Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2008

MARKING SCHEME

CHEMISTRY

HIGHER LEVEL

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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 <u>two</u> questions must be answered from this section]

1. (a) Why: 5; (b) Describe: 5 x 3; (c) Name: 3 Justify: 3 State: 2 x 3; (d) Calc: (i) 6 (ii) 3 State: 3 Express: 3; (e) Identify: 3.

2. (a) Describe: 5 x 3; (b) Explain: 6; (c) What: 3; (d) Name: 2 x 3; (e) Explain: 6; (f) Describe: 6 Name: 3; (g) Calculate: 5.

3. (a) Draw: 5; (b) Write: 2 x 3; (c) Draw: 3, 6, 3; (d) Plot: 4 x 3 Explain: 3; (e) (i) 6 (ii) 6.

4. (a) 6; (b) 6; (c) 2 x 3; (d) 6; (e) 3, 3; (f) 2 x 3; (g) 2 x 3 or 6; (h) (i) 3 (ii) 3; (i) 6; (j) 2 x 3; (k) **A** 2 x 3 or **B** 2 x 3.

5. (a) Define: 3 + 2; (b) State: 3 Explain: 2 x 3; (c) Bonds: 3 x 3; (d) 2 x 3; (e) Explain: 6; (f) Use: 3 Suggest: 3; (g) Account: 2 x 3 Explain: 3.

6. (a) (i) What: 5 (ii) Draw: 2 x 3 (iii) Name: 2 x 3 (iv) What: 2 x 3 (v) Example: 3 Give: 2 x 3; (b) Write: 2 x 3 Calc: 12.

7. (a) What: 5 When: 3 Explain: 3; (b) Write: 6 Calc: 12; (c) State: 2 x 3 Predict: (i) 3 (ii) 3 Explain: 3 Change: 3 Explain: 3.

8. (a) (i) Write: 3, 2 (ii) Define: 3 Show: 3, 3, 3 (iii) Strong: 3 Weak: 9; (b) (i) Expl: 3 x 3 (ii) Two: 2 x (2 x 3).

9. (a) Draw: 2 x 4; (b) Isomer: 6 Indicate: 2 x 3; (c) Explain: 6; (d) Draw: 6 Give: 3 x 3 How: 3; (e) Name: 3 Draw: 3

10. (a) (i) Suspended: 3 x 3 (ii) Dissolved: 3 x 3 (iii) Test: 4 + 3.

(b) Define: (i) & (ii) 4 + 3 (iii) 1^{st}: 3 2^{nd}: 3 (iv) 1^{st}: 2 x 3 2^{nd}: 2 x 3.

(c) (i) Define: 4 (ii) States: 2 x 3 (iii) Name: 3 (iv) Explain: 4 x 3.

11. (a) (i) Catalyst: 4 (ii) Alcohol: 3 (iii) Draw: 3 Class: 3 (iv) Which: 3 Name: 3 Structure: 3 (v) Use: 3.

(b) (i) Mass: 6 (ii) Moles: 6 (iii) Volume: 6 SUV: 7.

(c) **A** (i) Explain: 4 + 3 (ii) State: 2 x 3 (iii) What: 3 x 3 (iv) Name: 3.

(c) **B** (i) Name: 4 What: 3 (ii) Pos: 2 x 3 Neg: 2 x 3 (iii) What: 3 Why: 3.

SECTION A

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

QUESTION 1

(a) WHY: **vinegar (it) too concentrated / would require very concentrated (corrosive) NaOH solution / to suit concentration of NaOH solution /** very **large volume* of NaOH needed to be get a reasonable titration / small** acid **titration volume lowers accuracy /**
small acid **titration volume increases** percentage **error** *[*Allow "value", "figure", "amount"]* (5)
[In the absence of adequate qualification, allow 3 marks for "for accuracy", "large volume of NaOH needed", "small titration figure(s) / titration figure(s) too small / end point(s) too low"]

(b) DESCRIBE: **rinse pipette (burette) with water //**
and then with **vinegar //**
fill with **pipette filler / have bottom of meniscus on mark / read** pipette (burette)
at eye level (vertically) //
deliver (add, let flow) 25 cm^3 **to** 250 cm^3 **volumetric flask //** ***available from diagram***
add deionised (distilled, pure) water until level of water near mark //
add **dropwise (by dropper / by pipette / by wash bottle) //**
bring **bottom of meniscus to (on, at) mark /** vol. flask **at eye-level (vertical) //**
stopper and **invert** several times / **mix** thoroughly / solution **homogeneous (even concentration, same concentration throughout)** ANY FIVE: (5 × 3)

(c) NAME: **phenolphthalein / thymolphthalein / thymol blue / cresol purple / neutral red / phenol red / bromothymol blue** (3)

JUSTIFY: **pH change (drop, jump** down**)** at end point **c11 – c6 (c6 – c11)* / specify indicator range /** titration of **weak acid-strong base / pH at end point passes through indicator range** (3)
**Change of three to five units of pH required. [Allow "passes through midpoint of range".]*
Name and Justify are not linked.

STATE: **colour before (in base, in NaOH) // colour after (in acid)** (2 × 3)

phenolphthalein	pink (purple, violet, red) // colourless
thymolphthalein	blue // colourless
thymol blue	blue // yellow
cresol purple	purple (pink, violet) // yellow
neutral red	yellow-brown (yellow, brown) // red
phenol red	red // yellow
bromothymol blue	blue // yellow

[Colour change must be matched with chosen indicator. Allow 3 for reversed colour change.]

