Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2008

MARKING SCHEME

PHYSICS & 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 **11×6**

(a) Define the unit of work, i.e. *the joule*.

(force) of one newton …3
moves one metre …3
[W = F × s …3]

(b) What force is required to bring a car of mass 650 kg travelling at 20 m s^{-1} to rest in 5 seconds?

$0 = 20 + a5$ / $a = (-)4$ …3
$F = 650 \times 4 = 2600$ (N) …3

(c) What is the relationship between *G*, the gravitational constant and *g*, the acceleration due to gravity?

$g = GM$ …3
$\div r^2$ …3

(d) Why does a dentist use a concave mirror rather than a plane mirror when examining teeth?

forms a magnified image …6

(e) Name the phenomenon shown in Figure 1 and name the colour which appears at X.

dispersion …3
red …3

(f) Define *critical angle*.

angle of incidence …3
corresponding to angle of refraction of 90º …3
[$n = 1 \div Sin\ C$ …3]

(g) Explain the term *diffraction*.

spreading out / bending of a wave …3
as it passes behind an obstacle / through a narrow gap …3
[good diagram 2 × 3]

(h) What is emitted in the photoelectric effect?

electrons …6
[negatively charged particles …3]

(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) Why is it necessary to have a standard thermometer?

different/other thermometers …3
are based on different thermometric properties / register different values at the same temperature …3
[to calibrate other thermometers …6]

(k) A positively charged rod is brought near to an uncharged, insulated metal sphere as shown in Figure 2. Draw a diagram showing the charges induced on the sphere.
negative charges at right hand side near rod …3
positive charges at left hand side …3

(l) Give one use of a capacitor.
to store // to tune // to separate AC // to smooth the output …3
charge/energy // a radio or TV // from DC // from a rectifier …3
[to operate a timing circuit / to light a flash bulb etc. …6]

(m) Explain what happens to the strip of aluminium foil lying between the poles of a horseshoe magnet, as shown in Figure 3, when the switch is closed.
aluminium foil jumps or experiences a force / there is a force on a current carrying conductor in a magnetic field / interaction between the magnetic field of the permanent magnet and the magnetic field created around the conductor when current flows any one …6

(n) How much energy is released when a sample of uranium undergoes a mass loss of 0.002 kg in a nuclear fission reactor?
$E = mc^2 / E = 0.002 \times (2.998 \times 10^8)^2$ …3
$E = 1.798 \times 10^{14}$ joules …3

(o) What is *nuclear fusion*?
two (small / light) nuclei …3
join to make a larger/heavier nucleus / with the release of energy …3

Question 2

Define (i) *acceleration,* (ii) *potential energy*. **2×3, 6**

(i) rate of change // $\frac{v-u}{t}$ …3

of velocity/of speed in a given direction //explain v, u, t …3

(ii) energy due to an object's position / mechanical condition // $E_p = mgh$ + notation explained …6
[$E_p = mgh$/ example ...3]

State the *principle of conservation of energy*. **2×3**
energy is neither created nor destroyed // (total) energy is constant …3
but can be converted from one form into another // in a closed system …3

Discuss the energy conversions that take place as an object falls from a height and strikes the ground. **2×3**
potential energy is // kinetic energy is …3
converted to kinetic energy // converted to sound / heat / vibrational energy …3

Describe an experiment to measure the acceleration due to gravity, *g*. **6×3**
timer, electromagnet, ball, trapdoor // pendulum, cork/support, string, stopwatch …2×3
[any two …3]
correct arrangement …3

measure distance, s // measure length of pendulum, l
allow ball to free fall // allow pendulum to perform 10 or more oscillations
record the time, t, for fall // determine time, T, for one oscillation
graph s versus t^2 & calc $\boldsymbol{g}$ from slope // graph l versus T^2 & calc $\boldsymbol{g}$ from slope

