Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scéim Mharcála

Fisic agus Ceimic

Scrúdú na hArdteistiméireachta 2006

Ardleibhéal

Marking Scheme

Physics & Chemistry

Leaving Certificate Examination 2006

Higher Level

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.

Section I - Physics

Question 1

(a) Distinguish between a vector and a scalar.

vector has direction …3
scalar no direction …3

(b) Define the unit of force – the newton.

(1 newton) gives a mass of 1 kilogram …3
an acceleration of 1 metre per second squared …3
[$F = ma$ …3;]

(c) Write an expression for the gravitational force between two objects each of mass m whose centres are separated by a distance *d*.

($F \alpha$) $m_1 m_2$ / ($F =$) $G\, m_1 m_2$ …3
$\div d^2$ …3

(d) Give two properties of an image formed by a convex mirror.

erect / virtual / diminished / behind the mirror / laterally inverted /
formed between the pole and focus any two …2×3

(e) The path of a light ray as it travels through a semicircular block of glass of refractive index 1.4 is shown in Fig. 2. What is the size of the angle marked A?

$n = \frac{\sin i}{\sin r}$ / $1.4 = \frac{\sin A}{\sin 40^0}$ …3
64.1º …3
[27.3^0 … (–1)]

(f) Explain the term total internal reflection.

angle of incidence (in denser medium) …3
greater than the critical angle (in the less dense medium) …3
[diagram …2×3]

(g) What is the photoelectric effect?

release of electrons from a metal …3
when light (electromagnetic radiation) of a suitable frequency falls on it /
UV light shines on zinc …3

(h) Give an expression that defines temperature on the Celsius scale.

($\theta =$) $\frac{(Y_\theta - Y_0)}{Y_{100} - Y_0}\, 100$ // $(\theta =)\ T - 273$ …6

Question 1 (continued)

(i) What is Brownian movement?
constant (continuous) movement of particles/molecules …3
in a fluid / liquid or gas
[example …3]

(j) Name two effects of an electrical current as it passes through a conductor.
heating, magnetic, chemical any two…2×3

(k) Copy the diagram and sketch the electric field around the two equal positive charges.
lines of force …3
showing repulsion (between the charges) …3

(l) State Faraday's law of electromagnetic induction.
induced emf (current) / is proportional to rate of change of /
magnetic flux (field) …2×3
[any two …3]

(m) Why does the ESB use high voltage to transmit electric current over long distances?
less heat (energy) lost / more efficient …6
[low current / $P = VI$ / $P = RI^2$ 3]

(n) What is meant by mass-energy conservation?
mass-energy of reactants // loss in mass …3
= mass-energy of products // = gain in energy …3
[mass and energy are equivalent / $E = mc^2$ …3]

(o) What is nuclear fusion?
joining of two small nuclei (atoms) …3
to form of larger / heavier nucleus (atom) / with large amounts of energy released …3

Question 2

Define momentum. **2×3**
product of mass / m × …3
and velocity // v …3

State Newton's third law of motion. **2×3**
for every action …3
there is an equal and opposite reaction …3

State the principle of conservation of momentum. **3×3**
in a closed system / where no external force acts …3
total momentum // momentum before …3
is a constant // =momentum after …3

Use the principle of conservation of momentum to explain how a rocket can change its velocity. **3**
gases expelled with certain momentum
rocket gains equal momentum …3

Describe an experiment to verify the principle of conservation of momentum. **5×3**
App: 2 trolleys, timing device, method of joining/separating any two …3

Method: correct arrangement of apparatus shown (stated)
give trolley a push (release the spring)
measure mass of both trolleys
explain how velocity is measured
explain how result verifies principle any four …4×3

What is the velocity of the displaced water? **3**
7.5 m s^{-1} …3
incorrect units/no units (-1)

By applying the principle of conservation of momentum calculate the velocity of the boat. **3×3**
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ / $m_1v_1 = m_2v_2$ …3
$(500 \times 0) + (100 \times 0) = 500\ v_1 + (100 \times -7.5)$ / $500\ v_1 = (100 \times -7.5)$ …3
1.5 m s^{-1} …3
incorrect units/no units (-1)

