Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scéimeanna Marcála	Scrúduithe Ardteistiméireachta, 2007
Fisic agus Ceimic	**Ardleibhéal**

Marking Scheme	Leaving Certificate Examination, 2007
Physics and Chemistry	**Higher Level**

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Introduction

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

Any eleven parts

(a) Define displacement.

distance …3

in a particular direction …3

(b) A car moving with a velocity of 20 m s^{-1} stops in a distance of 50 m. Calculate the acceleration of the car.

$v^2 = u^2 + 2as$ /0 = $20^2 + 2a50$ …3

a = (–) 4 (m s^{-2}) …3

(c) What is potential energy?

energy due to its position or condition …6

[$E_p = mgh$ / example …3]

(d) An object is placed inside the focus of a concave mirror. Describe the image formed by the mirror.

virtual, upright, magnified, laterally inverted, behind the mirror any one…6

(e) Figure 1 shows a waveform. Name the quantities marked A and B.

wavelength / λ …3

amplitude …3

(f) Under what circumstances does constructive interference of waves occur?

two or more waves meet …3

in phase …3

(g) The temperature inside a freezer is –15 °C. What is the absolute temperature inside the freezer?

273 …3

258 (K) …3

(h) What is the thermometric property of a constant volume gas thermometer?

pressure …6

(i) State Boyle's law.

fixed mass of gas, at constant temperature, …3

pressure (p), inversely proportional to volume ($\propto 1/V$) …3

[two correct expressions / $pV = k$ / $p_1V_1 = p_2V_2$ …3]

(j) Calculate the effective capacitance of the arrangement shown in Figure 2.

parallel = 6 (μF). …3

series = 3 (μF) …3

[one correct equation …3]

(k) A pear-shaped conductor is placed on an insulated stand as shown in Figure 3. Copy the diagram and show how the charge is distributed over the conductor when it is positively charged.

concentration of positive charge at pointed end …3

low density of positive charge at other end …3

(l) **Figure 4 shows current flowing through a solenoid. Copy the diagram and draw the magnetic field pattern around the solenoid.**

loops showing magnetic field …3

arrows showing direction of magnetic field …3

(m) **Name one way to reduce energy loss in a transformer.**

laminate the core, reduce resistance of wires, use soft iron core, wind coils closely, etc.

…6

(n) **Give two properties of gamma radiation.**

high energy photons, high frequency, very short wavelength, very penetrating, travels at speed of light, poor ionising ability etc.

[use …0] any two…2 × 3

(o) **The half-life of polonium-210 is 138 days. When will the activity of a sample of polonium-210 reduce to 25% of its original value?**

two half-lives …3

276 days …3

[$T_{1/2}$ = 138 days …3]

Question 2

Define the term force. **2×3**

causes a body // push or pull //gives a mass of 1 kg // $F = ma$ …3

to accelerate // which changes state of rest or uniform motion //an acceleration of 1 m s^{-2}

// explain the terms …3

State Newton's law of gravitation. **3×3**

force is proportional to // $F \propto m_1 m_2$ / $F = Gm_1 m_2$ …3

the product of the masses // $\div r^2$ …3

and inversely proportional to the square of the distance between them // explain terms …3

Derive the relationship between *G*, the gravitational constant and *g*, the acceleration due to gravity. **4×3**

$$F = G\frac{Mm}{r^2}$$ …3

$$F = mg$$ …3

$$mg = G\frac{Mm}{r^2}$$ …3

$$g = G\frac{M}{r^2}$$ …3

Why does the value of *g* vary at different locations on the earth? **3**

distance between centre of earth and an object changes / earth not a true sphere …3

Describe an experiment to measure the acceleration due to gravity, *g*. **6×3**

timer, electromagnet, ball // pendulum, cork/support, stopwatch …3

measure distance, *s* // measure length of pendulum, *l* …3

allow ball to free fall // allow pendulum to perform 10 or more oscillations …3

record the time, *t*, for fall // determine time, *T,* for one oscillation …3

graph *s* versus t^2 / $s = \frac{1}{2}gt^2$ // graph *l* versus T^2 / $T = 2\pi\sqrt{\frac{l}{g}}$ …3

