MS4
£4.00

GCE MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

SUMMER 2009

CH2

Section A

1.

Conducts electricity		Melting temperature		Bonding	
Yes	No	High	Low	Covalent	Ionic
✓		✓		✓	

[1]

2. (i) $Ba + 2\,H_2O \rightarrow Ba(OH)_2 + H_2$ [1]

(ii) Reagent: e.g. sulfuric acid [1]

Observation: white precipitate [1]

3. (i) There is no free rotation **about a double bond** / the compound has two different groups either side of the double bond [1]

(ii) potassium dichromate(VI) / $K_2Cr_2O_7$ / dichromate / $Cr_2O_7^{2-}$ [1]

(iii) oxidation / redox [1]

(iv) (relative) molecular mass / molar mass [1]

4. (i) $F_2 + 2\,e^- \rightarrow 2\,F^-$ [1]

(ii) (A) fluorine (atom) needs to gain an electron to have a full (outer) shell / fluorine has a high electronegativity [1]

Section A Total [10]

Section B

5. *(a)* (i) atom economy = $\frac{34 \times 100}{(2 \times 53.5) + 74}$ (1) = 19 (1) [2]

(ii) 45 g / 100 cm^3 ≡ 450 g dm^{-3} (1)

concentration = $\frac{450}{111}$ = 4.05 (accept 4.1) mol dm^{-3} (1) [2]

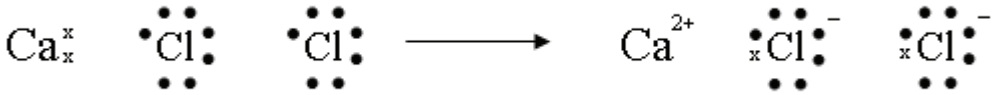
(iii) $Ca + 2HCl \rightarrow CaCl_2 + H_2$ [1]

(iv) orange-red / brick red [1]

(v) Reagent: silver nitrate / $AgNO_3$ / Ag^+ / silver ions [1]

Observation: white precipitate [1]

(vi)



left hand side correct (1) right hand side correct (1) [2]

(vii) 111g of calcium chloride removes / react with 2 ×18.0 g water (1)

∴5.55 g of calcium chloride mass removes / reacts with = $\frac{5.55 \times 2 \times 18.0}{111}$

= 1.80 (g) (1)

or in moles:

moles of calcium chloride 0.05 (1) moles of water 0.10 (1)

[2]

(viii) a covalent bond where one of the atoms (of the bond) provides both electrons [1]

Total [13]

6. *(a)* (i)  Na^+ Cl^- [1]

(ii) 6 : 6 [1]

(iii) 8 : 8 (1)

Cs^+ ion / cation is much larger than the Cl^- ion / anion (1)

[2]

(b) (i) Na^+ ions are attracted to (δ-) oxygen of water molecules (1)

Cl^- ions are attracted to (δ+) hydrogen of water molecules (1) [2]

(ii) I Mass of evaporating basin + sodium chloride solution = 140.57 g
Mass of evaporating basin = 72.00 g
∴ Mass of sodium chloride solution = 68.57 g

Mass of evaporating basin + dry sodium chloride = 90.57 g
Mass of evaporating basin = 72.00 g
∴ Mass of dry sodium chloride = 18.57 g

[1]

II 50.00 g [1]

III 2 × 18.57 = 37.14 g / 100 g water [1]

IV temperature [1]

(c) the **outer** electron of an atom is an s electron [1]

(d) $4\,Na + TiCl_4 \rightarrow Ti + 4\,NaCl$

0 +4 (-1 x 4) 0 4 (+1) 4(-1) (1)

sodium has increased its oxidation number i.e. oxidation (1) [2]

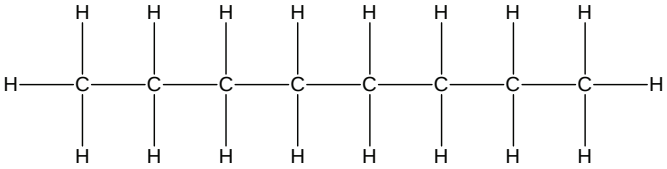
Total [13]

7. *(a)* (i) Separation of the alkanes by differences in their boiling temperatures [1]

(ii) C_9H_{20} [1]

(iii) Breaking of larger (alkane) molecules into smaller molecules (1)
which are more useful / in relative short supply (1) [2]

(iv)



[1]

(b) (i) The chlorine molecule is split by UV light (1) by homolytic fission (1)
giving two chlorine free radicals

$$Cl_2 \rightarrow 2\ Cl\bullet \quad (1)$$

In the propagation stage radicals react to produce new radicals

$$CH_3Cl + Cl\bullet \rightarrow \bullet CH_2Cl + HCl \quad (1)$$

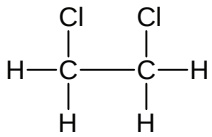
$$\bullet CH_2Cl + Cl_2 \rightarrow CH_2Cl_2 + Cl\bullet \quad (1)$$

In the termination stage two radicals combine giving dichloromethane

$$\bullet CH_2Cl + Cl\bullet \rightarrow CH_2Cl_2 \quad (1)$$ [6]

(QWC) organise information clearly and coherently, using specialist vocabulary when appropriate [1]

(ii) $C_2H_4Cl_2$ (1) displayed formula is



(accept the displayed formula of 1,1-dichloroethane) (1)

formed by the reaction together of two $\bullet CH_2Cl$ radicals (1)

[3]

Total [15]

8. *(a)* (i) I the colour changes from red/brown/orange to colourless [1]

II the name of the compound is 1,2,3-tribromobutane / 1,3-dibromobutan-2-ol / 1,2-dibromobutan-3-ol [1]

(ii) I (warm) with (aqueous) sodium hydroxide / NaOH / alkaline solution [1]

II this would give a white precipitate with aqueous silver nitrate / a source of chloride ions [1]

III the precipitate is not completely soluble in dilute aqueous ammonia / the precipitate is soluble in concentrated aqueous ammonia [1]

(b) (i) The sample would give a (broad) signal at 2500 – 3550 cm^{-1} (1)
characteristic of the O–H bond (1)
accept answers based on C–O [2]

(ii) Both molecules possess van der Waals forces (1)
Both molecules possess dipole-dipole forces (1) e.g. $C^{\delta+}– Br^{\delta-}$ or $C^{\delta+}– OH^{\delta-}$ (1)
But-2-en-1-ol has hydrogen bonding and the bromo compound does not (1)
Hydrogen bonding is stronger than other intermolecular forces (1)
therefore more energy is needed to separate the molecules (1)
[6]

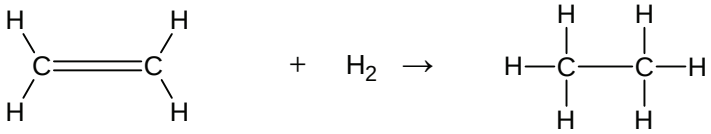
(QWC) *Ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear* [1]
Select and use a form and style of writing appropriate to purpose and to complex subject matter [1]

Total [15]

9. *(a)* (i) lone pair / bonding pair repulsion is
greater than bonding pair / bonding pair repulsion [1]

(ii) nitrogen and hydrogen have different electronegativities (1)
and this results in polarity / unequal electron distribution in the bond (1) [2]

(b) (i) e.g.



equation using displayed formulae (1)

ethane named (1) [2]

(ii) e.g. spectacle frames / teeth brace [1]

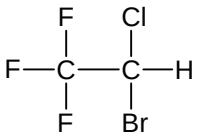
(iii) 109^{o} 28’ / 109½° / 109° [1]

(c) (i) 60 – 70 atmospheres [1]

(ii) I e.g. Al_2O_3 / porous pot / concentrated sulphuric acid /
concentrated phosphoric acid [1]

II elimination / dehydration [1]

(d) (i)



[1]

(ii) e.g. refrigerants / dry cleaning / solvents / pesticides / polymers [1]

(iii) Any TWO from:

the C – Br bond is the weakest and this has the greatest effect on the ozone layer, seen in $CHClF_2$ (0.05) and $CBrClF_2$ (10) (1)

increasing numbers of C – Cl bonds increase the RODP effect (1)

there is a marked increase in effect when going from 1 chlorine atom in a molecule to 2 chlorine atoms (1)

there is not such a marked change in effect when going from 2 chlorine atoms in a molecule to 3 chlorine atoms (1)

the C – F bond is the strongest and does not cause destruction of the ozone layer / has little effect on the ozone layer (1)

[2]

Total [14]

Section B Total [70]

WJEC
CBAC

GCE MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

JANUARY 2010

CH2

Section A

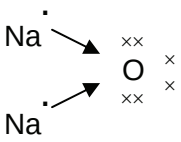
1. D [1]

2. D [1]

3. $BeCl_2$ 2 (1)

   PCl_3 pyramidal (1)

   CCl_4 tetrahedral (1) [3]

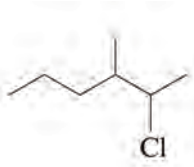
4. 

(1)

   forming Na^+ and O^{2-} ions (1) [2]

5. Mass in 100 g water = 41 g (1)

   Mass in 50 g water = 20.5 g (1) [2]

6. 