Find as the boat comes to rest, (i) the average acceleration of the boat. **3×3**
$v^2 = u^2 + 2as$ …3
$0^2 = 1.5^2 + 2a \times 10$ …3
$a = -0.1125$ m s^{-2} …3
incorrect units/no units (-1)

(ii) the force exerted by the water on the boat. **2×3**
$F = ma = 500 \times 0.1125$ …3
$= 56.25$ N …3
incorrect units/no units (-1)

Question 3

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

the incident ray, the refracted ray and the normal …3
lie in the same plane …3

sin ***i*** ∝ / sin ***i*** = …3
sin ***r*** / constant sin ***r*** …3

Describe, with the aid of a labelled diagram, an experiment to measure the focal length of a converging (convex) lens. **6×3**

App converging lens, lamp box (search pins), screen (plane mirror) …2×3
[any two …3]

Method: correct arrangement of apparatus shown and one label …3
describe how to locate image …3
measure object and image distance …3
calculation of results by formula or graph …3

Fig. 5 shows a converging lens of focal length 10 cm being used as a simple microscope (magnifying glass) to examine an insect of length 4 mm which is 5 cm from the lens.

Find (i) the position of the insect's image **3×3**

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

$\frac{1}{10} = \frac{1}{5} + \frac{1}{v}$ …3

v = (–) 10 cm …3

(ii) the magnification of the image **3**

m = 2 …3

(iii) the length of the image. **3**

length = 8 mm …3

Draw a ray diagram to show how the final image is formed in a compound microscope. **6, 3×3**

two convex lenses …6
object shown outside focal length of objective …3
correct formation of first magnified inverted image …3
first image shown inside/at focal length of eyepiece and **correct formation** of second image (i.e. two correct rays from I_1 to I_2) …3

Greater magnification can be achieved using a compound microscope instead of a simple microscope. Explain why. **2×3**

magnified image formed by first lens …3
is further magnified by second lens …3
[compound microscope has two lenses / object is magnified twice …6]

Question 4

State Boyle's Law **2×3**
fixed mass of gas, at constant temperature, pressure (p), inversely proportional to volume ($\propto 1/V$) …2×3
[two correct expressions / $pV = k$ / $p_1V_1 = p_2V_2$ …3]

Draw a suitable graph on graph paper to show the relationship between the pressure of the gas and its volume. **5×3**

p (kPa)	103	121	133	150	202	243	298
$1/V$ (cm $^{-3}$)	0.008	0.01	0.011	0.0125	0.0167	0.02	0.025

values for 1/V …3
axes labelled correctly …3
correct scale …3
5 points plotted correctly …3
one relevant straight line …3
[graph paper not used …. deduct 6]

Explain how your graph verifies Boyle's law. **2×3**
straight line through origin (only for p vs 1/V) …3
shows p α 1/V / verifies Boyle's law …3

There are 5.2×10^{-3} moles of oxygen gas in the syringe. Use the slope of your graph to calculate the temperature of the oxygen on (i) the absolute (Kelvin) scale **5×3**
equation for the slope of the line …3
two points on the line …3
m = 11.93 [accept 11.30 – 12.56] …3
[calculate pV from data ….allow 3]

$pV = nRT$ / 11.93 = $5.2 \times 10^{-3} \times 8.3 \times T$ …3
T = 276.41 (K) …3

(ii) the Celsius scale **3**
θ = (276.41 – 273) 3.4 (º C) …3

What is an ideal gas? **2×3**
obeys Boyle's law (gas laws)/ satisfies the Kinetic Theory assumptions …3
always / exactly / at all temperatures and pressures …3

Under what conditions do real gases like oxygen behave like an ideal gas? **6**
high temperature / low pressure …6

Define a thermometric property. **2×3**
property which changes continuously/measurably …3
with temperature / hotness …3

Name the thermometric property on which the constant volume gas thermometer is based. **3**
pressure …3

Question 5

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

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

Describe an experiment to demonstrate the principle on which a moving-coil galvanometer is based. **4×3**