$g = 2 \times$ slope / repeat and average g // $g = 4\pi^2 \times$ slope / repeat and average g …3

(i) Using the relationship between *g* and *G*, calculate the mass of the earth. **6, 3**

$$9.81 = 6.67 \times 10^{-11}\frac{M}{\left(6.38 \times 10^6\right)^2}$$ …6

$M = 5.99 \times 10^{24}$ kg …3

incorrect units/no units (–1)

(ii) Calculate the volume of the earth, assuming it is a sphere. **2×3**

$V = \frac{4}{3}\pi r^3 / \frac{4}{3}\pi\left(6.38\times10^6\right)^3$ …3

$V = 1.09\times10^{21}\ \text{m}^3$ …3

incorrect units/no units (–1)

(iii) Hence calculate the average density of the earth. **3**

$\rho = \frac{m}{V}$ / $\rho = \frac{5.99\times10^{24}}{1.09\times10^{21}} / 5495.41\ \text{kg m}^{-3}$ …3

incorrect units/no units (–1)

Question 3

State Snell's law of refraction. **2×3**

sine of angle of incidence // sin i // sin $i \div$ sin r …3

is proportional to sine of angle of refraction // $\propto \sin r$ // = constant …3

Describe an experiment to verify Snell's law using a glass block. **6×3**

glass block, ray box / pins, drawing paper …3

correct arrangement shown or stated …3

incident and emergent rays obtained …3

draw normal and refracted ray …3

measure i and r …3

graph of sin i versus sin r is a straight line through origin // repeat and sin $i \div$ sin r = constant …3

How is the refractive index of the glass obtained from the experiment? **3**

slope of graph is refractive index // sin $i \div$ sin $r = n$ …3

Explain (i) critical angle **2×3**

angle of incidence …3

corresponding to angle of refraction of 90º …3

[one correct reference to the density of the medium is necessary]

(ii) total internal reflection. **2×3**

when angle of incidence …3

exceeds the critical angle …3

A ray of light travels through a semicircular glass block, as shown in Figure 5.

(iii) Describe what happens to the ray of light when it enters the glass block at X. **3**

the ray is not deflected / slows down / not refracted etc any one …3

(iv) If the refractive index of the glass is 1.48, calculate the value of the angle B when angle A is 35º. **2×3**

$n = \dfrac{\sin i}{\sin r}$ / $1.48 = \dfrac{\sin B}{\sin 35}$ …3

(sin B = 0.8489)

B = 58.09º …3

(v) Describe what is observed as the angle A is gradually increased. **3**

angle B increases // angle B reaches 90º // total internal reflection occurs …3

(vi) Calculate the critical angle of the glass. **3×3**

$n = \dfrac{1}{\sin c}$ / $1.48 = \dfrac{1}{\sin c}$ …3

sin C = 0.6757 …3

C = 42.5º …3

(vii) Give two applications of total internal reflection. **2×3**

optical fibres, prisms in binoculars, periscopes, sparkle of gemstones, reflectors on bicycle pedals, rear lights and reflective clothing etc. any two…2×3

Question 4

State Coulomb's law of force between electric charges. **2×3**
force is proportional to the product of the charges / $F \propto Q_1Q_2$ // $F = k\frac{Q_1Q_2}{d^2}$ …3
and inversely proportional to the square of the distance between them //explain the terms …3

What is an electric field? **2×3**
region around a charged body …3
where another charge would experience a force / where it has an effect …3

Figure 6 shows two equal positive charges. Copy the diagram and draw the electrical field pattern around the charges. **2×3**
lines of force …3
showing repulsion …3

The electrostatic force between two identical charges is 0.16 N.
What is the size of the force between the charges when (i) each charge is doubled? **2×3**
4F …3
0.64 N …3