[1]

Section A Total [10]

Section B

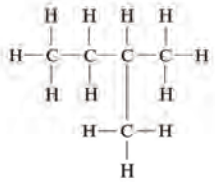
7. (a) Long chain hydrocarbons have more/stronger intermolecular forces (1)
- **van der Waals** forces specified (1)
Higher temperatures/more energy required to break these forces (1) [3]

QWC The information is organised clearly and coherently,
using specialist vocabulary where appropriate [1]

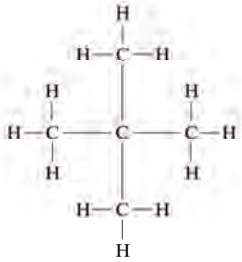
(b) (i) Alkanes [1]

(ii) I Same molecular formula (1)
different structure / arrangement /
structural formula / displayed formula (1) [2]

II



(1)



(1)

2-methylbutane (1) 2,2-dimethylpropane (1) [4]

(c) Breaking down of a long chain hydrocarbon into smaller ones (1)

Which are more useful / one of which is an alkene (1) [2]

Total [13]

8. (a) (i) Chlorofluorocarbon [1]

(ii) Anaesthetics / propellants in aerosols / cleaning solvents / blowing plastics / fire extinguishers [1]

(iii) I A species / atom / molecule with an unpaired electron [1]

II C – F bond stronger than C – Cl bond [1]

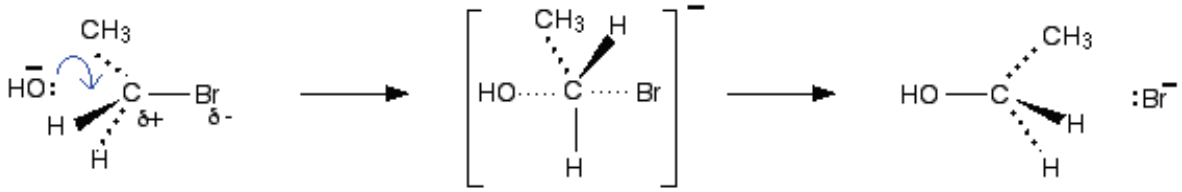
(iv) I To neutralise the sodium hydroxide [1]

II Silver nitrate [1]

III Cream precipitate [1]

IV $Ag^+ + Br^- \longrightarrow AgBr$ [1]

(b)



Reactants:
Polarisation (1)
curly arrow (1)

Intermediate (1)
(accept curly arrow to show
C-Br breaking instead of –ve charge) [3]

(c) (i) Ethene [1]

(ii) In alcohol (and heat) [1]

Total [13]

9. (a)

	C	:	H	:	O	
%	54.5		9.10		36.4	(1)
moles	4.54		9.01		2.28	(1)
ratio	1.99		3.95		1	

empirical formula = C_2H_4O (1)

molecular formula = $C_4H_8O_2$ (1) [4]

(b) (i) Absorption at about 3300 cm^{-1} characteristic of OH group [1]

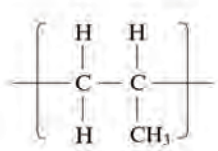
(ii) Propanoic acid (1)

Absorption at around 1700 cm^{-1} due to C = O group (1) [2]

(c) (Concentrated) sulphuric acid / phosphoric acid / aluminium oxide [1]

(d) Add bromine (water) (1)
turns from brown to colourless (1) [2]

(e)



[1]

(f) PVC / Polystyrene / PTFE [1]

Total [12]

10. (a) (i) Ability to attract electrons in a covalent bond/a shared electron pair [1]

(ii) Increases [1]

(iii) Increase in number of protons / charge on the nucleus (1)

But same number of electron shells / no increase in shielding (1)

Greater power to attract (bonding pair of) electrons (1) [2]

(1^{st} marking point + 1 other)

(b) (i) Increases from group I to group IV, large decrease to group V, slight decrease / not much change to group VII [2]
(All three trends 2 marks, any two trends 1 mark)

(ii) 930 – 1650 K [1]

(iii) Mg has more outer electrons (1)

Therefore stronger bonds since it has more delocalised (valence) electrons / stronger metallic bond (1) [2]

(iv) Electron cloud / molecular size increases down group (1)

Greater van der Waals / induced dipole forces need to be overcome (1) [2]

(c) Giant molecular structure (or similar) (1)

with strong covalent bonds between atoms (1) [2]

Total [13]

11. (a) (i) I Stream of bubbles / fizzing (1)
White precipitate / cloudiness (1)
Calcium sinks and rises (1)
(any 2 from 3) [2]

II $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ [2]
products (1) balancing (1)

III More reactive (1)
Electrons in strontium lost more easily / ionisation energy is less (1)
(Must have reason to obtain 1st mark)
(More reactive as reactivity increases down group – (1) only)
[2]

(ii) I No. moles = $\frac{2 \times 20}{1000} = 0.04$ [1]

II Moles Ca = 0.02 (1)
Mass Ca = 0.02 x 40.1 = 0.802 g (1) [2]

III Flame test (1)
Flame turns brick-red (1) [2]

(b) Sodium is too reactive to add to acid (1)
Hydrochloric acid + sodium hydroxide / sodium carbonate (1) [2]

(c) Calcium chloride conducts electricity when molten / in solution (1)
Calcium conducts electricity when (molten or) solid (1)
When molten, ions in calcium chloride are mobile (1)
Calcium has delocalised electrons in solid state (1) [4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning (1)
Selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1) [2]

Total [19]

Section B Total [70]

GCE MARKING SCHEME

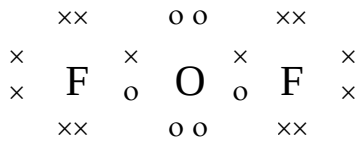
CHEMISTRY
AS/Advanced

SUMMER 2010

CH2

SECTION A

1. (i)



[1]

all outer electrons must be shown.

(ii) $F_2O + 2Mg \rightarrow MgO + MgF_2$ [1]

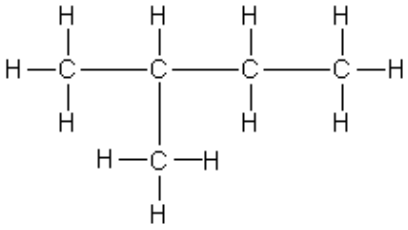
2. 23.8 g produced per 100 g of water (1)
5×23.8 g produced per 500 g of water = 119 (g) (1) [2]

3. (i) Ni / Pt /Pd [1]

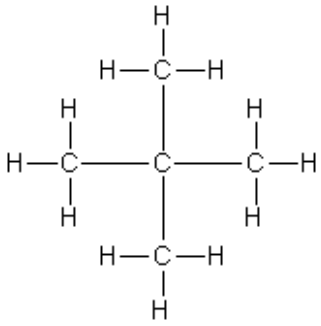
(ii) eg because of restricted/no rotation about the double bond [1]

4. (i) C_5H_{12} [1]

(ii)



or



[1]

5. ……. increases……. …… decreases. [1]

6. elimination / dehydration [1]

Section A Total [10]

SECTION B

7. (a) (i)

Number of bonding pairs	Number of lone pairs	F – S – F	Shape
6	0	90° / 180°	octahedral

one mark for each correct answer [4]

(ii) There is an unequal electron distribution in the bond (1) because fluorine has a higher electronegativity (in this bond) (1) (accept a diagram) [2]

(iii)

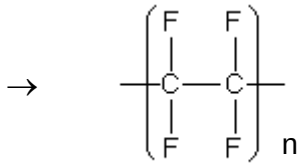
Oxidation state of sulfur in SF_6	Oxidation state of sulfur in H_2S	Oxidation state of sulfur in sulfur, S
(+)6	–2	0

(1)

The sulfur atom in sulfur hexafluoride has become less positive / more negative
∴ reduced by reaction with hydrogen sulfide (1) [2]

(b) Na^+ F^- correct formula of both ions (1)
6 : 6 (1) [2]

(c) (i)



[1]

(ii) diagram shows correct δ^+ / δ^- (1) correct lone pairs (1)
intermolecular bonding correct (1) [3]

Total [14]

8. (a) (i) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ [1]

(ii) from the graph the mass of pure calcium = 0.104 g (1)

$$\% \text{ purity of calcium} = \frac{0.104 \times 100}{0.115} = 90.4 \quad (1)$$ [2]

(iii) The (2) outer electrons to be removed are further from the nucleus in a strontium atom/strontium atom is larger/has an extra shell of electrons (1)
There is less electron shielding in the calcium atom / more electron shielding in the strontium atom (1) [2]

(b) addition of a sulfate (ion) / sulfuric acid – white precipitate (1)
addition of an acid-base indicator / pH probe – solution is basic / pH > 7 (1) [2]

(c) strontium
writing / diagram indicates lattice of cations with 'sea' of electrons (1)
electrons able to move (under applied potential), carry charge (1)

graphite
diagram shows hexagonal layer structure (1)
weak intermolecular/Van der Waals forces between layers (1)
(Delocalised) electrons able to move / carry charge (under applied potential) (1) [5]

QWC *ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear* [1]

(d) nanotubes consist of layers / pipelines of graphite hexagons (1)
closed at the end by (pentagons of) carbon atoms / OWTTE (1) [2]

Total [15]

9. (a) (i) Homolytic fission – a process of **covalent** bond breaking where each atom (of the bond) receives an electron (from the bond) (1)

$Cl - Cl \rightarrow 2\ Cl\bullet$ (1) [2]

(ii) Propagation stage – a stage where a (free) radical reacts and another is generated (to carry on the reaction) (1)

eg $Cl\bullet + CH_4 \rightarrow \bullet CH_3 + HCl$ (1) [2]

(b) (i) The C – F bond is stronger than the C – Cl bond (1)
and is not broken by **UV** radiation (1) [2]

(ii) I m/e 60 $\rightarrow$ M_r 60 (1)
1725 cm^{-1} $\rightarrow$ C = O (1)
2500-3500 cm^{-1} $\rightarrow$ O – H (1)
likely to be ethanoic acid (1) (accept 2-hydroxyethanal) [4]

II Reagent – silver nitrate / $AgNO_3$ / silver ions / Ag^+ (assume aqueous) (1)
White precipitate (1) [2]

Total [12]

10. (a) (i) $2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$ [1]
accept stoichiometric equation, e.g. using NaBr (not HBr)

(ii) I An oxidising agent is itself reduced / gains electrons / removes electrons from the other reactant. [1]

II In this reaction the outer electron shell of a chlorine atom is closer to the nucleus than in a bromine atom / chlorine is a smaller atom (1) and therefore the attraction for the electron is greater (1) [2]

(iii) Iodine is a bigger molecule / contains more electrons (or vice versa) (1)
therefore intermolecular Van der Waals forces are greater for iodine (1),
(more energy is needed to separate iodine molecules, therefore less volatile than bromine) [2]

(unqualified mention of Van der Waals forces (1))

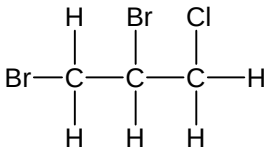
(b) (i) M_r of calcium bromide $\rightarrow$ 200 / 199.9 (1)
Concentration = $\frac{\text{no. of moles}}{\text{volume}}$ = 1200 / 200 ÷ 1 = 6 (mol dm^{-3}) (1) [2]

(ii)

Compound	*Flame colour(if any)*
magnesium bromide	none (1)
calcium bromide	brick red (1)

[2]

(c) (i)



[1]

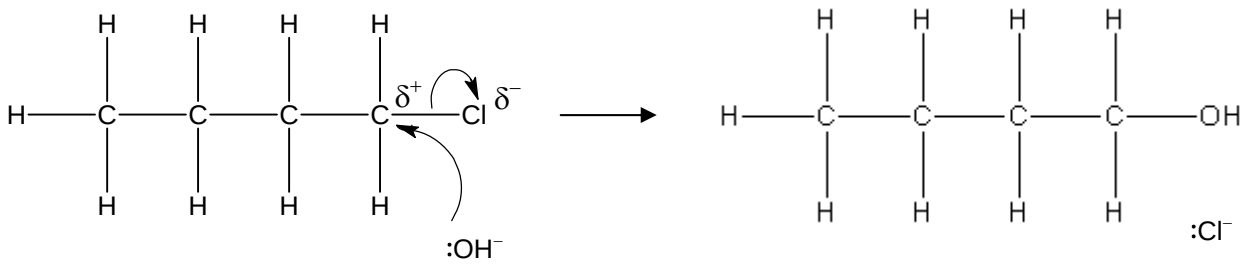
(ii) I (Bromine is added) across the double bond [1]

II Any correct carbocation / H^+ / Cl^+ / NO_2^+ / accept H_2 / accept Cl_2 [1]

III A movement of **two** electrons/an electron pair/a lone pair [1]

Total [14]

11. (a) 1-Chlorobutane is heated / refluxed (1) with aqueous (1) sodium hydroxide.



