frac{20 \times M_2}{1}$ …3

$M_2 = 0.13$ (M / moles per litre (dm^3)) …3

Question 11

The gas ethyne (acetylene) (C_2H_2) is an <u>unsaturated</u> <u>hydrocarbon</u>.
Explain the underlined terms.

unsaturated: double / triple …3
bonds …3
[not all valencies satisfied …3]

hydrocarbon: carbon …3
hydrogen compound (only) …3
[named example …3]

Describe a chemical test to show that ethyne is unsaturated.

decolourises
bromine / potassium permanganate 1st correct …9
2nd correct …3

Draw the structural formula of ethyne (C_2H_2).

correct functional group
H's attached (implied) 1st correct …6
2nd correct …3

Name the homologous series to which ethyne belongs.

alkynes …6

Name another homologous series of 'unsaturated hydrocarbons'.

alkenes / aromatic …6
[saturated organic compound …3]

Carbon dioxide is produced when ethyne reacts with oxygen.
Name the other substance produced during this reaction.

water …6

Write an equation to show this reaction.

$C_2H_2 + O_2 = CO_2 + H_2O$ …6
[any one correct …3]

Describe a test for the presence of carbon dioxide gas.

limewater
turns milky 1st correct …6
2nd correct …3

Question 12

(*a*) Define (i) oxidation, (ii) reduction, in terms of electron transfer.

(i) loss

(ii)gain — 1st correct …6; 2nd correct …3

of electrons …3

[reverse order …9: gain / loss of oxygen …3]

State the substance oxidised in <u>each</u> the following reactions:

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

$$\mathbf{2KI + Cl_2 \rightarrow 2KCl + I_2}$$

hydrogen

KI — 1st correct …6; 2nd correct …3

[reverse …6]

Copy, complete and balance the following reaction of calcium with hydrochloric acid:

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

$CaCl_2$

H_2 — 1st correct …6; 2nd correct …3

[incorrect subscript / not balanced (−1)]

Identify the oxidising agent in this reaction.

HCl 3

(*b*) What is the purpose of a catalyst?

alters …3

the rate of the reaction …3

Name a suitable catalyst for this reaction.

manganese dioxide …6

Write a balanced equation for the reaction.

$2H_2O_2 \rightarrow 2H_2O + O_2$ — any one part correct …6; remainder …3

How would you identify the gas produced?

relights

glowing splint — 1st correct …6; 2nd correct …3

Give <u>one</u> use for the gas produced.

hospitals / mountain climbing / diving etc …3

Question12 (continued)

(*c*) Define heat of combustion.

heat change
one mole
burned

1st correct …6
remainder …3

Propane (C_3H_8) is a gas used as a camping fuel. Propane burns in air and the equation for the reaction is:

$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)} \quad \Delta H = -2220 \text{ kJ mol}^{-1}$$

Calculate:(i) the quantity of heat released in the combustion of *two* moles of propane

2×2220 / 4440

(ii) the number of moles of oxygen needed for the combustion of *two* moles of propane

2×5 / 10

(iii) the quantity of heat released in the combustion of 22 g of propane.

1110

[M_r = 44 / 0.5 mole …6]

1st correct …12
2nd correct …9
remainder …3