(ii) the distance between the original charges is doubled? **2×3**
¼ F …3
0.04 N …3

Describe how an electroscope is charged negatively. **2×3**
bring a positively charged rod near …3
earth the electroscope, remove rod …3
[touch cap of electroscope with a negatively charged rod …6]

When the zinc is illuminated with ultraviolet radiation, as shown in Figure 7, the leaves of the electroscope collapse. Name this phenomenon. **6**
photoelectric effect …6

Why do the leaves of the electroscope collapse? **2×3**
electrons released …3
from the zinc …3

Why do the leaves not collapse when the electroscope is positively charged and the zinc is illuminated with ultraviolet light? **3**
electrons are attracted back to the electroscope …3

Ultraviolet light of wavelength 254 nm is used in this experiment.
Calculate: (i) the frequency of the ultraviolet radiation; **3×3**
$c = f \times \lambda$ …3
$3\times10^8 = f \times 254 \times 10^{-9}$ …3
$f = 1.18 \times 10^{15}$ Hz …3
incorrect units/no units (–1)

(ii) the energy of a photon of the ultraviolet radiation. **2×3**
$E = hf$ / $E = (6.67 \times 10^{-34})(1.18 \times 10^{15})$ …3
$E = 7.87 \times 10^{-19}$ J …3
incorrect units/no units (–1)

Question 5

State Ohm's law. **2×3**

current is proportional to potential difference // $V \propto I$ / $V = RI$, R constant …3

at constant temperature …3

Define the ampere, the unit of electric current. **3×3**

two infinitely long parallel conductors …3

one metre apart in a vacuum …3

exerts a force of 2×10^{-7} N per metre …3

How would you show that a current-carrying conductor in a magnetic field experiences a force?

4×3

battery / d. c. power supply, conductor, magnet …3

correct arrangement of apparatus shown or described …3

switch on current …3

observe conductor moves …3

Draw a labelled diagram of the apparatus used in the experiment. **3×3**

container, thermometer, d.c. supply, heating coil, ammeter and rheostat …6×1

correct arrangement …3

How was the current changed during the experiment? **3**

by adjusting the rheostat …3

D**raw a suitable graph on graph paper to show that the rise in temperature is proportional to the current squared.** **5×3**

I^2/A^2	0.16	0.25	0.36	0.49	0.64	0.81	1.0
$\Delta\theta/°\text{C}$	1.2	1.9	2.6	3.6	4.5	5.7	7.0

values for I^2 …3

axes labelled correctly …3

correct scales …3

five points plotted correctly ..3

suitable straight line through the origin …3

[graph paper not used …deduct 6]

A kettle attached to a 230 V supply has a power rating of 2.5 kW.
Calculate (i) the current flowing **2×3**

$P = VI$ / $2500 = 230I$ …3

$I = 10.87$ (10.9)A …3

incorrect units/no units (–1)

(ii) the resistance of the heating coil in the kettle. **2×3**

$P = RI^2$ / $2500 = R\ (10.87)^2$ // $V = RI$ / $230 = R \times 10.87$ …3

$R = 21.16$ (21.04) Ω …3

incorrect units/no units (–1)

Question 6 (a)

Define momentum. **2×3**

product of mass // $m\times$ …3

and velocity // v …3

State the principle of conservation of momentum. **2×3**

in a closed system / where no external force acts …3

total momentum is constant / momentum before = momentum after / $m_1u_1+m_2u_2=m_1v_1+m_2v_2$ …3

Trolley A (mass 0.50 kg) moving with constant velocity travels 15.2 cm every 0.2 s and collides with another trolley B (mass 0.45 kg) which is at rest. After the collision the two trolleys move together at constant velocity travelling 8.0 cm every 0.2 s.

