



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2012

Marking Scheme

Chemistry

Ordinary Level

Introduction

In considering the marking scheme the following should be noted.

1. In many cases only key phrases are given which contain the information and ideas that must appear in the candidate's answer in order to merit the assigned marks.
2. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.
3. The detail required in any answer is determined by the context and the manner in which the question is asked, and by the number of marks assigned to the answer in the examination paper and, in any instance, therefore, may vary from year to year.
4. The bold text indicates the essential points required in the candidate's answer. A double solidus (//) separates points for which separate marks are allocated in a part of the question. Words, expressions or statements separated by a solidus (/) are alternatives which are equally acceptable for a particular point. A word or phrase in bold, given in brackets, is an acceptable alternative to the preceding word or phrase. Note, however, that words, expressions or phrases must be correctly used in context and not contradicted, and where there is evidence of incorrect use or contradiction, the marks may not be awarded.
5. In general, names and formulas of elements and compounds are equally acceptable except in cases where either the name or the formula is specifically asked for in the question. However, in some cases where the name is asked for, the formula may be accepted as an alternative.
6. There is a deduction of one mark for each arithmetical slip made by a candidate in a calculation.

Outline Marking Scheme

Section A [At least two questions must be answered from this section]

Eight questions to be answered in all. These *must* include at least **two** questions from Section A.

Section A

Question 1 (a) $(5 + 3)$; (b) (2×3) ; (6); (c) (6); (d) $(6 + 3 + 3)$; (e) $(6 + 3 + 3)$.

Question 2 (a) $(5 + 3)$; (3); (b) $(6 + 2 \times 3)$; (c) (6); (d) (3); (e) (3); (2×3) ; (f) (9).

Question 3 (a) $(5 + 3)$; (b) $(6 + 3)$; (c) (2×3) ; (3); (d) (i): (9); (ii): (6); (iii): (3); (e) (6).

Section B

Question 4

Eight highest scoring items to count. One additional mark to be added to the first two items for which the highest marks are obtained.

(a) (6); (b) (6); (c) (2×3) ; (d) (2×3) ; (e) (2×3) ; (f) (2×3) ; (g) (2×3) ; (h) (6); (i) (6); (j) (6); (k) **A**: (6); **B**: (6).

Question 5 (a) $(5 + 3)$; (b) (7×3) ; (c) (6); (d) (2×3) ; (3); (e) (6).

Question 6 (a) (5); (b) $(6 + 3)$; (2×3) ; (c) (i), (ii), (iii) $(2 \times 6 + 2 \times 3)$; (d) (i), (ii) $(9 + 3)$.

Question 7 (a), (5); (i): (6); (ii): (6); (b) $(6 + 3)$; (c) (3); (6); (d) (i) (3); (ii) (2×3) ; (iii) (2×3) .

Question 8 (a) $(5 + 3)$; (b) $(2 \times 6 + 2 \times 3)$; (c) (2×3) ; (d) (6); (e) (6); (2×3) .

Question 9 (a) $(5 + 3)$; (b) (2×3) ; (c) (3); (3); (2×3) ; (d) (3); (3); (2×3) ; (e) (2×3) ; (6).

Question 10 (a) (i): $(4 + 3)$; (ii) $(2 \times 3) + (2 \times 3)$; (iii) (6).
(b) $(4 + 3)$; (6); (6); (6).
(c) $(3 \times 6) + (1 \times 4) + (1 \times 3)$.

Question 11 (a) (i): (4); (ii): (6); (iii): (6); (iv): (6); (v): (3).
(b) (i): (7); (ii): 6; (iii) (2×3) ; (2×3) .
(c) **A** (i) $(4 + 3)$; (ii) (3); (2×3) ; (iii) (3); (iv) (6).
B (i) (5×3) ; (ii) (2×3) ; (4).

SECTION A

At least **two** questions must be answered from this section.