/ $s = \frac{1}{2}gt^2$ / $T = 2\pi\sqrt{\frac{l}{g}}$ any three…3×3

A basketball of mass 0.60 kg which was resting on a hoop falls to the ground 3.05 m below, as shown in Figure 4. What is the maximum potential energy of the basketball? **3×3**
$E_p = mgh$ …3
$E_p = 0.6 \times 9.81 \times 3.05$ …3
$E_p = 17.95$ joules …3
incorrect units/no units (–1)

What is the maximum speed of the ball as it falls? **3×3**
$E_p = E_k = \frac{1}{2}mv^2$ // $v^2 = u^2 + 2gs$ …3
$17.95 = 0.5 \times 0.6 \times v^2$ // $v^2 = 0 + 2(9.81)(3.05)$ …3
$v = 7.74$ ms^{-1} …3
[incorrect units/no units (–1)]

The ball loses 6.15 joules of energy when it bounces off the ground for the first time. Calculate the height of the first bounce. **2×3**
new $E_p = 17.95 - 6.15 = 11.80$ …3
$11.80 = 0.60 \times 9.81 \times h$
$h = 2.00$ m …3
incorrect units/no units (–1)

Question 3

State the *laws of refraction of light.* **4×3**

incident ray, refracted ray and the normal …3

lie in the same plane …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

Give one difference between a real image and a virtual image. **2×3**

formed by the intersection of light rays, formed by the apparent intersection of light rays //

can be formed on a screen, cannot be formed on a screen //

upright image, inverted image …2×3

Draw ray diagrams to show the formation of (i) a real image, (ii) a virtual image, by a converging lens. **6, 3**

object outside focus,

correct formation of real image using two rays

object inside focus

correct formation of virtual image using two rays 1st correct …6

2nd correct …3

[any two parts correct …3]

In an experiment to measure the focal length of a converging lens a student first obtained an approximate value for the focal length. Then for a range of object distances *u* the corresponding real image distances *v* were measured. The following data were recorded.

u/cm	15.0	25.0	35.5
v/cm	60.5	23.0	18.0

How did the student find an approximate value for the focal length of the lens? **3**

focussing an image of a distant object on a sheet of paper / measuring distance from lens to paper …3

Describe, with the aid of a labelled diagram, how the student found the position of an image. **4×3**

convex lens, ray box / search pins, screen / plane mirror …2×3

[any two …3]

correct arrangement of apparatus and one label …3

move screen or object until sharp image is formed / search pin is moved to position of no parallax with image pin …3

Using all the data, calculate the average value for the focal length of the lens. **5×3**

$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ / $\frac{1}{15}+\frac{1}{60.5}=\frac{1}{f}$ …3

f = 12.0 (cm) …3

$\frac{1}{25}+\frac{1}{23}=\frac{1}{f}$, f = 11.9 (cm) …3

$\frac{1}{35.5}+\frac{1}{18}=\frac{1}{f}$, f = 11.9 (cm) …3

…3

f = (12.02 + 11.98 + 11.94) ÷ 3 = 11.98 cm
[incorrect units/no units (–1)]
[calculations using averaged values …9 max]

An astronomical telescope has two converging lenses A and B of focal lengths 120 cm and 10 cm, respectively, arranged as shown in Figure 5. Name lens B. **3**
eyepiece (lens) …3

How far from lens A is the first image of a distant object formed? **3**
120 cm / at a distance of focal length of A …3

What is the location of the final image? **3**
at infinity …3

Question 4

(a)

A thermometric property, two reference points and a scale are required to measure temperature. The reference points for the Celsius scale are the temperature of melting ice and the temperature of steam above boiling water. The lower reference point of the Kelvin temperature scale is absolute zero.