Calculate(i) the initial velocity of trolley A **2×3**

$v = \frac{s}{t}$ / $v = \frac{0.152}{0.2}$ …3

0.76 m s^{-1} / 76 cm s^{-1} …3

incorrect units/no units (–1)

(ii) the combined velocity of trolleys A and B after the collision. **3**

0.4 m s^{-1} / 40 cm s^{-1} …3

incorrect units/no units (–1)

Show how these values verify the principle of conservation of momentum. **2×3**

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$ // $0.5 \times 0.76 + 0.45 \times 0 = 0.95 \times 0.40$ …3

0.38 (kg m s^{-1}) = 0.38 (kg m s^{-1}) …3

In the collision kinetic energy is lost. What happens to the lost kinetic energy? **6**

converted to sound / vibration / heat …6

Question 6 (b)

State two assumptions of the kinetic theory of gases. **2×3**

A small quantity of a gas has a very large number of molecules,
the molecules are in constant (rapid) (random) motion, all collisions are elastic,
the molecules collide with each other and the walls of the container,
time spent colliding is small compared to the time in between collisions,
there are no forces between the molecules (except during collisions) any two…2×3

Describe how Brownian movement can be demonstrated. **3×3**

smoke cell, microscope, light source …3

correct arrangement of apparatus shown or described …3

observation …3

What is an ideal gas? **2×3**

a gas that obeys the gas laws / Boyle's law …3

at all temperatures and pressures …3

What happens to the molecules of a gas as its temperature increases? **3**

they move faster / they gain kinetic energy …3

A sample of helium gas contains 0.2 moles and has a volume of 2.5 litres at a pressure of 2.0×10^5 N m^{-2}. What is the temperature of the helium gas? **3×3**

$PV = nRT$ …3

$2.0 \times 10^5 \times 2.5 \times 10^{-3} = 0.2 \times 8.3 \times T$ …3

$T = 301.2$ K …3

incorrect units/no units (–1)

Question 6 (c)

State Faraday's law of electromagnetic induction. **2×3**

induced emf / current, proportional to, …3

rate of change, of magnetic flux / field …3

[any two ..3]

Figure 8 shows an a.c. generator. Name the parts labelled A and B. **2×3**

A = slip ring …3

B = brush …3

Draw a graph to show the variation of the output voltage from the generator with time. **3, 6**

correctly labelled axes …3

sine wave …6

State how the output voltage from the generator changes:

(i) as the coil is turned more slowly **6, 2×3**

voltage decreases

(ii) if a stronger magnet is used

voltage increases

(iii) if more turns of wire are used in the coil.

voltage increases 1st correct …6

remainder …2×3

Question 6 (d)

Distinguish between nuclear fission and nuclear fusion. **4×3**

a (large) nucleus …3

splits into two (smaller) nuclei …3

two (small) nuclei …3

join to form a (larger) nucleus …3

Identify the isotope X in the following nuclear equation. **3×3**

$${}^{235}_{92}\mathbf{U} + {}^{1}_{0}\mathbf{n} \rightarrow {}^{141}_{56}\mathbf{Ba} + {}^{92}_{36}\mathbf{X} + 3\,{}^{1}_{0}\mathbf{n} + \text{energy}$$

X = Kr / krypton …9

[a = 92 …3 ; b = 36 …3]

The following nuclear reaction occurs in the sun. $${}^{2}_{1}\mathbf{H} + {}^{1}_{1}\mathbf{H} \rightarrow {}^{3}_{2}\mathbf{He} + \text{energy}$$

Show that there is a loss of mass in this nuclear reaction and hence calculate the energy released when one He-3 nucleus is formed. **4×3**

mass of reactants $1.673 \times 10^{-27} + 3.345 \times 10^{-27} = 5.018 \times 10^{-27}$ kg …3

the mass on right is less / 5.010×10^{-27} kg / $5.018\ 10^{-27} - 5.010 \times 10^{-27} =$ 8.0×10^{-30} (kg) …3

$E = mc^2$ / $E = 8.0 \times 10^{-30} \times (2.998 \times 10^{8})^2$ …3

$E = 7.1904 \times 10^{-13}$ J …3

incorrect units/no units (–1)