QUESTION 1

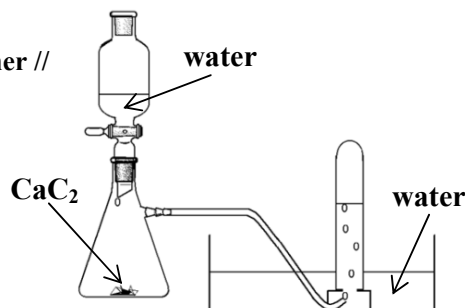
(a) IDENTIFY: (i) **ethanol / C₂H₅OH / CH₃CH₂OH //**
 (ii) **aluminium oxide / alumina / Al₂O₃** (5 + 3)

(b) PREVENT: **before heating is stopped (removed, turned off) / at the end //**
remove delivery tube from water /
loosen stopper before removing heat (2 × 3)

RISK: **cold water sucked into test tube / test tube cracks /**
fire / explosion / injury due to broken glass (6)

(c) NAME: **elimination / dehydration** (6)

(d) DRAW: **dropping funnel and buchner //**
collection over water //
calcium(II) dicarbide /
calcium dicarbide /
calcium carbide /
CaC₂ in flask //



water in funnel ANY THREE: (6 + 2 × 3)
 [Absence of diagram lose 3 marks]

(e) EXPLAIN: **having a double (triple) carbon-carbon bond //**
shake with (bubble through, add to) bromine (Br₂) water (solution) /
acidified potassium manganate(VII) (permanganate, KMnO₄, MnO₄⁻)
soln. //

reagent decolourised (6 + 2 × 3)

QUESTION 2

- (a) NAME: **A pipette //**
B burette (5 + 3)

WHY: **safety / hygiene / avoid solution in mouth / avoid swallowing / solution (NaOH) may be corrosive (burning, dangerous, poisonous)** (3)

- (b) RINSE: **with deionised (distilled, pure) //**
water //
with a little of the solution to be measured (6) (2 × 3)

- (c) EXPLAIN: last drop would **add to (give more than) the required (measured) volume / pipette designed to deliver (give) the required (measured) volume with last drop left in it /**
pipette designed to deliver (give) the required (measured) volume without removing the last drop / pipette designed to retain last drop (6)

- (d) NAME: **titration (conical) flask / wash (squeeze) bottle / beaker / glass rod / white tile / funnel / retort stand** (3)

- (e) INDIC: **name of suitable indicator** (3)
initial colour // final colour (2 × 3)

[Indicator and colour change must match to achieve full marks]

methyl orange	orange (yellow) to red (accept pink, peach)
methyl red	yellow to red (accept pink)
phenolphthalein	pink (purple, violet, red) to colourless
bromothymol blue	blue to yellow
cresol purple	purple (pink, violet) to yellow
neutral red	yellow-brown (yellow, brown) to red
phenol red	red to yellow
bromothymol blue	blue to yellow
thymolphthalein	blue to colourless

- (f) CALC: **0.064** moles per litre (9)
[Accept 0.06]

$$\begin{array}{l} 25 \times M_{\text{NaOH}} \quad (3) = \quad 20 \times 0.08 \quad (3) \\ M_{\text{NaOH}} = \quad 0.064 \quad (3) \end{array}$$

QUESTION 3

(a) EXPLAIN: heat change when **one mole of HCl** /
heat change when **one mole of NaOH** /
heat change when the numbers of **moles in the equation** //
react(s) completely / neutralise(s) completely (5 + 3)

(b) WHAT: reaction in which **heat is lost (emitted, evolved, given out)** /
reaction for which **ΔH is negative (minus, -)**
STATE: **heat was produced / temperature rose** (6 + 3)

(c) INDIC: polystyrene **cup // cover** (2 × 3)
EXPLAIN: *cup*: polystyrene a good **insulator (poor conductor)** /
cover: **stops escape (loss) upwards of heat / insulator (poor conductor)** (3)

(d) CALC: (i) **0.2 moles** (9)

$\frac{100}{1000} \times 2 \quad / \quad \frac{2}{10} \quad (6)$
$= 0.2 \quad (3)$

(ii) **57 kJ mol⁻¹** (6)

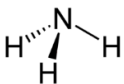
$\frac{11.4}{0.2} \quad / \quad 11.4 \times 5 \quad (3)$
$= 57 \quad (3)$

ΔH **- 57 kJ mol⁻¹** (3)

(e) SYMBOL: **corrosive** (6)

SECTION B

Eight items to be answered. Six marks to be allocated to each item and one additional mark to be added to each of the first two items for which the highest marks are awarded.