Explain the three underlined terms **6×3**

property which changes continuously/measurably …3
with temperature/hotness …3

a measure of hotness / coldness …2×3

lowest temperature // temperature …3
which exists // where an (ideal) gas has zero volume/no kinetic energy …3
[-273^0C …6]

What is the upper reference point on the Kelvin scale? **3**
triple point of water / 273.16 / 0.01^0C …3
[freezing point of water / 0 °C / 273 K …3]

The mercury in a thermometer has a length of 60 mm in melting ice, 280 mm in steam above boiling water and 165 mm in the air of a sauna. Calculate the sauna temperature in (i) degrees Celsius, (ii) Kelvin. **4×3**

(i) $\frac{y_\theta - y_0}{y_{100} - y_0} \times 100$ …3

$\frac{165 - 60}{280 - 60} \times 100$ …3

= 47.73 °C …3

(ii) 47.73 + 273 = 320.73 K …3

(b) Give 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

Outline an experiment in support of the kinetic theory. **3×3**
smoke cell, microscope, light source …3
correct arrangement of apparatus shown or described …3
observation …3

State one way in which a real gas differs from an ideal gas. **3**

real gas molecules occupy space while molecules of an ideal gas are point masses/
real gas molecules are attracted to one another while molecules of an ideal gas have no intermolecular forces, real gases can liquefy while ideal gases cannot /
it does not obey Boyle's law a all temperatures and pressures any one…3

A fixed mass of gas was sealed into a container as shown in Figure 6.

Use the kinetic theory of gases to explain why the pressure reading drops when the container is cooled. **2×3**

the molecules have less kinetic energy …3
collide less frequently with container walls …3

Describe the motion of the molecules of the gas as its temperature approaches absolute zero. **3**

molecules move with very low energy/speed …3

Calculate the temperature of one mole of a gas when it occupies a volume of 2.24×10^{-3} m^3 at a pressure of 1.01×10^5 N m^{-2}. **2×3**

$PV = nRT$ / $(1.01 \times 10^5) \times (2.24 \times 10^{-3}) = 1 \times 8.31 \times T$ …3
T = 27.23 K …3
[incorrect / no units …(−1)]

Question 5

Define the resistance of a conductor. **2×3**

ratio of potential difference / voltage // $V \div I = R$ …3
to current (across conductor) // and explain notation …3
[opposition to the flow of current …3]

State *Ohm's law*. **2×3**

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

In an experiment to verify Ohm's law for a metallic conductor, a student measured the current *I* through the conductor for different values of the potential difference *V* across it. The temperature of the conductor was kept constant. The following data were recorded.

***V*/V**	**1.00**	**2.00**	**3.00**	**4.00**	**5.00**	**6.00**	**7.00**
***I*/A**	**0.10**	**0.19**	**0.28**	**0.39**	**0.46**	**0.55**	**0.66**

Draw a diagram of a circuit used in this experiment. **3×3**

battery / d. c. power supply, metallic conductor and rheostat …3
correct arrangement of ammeter shown …3
correct arrangement of voltmeter shown …3

How was the circuit adjusted to supply different values of potential difference? **3**

by adjusting the rheostat /potential divider …3

Using the data, draw a suitable graph on graph paper to show the relationship between the potential difference and the current through the conductor. **4×3**

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]

Explain how your graph verifies Ohm's law for this conductor. **2×3**

straight line through the origin …3
shows that $V \propto I$ …3

Use your graph to calculate the resistance of the conductor. **3×3**

equation for slope of line …3
two points on the line [origin acceptable] …3
$R = 10.77\ \Omega$ [accept $10.29 - 11.11\ \Omega$] …3
[incorrect units/no units (–1)]
[calculate R from data / R inverse instead of R …allow 6]

The conductor was used as the heating element for a fish tank. Calculate the heat produced when a current of 0.60 A flows for 30 minutes. Assume its resistance stays constant. **3×3**

$E = RI^2t$ …3

$E = R(0.60)^2(30 \times 60)$ …3

$E = 648 \times R$ J …3

[incorrect units/no units (–1)]

What is the relationship between the rise in temperature of the water in the tank in a given period of time and the current flowing through the heating element? **2×3**

rise in temperature is proportional to …3

current squared …3

Question 6
Answer any two parts

(a) State the principle of conservation of momentum. **3×3**
in a closed system / where no external force acts …3
total momentum // momentum before = // $m_1u_1+m_2u_2=$ …3
constant //momentum after // $m_1v_1+m_2v_2$ …3