(d) CALC: (i) **0.11** mol l^{-1} *[Multiplied (or divided) by 4:loses 3 marks.]* (6)

Mean titre = $(22.6 + 22.7)/2 = 22.65$ *[Loses 3 if incorrect]*
$22.65 \times M = 25.0 \times 0.10$ (3) $M = 0.11$ (3)

(ii) **6.6** g l^{-1} (3)

$0.11 \times 60^* = 6.6$ (3)
** Addition must be shown for error to be treated as a slip.*

STATE: **66** g l^{-1} (3)

$6.6 \times 10 = 66$ (3)

EXPRESS: **6.6** % (w/v) (3)

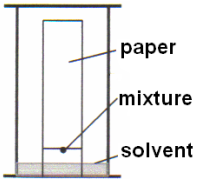
$66 \div 10 = 6.6$ (3)

(e) IDENTIFY: **methanoic (formic)** acid / **HCOOH / CH_2O_2** (3)
[If name & formula are given and one is incorrect, award marks on basis of first answer given.]

QUESTION 2

(a) DESCRIBE:

Paper chromatography *[Lid not required in diagram.]*



apply mixture using dropper (capillary tube) / spotting on paper (3)
[Some description of application required.]

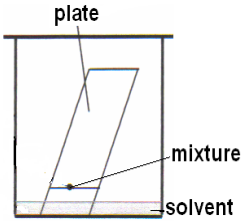
about 2 cm **above eluent*** / just **above (or below:** *see note 2*) **eluent** (3)

place in tank (beaker, other suitable container) with eluent* (3)

elute (solvent moves up – or down – *see note 1*) (3)

state or show separation of components of mixture (3)

Thin-layer chromatography *[Lid not required in diagram.]*



apply mixture using dropper (capillary tube) / spotting on plate (3)
[Some description of application required.]

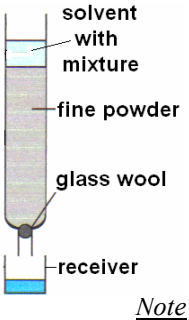
about 2 cm **above eluent*** / just **above eluent*** (3)

place plate in tank (beaker, other suitable container) with eluent* (3)

elute (solvent moves up – *see note 1*) (3)

state or show separation of components of mixture (3)

Column chromatography



dissolve mixture in eluent* // add to column /
add mixture to column // add eluent* (2 x 3)

continue to add eluent* so that it flows through column (3)

separation occurs / bands shown (3)

collect components / show separation into bands (3)

* *Accept mobile phase, solvent or named solvent*

Note 1: *The elution stage (point 4 above) must be clearly cited, either by a statement to that effect, or by clearly shown (labelled) solvent fronts in the case of paper or thin-layer chromatography.*

Note 2: *In paper chromatography, the solvent can be at the top of the tank and move down the paper.*

Note 3: *If no diagram, or diagram without at least one label, deduct 3,but only if at least 3 marks have been awarded.*

(b) EXPLAIN: **diff. adsorbance** on **(affinity** for, **attraction** for, **interaction** with, **partitioning** between) **mobile (or name) and (or) stationary (or name) phases** (6)

(c) WHAT: **do not mix / do not dissolve** in **each other** (3)

(d) NAME: **name // plant material** *[Correct order not required.]* (2 x 3)

clove oil (eugenol) // cloves	rose oil // rose petals	oil of lavender // lavender
citrus (orange, lemon, grapefruit) oil // orange, etc., skins		oil of thyme // thyme
oil of fennel // fennel	other correct name // plant material	

(e) EXPLAIN: **release of pressure / prevents build up of steam / avoids explosion** (6)
[allow 3 marks for 'safety' without further correct clarification]

(f) DESCRIBE: **cloudy** liquid / **milky / white (creamy)** liquid (6)
[Allow 3 marks for " emulsion".] *Cancelling applies*

NAME: **solvent extraction / shake with suitable solvent (cyclohexane, ether, etc.)** (3)
[Allow 3 marks for mention of 'cyclohexane' etc. without qualification]

(g) CALCULATE: **1.25** % (5)

$^{0.25}/_{20}$ (3) $\times 100 = 1.25$ (2)

QUESTION 3

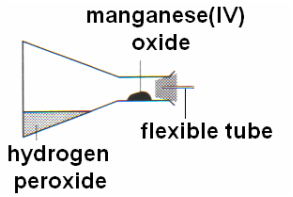
(a) DRAW:  OR **circle (ball, sphere, ring) with flames** rising (5)

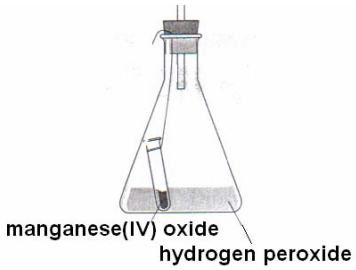
[Diagram need not show box or other border.]

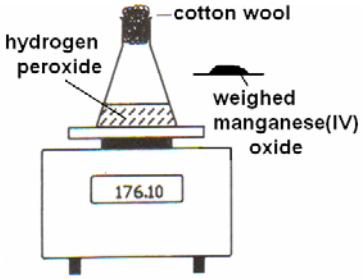
(b) WRITE: $\mathbf{H_2O_2 \rightarrow H_2O + {}^1/_2O_2}$ / $\mathbf{2H_2O_2 \rightarrow 2H_2O + O_2}$ FORMULAS: (3) BALANCING: (3)

(c) DRAW: **apparatus with hydrogen peroxide and catalyst** separate (3)

arrangement for mixing at a precise time (see diagrams and note) (6)







Note: *Allow "addition of solid catalyst followed by immediate stoppering" only if clearly stated. Completely unlabelled diagram (– 3)*

suitable method of monitoring rate shown on diagram {graduated cylinder over water / graduated gas syringe / pressure sensor (manometer) / balance} (3)

Note: *Allow syringe method only if stated that liquid volume is subtracted from each reading or that the syringe is pulled back to original level.*

(d) PLOT: see sample graph overleaf
axes accurately labelled with numbers //
axes with correctly labelled units (quantities) //
eight points accurately plotted //
curve accurately drawn from origin (4 x 3)

Note: *If not on graph paper, accuracy must be checked with ruler.*

EXPLAIN: **greatest rate** // **highest concentration** of H_2O_2 // **most collisions** (3)

[Accept "rate decreases". Do not accept "amount" for "concentration".]