- (a) NAME: **solid, liquid, gas** (6)
- (b) IDENT: **nitrogen / N** (6)
- (c) WHAT: **two or more elements // combined (bonded, joined chemically)** (2 × 3)
- (d) COLOUR: (i) *lithium: red / crimson //*
(ii) *copper: blue-green / green* (2 × 3)
- (e) DEFINE: **relative attraction //**
for shared pair of electrons / for electrons in a covalent bond (2 × 3)
- (f) REAG: **iron(II) sulfate / ferrous sulfate / FeSO₄ //**
concentrated sulfuric acid / H₂SO₄ (2 × 3)
- (g) EFFECT: **stream attracted (deflected towards, moves towards, bends towards) rod** (6)
[Allow 3 marks for 'deflected']
- (h) SHAPE: **pyramidal /**  (6)
[Accept "tetrahedral" for 3 marks]
[Accept diagram with or without lone pair.]
- (i) WHAT: **16 g**
[Allow (3) for 0.5 moles or 11.2/22.4 moles]
- (j) STATE: **finding relative atomic mass (molecular mass) / separating isotopes /**
finding percentages (relative abundances) of isotopes / identification /
determining structure / analysing waste gases (from cars, dumps, etc.) /
water analysis / environmental analysis / detecting drug metabolites /
quality control (6)
- (k) **A**
EXPL: **products formed other than (as well as) the main (principal) product** (6)
or
B
GIVE: **Bragg** (6)

QUESTION 5

- (a) DEFINE: (i) **atom: the smallest part of an element / tiny particle of matter //**
- (ii) **molecule: group of atoms combined (bonded, joined together) / smallest part of element (compound, substance) that can exist independently (free, on its own)** (5 + 3)

- (b) FILL: (7 × 3)

PARTICLE	RELATIVE MASS	RELATIVE CHARGE	LOCATION
electron (3)	0.0005 to 0.00056* (3)	-1	cloud / shell(s) / outside nucleus (3)
neutron (3)	1	0	nucleus (3)
proton	1 (3)	1 / +1 / + (3)	nucleus

* $\frac{1}{2000}$ to $\frac{1}{1800}$ [Accept "negligible"]

- (c) WHAT: **it has one proton only // it has no neutron** (6)

- (d) SIM: **number of protons (6 protons) // number of electrons (6 electrons)** (2 × 3)

- DIFF: **number(s) of neutrons / 6 neutrons in carbon-12, 8 neutrons in carbon-14 / two neutrons extra in carbon-14** (3)

- (e) NAME: **Ernest Rutherford** (6)

QUESTION 6

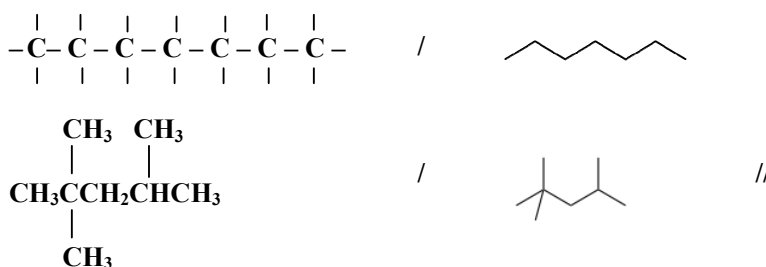
(a) WHAT: compounds which **contain carbon and hydrogen only** (5)

(b) NAME: refinery gas // light gasoline (petrol) // naphtha // kerosene //
gas oil (diesel) // residue (bitumen) ANY TWO: (6 + 3)