Correct formulae and charges (1) curly arrows (1) polarisation (1)

The reaction mechanism is nucleophilic substitution (1) [6]

QWC *select and use a form and style of writing appropriate to purpose and to complex subject matter [1]*
organise information clearly and coherently, using specialist vocabulary when appropriate [1] [2]

(b) (i) (2-)methylpropan-1-ol [1]

(ii) number of moles of compound G $= \frac{0.50 \times 86}{100} = 0.43$ (1)

mass of compound G $= 0.43 \times 74 = 31.8 / 32$ g (1) [2]

(iii) oxidising agent (potassium) dichromate / $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ (1)

observation orange to green (solution) (1) [2]

accept correct answers based on potassium manganate(VII)

(c) temperature 300°C (1) pressure 60-70 atmospheres (1) [2]

Total [15]

Total Section B [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2011

CH2

SECTION A

1. (a) Specific health problem e.g. liver disease / cirrhosis / heart failure / stroke [1]

(b) **Acidified** potassium dichromate(VI) / **Acidified** potassium manganate(VII) [1]

2. Bones / teeth / coral / shells / muscle contraction (accept skeleton) [1]

3. B / H_2O [1]

4. $Cl_2 + 2\ NaBr \rightarrow Br_2 + 2\ NaCl$ or $Cl_2 + 2\ Br^- \rightarrow Br_2 + 2\ Cl^-$ [1]
(State symbols not required)

5. (a) $\delta-$ O-H $\delta+$ $\delta-$ C-H $\delta+$ $\delta+$ B-Cl $\delta-$ $\delta+$ C=O $\delta-$

2 correct for 1 mark, all four for 2 marks [2]

(b) O-H [1]

6.

Element	Initial oxidation State	Final oxidation state	Oxidation or reduction
xenon	+2	0	reduction
oxygen	-2	0	oxidation

1 mark for each line completely correct

(If all oxidation states correct without oxidation/reduction indicated then award 1 mark in total.) [2]

Section A Total [10]

SECTION B

7. (a)

Test	Observation
Flame test	Lilac flame (1)
Addition of nitric acid followed by aqueous silver nitrate	White precipitate (1)
Addition of sodium hydroxide solution	White precipitate (1)

[3]

(b) Heat to evaporate some water to form a saturated solution
(Do not accept evaporate all water or to dryness) (1)

Allow to cool for crystals to form (1)

Filter off crystals / evaporate at room temperature (1) [3]

(c) (i) 1.25 g [1]

(ii) 169.9 / 170 [1]

(iii) Moles carnallite = $1.95 / 169.9 = 1.15 \times 10^{-2}$ moles
Moles water = $1.25 / 18.02 = 6.94 \times 10^{-2}$ moles
Both moles for (1)

$X = 6.94 \times 10^{-2} / 1.15 \times 10^{-2} = 6$ (Mark consequentially) (1) [2]

(d) Moles carnallite = 100 000 / 169.9 = 588.6 moles (1)

This produces 588.6 moles of $MgCl_2$ (1)

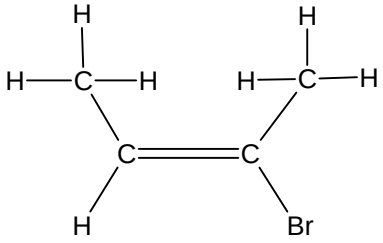
Mass $MgCl_2 = 588.6 \times 95.3 = 56.1$ kg or 56100 g
[units must be stated to obtain mark] (1) [3]

Total [13]

8. (a) (i) Compounds A and B have C=C double bonds, but compound B does not (1)

There is restricted rotation **about the double bond** (1) [2]

(ii)



Correct connectivity of bonds (1)

Correct geometrical isomer (1) [2]

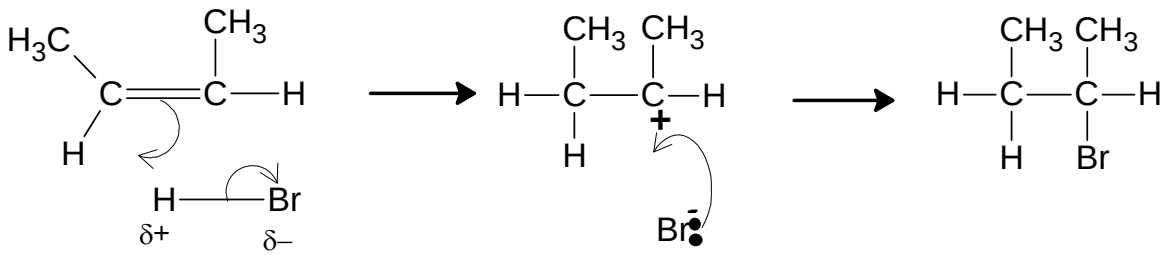
(b) (i) Orange to colourless (do not accept 'clear') [1]

(ii) 2,3-dibromobutane [1]

(iii) Cannot form hydrogen bonds / strong intermolecular forces **with water molecules** [1]

(iv) Sodium or potassium hydroxide (1)
Dissolved in alcohol and heat (1) [2]

(c) (i) 1 mark for arrows in first diagram; 1 mark for dipole on H-Br molecule; 1 mark for arrow in second diagram; 1 mark for charges in second stage [4]



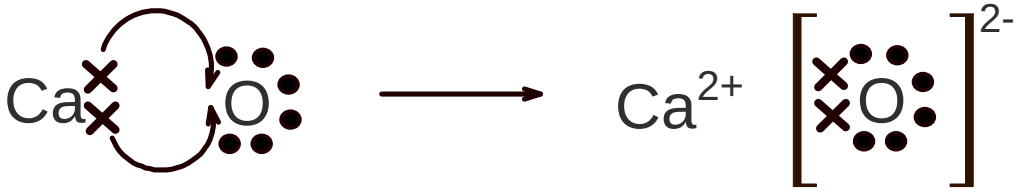
(ii) Electrophilic addition [1]

Total [14]

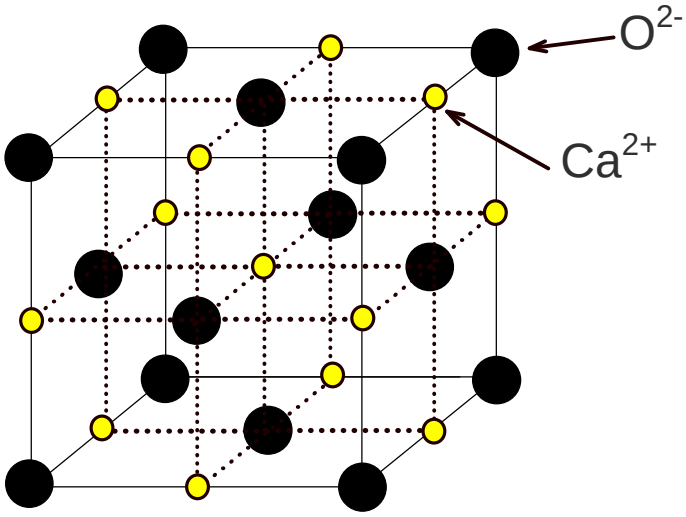
9. (a) M_r ($CaCO_3$) = 100.1 M_r (CaO) = 56.1 both values gives 1 mark

Atom economy = (56.1 /100.1) x 100 = 56.0 % (1) [2]

(b) 1 mark showing movement of electrons; 1 mark showing dot and cross of CaO [2]



(c) (i) 1 mark for cubic arrangement; 1 mark for 6 counterions arranged octahedrally around each ion [2]



Accept smaller diagram that shows the octahedral arrangement of ions around counterions

(ii) (CaO and NaCl have 1:1 formulae), $CaCl_2$ has 1:2 [1]

(d) (i) 3 Ca + 2 H_3PO_4 → $Ca_3(PO_4)_2$ + 3 H_2

1 mark for formula of calcium phosphate; 1 mark for equation

All total of 1 mark for balanced equation with incorrect formula for calcium phosphate
e.g. 2 Ca + 2 H_3PO_4 → 2 $CaPO_4$ + 3 H_2 [2]

(ii) Calcium sulfate is insoluble (1)

This produces a **layer** over the surface of the metal preventing reaction (1) [2]

Total [11]

10. (a) $Cl_2 \rightarrow 2\ Cl^{\bullet}$ [1]

(b) Fractional distillation (1)
Different products have **different boiling points** (1) [2]

(c) (i) One intermediate is a $C_5H_{11}^{\bullet}$ radical / a five carbon radical (1)
Two of these radicals combine together in a termination reaction (1)
[2]

(ii) Peak at 650-800 cm^{-1} (due to C-Cl bond) in chloropentane will be gone (1)
Peak at 2500-3500 cm^{-1} (due to O-H) in pentanol will be present (also accept 1000-1300 cm^{-1} for C-O bond) (1) [2]

(d) (i) Pentan-1-ol has hydrogen bonding between molecules but 1-chloropentane does not (1)
Hydrogen bonding is the strongest intermolecular force (1) [2]

(ii) Both compounds have similar hydrogen bonding **between molecules** (1)
Pentan-1-ol is a larger molecule than propan-1-ol (1)
Pentan-1-ol has more stronger van der Waals forces **between molecules** than propan-1-ol (1)
Any 2 out of 3 [2]

(iii) Propan-1-ol (1)

-OH can hydrogen bond **with water** (whilst –Cl cannot) (1)

Pentanol has a larger part of the molecule that cannot hydrogen bond / hydrocarbon chain is hydrophobic (1) [3]

(e) C-Cl has the largest δ+ on carbon / C-I has smallest δ+ on carbon (1)

If dipole was controlling factor, C-Cl would be fastest as nucleophile most attracted to this (1)

Easier to break bonds as go down the group / bonds get weaker down the group (1)

If bond strength was the governing factor we would expect rate to become greater down the group (1)

Dipole is not the controlling factor for rate / Bond strength is the governing factor (1)
[MAX 4]

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning. [1]

Total [19]

11. (a) (i) Li [1]

(ii) K [1]

(iii) Li / Na / K / Mg / Ca [1]