(e) (i): see graph overleaf

4.0 – 6.0 $cm^3\ min^{-1}$ (from correctly drawn tangent) (6)

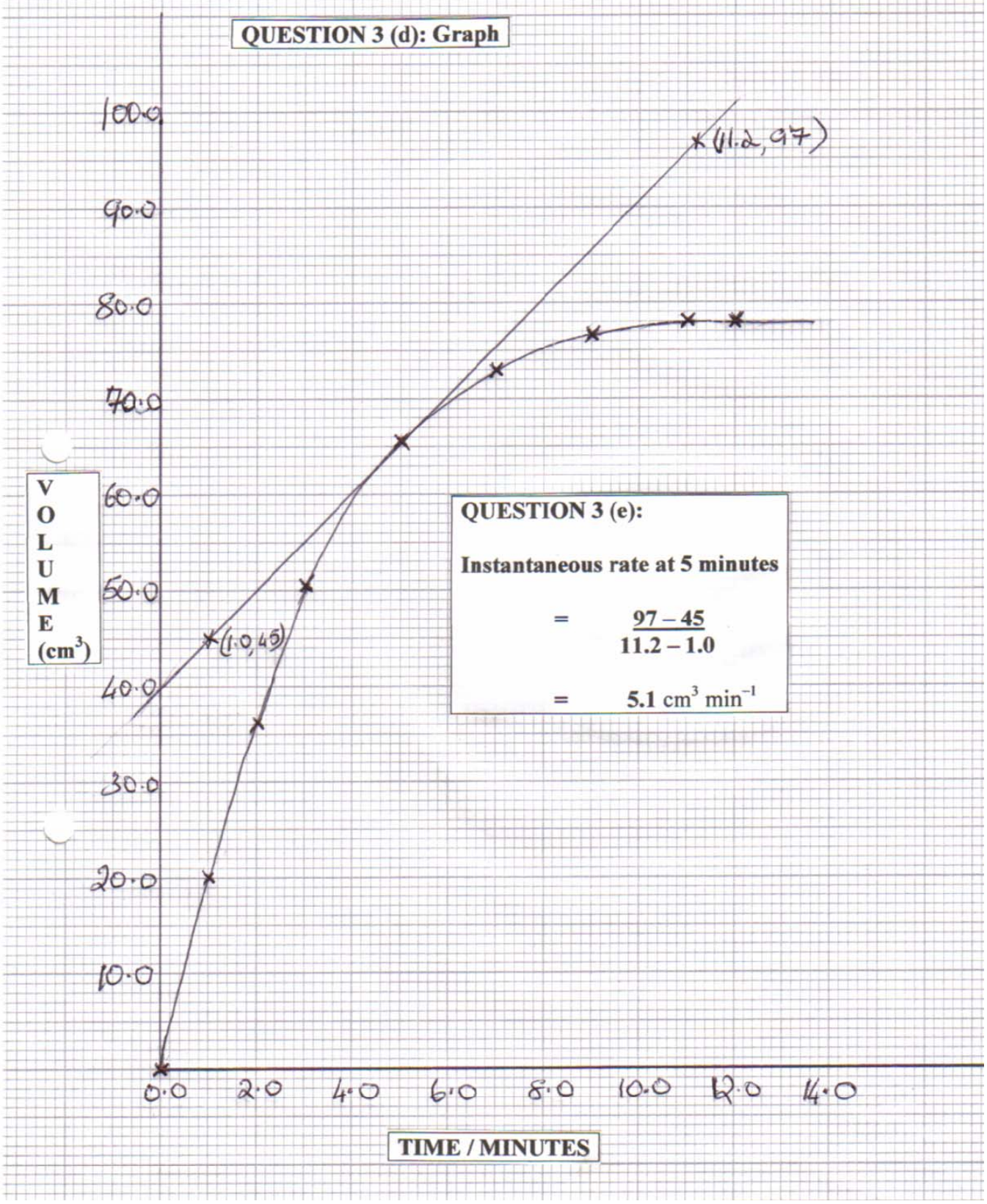
[Allow 3 marks for tangent drawn at 5 minutes]

(ii) **0.104** g *[Accept 0.1]* (6)

78 ÷ 1000 ÷ 24 = 0.00325 mol (3) × 32 = 0.104 (3)

[Use of 22.4 loses first 3 marks. Use of PV = nRT also loses 3 marks except in cases where it gives the correct answer.]

QUESTION 3 (d): Graph



QUESTION 3 (e):

Instantaneous rate at 5 minutes

$$= \frac{97 - 45}{11.2 - 1.0}$$

$$= 5.1 \text{ cm}^3 \text{ min}^{-1}$$

SECTION B

QUESTION 4

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) **$1s^2 2s^2 2p^6$ / $[1s^2 2s^2 2p^6]^{3+}$ / [He] $2s^2 2p^6$** (6)

(b) **characteristic positive charge** for element / **atomic number / number of protons** in nucleus (6)
[Accept "arranged in increasing atomic number".]