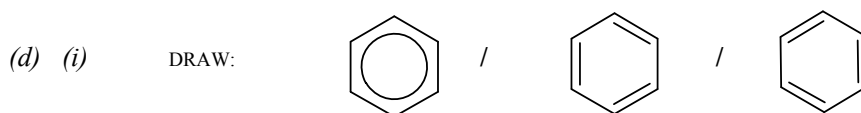
GIVE: refinery gas: cooking / heating / LPG / refinery fuel //
light gasoline: motor fuel / petrol //
naphtha: motor fuel / petrol / petrochemicals //
kerosene: heating / cooking / lighting (lamps) / jet fuel //
gas oil: motor fuel / diesel / feedstock for cracking //
residue: heavy fuel oil / bitumen / road surfaces / waterproofing / roofing /
lubricants / waxes / greases / feedstock for cracking
[The two uses must correspond to the two named fractions, one
for each fraction.] (2 × 3)

(c) (i) WHAT: heptane: 0 //
2,2,4-trimethylpentane: 100 //

(ii) WRITE: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ / $\text{CH}_3(\text{CH}_2)_5\text{CH}_3$ /



(iii) STATE: isomerisation / reforming / dehydrocyclisation / cracking /
additive(s) / oxygenate(s) / alcohol / ethanol / methanol /
methyl-*t*-butyl ether (MTBE, 2-methoxy-2-methylpropane) /
lead compounds / addition of high octane substrates (ring cpds.,
short chained cpds., branched cpds.) ANY FOUR: (2 × 6 + 2 × 3)



(ii) WHAT: **carcinogenic** (9 + 3)

QUESTION 7

(a) DEFINE: $-\log [\text{H}^+] / -\log [\text{H}_3\text{O}^+] /$ negative (–) log of the hydrogen ion (H^+)
 {hydronium ion (H_3O^+)} concentration (5)

CALC: (i) 12 (6)

$\text{pOH} = -\log 0.01 / = 2$ (3)	$[\text{H}^+] = 10^{-14} \div 0.01 = 10^{-12}$ (3)
$\text{pH} = 14 - 2 / = 12$ (3)	$\text{pH} = -\log 10^{-12} = 12$ (3)

(ii) 1 (6)

$3.65 \div 36.5 / = 0.1$ (3)
$\text{pH} = -\log 0.1 / = 1$ (3)

(b) (i) lime (calcium hydroxide) / washing soda (sodium carbonate) / soda ash /
 caustic soda (sodium hydroxide) / base [Name or formula]//

(ii) sulfuric acid / carbon dioxide / carbonic acid / acid (6 + 3)

(c) NAME: aluminium sulfate /aluminium chloride / aluminium(III) / alum /
 iron(III) sulfate (ferric sulfate) / iron(III) chloride (ferric chloride) /
 iron(III) / lime (calcium hydroxide) / polyelectrolytes [Name or formula] (3)

EXPLAIN: causes fine suspended particles (solids) clump (join together, coagulate,
 aggregate) / forms flocs / helping sedimentation (settlement, sinking) /
 helping filtration (6)

(d) (i) does not readily form lather with soap /
 forms scum with soap /
 contains calcium ions (Ca^{2+}) /
 contains Ca salts (or named soluble Ca salt) /
 contains magnesium ions (Mg^{2+}) /
 contains Mg salts (or named soluble Mg salt) (3)

(ii) temporary: removed by boiling (heating) / contains dissolved $\text{Ca}(\text{HCO}_3)_2$ //
 permanent: not removed by boiling (heating) /
 contains appropriate dissolved Ca or Mg salt (2 × 3)

[If only one is given, assume the other; if the words “temporary” and “permanent”
 are omitted, follow the order of the question in assigning marks.]

(iii) advantage: healthy / has calcium / good for bones (teeth) / good for
 brewing (tanning) / nice taste //
 disadvantage: wastes soap / blocks pipes / scale (deposit) on kettles (boilers) /
 scum on baths, sinks, etc. / could cause explosion in boilers (2 × 3)

QUESTION 8

(a) EXPLAIN: **general formula // differ by CH₂ // same functional group // similar chemical properties // gradation in physical properties // similar preparation** ANY TWO: (5 + 3)
 [Accept “uniform chemical type” for “similar chemical properties.”]