App: battery (d. c. power supply), conductor, magnet …3
Method: correct arrangement of apparatus shown or described …3
switch on current …3
note movement of conductor …3

Name the parts labelled A, B and C and give the function of any two of them. **5×3**

A: spring …3
B: iron core …3
C: coil …3

Fn of A: oppose the motion of the coil / carries current to the coil
Fn of B: is to concentrate the magnetic lines of force / to ensure a radial magnetic field/ to ensure coil rotates in a magnetic field of constant intensity
Fn of C: turns (in the magnetic field) moving the pointer / turns showing size of the current any two… 2×3

When the galvanometer is connected to a 550 Ω resistor and a 6 V battery as shown in Fig. 7 it gives a full-scale deflection of 10 mA.

Calculate (i) the total resistance in the circuit. **4×3**

$V = IR$ …3
$6 = 0.01 \times R$ …3
$R = 600\ \Omega$ …3
incorrect units/no units (-1)

(ii) the internal resistance of the galvanometer.

$R_g = 50\ \Omega$ …3

How would you convert this galvanometer to an ammeter capable of reading larger currents? **2×3**

small resistor / shunt …3
connected in parallel …3

Calculate the size of the resistor required to enable the galvanometer measure currents up to 10 A. **4×3**

$10 - 0.01 = 9.99$ A …3
$V_r = V_g / I_r R_r = I_g R_g$ …3
$9.99 \times R = 0.01 \times 50$ …3
0.05 Ω …3

Question 6 (a)

Define (i) potential energy (ii) kinetic energy. **6, 3**

(i) energy due to position / mechanical condition // $E = mgh$
(ii)energy due to motion // $E = ½mv^2$ 1st correct …6
2nd correct …3

What is the relationship between the potential energy and the kinetic energy of an object which is falling freely? **2×3**

sum of potential and kinetic energies // loss in E_p // E_p changes …3
is a constant // = gain in E_k // to E_k …3
[$E_p = E_k$ / $mgh = ½mv^2$ …3]

Calculate (i) the potential energy of the stone as it is released **2×3**

$E = mgh$ / $E = 2.5 \times 9.8 \times 170$ …3
4165 J …3
incorrect units/no units (-1)

(ii) the kinetic energy of the stone as it strikes the water **3**
4165 J …3

(iii) the speed with which the stone strikes the water **2×3**
$E_k = ½mv^2$ / $4165 = ½ \times 2.5 \times v^2$ // $v^2 = u^2 + 2gs$ / $v^2 = 2 \times 9.8 \times 170$ …3
$v = 57.7$ m s^{-1} …3
incorrect units/no units (-1)

(iv) a value for the speed of sound in air. **3**
340 m s^{-1} …3
incorrect units/no units (-1)

Question 6 (b)

(b) Define capacitance. **2×3**

ratio of charge / Q ÷ …3
to potential / *V* …3

Describe an experiment to show how the capacitance of a parallel plate capacitor depends on the common area between the plates. **5×3**

App: parallel plate capacitor, electroscope …3

Method: correct arrangement shown or described …3
increase (decrease) common area between plates …3

Result: potential difference is decreasing (increasing) / leaves converge (diverge) …3
thus capacitance increases (decreases) …3

Name two other factors which affect the capacitance of a parallel plate capacitor. **2×3**

distance between plates …3
permittivity …3

Give one use for a capacitor. **6**

storage of charge / to tune radio (TV) to different stations / to separate a.c. from d.c. /
to operate a timing circuit / to smooth the output from rectifiers etc. any one…6

Question 6 (c)

Define radioactivity. **2×3**

the decay / disintegration of nuclei …3
with the emission of radiation / energy / particles …3

Describe the nature of alpha particles. **2×3**

positively charged // charge of plus 2 or 3.2×10^{-19} C /
a helium nucleus // consist of 2 protons and 2 neutrons /
mass about 4 times the mass of 1 proton // mass 36.4×10^{-31} kg /
deflected in an electrical field / deflected in a magnetic field /
low penetration power /good ionising ability /
short wide tracks in cloud chamber / fast moving any two …2×3