Describe an experiment to verify the principle of conservation of momentum. **5×3**
2 trolleys, timing device, method of joining / separating any two…2×3
correct arrangement of apparatus shown / stated
give trolley a push / release spring
measure mass of both trolleys
explain how velocity is measured
explain how result verifies principle any three…3×3

A child of mass 30 kg skating in a straight line on smooth horizontal ice collides with an adult of mass 60 kg skating in the opposite direction at 1.5 m s^{-1}. After the collision they both slide together at 0.5 m s^{-1} in the direction the child had been skating. Calculate the speed of the child before the collision. **3×3**
$m_1u_1+m_2u_2= m_1v_1+m_2v_2$ …3
$(30 \times u) + (60 \times -1.5) = (90 \times 0.5)$ …3
4.5 m s^{-1} …3
incorrect units/no units (–1)

Question 6 (b)

Explain the terms (i) *frequency*, (ii) *photon*. **4×3**

the number of waves passing …3
(a fixed point) per second …3

quantum / small packet / small bundle …3
of (light) energy …3

Give two properties of infrared radiation. **2×3**

wavelength longer than visible light, frequency less than visible light, has a heating effect, can be detected using a thermometer, can penetrate fog and mist, effects photographic film, invisible any two…2×3

How do the energies of an infrared photon and an ultraviolet photon differ? **3**

(infrared photon) has lower energy (than an ultraviolet photon) …3

A remote control for a television transmits infrared radiation of frequency 1.5×10^{12} Hz.

Calculate (i) the wavelength of the infrared radiation **2×3**

$c = f\lambda$ / $3.0 \times 10^{8} = 1.5 \times 10^{12}\ \lambda$ …3
2×10^{-4} m …3
incorrect units/no units (–1)

(ii) the energy of a photon of the infrared radiation. **2×3**

$E = hf$ / $E = 6.6 \times 10^{-34} \times 1.5 \times 10^{12}$ …3
9.9×10^{-22} J …3
incorrect units/no units (–1)

Question 6 (c)

State the *laws of electromagnetic induction*. **4×3**

induced emf / current, proportional to, …3
rate of change, of magnetic flux / field …3
[any two ..3]

the direction of the induced emf/current …3
opposes the change which caused it …3

Name a device based on electromagnetic induction. **3**

transformer / induction coil / induction motor / induction hob / alternator / generator / dynamo, etc. any one…3

When a magnet is moved into a coil connected to a galvanometer G, as shown in Figure 7, the needle of the galvanometer deflects. Give two ways of increasing the size of the deflection. **2×3**

increase the strength of the magnet, increase the number of turns in the coil, move the magnet faster any two…2×3

What is observed when the magnet is moved out of the coil? **2×3**

a deflection in the galvanometer …3
in the opposite direction …3

What is observed when the magnet is stationary? Justify your answer. **2×3**

no galvanometer deflection/ nothing …3
no change in magnetic flux / field …3

Question 6 (d)

Define *radioactivity*. **2×3**

the decay/disintegration of nuclei (atoms) …3

with the emission of radiation /energy / particles …3

What is meant by the *half-life* of a radioactive isotope? **2×3**

time taken …3

for half a (radioactive) sample to decay/for the activity to decrease by half …3

Radioisotopes are used in medicine. Iodine–123 emits gamma radiation and is used in cancer treatment. Give two properties of gamma radiation. **2×3**

electromagnetic radiation / very short wavelength / very high frequency / very high energy photons / not deflected in magnetic/electric fields / very penetrating/ penetrates up to 10 cm lead / not very ionizing / effects photographic film any two…2×3

Sodium–24 emits beta particles and is used as a tracer in medical tests.
Write a nuclear equation to represent the decay of a sodium–24 nucleus when it emits a beta particle. **2×3**