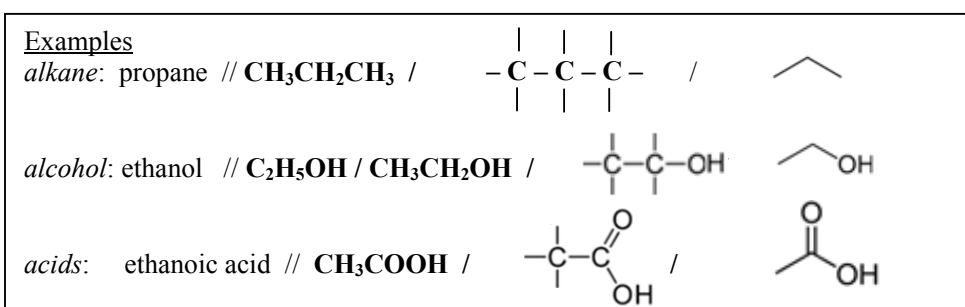
(b) GIVE: **name 1 // name 2**

[Accept “methyl alcohol” for methanol; accept “formic” & “acetic” for “methanoic” & “ethanoic” resp.]

structure 1 // structure 2

(2 × 6 + 2 × 3)

[For the alkane, the minimum required is that all Cs must be separated e.g. CH₃CH₃ for ethane. However, methane must be fully expanded. For the alcohol and carboxylic acid, the functional group must be shown but the alkyl radical need not be expanded.]



(c) GIVE: **use of 1 // use of 2**

(2 × 3)

<p><u>Uses:</u> methane: fuel / cooking / heating / electricity generation / hydrogen prod. ethane: prod. of ethene / prod. of chloroethene (vinyl chloride) / prod. of ethanoic (acetic) acid propane: fuel / LPG / cooking / heating butane: fuel / LPG / cooking / heating / cigarette lighters // methanol: fuel / solvent / denaturing agent (methylated spirit) / antifreeze / camping stoves / fuel cells ethanol: drinks / fuel / solvent / antiseptic / disinfectant / preservative / spirit lamps / production of esters (halides) // methanoic acid: preservative / silage-making / tanning / dyeing / cleaning fluid ethanoic acid: preserving / pickling / flavouring / cellulose acetate [The uses must match the two compounds named in (b)]</p>	(2 × 3)
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(d) TYPE: **oxidation**

(6)

(e) GIVE: **carbon dioxide / CO₂**

(6)

TEST: bubble through limewater [calcium hydroxide {Ca(OH)₂} solution] //

turns milky / goes cloudy / white precipitate (ppt) produced / precipitate of calcium carbonate (CaCO₃) produced

(2 × 3)

QUESTION 9

- (a) DEFINE: (i) **loss of electrons** // (5 + 3)
(ii) **gain of electrons**
- (b) IDENT: (i) **sodium / Na** // (2 × 3)
(ii) **chlorine / Cl₂ / ½Cl₂ [Accept Cl.]**
- (c) NAME: **covalent / single / sigma** (3)
GIVE: **fluorine (F₂) / bromine (Br₂) / iodine (I₂) / astatine (At₂) / ozone (O₃) / sulfur (S₈) / phosphine (PH₃) / name or formula of organic molecule** (3)
[Accept molecules with multiple bonds such as O₂ and N₂ and polar covalent molecules.]
STATE: **low m.p. (liquids) // low b.p. (gases) // insoluble (slightly soluble) in polar solvents (water) // soluble in non-polar (organic) solvents (named solvent e.g. cyclohexane) // non-conductor of electricity // soft solids** ANY TWO: (2 × 3)
- (d) TYPE: **ionic / electrovalent** (3)
GIVE: **metal (ammonium) chloride, sulfate or nitrate [lithium chloride (LiCl) / potassium sulfate (K₂SO₄) / ammonium nitrate (NH₄NO₃) / etc.]** (3)
STATE: **high m.p. // high b.p. // solids // soluble in polar solvents (water) // insoluble in non-polar (organic) solvents (named solvent e.g. cyclohexane) // do not exist as molecules // exist as ionic crystal lattices // conductors of electricity // hard solids** ANY TWO: (2 × 3)
- (e) DESC: **reaction // sodium forms sphere (ball) // floats // moves about // decreases in size (gradually disappears) // small spark (flash) // soapy solution formed / fizzing / bubbling** ANY TWO: (2 × 3)
NAME: **sodium hydroxide (caustic soda) / hydrogen** *[Accept formula.]* (6)