Question 7

(a) What are isotopes?
atoms with the same number of protons / same atomic number / of the same element …3
and different numbers of neutrons / different mass number …3

(b) Identify the ion that has 23 electrons and 26 protons.
iron …3
3+ …3

(c) Define relative atomic mass.
mass of an atom compared with …3
one twelfth of the mass of carbon-12 (isotope) …3

(e) Explain in terms of bonding why metals are good conductors of electricity.
electrons …3
valence / cloud / are free to move …3

(e) Select the molecule which has a dipole moment.
NH_3 …6

(f) Calculate the percentage by mass of oxygen in ethanoic acid (CH_3COOH).
$M_r = 60$ …3
53.33% …3

(g) Define electronegativity.
relative attraction of an atom for …3
the shared pair of electrons …3

(h) Identify two conjugate acid-base pairs in the following reaction:

$$\mathbf{H_2SO_4 + HF \rightleftharpoons HSO_4^- + H_2F^+}$$

H_2SO_4 and HSO_4^- …3
HF and H_2F^+ …3

(i) According to the Brønsted-Lowry theory, what is a weak acid?
poor proton // not fully …3
donor // dissociated …3

(j) What is meant by an amphoteric oxide? Give an example.
a substance which can act either as an acid or a base …3
water, aluminium oxide (Al_2O_3), zinc oxide(ZnO), iron(III) oxide (Fe_2O_3) any one…3

(k) QCl_3 represents the formula of a covalent chloride where Q represents an element from the third period of the periodic table. Identify Q.
phosphorus, aluminium any one…6
[Sc / B / Ga …3]

(l) When 5 g of sodium hydroxide dissolves in a large quantity of water, 5338 J of energy are released. Calculate the heat of solution of sodium hydroxide.
40 g / 1/8 / 0.125 moles …3
($\Delta H =$) 42704 (J mol^{-1}) …3

(m) Identify each of the functional groups in Figure 9:

(i) ketone / carbonyl group …3

(ii) aldehyde …3

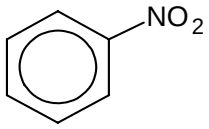
(n) Name the ester formed from methanol and ethanoic acid.

methyl …3

ethanoate …3

[CH_3COOCH_3 …3]

(o) Draw the structure of the nitrobenzene molecule.



benzene ring …3

NO_2 attached …3

[double bonds / ring omitted (-1)]

Question 8 (a)

Explain the terms (i) energy level, (ii) atomic orbital. **4×3**
(i) definite (discrete) (specific) level of energy …3
which an electron has (in an atom) …3

(ii) region in space / around the nucleus / in an atom …3
where there is a high probability of finding an electron …3

(i) How does an electron in an atom become excited? **3**
it gains energy / heat / place in a discharge tube …3

(ii) Why does the electron not remain in the excited state? **3**
it is unstable / temporary / loses energy …3

(iii)What is the relationship between the energy of the excited energy level, the lower energy level and the frequency of the electromagnetic radiation emitted? **6, 3**
$E_2 - E_1$ …6
$= hf \ / \propto f$ …3

(iv) Flame tests on metal salts are based on electron transitions within atoms. What colour do potassium salts give to a Bunsen flame? **3**
lilac / purple …3

(v) Write the electronic (s, p) configuration of the potassium ion, K^+. **9**
$1s^2\ 2s^2\ 2p^6$ …3
$3s^2\ 3p^6$ …3
$[\quad]^+$ …3
$[[2, 8, 8]^+$ …3]

(vi) State the number of energy levels and the number of orbitals occupied by the electrons in the potassium ion, K^+. **2×3**
three energy levels …3
nine orbitals …3

Question 8 (b)

Define the first ionisation energy of an element. **2×3**
energy required to remove the most loosely bound / first / outermost electron …3
from a neutral / gaseous / isolated atom …3