$^{24}_{11}Na \rightarrow ^{24}_{12}Mg + ^{0}_{-1}e$ …6

[either product correct …3]

Sodium–24 has a half-life of 15 hours. An injection of sodium–24 is prepared 45 hours before being used. What fraction of the sodium–24 remains at the time of the injection? **2×3**

three half-lives …3

one-eighth …3

State one precaution medical personnel should take when using radioisotopes. **3**

use tweezers/ do not use fingers / wear gloves /store in lead containers / keep locked up (when not in use) / label radioisotopes appropriately/ use suitable shielding any one…3

Question 7
Any eleven parts **11×6**

(a) What colour do sodium salts give to a Bunsen burner flame?
yellow / orange …6

(b) Explain the term *principal quantum number*.
(main) energy level / shell …3
occupied by / of an electron …3

(c) How many (i) electrons, (ii) neutrons, are there in $^{9}_{4}Be$?
4 …3
5 …3

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

(e) What is a mole of a substance?
molecular mass // quantity which contains …3
expressed in grams // 6.0×10^{23} particles /Avogadro number of particles / same number of particles as in 12 g carbon / same number of particles as there are in 22.4 litres of a gas at STP …3

(f) What is the shape of (i) the H_2O molecule, (ii) the CH_4 molecule?
(i) v-shaped …3
(ii) tetrahedral …3

(g) State two characteristic properties of transition metals.
variable valency, form coloured compounds, are good catalysts, have an incomplete d-subshell, form at least one ion with a partially filled d-subshell any two…2×3

(h) What is the function of a catalyst in a chemical reaction?
to alter/speed up/slow down …3
the (rate) of a (chemical) reaction …3
[is not used up in the reaction …3]

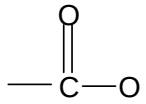
(i) Define *heat of combustion*.
heat change (liberated / evolved) when one mole of a substance …3
is burned in excess oxygen / is fully burned …3

(j) Identify (i) the conjugate acid of HSO_4^- (ii) the conjugate base of HF.
(i) H_2SO_4 / $H_2SO_4^+$ …3
(ii) F^- …3
[SO_4^{--} and H_2F^+ …3]

(k) Calculate the pH of a 0.05 M solution of nitric acid.
$PH = -\log_{10}[H^+]$ / $PH = -\log_{10}[0.05]$ …3
= 1.3 …3

(l) Name the piece of apparatus shown in Figure 8.
(reflux) (Liebig) condenser …6

(m) Draw the structure of the functional group in an ester.



…6

[— COO …3]

(n) Identify the compound formed when phenylhydrazine reacts with propanone (acetone).
propanone …3
phenylhydrazone …3

(o) Name the aromatic compounds shown in Figure 9.
phenol …3
methyl benzene / toluene …3

Question 8

(a) What is an atomic orbital? **2×3**

region in space / around the nucleus / in an atom …3

where there is a high probability of finding an electron …3

Sketch the shape of (i) the *s* atomic orbital, (ii) the *p* atomic orbital. **2×3**

(i) spherical shape …3

(ii) dumbbell shape …3

Identify the species represented by each of the following electron configurations:

(i) $1s^2\,2s^2\,2p^6\,3s^2\,3p^3$ **(ii) $[1s^2\,2s^2\,2p^6]^{2+}$** **2×3**

(i) phosphorus / P …3

(ii) magnesium ion / Mg^{2+} …3

(b) Define *electronegativity*. **2×3**

relative attraction of an atom / element …3

for a shared pair of electrons …3

Give one reason for the general increase in electronegativity values from Na to Cl across the periodic table. **3**

atomic radius decreasing / nuclear charge increasing …3

Distinguish between ionic and covalent bonding. **2×3**

ionic bonding is the attraction between oppositely charged ions / is formed when an electron or electrons are transferred from one atom to another …3

covalent bonding is the attraction (the atoms have) for (a) shared (pair of) electrons …3