(iv) O [1]

(b) Structures (Max 4 points on structure)

- Graphite: Giant covalent structure OR Hexagonal layers of carbon atoms
- Graphite: Delocalized electrons between the layers
- Aluminium: Lattice of **positive** metal **ions**
- Aluminium: (Sea of) delocalized electrons
- Caesium chloride: (Lattice of) anions and cations / giant ionic

Conditions required

- Graphite and Aluminium can conduct as solids
- Caesium chloride must be a liquid/solution to conduct

How material conducts

- Aluminium and Graphite: (Delocalised) electrons move to form a current
- Caesium chloride: **Mobile ions** carry allow electricity to flow

1 mark for each point giving [MAX 6]

QWC: 2 marks [2]

- *selection of a form and style of writing appropriate to purpose and to complexity of subject matter.*
- *organisation of information clearly and coherently; use of specialist vocabulary where appropriate.*

(c) Nanoscale electrical wires / electronic circuitry [1]
(accept miniature/tiny)

Total [13]

Section B Total [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2011

CHEMISTRY - CH2

SECTION A

Q.1 (a) Calcium carbonate [1]

(b) Sodium carbonate [1]

Q.2 Metallic (1)
Covalent **and** van der Waals (1) [2]

Q.3 $Ca_3(PO_4)_2$ [1]

Q.4 D [1]

Q.5 Materials that change their properties in response to a change in conditions / environment / surroundings [1]

Q.6 (a) Alkene / double bond (1)
Alcohol / hydroxyl / hydroxy (1) [2]

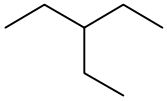
(b) $C_5H_{10}O$ [1]

Total [10]

SECTION B

Q.7 (a) Compound that contains no double bonds / single bonds only
(Accept contains maximum number of hydrogens) [1]

(b) (i) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ [2]
products (1)
balancing (1)

(ii) 

[1]

(c) Cracking (1)
Heat fraction strongly / heat over a catalyst (1)
Accept equation or description of cracking [2]

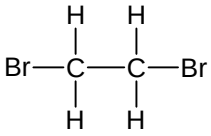
(d) Planar molecule with trigonal arrangement about each atom / bond angles roughly 120° (1)

Four (single) **covalent** C – H bonds and one C = C double bond (1)

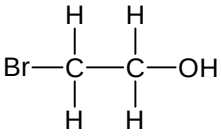
π bond in C = C formed by sideways overlap of p orbital (1) [3]

QWC: Information is organised clearly and coherently, using specialist vocabulary where appropriate. [1]

(e) Electrophilic addition (1)



accept



[2]

(f) Phosphoric acid [1]

(g) Moles ethanol = $\frac{230}{46}$ = 5 (1)

Moles glucose = 2.5 (1)

Mass glucose = 2.5 x 180 = 450 g (1) [3]

Total [16]

Q.8 (a) $C_4H_{10} + Cl_2 \longrightarrow C_4H_9Cl + HCl$ (1)

UV light (1)

any of following for 4 max

$Cl_2 \longrightarrow 2Cl^{\bullet}$ (1)

Free radical substitution / photochlorination (1)

$Cl^{\bullet} + C_4H_{10} \longrightarrow {}^{\bullet}C_4H_9 + HCl$ (1)

${}^{\bullet}C_4H_9 + Cl_2 \longrightarrow C_4H_9Cl + Cl^{\bullet}$ (1)

e.g. $Cl^{\bullet} + Cl^{\bullet} \longrightarrow Cl_2$ (1)

[6]

QWC: Selection of form and style of writing appropriate to purpose and to complexity of subject matter. [1]

(b) $C_4H_9Cl + NaOH \longrightarrow C_4H_9OH + NaCl$ (1)

Nucleophilic substitution / hydrolysis [2]

(c) Heat with NaOH (1)

Add HNO_3 then $AgNO_3$ (1)

White precipitate seen (1) [3]

(d) Ozone layer depleted / (leads to) increased incidence of skin cancer

Contributes to greenhouse effect / increases global warming [1]

Total [13]

Q.9 (a) C=O absorption at 1650–1750 cm^{-1}

C–O absorption at 1000–1300 cm^{-1}

O–H absorption at 2500–3500 cm^{-1}

3 correct peaks labelled

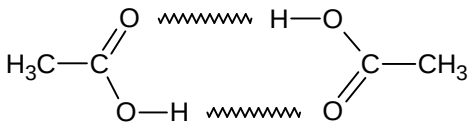
[2]

(2 correct peaks labelled 1 mark)

(b) Molecular ion at m/z 60 shows that M_r is 60 (1)

Peak at m/z 15 shows CH_3 group / peak at m/z 45 shows COOH group (1)
[2]

(c) (i)



[1]

(Accept 1 hydrogen bond)

(ii) (Intermolecular bond formed) when hydrogen attached to a highly electronegative atom (oxygen) (1)

is bonded to an electronegative atom in another molecule (1)

forming very strong dipole – dipole attraction (1) [3]

QWC: Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(d) (i) Acidified and heat / reflux [1]

(ii) Colour change from orange to green [1]

(e) Propane would be lower as it cannot form hydrogen bonds / only forms van der Waals forces between molecules (1)

Butan-1-ol would be higher as it (also has hydrogen bonds but) has more van der Waals forces between molecules (1) [2]

Total [13]

Q.10 (a) (i) $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$ [1]

(ii)

Element	*Initial Oxidation State*	*Final Oxidation State*
Nitrogen	–3	2
Hydrogen	1	1
Oxygen	0	–2

All three rows correct (2)
(1 mark if two rows correct)

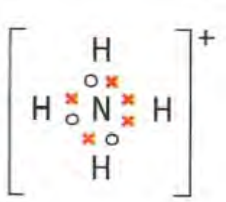
Nitrogen oxidised as its oxidation state has increased (1) [3]

(iii) NH_3 has 3 bonding and 1 non bonding pair of electrons (1)

BF_3 has 3 bonding pairs only (1)

Electron pairs position themselves as far apart as possible (to minimise repulsion) (1) [3]

(b) (i) A covalent bond where one of the atoms has donated both electrons in the shared pair [1]



charge spread over ion (1)

correct bonding (1)

[2]

(iii) Tetrahedral (1)

109½º (1) (accept 109°) [2]

(iv) Water is polar / a polar solvent (1)

Anion is attracted to $H^{\delta+}$ / cation is attracted to $O^{\delta-}$ (1) [2]

Total [14]

Q.11 (a) (i) Lilac flame (1)

White solid / white fumes / potassium melts (1) [2]

(ii) $4K + O_2 \longrightarrow 2K_2O$ [1]

(iii) More reactive (1)

Electrons in rubidium lost more easily / ionisation energy is less / explanation e.g. increased sheilding (1) [2]

(Need reason to get first mark but accept more reactive as reactivity increases down group for 1 mark)

(b) (i) No. moles = $\frac{0.098}{23} = 0.00426$ [1]

(ii) Moles $H_2 = 0.00213$ (1)

Volume $H_2 = 0.00213 \times 24 = 0.0511\ dm^3$ (1) [2]

(iii) Moles NaOH = 0.00426 (1)

Concentration NaOH = $\frac{0.00426}{0.200} = 0.0213\ mol\ dm^{-3}$ (1) [2]

(c) (i) Do the experiment in a fume cupboard [1]

(ii) I 6:6 [1]

II Electrostatic forces between the oppositely charged ions (1)

ionic bonds are / ionic lattice is very strong so large amount of energy needed (1) [2]

Total [14]

Section B Total [70]

WJEC
CBAC

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2012

GCE Chemistry – CH2

SECTION A

Q.1 They show a change in properties with a change in conditions (1)

This change in properties is reversible (1) [2]

Q.2 Equation $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (1)

pH Accept any value 8 to 14 inclusive / above 7 (1) [2]

Q.3 4-methylpent-2-ene [1]

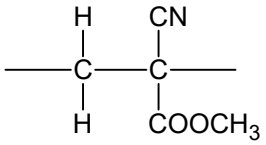
Q.4 (a) Orange to green [1]

(b) (i) C–H [1]

(ii) C [1]

(iii) 1650 to 1750 cm^{-1} C = O [1]

Q.5

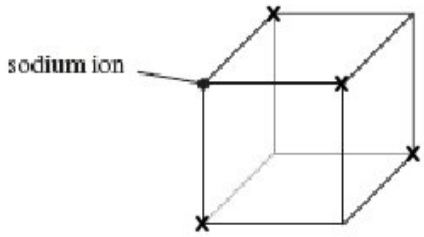


[1]

SECTION A TOTAL [10]

SECTION B

Q.6 (a) (i) [1]



Any of crosses shown

(ii) 6 (not 6,6) [1]

(b) Stir the mixture (before filtering) / heat (1)
Wash the mudstone / residue in the filter paper with water (and add the washings to the filtrate) (1) [2]

(c) (i) Add $AgNO_3$ / Ag^+ ions (assume aqueous) (1) [2]
White precipitate (1)

(ii) Add (aqueous) sodium hydroxide (solution) (1) gives (faint) white precipitate with kainite, no reaction with rock salt (1)

OR

Add barium chloride / barium nitrate / barium ions (1) gives white precipitate with kainite, no reaction with rock salt (1)

OR

Add potassium carbonate / carbonate ions (1) gives white precipitate with kainite, no reaction with rock salt (1) [2]

(d) (i) (The gaining of an electron) gives a full / stable (outer) electron shell [1]

(ii) There is less attraction between the nucleus and the (incoming) electron / oxidising power decreases down the group (increases in size is a neutral answer) [1]

(e) (i) The C–Cl bond (present in 1,1,1-trichloroethane) is **weaker** than the C–H bond (in methylcyclohexane) (1) and is broken by UV light / radicals present (that damage the ozone layer) (1) [2]

(ii) Reagent(s) Bromine (aqueous) (1)
Observation red/ brown $\rightarrow$ colourless / decolourised (1) [2]

Total [14]

Q.7 (a) (i) % of solid remaining = $\frac{2.01 \times 100}{3.24}$ = 62.0 (1)

% decomposition = 87 (1) [2]

(ii) I To avoid contamination / ensure that all Ca^{2+} ions came from the solid [1]

II So that all the calcium hydroxide that could dissolve had dissolved / to produce a saturated solution / to ensure homogeneity [1]

(iii) I 0.0225 [1]

II 0.0225 x 74.1 = 1.67 (g dm^{-3}) [1]

(iv) Calcium carbonate was removed (by filtration) [1]

(b) Brick red (1)
The 'calcium' will give a flame test colour (1) [2]

(c) $Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4$ [1]

(d) Find out if the nano-particles have 'side effects' / further research to see if they work [1]