QUESTION 10

(a) (i) **hydrogen peroxide // H_2O_2** (4 + 3)

(ii) See graph below.

axes correctly labelled // axes correctly scaled // time axis correctly labelled and scaled // volume axis correctly labelled and scaled

[Accept "time" or "min" & "vol" or " cm^3 ."]]

ANY TWO: (2 × 3)

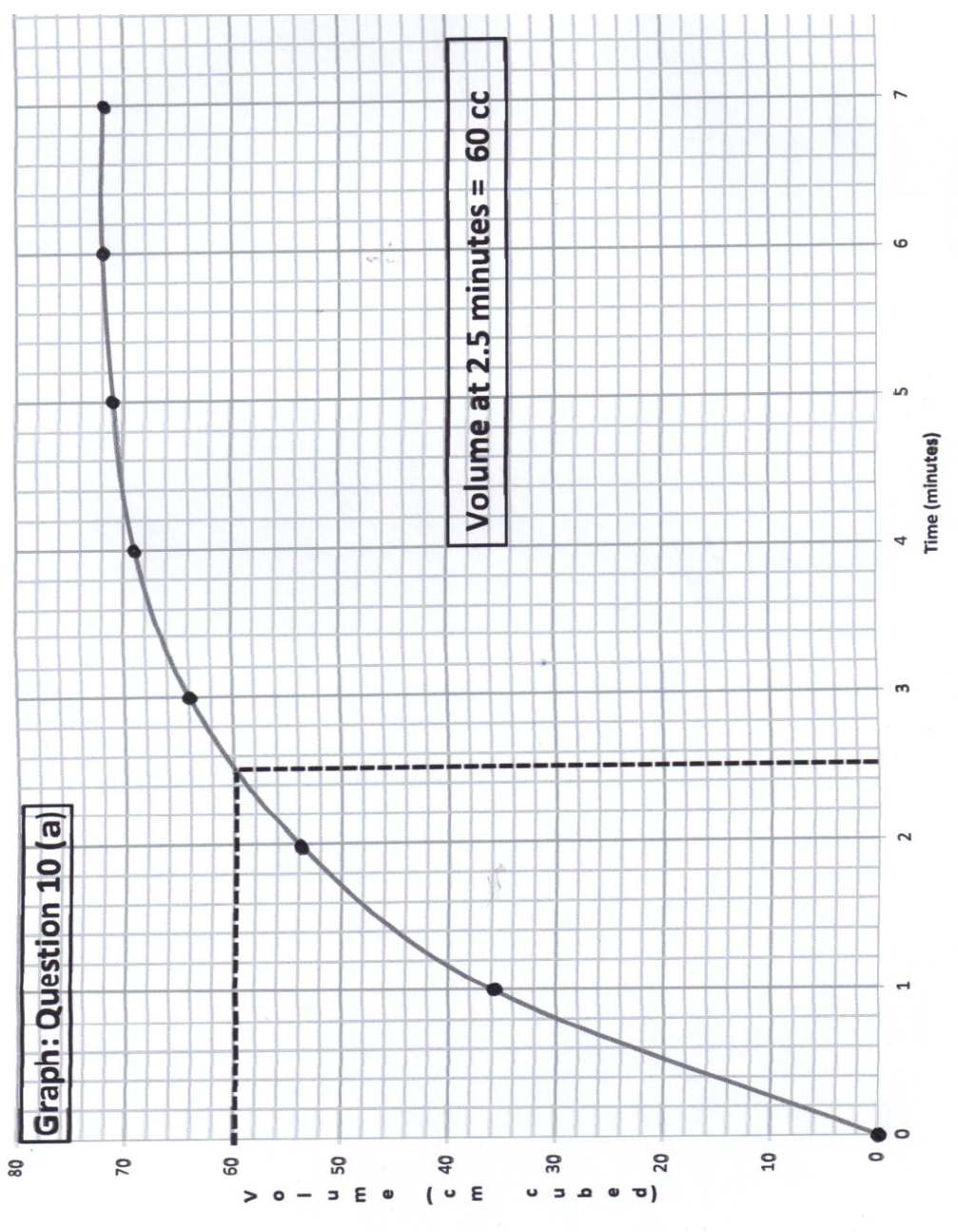
six points correctly plotted //

curve correctly drawn

(2 × 3)

(iii) See graph below **58 to 62 cm^3**

(6)



Question 10 continued/

(b) WHAT: average **mass of molecule(s)** //
relative to (based on, compared with) $^{1/12}$ mass of **carbon-12** atom (4 + 3)

CALC: **180** (6)

$$\begin{aligned} & 6 \times 12 + 12 + 6 \times 16 / 72 + 12 + 96 & (3) \\ & = 180 & (3) \end{aligned}$$

FIND: **6.6 to 6.7%** (6)

$$\frac{12}{180} (3) // \times 100 (3) / = 6.6 \text{ to } 6.7 (3)$$

HOW: **0.05 mol** (6)

$$\frac{9}{180} (3) = 0.05 (3)$$

(c) WRITE: **1: The Greeks //**

2: Boyle //

3: Davy //

4: Mendeleev //

5: Moseley (3 × 6) + (1 × 4) + (1 × 3)

QUESTION 11

- (a) (i) **steam distillation** (4)
- (ii) **condenser** (6)
- (iii) **tube A** (6)
- (iv) **safety / release pressure / release steam / prevent explosion / vent** (6)
- (v) **clove oil (eugenol) / rose oil / oil of lavender / oil of thyme / oil of fennel / citrus (orange, lemon, lime, grapefruit) oil / other correct substance** (3)
- (b) (i) **rate of forward reaction = rate of backward (reverse) reaction / a steady state where concentrations of reactants and products are static (unchanging)** (7)
- (ii)
$$\frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$$
 (6)
- (iii) STATE: if a system **at equilibrium** is disturbed (experiences a stress) // **it tends to minimise (oppose, relieve) the disturbance (stress)** (2 × 3)