What is meant by a polar covalent bond? **2×3**

unequal sharing // sharing electrons between atoms // EN difference < 1.7 …3

of electrons // with different electronegativities …3

Explain how electronegativity values are used to predict the type of bond in the compound formed between

(i) magnesium and chlorine; **2×3**

electronegativity difference exceeds 1.7 / EN difference = 1.8 …3

ionic …3

(ii) hydrogen and phosphorus; **2×3**

no electronegativity difference / EN difference = 0 …3

(pure) covalent …3

(iii) hydrogen and chlorine. **2×3**

electronegativity difference less than 1.7 / EN difference = 0.9 …3

polar covalent …3

Which one of these compounds would you expect to exist as a solid with a high melting point? **3**

$MgCl_2$ /magnesium chloride / compound formed between magnesium and chlorine / (i) …3

Which one of these compounds would you expect to be insoluble in water? Justify your answer. **2×3**

PH_3 /phosphine / compound formed between phosphorus and hydrogen / (ii) …3

pure covalent compounds are insoluble in water /

no attraction between the polar water molecules and non-polar PH_3 molecules …3

Question 9

In a titration a student used a standard solution of sodium carbonate to determine the concentration of a solution of hydrochloric acid which is a strong acid.

(a) Explain the underlined terms. **6, 2×3**

solution of known concentration …6

good // fully …3

proton donor // dissociated in solution …3

(b) The student was given exactly 2.65 g of anhydrous sodium carbonate on a clock glass. Describe the correct procedures for dissolving this solid and for making the solution up to exactly 500 cm^3 in a volumetric flask. **4×3**

rinse with deionised water into a beaker,
stir to dissolve,
(use funnel to) transfer to volumetric flask,
rinse beaker and add rinsings to volumetric flask,
top up to near mark with deionised water,
add deionised water dropwise/using pipette to bring bottom of meniscus in line with mark/ adjust until bottom of meniscus lies on the mark
stopper and invert the flask any four…4×3

Calculate the molarity of this solution. **2×3**

$2.65 \times 2 = 5.3$ g/L …3

$5.3 \div 106 = 0.05$ M …3

(c) Name a suitable indicator for the titration. Justify your answer. **6, 3**

methyl orange …6

suitable for strong acid and weak base titration / changes colour at endpoint / changes colour in correct pH range …3

During the titration why did the student

(i) swirl the conical flask; **3**

to ensure the reagents mixed …3

(ii) use deionised water to wash down the sides of the conical flask; **3**

wash down any drops of acid or base on the sides // to ensure all the acid and base reacts // deionised water contains no chemicals / ions / impurities which could effect the titration // deionised water will not alter the molarity / concentration // …3

(iii) stand the conical flask on a white tile? **3**

the colour change / end point can be seen clearly …3

(e) Write a balanced equation for the titration reaction. **2×3**

$Na_2CO_3 + 2HCl$ / $Na_2CO_3 + HCl \rightarrow NaCl + H_2O + CO_2$ …3

$2NaCl + H_2O + CO_2$ …3

(g) An average of 22.3 cm^3 of the hydrochloric acid solution was required to neutralise 25.0 cm^3 portions of the sodium carbonate solution. Calculate the concentration of the hydrochloric acid solution in (i) moles per litre (dm^3), (ii) grams per litre (dm^3). **2×3**

$$\frac{V_1 \times M_1}{n_1} = \frac{V_2 \times M_2}{n_2} / \frac{22.3 \times M_1}{2} = \frac{25 \times 0.05}{1}$$ …3