Name a material which can be used to stop alpha particles. **3**

paper / aluminium / lead etc …3

Why is the build-up of radon-222 a hazard? **3**

toxic gas / carcinogen / causes cancer etc. …3

Complete the nuclear reaction for the decay of radon-222: **3×3**

$$^{222}_{86}\text{Rn} \rightarrow {}^{21}_{8}\text{Po} + {}^{4}_{2}\text{He}$$

mass balanced …3
atomic numbers balanced …3
atomic symbols for polonium and helium (alpha) included correctly …3
[Rn and Po fully correct …6]

How long does it take a sample of radon-222 to decay to one-sixteenth of its original mass? **2×3**

4 half-lives …3
15.2 days …3

Question 6 (d)

Why are light waves and ripples in water classified as transverse waves? **2×3**
the direction of vibration …3
is perpendicular to the direction of propagation …3
[they can be polarised …6]

Name the phenomenon which occurs as the water waves pass through the gaps. **6**
diffraction …6

How can this effect be made more pronounced? **3**
reduce width of gaps / increase wavelength of the ripple …3

Another wave phenomenon is observed where the waves overlap. Name this phenomenon. **3**
interference …3

Describe how you could demonstrate the phenomena shown in Fig. 8 using a monochromatic light source. **2×3**
Monochromatic light source / laser, pair of narrow slits / diffraction grating,
screen / spectrometer (telescope) …3
correct arrangement …3

What measurements should you take to calculate the wavelength of the light source? **3×3**
grating constant / lines per mm // separation between slits
read angle on one side //distance between slits and screen
read angle on other side // distance between images
number of images / fringe order any three …3×3

Section II - Chemistry

Question 7

(a) What are allotropes?

different forms // forms of an element that differ … 3
of an element // in the way atoms are bonded …3
[example …3]

(b) Naturally occurring chlorine consists of two isotopes: 75.5% $^{35}_{17}$Cl and 24.5% $^{37}_{17}$Cl. Calculate the relative atomic mass of chlorine.

$(35 \times 75.5) + (37 \times 24.5)$ / 2642.5 + 906.5 …3
35.49 …3

(c) How many (i) neutrons, (ii) electrons are there in $^{23}_{11}Na^{+}$?

(i) 12 neutrons …3
(ii)10 electrons …3

(d) What colour do lithium salts give to a Bunsen burner flame?

red / crimson …6

(e) State (i) the principal (first) quantum number, (ii) the subsidiary (second) quantum number of an electron in this orbital.

(i) 2 …3
(ii) 1 …3

(f) Calculate the molecular formula of the alkane which is composed of 75% carbon and 25% hydrogen by mass.

$\frac{75}{12} = 6.25 \quad \frac{25}{1} = 25$ / C:H = 6.25:25 / C : H = 1:4 …3
CH_4 …3

(g) What is the shape of (i) the BF_3 molecule, (ii) the CO_2 molecule?

(i) triangular planar …3
(ii) linear …3
[correct shapes drawn …2×3]

(h) What is the role of a catalyst in a chemical reaction?

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

Question 7 (continued)

(i) Write a balanced equation for the reaction which takes place when chlorine gas is bubbled through a solution of sodium bromide.

$2NaBr + Cl_2 \rightarrow / NaBr + Cl_2 / NaCl + Br_2 / NaBr + Cl \rightarrow NaCl + Br$ …3

$2NaCl + Br_2$ …3

(j) How many molecules are there in 560 cm^3 of carbon dioxide gas at STP?

$560 \div 22\,400 \quad / \quad 0.025$ …3

1.5×10^{22} …3

(k) What is the molarity of the solution when 10.6 g of sodium carbonate (Na_2CO_3) is dissolved in one litre of aqueous solution?

$M_r = (23 \times 2) + 12 + (3 \times 16) / 106$ …3

0.1 (M) …3

(l) Calculate the pH of a 0.2 M solution of KOH.