(e) 5000 tonnes of fluorapatite give 8600 tonnes of superphosphate (1)

but yield is 93% $\therefore$ $\frac{8600 \times 93}{100}$ = 7998 / 8000 (tonnes) (1) [2]

(f) The two elements both have 2 electrons in their outer energy level / valence shell can both lose 2 electrons to become Ra^{2+} / Ca^{2+} / OWTTE [1]

Total [14]

Q.8 (a) (i) (+) 7 [1]

(ii) M_r H_2O_2 is 34.02 / 34 (1)

Concentration = $\frac{76.5 \times 10}{34.02}$ = 22.49 / 22.5 (mol dm^{-3}) (1) [2]

(iii) A covalent bond where the electrons are not shared equally between the atoms / unequal electron density (1) because of differences in electronegativity between the nitrogen and hydrogen atoms (1) [2]

(iv) A (covalent) bond where **both** electrons come from the same / one atom [1]

(v) (Nitrogen has three bonding pairs and one lone pair of electrons) and these repel each other to take up the position of minimum repulsion (1) The lone pair / bonding pair repulsion > bonding pair / bonding pair repulsion (1) [2]

(b) (i) It contains an unpaired electron [1]

(ii) I $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ [1]

II A radical reacts to produce a new radical (that can continue the process) [1]

(iii) C_7H_{16} [1]

(iv) (Bond fission where a covalent bond breaks) and each atom receives an electron [1]

Total [13]

Q.9 (a) Hydrogen bonding occurs between (1) oxygen, nitrogen or fluorine (1) of one molecule and hydrogen, which is bonded to oxygen / nitrogen / fluorine of another molecule (1)
Alkanes do not contain an O-H, N-H or F-H bond and cannot therefore hydrogen bond to water molecules (1) [4]

QWC *Candidates should have use 'a selection and form of writing appropriate to purpose and to complexity of subject matter'* [1]

(b) (i) The (purified) petroleum is separated by heating (1) due to the different boiling temperatures of different fractions (1)

OR the mixture is vaporised (1) and then condensed according to boiling temperatures (1) (as at the oil refinery) [2]

(ii) $CuCl_2$ Cu +2 CuCl Cu +1 (1)

(reduction occurs when) the oxidation number becomes less positive (1) [2]

(c) (i) Same molecular formula but a different structural formula / structure [1]

(ii) Both of the carbon atoms of the double bond have different atoms / groups bonded to them (1)
There is no free rotation about the double bond (1) [2]

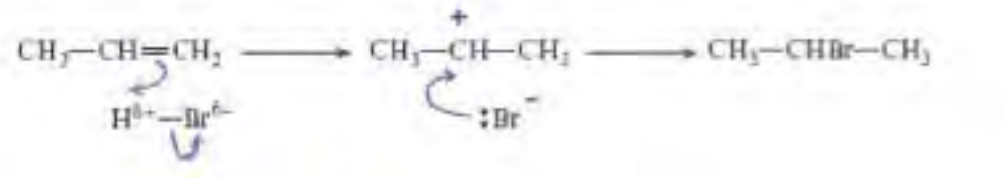
(iii) M_r of compound **A** is 146.3 / 146 (1)

Cost per mole is $\frac{146.3 \times 48 \times 100}{100 \times 73}$ = £96.20 (1)

(Accept £96.00 per mole if M_r of 146 has been used) [2]

Total [14]

Q.10 (a) (i)



curly arrows (1)
charges (1) [2]

(ii) Nucleophile hydroxide ion / OH^- / water (1)

Substitution the replacement of one functional group by another (1) [2]

(iii)

$CH_3CH_2Br + NaOH \rightarrow CH_2\ CH_2 + \mathbf{NaBr} + \mathbf{H_2O}$

(accept $\mathbf{Na^+}$ and $\mathbf{Br^-}$ in place of NaBr) [1]

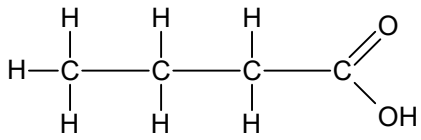
(b) $M_r = 88$ (1)

'M_r' R = 88 - (45) = 43 (1)

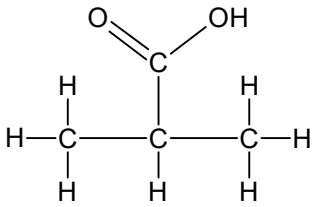
COOH

∴ R (an alkyl group) is C_3H_7

thus acid is



or



(1) [3]

(c) In graphite each carbon atom is bonded to three other carbon atoms (1) (using covalent bonding)
The other (outer) electron for each carbon atom is delocalised (1), throughout the structure and is able to move (1), conducting electricity
In iodine the two iodine atoms are bonded together (using covalent bonding) and there are no free electrons to carry the charge (1)
Mention of covalent bonding for either element (1) [5]

QWC *Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning (1)*
Organisation of information clearly and coherently; use of specialist vocabulary where appropriate (1) [2]

Total [15]

SECTION B TOTAL [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2012

CH2

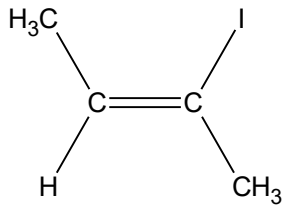
SECTION A

Q.1 (a) $C_{19}H_{40}$ [1]

(b) $C_{19}H_{40} \rightarrow C_8H_{18} + C_{11}H_{22}$ - allow ecf [1]

Q.2 2-chlorobutane [1]

Q.3 [1]



Q.4 any number in range 1 to 6 [1]

Q.5 (a) maximum mass = 44-45 (g) [1]

(b) (less solute would form as a solid) because more will remain in the solution [1]

Q.6 (a) iodine force is Van der Waals/ induced dipole-induced dipole (1)

diamond force is covalent bond/ description of attractive forces in a covalent bond (1) [2]

(b) diamond would have a higher sublimation temperature because it has strong**er** forces/ forces are hard**er** to break [1]

Section A Total [10]

SECTION B

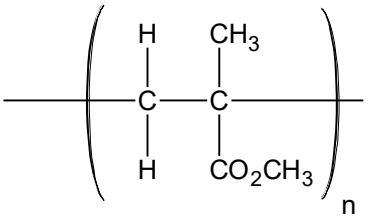
Q.7 (a) (i) one σ bond/ description of σ bond/ diagram to show overlap of s orbitals (1)

one π bond/ description of π bond/ diagram to show sideways overlap of p orbitals (1)

[2]

(ii) joining of **many**/**lots of** (small) units or many alkenes / molecules to make a **large**/**long** unit/ molecule [1]

(iii)



[1]

(iv) C_4H_5Cl [1]

(b) (i) BF_3 is planar triangular/ trigonal planar (1)

NH_3 is pyramidal/ trigonal pyramid (1) [2]

(ii) BF_3 has 3 bond pairs (1)

NH_3 has 3 bond pairs and 1 lone pair (1) [2]

QWC the information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(c) (i) co-ordinate/ dative covalent/ dative
- no credit for 'covalent' [1]

(ii) 109½° (accept any in range 109°-110°) [1]

(iii) 4 bond pairs/ bonds (around B)
- no credit for 'tetrahedral' [1]

Total [13]

Q.8 (a) (i) % H = 14.3 (1)

$$C : H = \frac{85.7}{12.0} : \frac{14.3}{1.01} = 7.14 : 14.16 \text{ (1)}$$

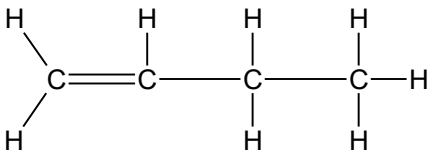
empirical formula = CH_2 (1) [3]

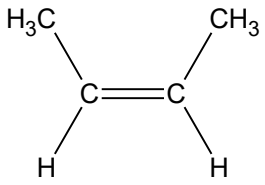
(ii) M_r = 42/ largest fragment has mass 42 (1)

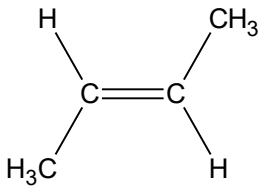
(CH_2 = 14) therefore molecular formula = C_3H_6 (1) [2]

(iii) CH_3 is present [1]

(b) 1 mark for each [3]







Total [9]

Q.9 (a) apparatus in which reaction can occur, e.g. flask/ test tube, and delivery/ rubber tube (1)

apparatus in which to measure volume of gas, e.g. over water with measuring cylinder/ gas syringe (1) [2]

(b) (i) fewer **moles** of barium used / barium has a higher A_r [1]

(ii) reaction faster/ more vigorous/ less cloudy solution formed with barium (1)

because ionisation energy of barium is less/ electrons lost more easily from barium/ barium is lower in the group/
barium hydroxide is more soluble (1) [2]

(c) flame test (1) brick red for calcium **and** (apple) green for barium (1)

OR

add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

white precipitate with Ba^{2+}, less precipitate/ no precipitate with Ca^{2+} (1) [2]

(d) electrons correct – oxide ion clearly shows that 2 electrons originated from calcium atom (1)
charges correct (1) [2]

(e) (i) add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

filter (1)

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (1)
- state symbols ignored [3]

(ii) moles Ba = 2/137 (1)

mass $BaSO_4 = \frac{2 \times 233.1}{137} = 3.4$ (g) (1) [2]

Total [14]

Q.10 (a) both contain metallic bonds/ positive ions and delocalised electrons labelled on diagram (1)

those in magnesium are stronger/ harder to break/ need more energy to break (1)

because **2** electrons are involved in delocalisation/ attraction to the positive ions (1) [3]

(b) reaction is hydrolysis of halogenoalkane/ nucleophilic substitution of halogenoalkane (1)

$C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ X can be Cl or Br (1)

(white precipitate is) silver chloride and (cream precipitate is) silver bromide (1)

$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3 + X^- \rightarrow AgX + NO_3^-$ (1)

- state symbols ignored [4]

QWC selection of form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) caesium ions are bigger than sodium ions – accept 'atoms' (1)

co-ordination number 6 : 6 for sodium and 8 : 8 for caesium (1)

both cubic (1) [3]

(d) reaction is electrophilic addition (1)

two possible products are 1-bromopropane and 2-bromopropane (1)

more 2-bromopropane formed (1)

because of greater stability of intermediate positive ion/ 2° carbocation (1)
[4]

QWC legibility of text; accuracy of spelling, grammar and punctuation, clarity of meaning [1]

Total [16]

Q.11 (a) diagram completed with at least 1 water molecule and indication of interaction between O on one molecule and H on the other (1)

interaction between δ^+ on H and lone pair on O (1)

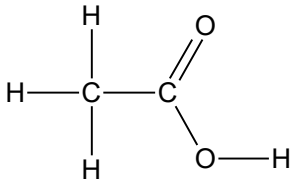
interaction labelled hydrogen bond (1) [3]