(c) **positive (+)** charge (**attracted to negative)** // **mass 4** // relatively **low velocity (speed)** // **poor penetration (high absorption, stopped by skin, stopped by** few **sheet(s) of paper, stopped by few cm of air)** // strong **ionisation** // **stable nucleus** // **gains two electrons to form helium** atom // **damages cells (causes cancer)** // **deflected by electric fields** // **deflected by magnetic fields** // causes **luminescence (fluorescence, phosphorescence)** ANY TWO: (2 ×3)
[Accept "low energy" in place of "low velocity". Do not accept "helium nucleus" or "2 protons + 2 neutrons".]

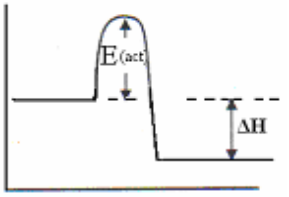
(d) **infra-red / IR / ir** (6)

(e) (i) **$Ca(HCO_3)_2$ / $Fe(HCO_3)_2$** *[Allow $Mg(HCO_3)_2$]* (3)
(ii) **$CaSO_4$ / $CaCl_2$ / $Ca(OH)_2$ / $MgSO_4$ / $MgCl_2$ / $Mg(OH)_2$** *[Do not accept names in (i) or (ii)]* (3)
[If not designated (i) & (ii), the order of the question should be followed. If only one is given and is undesignated, assume it is the first.]

(f) **platinum // palladium // rhodium** *[Accept symbols]* ANY TWO: (2 × 3)

(g) **lone pair(s)** of electrons in water *[Obtainable from correct diagram. Do not accept l.p. for lone pair.]* (3)
have **greater repelling power (repulsion) / push bonds closer** (3)
Abbreviation: l.p. : l.p. > l.p. : b.p. > b.p. : b.p. not acceptable without specific mention of repulsion (pushing bonds closer).
OR
Alternative marking: **lone pairs in water** *[Obtainable from correct diagram]* (6)

(h)



(i) **activation energy correctly shown** (3)
(ii) **Δ*H* correctly shown** (3)

(i) **remove (lower levels of) nitrogen compounds (nitrates) /** and **phosphorus compounds (phosphates)** (6)
[If no other marks have been awarded, allow 3 for "to prevent eutrophication"]

(j) **$C_2H_5OH + Na \rightarrow C_2H_5ONa + {}^1/_2H_2$ / $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$**
FORMULAS: (3) BALANCING: (3)

(k) **A** **lightning (electrical storms, thunderstorms) // bacteria {Rhizobium (legumes, named legume*), Plasmodiophorales (alder), Nitrobacter, Azotobacter, Clostridium, Krebsiella, blue-green algae (Cyanophyceae, Anabaena)}** (2 × 3)
** clover, lucerne, pea, bean, lentil, peanut, lupin, wisteria,vetch, etc.*
B steel **less brittle (more malleable, more ductile) // purer // lower carbon** content **// great(er) demand // more useful // can be re-worked // more rust resistant** ANY TWO: (2 × 3)

QUESTION 5

(a) DEFINE: **relative (measure of) attraction /**
number expressing (giving) attraction for shared electrons //
for a shared pair of electrons / for electrons in a covalent bond (3 + 2)

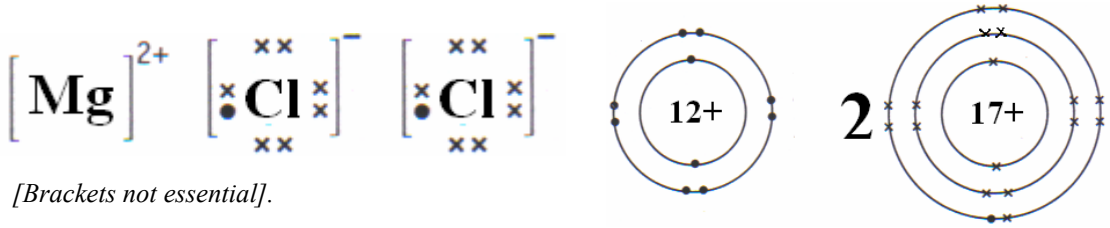
(b) STATE: **decrease** (3)

EXPLAIN: **increasing atomic radius / extra shell (shells) / outer electron further from nucleus** (3)

increased **shielding (screening)** offsets increased nuclear charge / **effective nuclear charge unchanged (constant) / decreased pulling power of nucleus on shared electrons / lower values represent lower hold on shared electrons** (3)

(c) BONDS: (i) *water*: **polar** covalent (3)
(ii) *methane*: **covalent** *[Accept "non-polar" or "slightly polar"]* (3)
(iii) *magnesium chloride*: **ionic (electrovalent)** (3)

(d) USE:



[Brackets not essential].

Note: The bond formation may be shown by clear illustration of electron transfer.
The charges, if not shown, may be inferred from the information given in the diagram.

Magnesium ion formed (3)
Chloride ions formed (3)

[It must be clear that there are two chloride ions but only one need be drawn.
Accept diagrams with all dots or all crosses.]

(e) EXPLAIN: attractive (repulsive) forces **between molecules** (6)

(f) USE: very **weak intermolecular (**weak **van der Waals, London, dispersion,** weak **dipole-dipole) forces (attractions, interactions)** (3)
[Accept "they are weak" if it is clear that "they" refers to intermolecular forces.]
SUGGEST: much stronger **hydrogen bonds** between water molecules (3)
[Accept "no hydrogen bonds in methane".]