$pOH = -\log_{10}[OH^-] \quad / pOH = -\log_{10}[0.2] \quad / \quad pOH = 0.7$ …3

pH = 13.3 …3

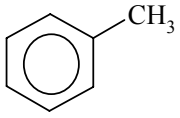
(m) Name the two reagents required for this conversion.

mercuric(II) sulphate / $HgSO_4$ …3

sulphuric acid / H_2SO_4 …3

(n) In Fig. 10 a sample of ethyne is bubbled through a solution of two reagents at 60 ºC and is converted to ethanal. Name and give the structural formula of an aromatic compound whose molecular formula is C_7H_8.

methyl benzene / toluene …3



…3

(o) Identify the two acidic organic compounds in the following list:

C_6H_5COOH CH_3CHO C_2H_5OH CH_3COOC_2H CH_3COCH_3

C_6H_5COOH …3

C_2H_5OH …3

Question 8

(a) Write the electron configuration of (i) the carbon atom (ii) the aluminium ion, Al^{3+} **6, 3**

(i) $C = 1s^2\ 2s^2\ 2p^2$

(ii) $Al^{3+} = [1s^2\ 2s^2\ 2p^6]^{3+}$ — 1st correct …6; 2nd correct …3

(b) Define (i) a covalent bond **6**

sharing of electrons …6

(ii) a polar covalent bond **6**

unequal sharing (distribution) of electrons (charge) // small EN difference / EN difference < 1.7 …6

(iii) electronegativity. **2×3**

attraction an atom (element) has …3

has for a shared pair of electrons …3

Use electronegativity values to predict the type of bonding in potassium bromide. **6**

ionic bonding …6

[KBr / two correct EN values / EN difference = 2.0 …3]

What are the general properties of compounds with this type of bonding? **2×3**

high melting points, high boiling points, soluble in water, conduct electricity when molten or in aqueous solution, fast reactions, solid etc — any two …2×3

(c) What type of crystal exists in each of these substances? **3×3**

iodine: molecular crystal …3

aluminium: metallic (metal) crystal …3

diamond: covalent /atomic crystal …3

Explain, in terms of bonding, why (i) iodine is insoluble in water **2×3**

iodine is non-polar …3

will dissolve in non-polar solvent / water is polar covalent …3

(ii) aluminium is a good conductor of electricity **6**

free electrons / cloud of valence electrons …6

[to carry current …3]

(iii) diamond is difficult to cut. **6**

atoms held by strong bonds / tetrahedral structure …6

[all valencies satisfied …3]

Question 9

(a) Distinguish between a strong acid and a weak acid. **3×3**

strong acid: good proton donor / fully dissociated
weak acid: poor proton donor / not fully dissociated — 1st correct …6, 2nd correct …3

What is a conjugate acid-base pair in terms of the Brønsted-Lowry theory? **2×3**

two species / substances / a pair …3
which differ by a proton …3

Ethanoic acid is a weak acid which dissociates in water as follows:

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

Identify two conjugate acid-base pairs in this reaction. **2×3**

CH_3COOH and CH_3COO^- …3
H_2O and H_3O^+ …3

Explain why the equilibrium lies on the left. **6**

equilibrium lies on the weaker side //
ethanoic acid is a weak acid / is not fully dissociated / is a poor proton donor / forms a strong conjugate base (CH_3COO^-) / remains as undissociated molecules //
water is a weak base / is a poor proton acceptor / forms a strong conjugate acid (H_3O^+)
any one …6

[L.H.S. more stable …3]

(b) (i) Describe how a burette was rinsed and then filled with the ethanoic acid solution. **6, 6, 3**

rinse with deionised water / rinse with ethanoic acid /
rinse with solution it is to hold — any one …6

fill using a funnel / fill above the zero mark / fill part below tap / ensure there are no air bubbles below tap / adjust until meniscus lies on zero / read at eye level — any two 6, 3

(ii) While adding the ethanoic acid solution to the sodium hydroxide solution what two operations should be carried out at the same time to ensure an accurate result? **2×3**

swirl the contents of the flask / wash down the walls of the flask with deionised water
add the acid dropwise near the end point /
use a white tile // hold white paper behind the burette — any two …2×3

