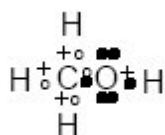


1. (a) (i) Hydrogen iodide / HI/ H-I / IH  
 ALLOW either correct name or formula  
 NOT hi / ih  
 NOT "+" or "-" on any formula  
 If both name and formula given but one is incorrect **(1)** 1
- (ii)  $H_3PO_4 + 3KI \rightarrow 3HI + K_3PO_4$   
 OR  
 $H_3PO_4 + 2KI \rightarrow 2HI + K_2HPO_4$  ALLOW  $HK_2PO_4$   
 OR  
 $H_3PO_4 + KI \rightarrow HI + KH_2PO_4$  ALLOW  $H_2KPO_4$
- Correct formulae **(1)** ALLOW minor slip in formula  
 Correctly balanced **(1)** 2  
 ALLOW multiples  
 If overall formula of salt is correct ignore charges, even if incorrect
- (iii) Reagent  
 silver nitrate (solution) /  $Ag^{(+)}NO_3^{(-)}$  **(1)**  
 If formula given must be correct  
 NOT  $Ag^+$
- Observation  
 Yellow / pale yellow **precipitate/solid/crystals (1)**  
 OR  
 Add chlorine/bromine with a hydrocarbon solvent to give  
 purple/pink/violet colour
- 2<sup>nd</sup> mark depends on correct test BUT allow 2<sup>nd</sup> mark if  $Ag^+$  given as reagent 2*
- (b) (i) Purple vapour / gas/ fumes  
 OR  
 Brown/black solid/solution/liquid  
 NOT increase in temperature/fizzing/solid dissolves  
 If more than one observation – eg all correct or correct plus neutral **(1)** but if correct plus contradictory **(0)** 1
- (ii) Paper goes black /silvery black / grey/brown/  
 black ppt forms / darkens  
 IGNORE original colours  
 NOT "discoloured" 1
- (iii) Lead(II) sulphide / Pb(II) sulphide  
 ALLOW Pb(II)S / lead(II) sulphide(II)  
 NOT lead sulphide (II)  
 NOT PbS  
 Brackets not essential 1

- (iv) Elements  
 iodine / I / I<sup>-</sup> / iodide and sulphur / S (1)  
 NOT I<sub>2</sub>
- Oxidation numbers  
 iodine oxidised from -1 to 0 (1)  
 sulphur reduced from (+)6 to -2 (1)  
*Oxidation numbers must be given in correct order*  
**1 mark for each correct pair of oxidation numbers** 3
- (c) (i) (Standard) sodium thiosulphate / Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>  
 ALLOW any named thiosulphate  
 ACCEPT "thiosulphate ions" / S<sub>2</sub>O<sub>3</sub><sup>2-</sup>  
 NOT "thiosulphate" on its own 1
- (ii) Starch (1)  
 Blue-black / (dark) blue/black to colourless (1)  
 ALLOW "no indicator/self-indicating/iodine" and 'yellow to colourless' 1 (out of 2)  
 If indicator left blank (0)  
 2<sup>nd</sup> mark is dependent on 1<sup>st</sup> 2
- (iii)  $4.8 \times 10^{-4} \times 20 = 9.6 \times 10^{-3} / 0.0096 / 0.00960 / 0.009600$  etc 1
- (iv) Molar mass of KI = 166  
 Mass pure KI =  $166 \times 9.6 \times 10^{-3}$  (1) = 1.59/1.593 / 1.5936 g  
 ALLOW TE from (iii)  
 % purity =  $(1.59/1.75) \times 100 = 90.9 / 91.1 / 91 / 91.06 / 91.063\%$  (1)  
 ALLOW sensible TE from molar mass  
 OR  
 Calculation based on moles  
 IGNORE SF 2

[17]

2.



- (a) (i)  
*Bonding pairs can be shown horizontally or vertically in all positions*  
*Can be all dots/crosses*  
*IGNORE inner shells of electrons if shown*  
*Watch for lone pairs on O*  
*H can be above or below O* 1

- (ii) Electron pairs/electron clouds repel allowing bigger angles in three dimensions

OR

It is a three-dimensional shape being represented in two dimensions

OR

Explanation of why angles are not  $90^\circ$  in  $\text{CH}_3$  / are not  $180^\circ$  in  $\text{COH}$  (1)

$\text{HCO}$  or  $\text{HCH} = 109^\circ / 109.5^\circ$

OR

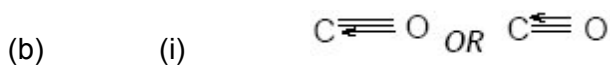
$\text{COH} = 103\text{-}105^\circ$  (1)