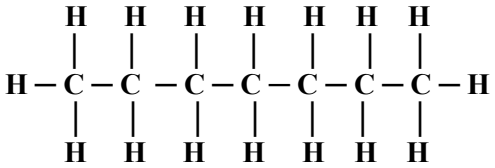
(g) ACCOUNT: **polarity of water** causes attraction to charged rod (3)
non-polarity of cyclohexane means it is not affected by charged rod (3)

EXPLAIN: stream of water still **attracted** to rod as molecules (dipoles) arrange themselves with positive pole towards rod *[Do not accept "deflected" if unqualified.]* (3)

QUESTION 6

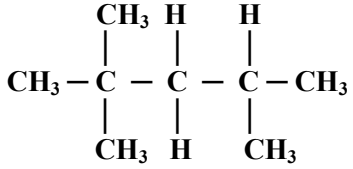
(a) (i) WHAT: measure of **tendency (likelihood) to auto-ignite (knock, pink, pre-ignite, ignite early, ignite before spark)** / number representing **ability (tendency, measure) to resist autoigniting (knocking, etc.)** / number **based on a scale where 2,2,4-trimethylpentane (*iso*-octane) is assigned a rating of 100 and heptane (*n*-heptane) a value of 0 / percentage by volume of 2,2,4-trimethylpentane (*iso*-octane) in a blend (mix) with heptane (*n*-heptane) that matches the behaviour of the fuel** (5)

(ii) DRAW: *heptane*: **$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$ / $CH_3(CH_2)_5CH_3$ /**

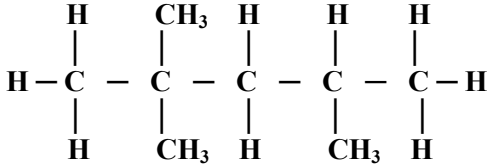


[Hs may be omitted in expanded structure.] (3)

2,2,4-trimethylpentane: **$(CH_3)_3CCH_2CH(CH_3)_2$ /**



/



[Single Hs may be omitted in expanded structures.] (3)

Note: candidate might expand methyl groups fully.

(iii) NAME: light **gasoline / petrol**eum (3)
naphtha (3)

(iv) WHAT: **removal (loss) of hydrogen** *[Accept "hydrogen produced".]* (3)
ring (aromatic, cyclic) formation (3)

(v) EXAMPLE: **methanol (methyl alcohol, wood spirit) / ether (alkoxyalkane) / methyl-*t*-butyl ether (MTBE, 2-methoxy-2-methylpropane) / propanol / butanol** *[Accept correct formula]* (3)

GIVE: **raise octane number (rating) / decrease knocking / engine (fuel) efficiency** (3)
less pollution / less carbon monoxide (CO) produced / cleaner emissions (burn) / more environmentally friendly / alternatives (substitutes) for lead (3)
[Accept "less harmful gases", "less harmful to environment", but not "less harmful".]

(b) WRITE: **$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$** FORMULAS: (3) BALANCING (3)

CALC: **– 1368** kJ mol^{-1} (12)

$2C + 2O_2$	$\rightarrow 2CO_2$	**– 788** kJ	(3)	
$3H_2 + 1^1/_2O_2$	$\rightarrow 3H_2O$	**– 858** kJ	(3)	*[Equations not required]*
C_2H_5OH	$\rightarrow 2C + 3H_2 + {}^1/_2O_2$	**+ 278** kJ	(3)	*[+ sign not required.]*
$C_2H_5OH + 3O_2$	$\rightarrow 2CO_2 + 3H_2O$	**– 1368** kJ	(3)	

$\Delta H = \sum \Delta H_{f(products)} - \sum \Delta H_{f(reactants)}$

ΔH = **2 × – 394/ – 788** (3) + **3 × – 286/ – 858** (3) – {**–278** (3) + 0}
OR **2 × – 394/ – 788** (3) + **3 × – 286/ – 858** (3) + **278** (3) – 0

ΔH = **– 1368** (3)

QUESTION 7

(a) WHAT: state in which **rate of forward reaction (R_f) = rate of reverse (backward) reaction (R_r, R_b)** (5)
[Accept "rates equal (the same) in both directions".]

WHEN: **no (not ceased, continuing, ongoing)** (3)

EXPLAIN: chemical equilibrium a **dynamic** state **/ concentrations** of reactants and products **unchanged (**remain **the same) because rates equal / loss(es) in one direction balanced by (equal to) gain(s) in other direction / both forward and reverse reactions still occur** (3)

(b) WRITE: $\frac{[HI]^2}{[H_2][I_2]}$ *[Square brackets essential]* (6)

CALC: **46.24** *[46.2 or 46 (– 1)]* (12)

H_2	+	I_2	$\rightleftharpoons$	2HI
11 mol		11 mol		0 mol
11 – x		11 – x		2x (3)
2.5 mol		2.5 mol		17 mol (3)

OR

2.5 mol (3)		2.5 mol (3)		17 mol

$K_c = \frac{17^2}{2.5^2}$ (3)

= 46.24 (3)

(c) STATE: reactions **at equilibrium** *[Must be clear that principle refers to an equilibrium situation.]* (3)
oppose (minimise, relieve) applied stress(es)*{disturbance(s)*} (3)

*[*If the word 'stress(es)' or 'disturbance(s)' is replaced by particular examples (e.g. pressure), all three (temperature, pressure and concentration) must be given.]*

PREDICT: (i) **lower (decreased)** yield of hydrogen iodide (3)

(ii) **darker (deeper, more intense)** pink (purple) **/** more **purple (light purple, pinker)** (3)