(iii) Name a suitable indicator for this titration and state the colour change observed at the end point. **2×3**

phenolphthalein …3
pink to colourless (clear) …3

(iv) Calculate the concentration of the ethanoic acid in (a) moles per litre (dm^3) **2×3**

$\frac{M_1 \times V_1}{n_1} = \frac{M_2 \times V_2}{n_2} \;/\; \frac{19.6 \times M_2}{1} = \frac{25 \times 0.1}{1}$ …3

M_2 = 0.128 / 0.13 (M / moles per litre (dm^3)) …3

(b) grams per litre (dm^3) **2×3**

$(12 \times 2) + (1 \times 4) + (16 + 2) = 60$ …3
$0.0128 \times 60 = 7.68$ / 7.8 …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 reducing agent in $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ **3**
carbon / C …3

Identify the reducing agent in $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ **3**
aluminium / Al …3

(b) State Faraday's second law of electrolysis. **2×3**
the mass liberated / deposited by the same quantity of charge …3
α chemical equivalent / α the relative atomic mass divided by the charge on the ion …3

Name a suitable material for the inert electrodes. **6**
platinum / carbon /graphite …6

Write a balanced equation for the cathode reaction. **3**
$Pb^{2+} + 2e^- \rightarrow Pb$ …3

Name the electrode where reduction takes place. **3**
cathode …3

A current of 2 A was passed through the lead(II) bromide. What mass of lead is produced in 10 minutes? **4×3**
$Q = It$ / $Q = 2 \times (10 \times 60)$ …3
$Q = 1200$ C …3
$\frac{1200}{96500} = 0.0124$ / $0.0124 \div 2 = 0.0062$ / 1 mole requires 2F …3
$0.0062 \times 207 = 1.28$ g /1.3 g …3

(c) Arrange the following metals in order of decreasing ease of oxidation according to the electrochemical series: Al Fe Cu Zn Pb **6**
Al Zn Fe Pb Cu …6
[three consecutively correct / reverse order …3]

Which of these elements occurs free in nature? **3**
copper / Cu …3

Write a balanced equation for the reaction between zinc and sulfuric acid. **2×3**
$Zn + H_2SO_4 \rightarrow$ …3
$ZnSO_4 + H_2$ …3

What is observed when (i) zinc metal is added to a copper(II) sulfate solution **6**
zinc becomes coated with copper // zinc displaces copper // blue colour fades //
brown substance collects at the bottom of container …6

(ii) copper metal is added to a zinc sulfate solution? **3**
nothing / no observation / no reaction …3

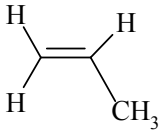
Question 11

Define (i) functional group **2×3**
atom (group of atoms) which determine// reactive part …3
the characteristic properties// of a molecule …3
[correct example …3]

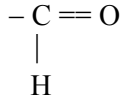
(ii) homologous series. **2×3**
successive members differ //group of compounds with …3
by $-CH_2$ //same functional group / same general formula …3

(i) To what homologous series does C_2H_4 belong? **3**
alkenes …3

Name and give the structural formula of the next member of this series. **2×3**
propene …3
$CH_3CH=CH_2$ / …3



(ii) Name the compound X and draw the structure of its functional group. **2×3**
ethanal …3



…3

(iii) What type of reaction is $C_2H_5OH \rightarrow X$? **3**
oxidation …3

What are the reagents required for this conversion? **2×3**
sulphuric acid / H_2SO_4 …3
sodium dichromate /$Na_2Cr_2O_7$ / potassium dichromate / $K_2Cr_2O_7$ …3

(iv) Name the ester formed when ethanol reacts with ethanoic acid. **3**
ethyl ethanoate / ethyl acetate …3

Write a balanced chemical equation for this reaction. **3×3**
$C_2H_5OH + CH_3COOH \rightarrow$ …3
$CH_3COOC_2H_5$ …3
$+ H_2O$ …3

Give one use for this ester. **3**
solvent / perfume / flavouring / food essence etc. …3