or
if a system is disturbed (experiences a stress) // it tends to minimise (oppose, relieve) it (2 × 3)
- EXPLAIN: reaction **shifts (goes) to left (backward, reverse, to reactants, endothermic direction) //**
to oppose (offset) temperature rise / to lower temperature / to absorb heat / to relieve disturbance (stress) (2 × 3)
[Accept “because forward reaction is exothermic” or “increase in temperature favours endothermic reaction” for 6 marks]

Question 11 continued/

(c) **A**

(i) NAME: **name of main product //**
STATE: **one important use** (4 + 3)

(ii) WHERE: **location** (3)

GIVE: two reasons that are appropriate to the chosen location such as:
workforce available // transport (road, rail, river, sea, air) available // raw materials near // local demand for product // river (sea) for cooling // important for local economy // etc. (2 × 3)

(iii) STATE: **safety training / protective clothing / ear muffs / first aid / medical personnel (doctor, nurse) available / fire service available / fire drills / alarms (sirens) / restricted areas / etc.** (3)

(iv) SUGGEST: **heat exchangers / better catalysts / recycling / co-products / improved efficiency / cheaper labour (lower wages) / sourcing cheaper raw materials / reducing transport costs / etc.** (6)

or

B

(i) COPY:

PROPERTY	METALS	NON-METALS
Hardness	hard /	soft //
Lustre	yes /	no //
Conduction of heat	yes /	no //
Conduction of electricity	yes /	no //
Ductility	yes /	no //

(5 × 3)

(ii) ALLOY: **mixture // of metals/ of metal and non-metal** (2 × 3)

EXAMPLE: **steel / brass / bronze / nichrome / alnico / solder / pewter / etc** (4)