EXPLAIN: reaction shifts **backward (reverse)** which is **exothermic (heat producing, to raise temperature) / disfavours forward endothermic (heat absorbing, lowering temperature)** reaction *[Accept "reaction is endothermic so reverse occurs".]* (3)
[Answers need not be linked]

CHANGE: **none (no change)** (3)

EXPLAIN: **equal** numbers of **molecules (moles) on both sides** of equation / pressure **does not change (has no affect on) the number of molecules (moles)** for this reaction (3)
[Answers must be linked]

QUESTION 8

(a) (i) WRITE: **$2H_2O \rightleftharpoons H_3O^+ + OH^- / H_2O \rightleftharpoons H^+ + OH^-$**
[Accept with = or →] FORMULAS: (3) BALANCING: (2)

(ii) DEFINE: **$[H^+][OH^-]$ / $[H_3O^+][OH^-]$ / product of concentrations of hydrogen** ions **(H^+) and hydroxyl (hydroxide) ions (OH^-)** in water (3)

SHOW: in pure water = **$[H^+]$ ($[H_3O^+]$) = $[OH^-]$ / $[H^+]^2$ ($[H_3O^+]^2$) = 1×10^{-14}** (3)

=> **$[H^+]$ ($[H_3O^+]$) = $\sqrt{1 \times 10^{-14}}$ = 1×10^{-7}** (3)

pH = **$-\log 1 \times 10^{-7}$ = 7** [Accept without '1 ×'] (3)

(iii) STRONG: **0.3** (3)

pH = $-\log 0.5$ = 0.3 (3)

WEAK: **2.52 (2.5)** (9)

$\frac{[H^+]^2}{0.5}$ = $\frac{1.8 \times 10^{-5} / [H^+]^2}{}$ = 9.0×10^{-6} (3)

=> $[H^+]$ = $\sqrt{9.0 \times 10^{-6}}$ = 3.0×10^{-3} (3)

pH = $-\log 3.0 \times 10^{-3}$ = 2.52 (3)

OR

pH = $-\log\sqrt{K_a \times M}$ (3) = $-\log\sqrt{1.8 \times 10^{-5} \times 0.5}$ (3) => pH = 2.52 (3)

(b) (i) EXPL: **settlement (sedimentation, allow to settle) //**

flocculation (coagulation, aggregation, clumping, joining together of particles) / adding aluminium sulfate {aluminium chloride, aluminium(III), alum, iron(III) sulfate (ferric sulfate), iron(III) chloride (ferric chloride), iron(III), polyelectrolytes, lime) //
[Accept correct formula]

decanting the cleared water / **allow water to overflow //**

filtration / passing through sand and gravel beds ANY THREE: (3 x 3)

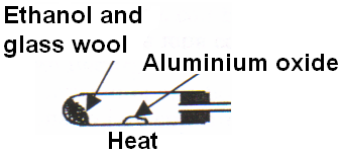
(ii) TWO: **first chemical** (3) **its purpose** (3) **second chemical** (3) **its purpose** (3)

chemical	**purpose**
carbon dioxide (CO_2) / sulfuric acid (H_2SO_4)	lower pH / make more acid / make less basic / if too basic
lime [calcium hydroxide, $Ca(OH)_2$] / sodium hydroxide [caustic soda, NaOH] / sodium carbonate (Na_2CO_3) / soda ash	raise pH / make less acid / make more basic / if too acidic *Note: Accept "alkaline" for "basic" in this box and the one above.*
chlorine (Cl_2) / hypochlorite [chlorate(I), ClO^-] / *[Accept HOCl]* ozone (O_3) *[Accept suitable salts in this box.]*	sterilise / disinfect kill micro-organisms (bacteria, germs) / prevent disease
fluoride (F^-) / *[Accept suitable salts in this box.]* hexafluorosilicic (hydrofluorosilicic) acid (H_2SiF_6) / fluosilicate (fluorosilicate, silicofluoride, SiF_6^{2-})	prevents tooth decay / oral hygiene

[If chemical not identified, give no marks for purpose. However, in the cases of fluorine and chloride, do not give the marks for chemical, but allow the marks for purpose.]

QUESTION 9

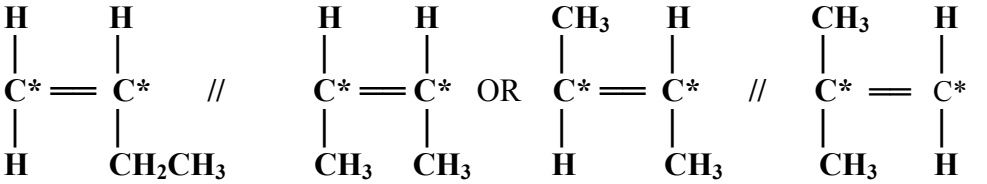
(a) DRAW:



ethanol (C_2H_5OH) and glass wool (4)
aluminium oxide (Al_2O_3) and heat (correctly positioned) (4)

[No diagram: (–3) but do not go below 0.]