(v) Describe with the aid of a labelled diagram how ethanol is converted to ethene. **6, 3×3**
Reagents: concentrated sulfuric acid // aluminium oxide …3
App: flask, heating method, collect ethene over water //
test tube, bunsen burner, collect ethene over water …6
[any two parts …3]
Method: correct labelled arrangement of apparatus … 3
heat ethanol and acid mixture // heat aluminium oxide (stated or shown) … 3

Question 12

(a) Define the first ionisation energy of an element. **2×3**

energy required to remove most loosely bound / first / outermost electron …3
from a neutral / gaseous / isolated atom …

Explain why first ionisation energies generally increase across a period of the Periodic Table. **2×3**

atomic radius decreasing …3
nuclear charge increasing …3

Explain why beryllium, despite this general increase, has a higher first ionisation energy than boron, and nitrogen has a higher first ionisation energy than oxygen. **2×3, 4**

Be = $1s^2\ 2s^2$ / Be has a full s-subshell / Boron has one electron in p-subshell …3
N = $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$ ($2p^3$) / nitrogen has a half filled p-subshell …3

extra stability / more difficult to remove an electron …4

(b) Describe what is observed when ethene reacts with a solution of bromine. **4**

decolourised …4

What does this reaction tell you about the bonding in ethene? **4**

contains a double/triple bond / ethene is unsaturated …4

Name (i) the reagent used in the mono-bromination of benzene **4**

bromine / Br_2 …4

(ii) the catalyst used in the mono-bromination of benzene. **4**

$FeBr_3$ / iron(III) bromide / ferric bromide / iron / Fe …4

The mono-bromination of benzene is a substitution reaction rather than an addition reaction. What does this tell you about the bonding in benzene? **6**

benzene has neither a double nor a triple bond
bonding in benzene is stable / aromatic nucleus is not easily broken any one …6

Question 12 (continued)

(c) Give the formula of an alkali metal hydride **4**
LiH / NaH / KH, etc …4

Write a balanced chemical equation for its reaction with water. **3**
$NaH + H_2O \rightarrow NaOH + H_2$ …3

Which of the following chlorides is a coloured compound? Justify your choice. **2×3**
$FeCl_3$ …3
transition metal compounds are coloured / Fe is a transition metal …3

Give the formula for (i) an acidic covalent oxide (ii) a basic ionic oxide (iii) a neutral oxide **3×3**
(i) CO_2 / SO_2 / SiO_2 / P_4O_{10} / Cl_2O_7, etc …3
(ii) MgO / CaO / Na_2O/ FeO etc …3
(iii) CO /NO /N_2O …3

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

Calculate the heat change for the reaction $Fe_2O_{3\,(s)} + 2Al_{(s)} \rightarrow 2Fe_{(s)} + Al_2O_{3\,(s)}$ **4×4**

$2Al_{(s)} + 1½O_{2\,(g)} \rightarrow Al_2O_{3\,(s)}$ / $\Delta H = -1669$ kJ //

$4Al_{(s)} + 3O_{2\,(g)} \rightarrow 2Al_2O_{3\,(s)}$ / $\Delta H = -3338$ kJ …4

$1½CO_{2\,(g)} \rightarrow 1½C_{(s)} + 1½O_{2\,(g)}$ / $\Delta H = 589.5$ kJ //

$3CO_{2\,(g)} \rightarrow 3C_{(s)} + 3O_{2\,(g)}$/ $\Delta H = 1179$ kJ …4

$Fe_2O_{3\,(s)} + 1½C_{(s)} \rightarrow 2Fe_{(s)} + 1½CO_{2\,(g)}$ / $\Delta H = 232.5$ kJ //

$2Fe_2O_{3\,(s)} + 3C_{(s)} \rightarrow 4Fe_{(s)} + 3CO_{2\,(g)}$ / $\Delta H = 465$ kJ …4

$2Al_{(s)} + Fe_2O_{3\,(s)} \rightarrow 2Fe_{(s)} + Al_2O_{3\,(s)}$ $\Delta H = -847$ kJ …4