(b) (i) reduction/ redox – accept 'oxidation' [1]

(ii) I OH [1]

II OH is also present in water [1]

(c) (i) [1]



(ii) peak at 1650-1750 (1)

due to C=O (1) [2]

Total [9]

Q.12 (a) incomplete p sub-shell/ outer electron configuration s^2p^5/ outer electrons in p subshell/ outer electrons in p orbitals/ valence electrons in p subshell/ valence electrons in p orbital [1]

(b) (i) gaining one electron completes shell/ gives p^6/ takes an electron from another species/gains an electron
- do not accept 'attracts an electron' [1]

(ii) **fluorine** because it is the smallest/ has the greatest electron affinity/ has the least shielding/ has the greatest effective nuclear charge/ oxidising power decreases as the group is descended
[1]

(c) oxidation state is (+)5/ V
- do not accept '5+' [1]

(d) (i) $Cl_2 \rightarrow 2Cl^{\bullet}$ - ignore hf
[1]

(ii) $CH_4 + Cl^{\bullet} \rightarrow HCl + {}^{\bullet}CH_3$ (1)

${}^{\bullet}CH_3 + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$ (1) [2]

(e) products: ${}^{\bullet}CFH_2$ and $Cl^{\bullet}$ (1)

C-**Cl** bond is the weak**est**/ **most** easily broken (1) [2]

Total [9]

Section B Total [70]

GCE MARKING SCHEME

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GCE CHEMISTRY - CH2

JANUARY 2013 MARK SCHEME

SECTION A

Q.1 Calcium – Bones, teeth, muscle contraction.
Magnesium – chlorophyll, activation of ATP. (Both for 1 mark) [1]

Q.2 4,4-dimethylpentan-1-ol (1) [1]

Q.3 (a) Ability of atom to attract electrons in a covalent bond towards itself. [1]

(b) δ- F-Cl δ+ δ+ At-Cl δ- Both needed for mark [1]

Q.4 CH_2 (Accept H_2C) [1]

Q.5 (a) C [1]

(b) B [1]

Q.6 Both O_2 and O_3 have oxidation states of zero (1) No change in oxidation state (1) [2]

Q.7 Reversible change in properties when conditions change. [1]

Total Section A [10]

SECTION B

Q.8 (a) (i) $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (state symbols not required) [1]

(ii) white precipitate [1]

(b) (i) apple-green / yellow-green (no credit for 'green') [1]

(ii) Reagents – silver nitrate (1)
Observation – white precipitate (1)
Must have correct reagent to get observation [2]

(c) Mass produced by cooling 1 dm^3 = 358-312 = 46 g (1)
Mass produced by 200 cm^3 = 46 x 200 ÷1000 = 9.2 g (1) [2]

(d) M_r of anhydrous $BaCl_2$ = 208 (1)
Water content = 36 so *x* =2 (1) [2]

(e) (i) $BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$ [1]

(ii) I. Moles = 50 x 0.50 ÷ 1000 (1) = 0.025 moles (1) [2]

II. Filtration [1]

III. Moles $BaCl_2$ = moles HCl ÷ 2 = 0.0125 mol (1)

Mass hydrated $BaCl_2$ = 0.0125 x 244 = 3.05 g (1) [2]

Total [15]

Q.9 (a) (i) ultraviolet / sunlight [1]

(ii) A species with an unpaired electron. [1]

(b) $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$ (1)
$CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ (1) [2]

(c) (i) Two $CH_3\bullet$ radicals combine (in a termination reaction). [1]

(ii) 24.3 ÷ 12 = 2.025 for C 4.1 ÷ 1.01 = 4.059 H 71.6 ÷ 35.5 = 2.017 Cl (1)
CH_2Cl (1) [2]

(d) (i) Nucleophilic substitution [1]

(ii) Methanol has hydrogen bonding between molecules (1)
Chloromethane has van der Waals forces / dipole-dipole forces between molecules (1)
Hydrogen bonding is stronger than Van der Waals/dipole-dipole (1) [3]

(iii) Acidified potassium dichromate / acidified potassium manganate(VII) (1)
Heat /warm (1) (Need correct reagent to gain heat mark) [2]

(e) Compounds **B** and **C** are stable enough to reach the ozone layer OR Compound **D** would not reach the ozone layer as it would decompose in the lower atmosphere. (1)

(The C-Cl forms) Cl• which will decompose the ozone. (1)

Compound **A** does not contain chlorine, (so it cannot form Cl•) / Compound A has a lower RODP (1)

[3]

Total [16]

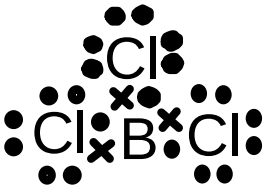
Q.10 (a)

- BCl_3 is trigonal planar or clear diagram.
- NCl_3 is pyramidal or clear diagram.
- BCl_3 has 3 bonded pairs
- NCl_3 has 3 bonded pairs
- NCl_3 has a lone pair
- BCl_3 has no lone pair
- Electron pairs repel to be as far from each other as possible / position of minimum repulsion.
- Lone pairs repel more than bonded pairs.

First two points and any other 4 for (1) each up to 6 max [6]

- *QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter.[1]*
-
- *QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning.[1]* [2]

(b)



accept crosses and dots exchanged (1)

Electron deficient: outer shell of boron has less than 8 electrons / is not full.(1) [2]

(c) NH_3 can form hydrogen bonds with water molecules (so it dissolves) (1)
NCl_3 cannot form hydrogen bonding. (1) [2]

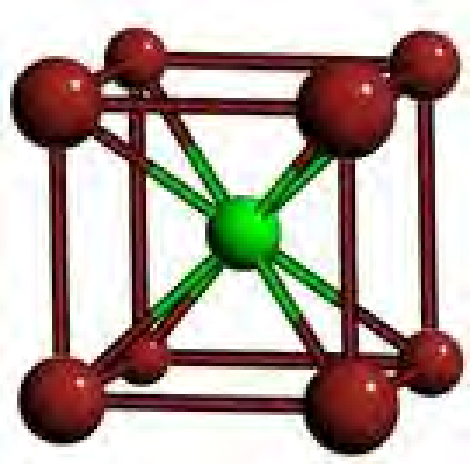
(d)

- Covalent has a pair of shared electrons one from each atom (1)
- Coordinate has a pair of shared electrons both electrons from same atom (1)

[2]

Total [14]

Q.11 (a) (i)



Clear 8 coordination number (1)
Labels of both Cl^- and Cs^+ (either way round) (1) [2]

(ii) Cs^+ ion larger than Na^+ so can have a larger coordination number. [1]

(b) (i) Any three from the following for (1) each up to 3 max – can gain these from labelled diagram

- Layers of carbon atoms.
- Hexagons of carbon atoms / each carbon bonded to three others.
- Weak forces between layers.
- Delocalised electrons above and below plane. [3]

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate. [1]

(ii) Delocalised electrons in graphite can move to carry a current (1)
Diamond has no delocalised electrons (1) [2]

(iii) Van der Waals forces between molecules need to be broken to form iodine gas (1)

Covalent bonds need to be broken to form a gas from diamond/graphite (1)

Van der Waals forces are much weaker than covalent bonds (1)
[3]

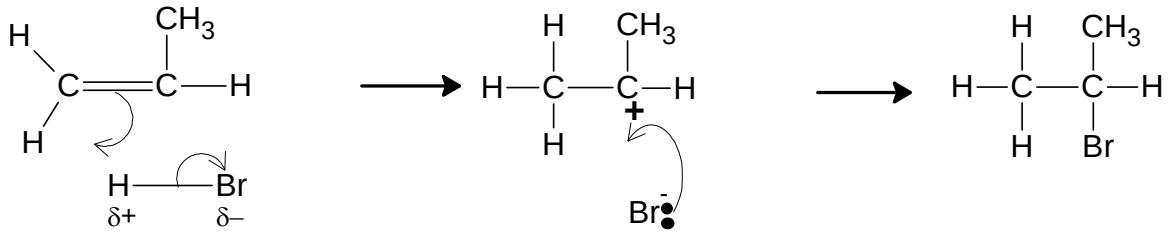
Total [12]

Q.12 (a) (i) Molecules with different numbers of carbon atoms have different boiling points. [1]

(ii) Any suitable reaction, e.g. $C_{10}H_{22} \rightarrow C_4H_8 + C_6H_{14}$ [1]

(b) (i) Turns from orange to colourless (no credit for 'red') [1]

(ii) (1) for arrows in first diagram; (1) for arrow in second diagram; (1) for all charges.



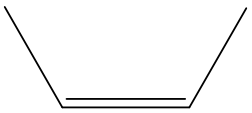
[3]

(iii) Ethanol OR Alcohol solution / Heat - both required [1]

(c) (i) Restricted rotation about double bond in but-2-ene but not butane (1)

2 groups attached to each carbon of the double bond are different in but-2-ene but in propene one carbon has the same two groups attached (1) [2]

(ii)



Accept any valid representation [1]

(d) (i) Steam, phosphoric acid catalyst, (1) 300°C, 70 atm pressure (1) [2]

(ii) Butan-2-ol will have IR absorptions at 2500-3550 cm^{-1} / 1000 – 1300 cm^{-1} and butene will not
OR
But-2-ene will have an IR absorption at 1620-1720 and butan-2-ol will not [1]

Total [13]

Total Section B [70]

GCE MARKING SCHEME

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SUMMER 2013 MARK SCHEME

Section A

Q.1 C **[1]**

Q.2 B **[1]**

Q.3 (a) Calcium chloride **[1]**

(b) Magnesium carbonate **[1]**

(c) Sodium sulfate **[1]**

Q.4

Species	Cl●	NH_3
Classification	Radical	Nucleophile

(1 for each box) **[2]**

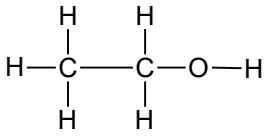
Q.5 e.g. wound dressing/sterilising sprays/deodorant socks/ refrigerator surfaces/anti-perspirants **[1]**

Q.6 Potassium and chlorine (1)

They have the largest electronegativity difference (1) **[2]**

Section B

Q.7 (a) (i) **[1]**

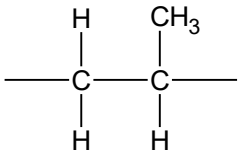


(ii) Nickel / platinum / palladium **[1]**

(iii) Potassium / sodium hydroxide (1)
in ethanol and heat (1) **[2]**

(iv) Elimination **[1]**

(b) (i) **[1]**



(ii) M_r poly(propene) unit = 42 (1)
Number of units = $\frac{1.05 \times 10^6}{42}$ = 25000 (1) **[2]**