State and explain the general trend in first ionisation energy values down any group in the periodic table. **6, 3**
values decrease down a group …6
due to increasing atomic radius / number of shells / energy levels / screening effect of inner electrons …3

Explain why the second ionisation energy of potassium (3070 kJ mol^{-1}) is significantly greater than its first ionisation energy value (418 kJ mol^{-1}). **6**
second electron is taken from a full 3rd shell / energy level / inner shell …6
[second electron removed from full p-orbital / more stable configuration, one correct (s,p) configuration …3]

Question 9

A <u>standard solution</u> of sulfuric acid was titrated against 25 cm^3 portions of an unknown sodium hydroxide solution.

(a) Explain the underlined term in the above statement. **<u>2×3</u>**

known / accurate / definite …3

concentration …3

(b) Describe how to prepare and fill the pipette to the mark with sodium hydroxide solution. **<u>3×3</u>**

rinse with deionised water,

rinse with sodium hydroxide solution / solution it is to contain (measure),

fill (using suction) above the mark,

adjust until bottom of meniscus lies on the mark any three…3×3

State a precaution to ensure that exactly 25 cm^3 of solution is delivered when the pipette is emptied into the conical flask. **<u>3</u>**

do not blow / shake out the last drop,

allow a few seconds drainage time after pipette empties,

touch tip of pipette gently against the side of the flask any one…3

(c) Why is the titration reaction carried out in a conical flask rather than in a beaker? **<u>3</u>**

it allows swirling of mixture, it prevents splashing, narrow neck etc. any one …3

How is the conical flask prepared for use? **<u>3</u>**

rinse with deionised water only …3

(d) Name an indicator suitable for this titration. **<u>6</u>**

methyl orange / phenolphthalein / litmus etc …6

Justify your choice of indicator and state the colour change expected in the conical flask at the end point. **<u>3×3</u>**

any indicator is suitable / a strong acid and a strong base / sharp colour change at the endpoint /

changes colour in correct pH range / correct for named indicator …3

first colour correct …3

second colour correct …3

[correct colours for named indicator, incorrect order ….3]

(e) Write a balanced equation for the titration reaction between sulfuric acid and sodium hydroxide. **<u>2 × 3</u>**

$H_2SO_4 + 2NaOH$ / $H_2SO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$ …3

$Na_2SO_4 + 2H_2O$ / $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ …3

(f) What is the average volume of the sulfuric acid required to neutralise 25 cm^3 portions of sodium hydroxide solution? **<u>0</u>**

21.15 cm^3 …0

(g) Calculate

(i) the molarity of the sodium hydroxide solution; **3×3**

21.15 …3

$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$ / $\frac{25 \times M_1}{2} = \frac{21.15 \times 0.12}{1}$ …3

$M_1 = 0.203$ M …3

(ii) the concentration of the sodium hydroxide solution in grams per litre (dm^3) **2×3**

$M_r = 40$ …3

$0.204 \times 40 = 8.12$ g/L …3

(iii) the pH of the sodium hydroxide solution. **2×3**

$pOH = -\log_{10}[OH]$ / $pOH = -\log_{10}(0.203)$ / $pOH = 0.69$ …3

$pH = 13.31$ …3

Question 10 (a)

Define in terms of electron transfer (i) oxidation, (ii) reduction. **2×3**
(i) loss of electrons …3
(ii) gain of electrons …3

Place the following metals in order of increasing difficulty of oxidation. **6**
magnesium, zinc, iron, copper …6
[three consecutively correct / reverse order …3]

Write a balanced equation for the reaction which occurs when magnesium is placed in dilute hydrochloric acid. **2×3**
$Mg + 2HCl$ / $Mg + HCl \rightarrow MgCl_2 + H_2$ …3
$MgCl_2 + H_2$ / $Mg + 2HCl \rightarrow MgCl_2 + H_2$ …3