$M_1 = 0.112$ M …3

(ii) grams per litre (dm^3). **2×3**

$M_r = 36.5$ …3

$0.112 \times 36.5 = 4.09$ g/L …3

Question 10

(a) Define (i) oxidation, (ii) reduction, in terms of electron transfer. **2×3**

(i) loss of electrons …3

(ii) gain of electrons …3

Identify the substance oxidised in the following reaction: **6**

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

zinc …6

Explain why zinc is placed above copper in the electrochemical series. **3**

zinc is more easily oxidised / more reactive …3

A zinc rod and a copper rod are placed in a solution of dilute sulfuric acid as shown in Figure 10. What happens when the rods are joined by a conducting wire. **6**

an electric current flows / needle deflects …6

(b) State Faraday's first law of electrolysis. **2×3**

mass of an element liberated/deposited during electrolysis …3

is proportional to the charge passed …3

Give one application of electrolysis. **3**

Electroplating / extraction of metals from ores / purifying metals /

anodizing aluminium / making electrolytic capacitors, etc any one…3

Figure 11 shows an apparatus used in the electrolysis of acidified water using inert electrodes. Identify: (i) a suitable material for the inert electrodes; **3**

platinum / carbon / graphite …3

(ii) which electrode is the cathode; **3**

Y / the negative electrode …3

(iii) the electrode at which reduction takes place; **3**

Y / the negative electrode / cathode …3

(iv) the gas collected at A; **3**

oxygen …3

(v) the gas collected at B. **3**

hydrogen …3

Write a balanced equation for the reaction at the cathode. **2×3**

$2H^+ + 2e^- \; // \; H^+ + e^-$ …3

$\rightarrow \; H_2 \quad // \rightarrow \; ½\, H_2$ …3

A current of 1.61 A was passed through acidified water for 12 minutes. Calculate

(i) the charge which flowed, **2×3**

$Q = It$ / $Q = 1.61 \times 12 \times 60$ …3

1159.2 C …3

incorrect units / no units (–1)

(ii) the mass of gas released at B. **3**

$\frac{1159.2}{96500}$ = 0.012 moles electrons / F

0.012 g …3

incorrect units / no units (–1)

What volume would this mass of gas occupy at STP? **3**

$0.006 \times 22.4 =$

0.134 L …3

incorrect units / no units (–1)

What volume of gas would be collected at A under the same conditions? **3**

$0.134 \times 0.5 =$

0.067 L …3

Question 11

Define (i) *unsaturated compound* **2×3**
contain at least one double // molecules which undergo // valencies ...3
or triple bond // addition reactions // not all satisfied ...3

(ii) *homologous series*. **2×3**
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]

Study the reaction scheme in Figure 12 and answer the following parts.
(a) Name and draw the structural formula of an unsaturated molecule in this scheme. Which homologous series does this compound belong? **3×3**
ethene // ethyne …3
correct structural formula …3
alkenes // alkynes …3

(b) What type of reaction is $C_2H_6 \rightarrow C_2H_5Cl$? What reagent is required for this conversion? **2×3**
substitution …3
chlorine …3

(c) Calculate the percentage by mass of hydrogen in C_2H_6. **2×3**
$M_r = 30$ …3
20% …3

C_2H_6 is a good fuel.
Write a balanced equation for the combustion of C_2H_6 in excess oxygen. **2×3**
$C_2H_6 + 3½O_2 \rightarrow$ …3
$2CO_2 + 3H_2O$ …3
[$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$ …3 for correct reagents and products unbalanced]

(d) Describe, with the aid of a labelled diagram, how you would carry out the conversion: $C_2H_5OH \rightarrow C_2H_4$ **5×3**
Reagents: Al_2O_3 // conc sulphuric acid …3
Apparatus: horizontal test tube, delivery tube, glass wool to hold ethanol // flask to hold reaction mixture, outlet tube, thermometer …3
solid shown half way along tube // acid in excess …3
Method: heat Al_2O_3 with Bunsen // heat mixture about 170 ºC …3
collect gas over water …3

(e) C_2H_5OH can be oxidised first to X and then to Y using the same two reagents in each conversion. Y is a carboxylic acid. Identify X and Y and the two reagents required. **4×3**
X: ethanal / CH_3CHO …3
Y: ethanoic acid / CH_3COOH …3
sodium dichromate / $Na_2Cr_2O_7$ …3
sulfuric acid / H_2SO_4 …3

Question 12

Answer any three parts

(a) Define (i) atomic number **3**

number of protons (in an atom) …3

(ii) mass number **3**

number of protons and neutrons (in an atom) …3

(iii) relative atomic mass **2×3**

mass of an atom (of an element) …3

compared to $1/12^{th}$ of mass of carbon-12 isotope …3

Naturally occurring chlorine consists of two isotopes: 75.50% $^{35}_{17}Cl$ and 24.50% $^{37}_{17}Cl$.