(c) (i) Percentage hydrogen = 4.6% (1)

C	H	Br	
$\frac{22.0}{12}$	$\frac{4.6}{1.01}$	$\frac{73.4}{79.9}$	(1)
1.83	4.55	0.92	
2	5	1	

Formula = C_2H_5Br (1) **[3]**

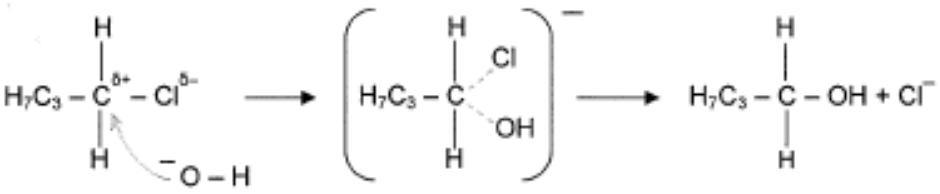
(ii) M_r of compound / number of atoms of any element in compound **[1]**

Total [12]

Q.8 (a) e.g. damages liver/ damages pancreas/causes cancer/causes skin disorders/ short-term effects (1)

e.g. more traffic accidents/violent behaviour/criminal behaviour (1) **[2]**

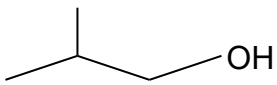
(b) (i) Nucleophilic substitution / hydrolysis (1)



Reactants: Intermediate (1)
Polarisation (1) (accept curly arrow to show
curly arrow (1) C – Cl breaking instead of intermediate) **[4]**
(Incorrect starting material or product maximum 2 marks from 3 for mechanism)

(ii) Peak at 650–800 cm^{-1} due to C – Cl bond will be gone (1)
Peak at 2500–3500 cm^{-1} due to O – H bond /
1000–1300 cm^{-1} due to C – O bond will be present (1) **[2]**

(c) (i)



[1]

(ii) Structural / positional / chain **[1]**

(iii) Colour change from orange to green **[1]**

(iv) Concentrated sulfuric acid / aluminium oxide (1)
$CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CHCH_2 + H_2O$ (1) **[2]**

(d) (i) C – F bond stronger than C – Cl bond (1)
C – Cl bond breaks (in stratosphere) forming Cl• which
reacts with ozone (1) **[2]**

(ii) Some CFCs still being used / CFCs take a very long time to reach the ozone layer / other substances deplete the ozone layer **[1]**

Total [16]

Q.9 (a) A mixture of (many) hydrocarbons / alkanes **[1]**

(b) $C_4H_{10} + 6½O_2 \longrightarrow 4CO_2 + 5H_2O$ **[1]**

(c) 109½° **[1]**

(d) H_2O has 2 bonding and 2 lone pair of electrons (1)

CH_4 has 4 bonding pairs only (1)

Repulsion between lone pairs and bond pairs is greater than between bond pairs and bond pairs (1) **[3]**

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate *QWC* **[1]**

(e) (i) Butane is higher because it has more van der Waals' forces between molecules **[1]**

(ii) Regular array of metal ions surrounded by a 'sea' of delocalised valence electrons (1)

Strong attraction between the positive ions and the delocalised electrons (1) (Can be obtained from labelled diagrams)

Malleable because when a force is applied the layer of metal ions slide over each other forming a new shape (1)

Conduct electricity since under a potential difference the delocalised electrons flow / the delocalised electrons flow towards the positive potential (1)
[4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning *QWC* **[1]**

Total [13]

Q.10 (a) (i) Chlorine – gas
Iodine – solid **[1]**

(ii) Chlorine – brown/orange solution (1)
Iodine – no change / no reaction (1)
$Cl_2 + 2KBr \longrightarrow Br_2 + 2KCl$ (1) **[3]**
(Accept ionic equation)

(b) Oxygen loses electrons therefore oxidised / oxidation state changes from -2 to 0 therefore is oxidised (1)

Chlorine gains electrons therefore reduced / oxidation state changes from 0 to -1 therefore is reduced (1) **[2]**

(c) (i) Boiling temperatures increase as relative molecular mass increases / number of electrons increases / down group (1)

HF has a higher boiling point than expected (1) **[2]**

(ii) Group 7 hydrides contain more dipole–dipole forces as group descended (1)
but HF contains hydrogen bonding between molecules (1)

Hydrogen bonds are stronger therefore HF's boiling temperature is greater / need more energy to break (1) **[3]**

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter *QWC* **[1]**

(iii) HCl more polar than SiH_4 therefore intermolecular forces are stronger / dipole greater in HCl / Cl more electronegative than Si **[1]**

Total [13]

Q.11 (a) (i) $2Ca + O_2 \longrightarrow 2CaO$ **[1]**

(ii) 

(1)

forming Ca^{2+} and O^{2-} ions (1) **[2]**

(b) (i) $Ca(OH)_2$ **[1]**

(ii) 8 – 14 **[1]**

(c) $Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$ **[1]**

(d) (i) Magnesium disappears / gets smaller (1)
Effervescence / bubbles (of hydrogen) (1)
Heat given off (1) **[2]**
(Accept any 2 points)

(ii) Moles Mg = $\frac{0.503}{24.3}$ = 0.0207 (1)
Moles HCl = 0.0414 (1)
Volume HCl = $\frac{0.0414}{1.6}$ = 0.0259 dm^3 (1) **[3]**

(iii) Volume H_2 = 0.0207 × 24 = 0.497 dm^3 **[1]**

(iv) Add aqueous silver nitrate (1)
White precipitate forms (1) **[2]**

(e) Less reactive (1)

Electrons in beryllium more difficult to lose / ionisation energy is higher (1) **[2]**

(Need reason to get first mark but accept less reactive as reactivity increases down group / outer electron has less shielding etc. for 1 mark)

Total [16]

GCE MARKING SCHEME

CHEMISTRY
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JANUARY 2014

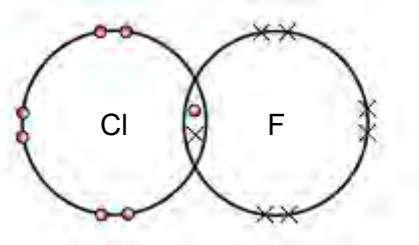
CH2

Section A

Q.1 C [1]

Q.2 (a) $Cl^{\delta+}$— $F^{\delta-}$
Electronegativity decreases down the group / fluorine is more electronegative (than chlorine) / chlorine is less electronegative (than fluorine) [1]

(b) [1]



Q.3 It has a full / stable (outer) electron shell [1]

Q.4 (a) $C_6H_{12}Br_2$ [1]

(b) Elimination [1]

Q.5 Temperature 200-300 (accept 470-570K)

Pressure 60-70 (accept 6000-7000 kPa) [1]

Q.6 Hex-2-ene (ignore references to cis/trans/*E/Z*) [1]

Q.7 (a) A process of bond breaking where the two electrons (of the covalent bond) go to one of the two atoms in the bond [1]

(b) $(CH_3)_3C^+$ and Cl^- (accept $(CH_3)_3C^-$ and Cl^+) [1]

Total Section A [10]

Section B

Q.8 (a) In SO_2 the oxidation number of sulfur is +4

In SO_2F_2 the oxidation number of sulfur is +6 (1)

Increase in (positive) oxidation number is oxidation (1) [2]

(b) The electrons in the bonds between sulfur and fluorine and sulfur and oxygen take up the position of minimum repulsion / maximum separation [1]

(c) (i) A lone pair donor / a species that seeks out a relatively positive site [1]

(ii) eg H_2O / OH^- / Cl^- (or other halogen) / CN^- / correct formula of an amine [1]

(iii) A shift of **two** electrons [1]

(d) $SO_2F_2 + 2Ca(OH)_2 \rightarrow CaSO_4 + CaF_2 + 2H_2O$

[(1) for correct formulae, (1) for balancing **if** formulae correct] [2]

(e) (i) UV radiation (1) is able to break the C—Cl and C—Br bonds (1) giving radicals (1) that attack / breakdown the ozone layer [3]

(ii) The S—F bond in sulfuryl fluoride is too strong to be broken by UV radiation [1]

Total [12]

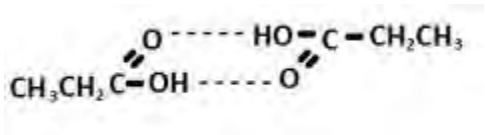
Q.9 (a) (i) 165 ± 5 °C [1]

(ii) As the number of carbon atoms in the acids increase the boiling temperature increases (1)
This is due to an increase in induced dipole-induced dipole / Van der Waals forces (1) between molecules (1) [3]

(iii) As the molecules increase in size the relative importance of the —COOH group decreases (1)
There is therefore less of a tendency to hydrogen bond **with water** (becoming less soluble) (1) [2]

(b) (i) Acidified (potassium) dichromate (accept H^+, $Cr_2O_7^{2-}$) / Acidified (potassium) manganate(VII) (accept H^+, MnO_4^-) [1]

(ii)



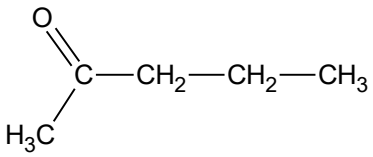
[1]

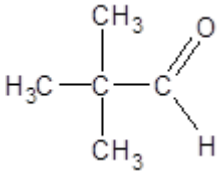
(iii) I 0.050 [1]

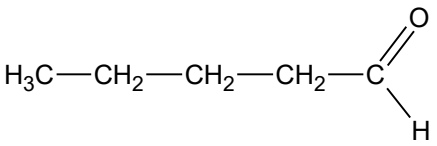
II 0.025 [1]

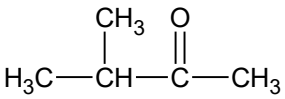
III 0.025 × 186 = 4.65 (g) [1]

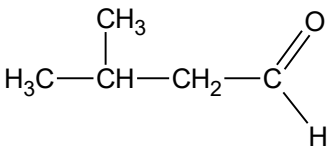
(iv) Any 2 of the following:

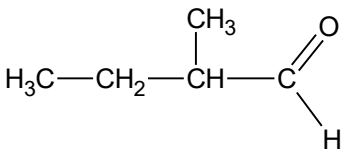












[2]

(c) (i) $\frac{49.3}{12} = 4.11$ $\frac{43.8}{16} = 2.74$ (1) Ratio of C:O is 3:2 (1) [2]

(ii) There are four oxygen atoms per molecule ∴ 6 carbon atoms (and 4 oxygen atoms)

∴ n = 6 – 2 in the acid groups ∴ n = 4 [1]

Total [16]

Q.10 (a) (i) Number of moles of HCl = $\frac{80 \times 0.20}{1000}$ = 0.016 (1)