Which element is oxidised in this reaction? **3**
magnesium …3

Why is there no reaction observed when copper is placed in dilute hydrochloric acid? **6**
copper is below hydrogen / Cu less reactive than hydrogen / copper not easily oxidised …6
[Cu low in activity series / hydrogen above copper in activity series …3]

Explain how iron is protected from corrosion by coating it with zinc. **6**
zinc forms a protective coat / prevents oxidation // zinc more easily oxidised …6

Name the two transition metals in the list above. **2×3**
copper …3
iron …3

State two characteristic properties of transition metals. **2×3**
variable valency, form coloured compounds, act as catalysts any two…2 × 3

Question 10 (b)

Figure 11 shows an arrangement used to purify copper by electrolysis. How is electricity conducted through the copper(II) sulfate solution? **3**
by ions …3

Write a balanced equation for the reaction that takes place at the cathode. **2×3**
$Cu^{2+} + 2e^-$ / $Cu^{2+} + e^- \rightarrow Cu$ …3
Cu / $Cu^{2+} + 2e^- \rightarrow Cu$ …3
[$Cu^+ + e^- \rightarrow Cu$ …(6−1)]

Calculate the increase in mass of the pure copper electrode when a current of 8.0 A flows for 30 minutes. **4×3**
$Q = It$ / $Q = 8.0 \times 30 \times 60$ …3
$Q = 14400$ C …3
$n = \frac{Q}{F} = \frac{14400}{96500} = 0.149$ moles electrons …3

(0.149 ÷ 2 = 0.0745 moles copper)
(0.0745 × 63.5 =) 4.73 g …3
incorrect units/no units (–1)

Question 11

Ethane, ethene and ethyne are <u>hydrocarbons</u> which belong to different <u>homologous series</u>. Ethene and ethyne are <u>unsaturated</u>.

(a) Define the underlined terms in the statement above. **<u>6×3</u>**

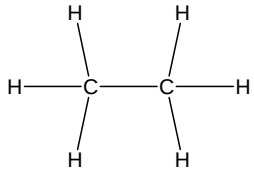
compounds / molecules /substances …3
containing hydrogen and carbon only …3

successive members differ // a group of (organic) compounds / molecules / substances with …3
by CH_2 // the same functional group / general formula …3

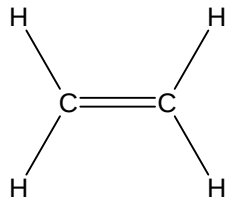
[a common method of preparation, a gradation in physical properties, have the same chemical properties any one...3]

contain at least one double // molecules which undergo // valencies ...3
or triple bond // addition reactions // not all satisfied ...3

(b) Draw the structural formula for each of the three hydrocarbons: ethane, ethene and ethyne. **<u>3×3</u>**



…3



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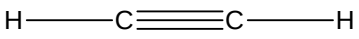


…3

(c) A sample of ethyne gas was prepared using the apparatus shown in Figure 12 by dropping liquid A on to solid B. Identify the substances A and B. **<u>2×3</u>**

water …3
calcium carbide / calcium dicarbide / CaC_2 …3

Write a balanced equation for the reaction between A and B. **<u>2×3</u>**

$CaC_2 + 2H_2O$ / $CaC_2 + H_2O \rightarrow C_2H_2 + Ca(OH)_2$ …3
$C_2H_2 + Ca(OH)_2$ / $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$ …3

Describe a test to verify that ethyne is unsaturated. **<u>3×3</u>**

(bubble ethyne into) bromine / bromine water // (bubble ethyne into) acidified potassium permanganate solution // Bayer test …6
goes colourless / decolourises …3

(d) Identify two products of the following substitution reaction between one mole of ethane and one mole of chlorine: $C_2H_6 + Cl_2 \rightarrow$ **2×3**

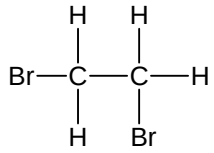
chloroethane / dichloroethane / trichloroethane / hydrogen chloride any two …2×3