Calculate the relative atomic mass of chlorine correct to two decimal places. **2×3, 2×2**

75.50 × 35 (= 2642.50) …3

24.50 × 37 (= 906.50) …3

2642.50 + 906.50 = 3548.50 …2

3548.5 ÷ 100 = 35.485 = 35.49 …2

(b) Define (i) base **3**

proton acceptor …3

(ii) conjugate acid-base pair, according to Brønsted-Lowry theory. **2×3**

two species / an acid and a base …3

which differ by one proton …3

Identify the two bases in the following equilibrium reaction:

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ **2×5**

NH_3 …5

OH^- …5

Give one chemical property of a base. **3**

Dissolves grease, changes colour of an indicator, neutralizes an acid any one…3

Question 12 (c)

Magnesium burns in air with an intensely bright white flame according to the following equation:

$$\mathbf{2Mg + O_2 \rightarrow 2MgO}$$

Calculate (i) the number of moles in 3.0 g of magnesium; **2×2**

$n = \frac{m}{A_r}$ / $n = \frac{3}{24}$ …2

0.125 (moles) …2

(ii) the mass of magnesium oxide formed when 3.0 g of magnesium is burned; **3×3**

0.125 moles MgO formed …3

$M_r = 40$ …3

$m = 5$ g …3

(iii) the number of molecules of oxygen required. **2×3**

0.0625 moles …3

3.75×10^{22} (molecules) …3

The magnesium oxide formed is dissolved in water.

Is the solution acidic, basic or neutral? **3**

basic …3

Question 12 (d)

Define *heat of formation.* **2×3**

heat change for formation of one mole (of a compound) …3

from its elements in their standard states …3

Calculate the heat change for the addition reaction:

$$\mathbf{C_2H_{4\,(g)} + HBr_{\,(g)} \rightarrow C_2H_5\,Br_{\,(l)}}$$

using the following heats of formation.

$\mathbf{2C_{\,(s)} + 2H_{2\,(g)} \rightarrow C_2H_{4\,(g)}}$ $\quad \mathbf{\Delta H = 52.3\ kJ\ mol^{-1}}$

$\mathbf{\frac{1}{2}H_{2\,(g)} + \frac{1}{2}Br_{2\,(l)} \rightarrow HBr_{\,(g)}}$ $\quad \mathbf{\Delta H = -36.3\ kJ\ mol^{-1}}$

$\mathbf{2C_{\,(s)} + 2\frac{1}{2}H_{2\,(g)} + \frac{1}{2}Br_{2\,(l)} \rightarrow C_2H_5\,Br_{\,(l)}}$ $\quad \mathbf{\Delta H = -90.5\ kJ\ mol^{-1}}$ **4×3**

$C_2H_{4\,(g)} \rightarrow 2C_{\,(s)} + 2H_{2\,(g)}$ / $\Delta H = -52.3$ kJ mol^{-1} …3

$HBr_{\,(g)} \rightarrow \frac{1}{2}H_{2\,(g)} + \frac{1}{2}Br_{2\,(l)}$ / $\Delta H = 36.3$ kJ mol^{-1} …3

$2C_{\,(s)} + 2\frac{1}{2}H_{2\,(g)} + \frac{1}{2}Br_{2\,(l)} \rightarrow C_2H_5\,Br_{\,(l)}$ / $\Delta H = -90.5$ kJ mol^{-1} …3

$\Delta H = -106.5$ kJ mol^{-1} …3

Is this addition reaction exothermic or endothermic? Justify your answer. **2×2**

exothermic …2

negative ΔH / energy released …2