Number of moles of calcium needed = 0.008 (1)

Number of moles of calcium actually used = $\frac{0.40}{40}$ = ~ 0.010 (1)

($\therefore$ calcium is present in excess)

[Calculation could be carried out in grams] [3]

(ii) gas bubbles / effervescence / some calcium 'dissolves' / colourless solution produced [1]

(b) Mass of **E** in solution at 0 °C = 0.13 × 2 = 0.26 g (1)

$\therefore$ Quantity precipitated = 1.50 – 0.26 = 1.24 g (1) [2]

(c) (i) Brick red / orange-red [1]

(ii) Cream precipitate (accept off-white precipitate) [1]

(iii) $Ag^+ + Br^- \rightarrow AgBr$ [1]

(iv) Red / brown solution [1]

(v) Calcium bromide is an ionic compound (1)
and contains Ca^{2+} and Br^- ions (1)
Chlorine reacts with the bromide ions in a redox / displacement reaction (1)
Chlorine is a more powerful oxidising agent / has a greater affinity for electrons than bromine (1)
$2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$ (1) [5]

QWC: ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear [1]

Total [16]

Q.11 (a) Iodine contains weak van der Waals forces /
bonds between each molecule (1)
Less energy is needed to overcome these weaker forces (1) *
Diamond contains strong covalent bonds between each atom (1)
and more energy is needed to overcome these 'bonds' (1) *
* alternative marks

Neither iodine nor diamond contain free / delocalised electrons to carry the charge (necessary for them to conduct electricity) (1) [4]

QWC: organise information clearly and coherently, using specialist vocabulary when appropriate [1]

(b) K^+ and I^- correctly given (1) and in their correct places on the diagram (1) [2]

(c) An excess / stoichiometric / 0.05 mol (1) of potassium sulfate (aq) is added to the barium chloride solution
Mixture is stirred (1) * and then filtered (1)
Precipitated barium sulfate is then washed with distilled water (1)
and dried (1) * [4]
* alternative marks

QWC: Select and use a form and style of writing appropriate to purpose and to complex subject matter [1]

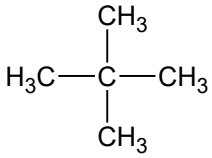
Total [12]

Q.12 (a) (i) Petroleum is heated/evaporated (1)
Fractions condense at different temperatures / separated into fractions with different boiling temperatures (1)

[2]

(ii) C_5H_{12} (1)

Branched chain therefore



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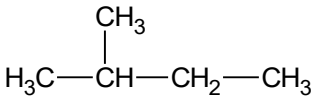


(1)

[2]

(b) (i) It enables more useful compounds to be made from the compound [1]

(ii) $C_9H_{20} \rightarrow CH_4 + C_4H_6 + C_4H_{10}$ [1]

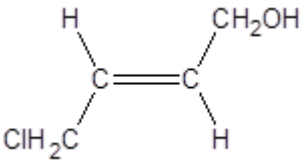
(c) (i) UV light [1]

(ii) A step during which a radical reacts and another one is formed [1]

(iii) $Cl\bullet + CH_4 \rightarrow \bullet CH_3 + HCl$

[or $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$] [1]

(d) (i)



[1]

(ii) Aqueous sodium hydroxide [1]

(iii) Pt / N / Pd [1]

(iv) Compound **E** does not contain an O—H bond (1)
This is present in Compound **D** at a frequency of 2500-3550 cm^{-1} (1)

[2]

Total [14]

Total Section B [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2012

CH2

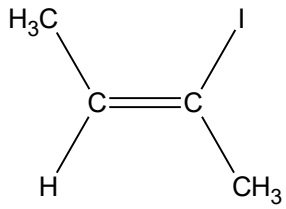
SECTION A

Q.1 (a) $C_{19}H_{40}$ [1]

(b) $C_{19}H_{40} \rightarrow C_8H_{18} + C_{11}H_{22}$ - allow ecf [1]

Q.2 2-chlorobutane [1]

Q.3 [1]



Q.4 any number in range 1 to 6 [1]

Q.5 (a) maximum mass = 44-45 (g) [1]

(b) (less solute would form as a solid) because more will remain in the solution [1]

Q.6 (a) iodine force is Van der Waals/ induced dipole-induced dipole (1)

diamond force is covalent bond/ description of attractive forces in a covalent bond (1) [2]

(b) diamond would have a higher sublimation temperature because it has strong**er** forces/ forces are hard**er** to break [1]

Section A Total [10]

SECTION B

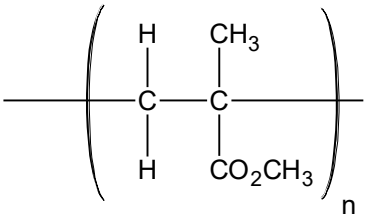
Q.7 (a) (i) one σ bond/ description of σ bond/ diagram to show overlap of s orbitals (1)

one π bond/ description of π bond/ diagram to show sideways overlap of p orbitals (1)

[2]

(ii) joining of **many**/**lots of** (small) units or many alkenes / molecules to make a **large**/**long** unit/ molecule [1]

(iii)



[1]

(iv) C_4H_5Cl [1]

(b) (i) BF_3 is planar triangular/ trigonal planar (1)

NH_3 is pyramidal/ trigonal pyramid (1) [2]

(ii) BF_3 has 3 bond pairs (1)

NH_3 has 3 bond pairs and 1 lone pair (1) [2]

QWC the information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(c) (i) co-ordinate/ dative covalent/ dative
- no credit for 'covalent' [1]

(ii) 109½° (accept any in range 109°-110°) [1]

(iii) 4 bond pairs/ bonds (around B)
- no credit for 'tetrahedral' [1]

Total [13]

Q.8 (a) (i) % H = 14.3 (1)

$$C : H = \frac{85.7}{12.0} : \frac{14.3}{1.01} = 7.14 : 14.16 \text{ (1)}$$

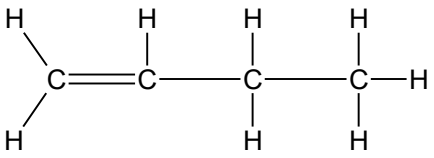
empirical formula = CH_2 (1) [3]

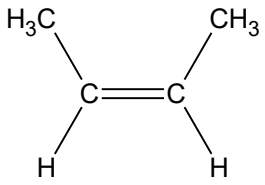
(ii) M_r = 42/ largest fragment has mass 42 (1)

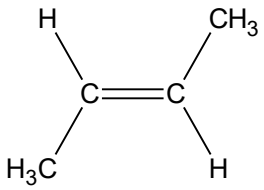
(CH_2 = 14) therefore molecular formula = C_3H_6 (1) [2]

(iii) CH_3 is present [1]

(b) 1 mark for each [3]







Total [9]

Q.9 (a) apparatus in which reaction can occur, e.g. flask/ test tube, and delivery/ rubber tube (1)

apparatus in which to measure volume of gas, e.g. over water with measuring cylinder/ gas syringe (1) [2]

(b) (i) fewer **moles** of barium used / barium has a higher A_r [1]

(ii) reaction faster/ more vigorous/ less cloudy solution formed with barium (1)

because ionisation energy of barium is less/ electrons lost more easily from barium/ barium is lower in the group/
barium hydroxide is more soluble (1) [2]

(c) flame test (1) brick red for calcium **and** (apple) green for barium (1)

OR

add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

white precipitate with Ba^{2+}, less precipitate/ no precipitate with Ca^{2+} (1) [2]

(d) electrons correct – oxide ion clearly shows that 2 electrons originated from calcium atom (1)
charges correct (1) [2]

(e) (i) add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

filter (1)

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (1)
- state symbols ignored [3]

(ii) moles Ba = 2/137 (1)

mass $BaSO_4 = \frac{2 \times 233.1}{137} = 3.4$ (g) (1) [2]

Total [14]

Q.10 (a) both contain metallic bonds/ positive ions and delocalised electrons labelled on diagram (1)

those in magnesium are stronger/ harder to break/ need more energy to break (1)

because **2** electrons are involved in delocalisation/ attraction to the positive ions (1) [3]

(b) reaction is hydrolysis of halogenoalkane/ nucleophilic substitution of halogenoalkane (1)

$C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ X can be Cl or Br (1)

(white precipitate is) silver chloride and (cream precipitate is) silver bromide (1)

$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3 + X^- \rightarrow AgX + NO_3^-$ (1)

- state symbols ignored [4]

QWC selection of form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) caesium ions are bigger than sodium ions – accept 'atoms' (1)

co-ordination number 6 : 6 for sodium and 8 : 8 for caesium (1)

both cubic (1) [3]

(d) reaction is electrophilic addition (1)

two possible products are 1-bromopropane and 2-bromopropane (1)

more 2-bromopropane formed (1)

because of greater stability of intermediate positive ion/ 2° carbocation (1)
[4]

QWC legibility of text; accuracy of spelling, grammar and punctuation, clarity of meaning [1]

Total [16]

Q.11 (a) diagram completed with at least 1 water molecule and indication of interaction between O on one molecule and H on the other (1)

interaction between δ^+ on H and lone pair on O (1)

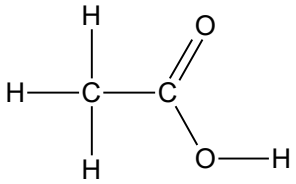
interaction labelled hydrogen bond (1) [3]

(b) (i) reduction/ redox – accept 'oxidation' [1]

(ii) I OH [1]

II OH is also present in water [1]

(c) (i) [1]



(ii) peak at 1650-1750 (1)

due to C=O (1) [2]

Total [9]

Q.12 (a) incomplete p sub-shell/ outer electron configuration s^2p^5/ outer electrons in p subshell/ outer electrons in p orbitals/ valence electrons in p subshell/ valence electrons in p orbital [1]

(b) (i) gaining one electron completes shell/ gives p^6/ takes an electron from another species/gains an electron
- do not accept 'attracts an electron' [1]

(ii) **fluorine** because it is the smallest/ has the greatest electron affinity/ has the least shielding/ has the greatest effective nuclear charge/ oxidising power decreases as the group is descended
[1]

(c) oxidation state is (+)5/ V
- do not accept '5+' [1]

(d) (i) $Cl_2 \rightarrow 2Cl^{\bullet}$ - ignore hf
[1]

(ii) $CH_4 + Cl^{\bullet} \rightarrow HCl + {}^{\bullet}CH_3$ (1)

${}^{\bullet}CH_3 + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$ (1) [2]

(e) products: ${}^{\bullet}CFH_2$ and $Cl^{\bullet}$ (1)

C-**Cl** bond is the weak**est**/ **most** easily broken (1) [2]

Total [9]

Section B Total [70]