What is the essential condition required for this reaction? **3**

UV light …3

(e) Give the name and structural formula for the addition product of bromine and ethene in the following reaction: $C_2H_4 + Br_2 \rightarrow$ **2×3**

1,2-dibromoethane …3



…3

(f) Name the product of the hydration of ethyne at 60 ºC in the presence of sulfuric acid and mercury(II) sulfate in the following reaction: $C_2H_2 + H_2O \rightarrow$ **3**

ethanal …3

Question 12 (a)

When 0.23 g of sodium is dropped into water the following vigorous reaction takes place:

$$Na + H_2O \rightarrow NaOH + \tfrac{1}{2}H_2$$

(i) How many moles of sodium are used? How many atoms are in this mass of sodium? …2×3

$n = \frac{m}{M_r}$ / $n = \frac{0.23}{23}$ / 0.01 (moles) …3

6.0×10^{21} (atoms) …3

(ii) What mass of sodium hydroxide is produced in the reaction? 2×3

$M_r = 40$ …3

$40 \times 0.01 = 0.4$ g …3

incorrect units/no units (–1)

(iii) Calculate the volume of hydrogen gas produced in this reaction at STP. 2×3

$0.01 \times ½ = 0.005$ moles …3

$0.005 \times 22.4 = 0.112$ L / $0.005 \times 22400 = 112$ cm^3 …3

incorrect units/no units (–1)

(iv) Why is sodium metal stored under oil? 4

sodium is very reactive / it reacts easily with air / reacts easily with moisture …4

Question 12 (b)

Methane, ammonia and water are the simplest hydrides of the elements carbon, nitrogen and oxygen, respectively. Which of these hydrides would you expect to have the highest boiling point? Justify your answer. 2×3

water …3

greatest electronegativity difference / greatest polarity / greatest degree of intermolecular bonding / strong hydrogen bonding present / strong forces between the molecules …3

Explain in terms of bonding why methane is insoluble in water while ammonia is very soluble in water. 4×3

methane is non-polar …3

ammonia is polar covalent …3

water is polar covalent …3

there is an attraction between the polar water molecules and polar ammonia molecules / there is no attraction between water molecules and methane molecules / like dissolves like …3

What is the shape of the methane molecule? 2

tetrahedral …2

State the bond angle in the methane molecule. 2

109.5 º …2

Question 12 (c)

Define heat of formation. **2×2**
heat change when one mole of a substance is formed …2
from its elements in their standard states …2

State Hess's law. **2×3**
heat change for a reaction …3
is independent of path …3

Glucose is formed from its elements in their standard states according to the equation:
$6C_{(s)} + 6H_{2(g)} + 3O_{2(g)} \rightarrow C_6H_{12}O_{6(s)}$
Use Hess's law to calculate the heat of formation of glucose. **4×3**

$6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$ / $\Delta H = +2816$ kJ …3
$6C_{(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)}$ / $\Delta H = -2358$ kJ …3
$6H_{2(g)} + 3O_{2(g)} \rightarrow 6H_2O_{(l)}$ / $\Delta H = -1716$ kJ ...3

$\Delta H = -1258$ kJ …3

Question 12 (d)

Figure 13 shows the sodium chloride crystal lattice. Name:
(i) the particles which occupy the lattice points of the crystal; **3**
ions …3

(ii) the type of bonds holding the crystal together. **3**
ionic bonds / electrostatic forces of attraction …3

Give two properties of compounds with this type of crystal structure. **2×5**
Hard / brittle crystalline solids, high melting points, high boiling points, soluble in water,
conducts electricity when molten or in solution, any two…2×5

Diamond and graphite are allotropes of carbon. Explain the difference in the hardness of diamond and graphite in terms of the bonding in their crystal structures. **2×3**
diamond: each carbon atom is bonded to four others // all valencies satisfied //
diamond is harder than graphite …3
graphite: each carbon atoms is bonded to three others // layers are bonded together by
weak van der Waals forces …3

[diamond has strong bonds / graphite has weaker bonds ...3]

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