(b) ISOMER:



CH_2=CHCH_2CH_3 **CH_3CH=CHCH_3** **$(CH_3)_2C$=CH_2** (6)

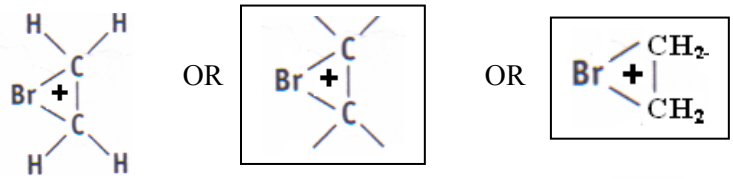
[Note: CH_3 and CH_2CH_3 may be expanded. CH_2CH_3 may be written C_2H_5. In CH_2CH_3, the C of CH_3 must not be bonded to a planar C (C). Single Hs may be omitted in expanded structures.]*

[Cancelling to be applied]

INDICATE: *planar*: **one C (C* in diagrams) at end of double bond** (clearly labelled or stated)** (3)
tetrahedral: **one C other than at end of double bond** (clearly labelled or stated)** (3)
Note: If C_3 alkene presented, allow the marks for indicating planar and tetrahedral carbons.
***Cancelling applies.*

(c) EXPLAIN: **having** at least **one multiple (double, triple)** carbon-to-carbon **bond / undergoes addition reactions** (6)

(d) DRAW:



[+ may be on Br] (6)

[Accept corresponding localised carbonium ion, 

]

GIVE: **three correct products (name or formula)** (3 x 3)

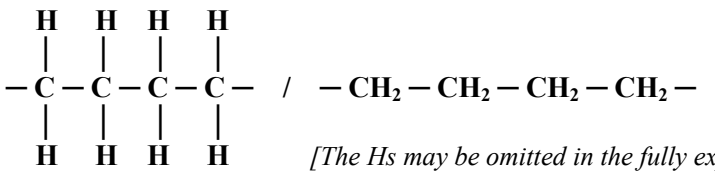
Name	Formula
1,2-dibromoethane	CH_2BrCH_2Br
2-bromoethanol	CH_2BrCH_2OH
1-bromo-2-chloroethane*	CH_2BrCH_2Cl

[accept 1-chloro-2-bromoethane, NaOH, NaBr.]*
[Accept dibromoethane if correct formula for 1,2-dibromoethane is given.] *[Cancelling applies]*

HOW: **different negative ions {anions, two of Br^-, OH^-, Cl^-,** also **water (H_2O)}** adding on **indicates (supports, shows, proves) presence of positive** intermediate **/ these products indicate the formation of a positive ion first and then the addition of different negative ions (nucleophiles, anions) to it** *[Can be shown by drawings] [HOW must be specifically related to organic products]* (3)

(e) NAME: **poly(ethene) / polythene** *[accept polyethene]* (3)

DRAW:



[The end bonds may be omitted] (3)

[The Hs may be omitted in the fully expanded structure]

QUESTION 10: Answer any *two* of the parts (a), (b) and (c).

(a) (i) SUSPENDED: filter **known volume through weighed filter paper** //
dry filter paper //
reweigh and **find increase (mass of** suspended **solids)** //
find **mass (g) l^{-1} and multiply by 1000** / **express mass in mg l^{-1}** ANY THREE: (3 × 3)

(ii) DISSOLVED: **evaporate known volume** to dryness //
in weighed container (dish, etc.,) //
cool, reweigh and **find increase (mass of** dissolved **solids)** //
find **mass (g) l^{-1} and multiply by 1000** / **express mass in mg l^{-1}** ANY THREE: (3 × 3)
[Accept "weight" for "mass"]

(iii) TEST: add **silver(I) nitrate (silver nitrate, $AgNO_3$)** solution and nitric acid //
white precipitate (ppt) / precipitate (ppt) soluble in ammonia (NH_3) solution (4 + 3)
[Note: the two points are not treated as linked for the purposes of marking.]

(b) DEFINE: (i) **loss (decrease)** of electrons
(ii) **increase (rise, gain)** in oxidation number (4 + 3)
[If not designated (i) and (ii), the order in the question should be followed. One undesignated is assumed to be the first.]

(iii) 1st **I^- (iodide** ion**) / I (–1) / $\underset{-1}{I}$ / arrow labelled "oxidised (oxidation)" from I^-** (3)

2nd **I_2 (iodine** molecule**) / I (0) / $\underset{0}{I_2}$ / $\underset{0}{I}$** (3)

[If not designated 1st and 2nd, the order in the question should be followed. One undesignated is assumed to be the first.]

(iv) 1st $ClO^- + \mathbf{2}I^- + \mathbf{2}H^+ \rightarrow Cl^- + I_2 + H_2O$ *[Cancelling applies]* (2 × 3)
2nd $I_2 + \mathbf{2}S_2O_3^{2-} \rightarrow \mathbf{2}I^- + S_4O_6^{2-}$ *[Cancelling applies]* (2 × 3)

(c) (i) DEFINE: **discrete (fixed, restricted, definite, specific) energy of electron /**
energy of electron in orbit /
orbit (shell) which electrons of equal energy can **occupy** (4)

(ii) STATES: *ground*: in **lowest energy** state / in n = **1** level (shell) / in **1s** orbital (3)
excited: **higher energy** state / in n > **1** level (shell) / in **orbital other than 1s** (3)
[If not designated 'ground' and 'excited' the order in the question should be followed. One undesignated is assumed to be the first.]

(iii) NAME: **Balmer** series (3)

(iv) EXPLAIN: **$E_2 - E_1$: energy difference between higher and** level **2** / *["higher" & "lower" required]*
energy difference between higher (e.g. E_2) and lower (e.g. E_1) level /
energy emitted when electron falls from higher to level **2** /
energy emitted when electron falls from higher (e.g. E_2) to lower (e.g. E_1) //

f **: frequency** of line in spectrum //

each **line (specific or definite frequency) produced (due to) electrons falling from particular (some) higher level to particular (some) lower level //**

***h is* Planck's constant / *hf* is a photon {quantum, packet (bundle) of energy} //**

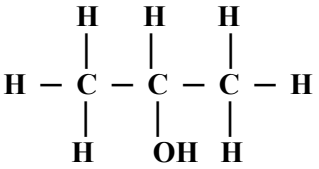
the expression indicates that **the energy difference ($E_2 - E_1$) is proportional to (varies directly with) the frequency (*f*) /**
the energy difference ($E_2 - E_1$) is a constant times the frequency (*f*) /
energy difference ($E_2 - E_1$) divided by frequency (*f*) equals (is, gives) a constant ANY FOUR: (4 x 3)

QUESTION 11: Answer any <u>two</u> of the parts (a), (b) and (c)

(a) (i) CATALYST: **nickel / palladium / platinum / copper** *[Accept symbol]* (4)

(ii) ALCOHOL: **propan-1-ol / 1-propanol / *n*-propyl alcohol** (3)
[Accept structural formula] [Not "propanol" unless correct structure shown, but does not cancel.]

(iii) DRAW:



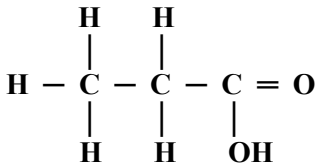
/ $CH_3CHOHCH_3$ / $(CH_3)_2CHOH$ (3)
[OH may be bracketed in condensed structures]

CLASS: **secondary** (3)

(iv) WHICH: **propanal** *[Accept structure]* (3)

NAME: **propanoic acid / propionic acid /** sod. **propanoate /** sod. **propionate** (3)

STRUCTURE:



/ CH_3CH_2COOH / C_2H_5COOH (3)
(O^- or **ONa** instead of **OH** for salts**)**

(v) USE: **removing nail varnish / cleaning glassware / solvent / chromatography / recrystallisation / dry cleaning / stain removing / grease removing** *[Do not accept "fuel".]* (3)

(b) (i) MASS: **1144** g (6)

143 x 8 = 1144 (6)

(ii) MOLES: **26** mol 1144 ÷ 44 (3) = 26 (3) *To be accepted as a slip, some work must be shown in these calculations.* (6)

(iii) VOLUME: **624** l (6)

26 x 24 (3) = 624 (3)

SUV: **528** l (7)

264 x 8 ÷ 44 x 24 = 1152 (4)	264 – 143 = 121 (3)	2112 – 1144 = 968 (3)	48 – 26 = 22 (3)
1152 – 624 = 528 (3)	121 x 8 ÷ 44 x 24 = 528 (4)	968 ÷ 44 x 24 = 528 (4)	22 x 24 = 528 (4)

[<u>Note</u>: subtraction step (3); other step(s) (4)]

[In part (iii), using 22.4 for 24 loses the 3 (4) marks for that step but the candidate is penalised <u>once only</u>. The same applies to the use of PV = nRT except in cases where the correct answer is obtained.]

Question 11 continued/

(c) Answer part **A** *or* part **B**.

A

(i) EXPLAIN: *greenhouse gas*: atmospheric **gas {gas** in atmosphere (air)**} that absorbs {retains, blocks, prevents escape (loss) of, radiates back} heat {infrared (IR, ir)** radiation**} / gas** that contributes to **global warming**

acidic oxide: oxide that **increases hydrogen ion (H^+)** concentration **(lowers pH) in water /** oxide that **gives acidic solution** in water **/** oxide that **neutralises base(s) /** oxide that **reacts with base(s) to give salt(s)** (4 + 3)

(ii) STATE: **combustion (burning) // respiration (excretion) // air travel* // sea travel* // land travel* // space travel // deforestation // electricity generating // fermentation (brewing) // baking // landfill (dumps) // refrigeration // aerosols // foams // fire extinguishers** ANY TWO: (2 x 3)
**Note*: *In place of the marks for these points, marks may be given for one example such as "cars"("car emissions") for land travel.*

(iii) WHAT: **carbonate* ion (CO_3^{2-}) // hydrogencarbonate* ion (HCO_3^-) // carbonic acid (hydrogen carbonate, H_2CO_3) // hydronium ion (H_3O^+) /* hydrogen ion (H^+)** ANY THREE: (3 x 3)
[Caution: single solidus]*
[Do not accept salts e.g. "sodium carbonate" or "calcium hydrogencarbonate".]*

(iv) NAME: ground **limestone (calcium carbonate) /** slaked (hydrated) **lime (calcium hydroxide) / sodium carbonate / sodium hydroxide / soda ash / magnesite (magnesium carbonate) / dolomite / magnesia / magnesium hydroxide** *[Allow water]* (3)

B

(i) NAME: **bauxite** (4)

WHAT: **sodium hydroxide (caustic soda, NaOH)** (3)

(ii) POS: **$O^{2-} - 2e^- \rightarrow {}^1/_2O_2$ / $2O^{2-} - 4e^- \rightarrow O_2$ / $3O^{2-} - 6e^- \rightarrow 1{}^1/_2O_2$ / $6O^{2-} - 12e^- \rightarrow 3O_2$**
FORMULA: (3) BALANCING: (3)

NEG: **$Al^{3+} + 3e^- \rightarrow Al$ / $2Al^{3+} + 6e^- \rightarrow 2Al$ / $4Al^{3+} + 12e^- \rightarrow 4Al$** FORMULA: (3) BALANCING: (3)
[If not labelled pos. & neg. or anode & cathode, the order of the question must be followed. In the case of one undesignated attempt, assume it to be the first.]

(iii) WHAT: **lowers melting point / dissolves alumina (aluminium oxide, Al_2O_3) / increased conductivity** (3)

(iv) WHY: **saves energy / cheaper / avoids litter / prevents loss of aluminium / conservation of natural resources** (3)