Angle can be stated rather than marked on the diagram but must be between two bonds, not between two atoms

ALLOW "it is tetrahedral not flat/two dimensional"

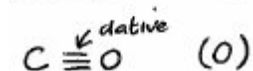
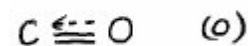
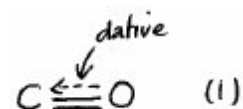
NOT "Tetrahedral" on its own

2



Arrow is essential

Watch out for arrow direction



1

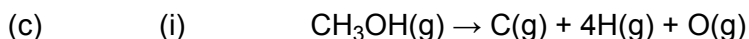
- (ii) Shorter/atoms are closer in CO (as multiple bond) (1)

More **electrons** / greater **electron** density (between the two nuclei) in the bond (1)

2<sup>nd</sup> mark depends on 1<sup>st</sup>

ACCEPT vice versa argument for methanol

2



Watch out Watch out

for wrong for  $\text{H}_2$

state symbol

1

- (ii)  $2039 = 3E(\text{C-H}) + E(\text{C-O}) + E(\text{O-H})$  (1)

$$= 3(413) + E(\text{C-O}) + 464$$

$$E(\text{C-O}) = 2039 - 1239 - 464$$

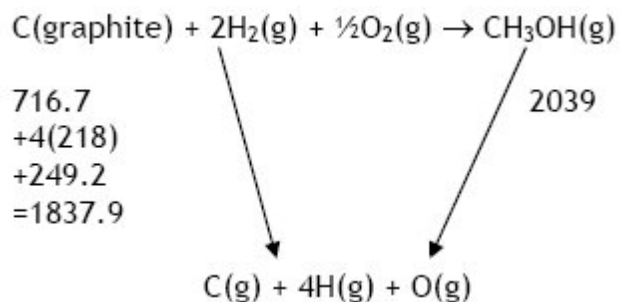
$$= (+) 336 \text{ (kJ mol}^{-1}\text{)} \text{ (1)}$$

Correct answer with no working (2)

If C-H not multiplied by 3, giving (+)1162 (kJ mol<sup>-1</sup>) 1 max

2

(iii)



Balanced cycle with state symbols and data (1)

Calculation

$$\Delta H_f^\ominus + 2039 = 1837.9 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus = 1837.9 - 2039 = -201(.1) \text{ kJ mol}^{-1}$$

Hess applied correctly with allowance for 4H (1)  
– which will give correct sign

Answer with units (1)

ALLOW TE from use of 1H or wrong  $\Delta H_{at}$

If 4H not used allow TE from cycle answer =  $-855(.1) \text{ kJ mol}^{-1}$

max 2 (out of 3)

If  $+336 \text{ kJ mol}^{-1}$  used instead of correct  $\Delta H_{at}$  answer =  $(+)1501.9 /$

$(+)1502 \text{ kJ mol}^{-1}$  max 2 (out of 3)

Penalise same error once ONLY

3

(iv) More negative as energy is given out when the liquid forms (from the gas)

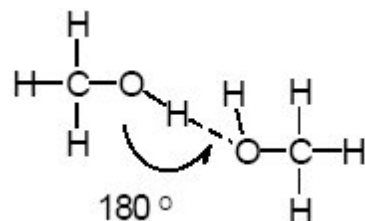
OR

More negative as more/stronger **intermolecular** bonds/forces are made

IGNORE type of intermolecular bond

1

(v)



Hydrogen bond/ dotted line between O in one molecule and hydroxyl hydrogen in another (1)

Bond angle 180° (1) – must go across H

2<sup>nd</sup> mark depends on correct atoms in bond

ALLOW diagram showing methanol/ethanol

NOT diagram showing methanol/ethanol and water

ALLOW minor slip eg one missing H on a CH<sub>3</sub>

2

- (d) Temperature  
 Low temperature as forward reaction is exothermic / reverse reaction uses heat / endothermic **(1)**

**Pressure**

Pressure high as number of molecules/moles is decreasing / fewer / 3 molecules/moles go to one **(1)**

If numbers specified must be correct

NOT 2 molecules go to 1

NOT 2 gases go to 1

*Explanation using Le Chatelier is fine BUT not "Le Chatelier" on its own*

*ALLOW 1 mark for correct choice of temperature (low) and pressure (high) with some attempt at explanation*

2

[17]

3. (a) (i) 1-chloropropane has more electrons than chloroethane **(1)**

So van der Waals' forces (between molecules) stronger/greater

OR

More/greater van der Waals' forces **(1)**

OR reverse argument

*If dipoles are mentioned they must be temporary /induced / transient / fluctuating / flickering*

2

- (ii) Molecules in 2-chloropropane make less contact / pack less well / can get closer together OWTTE

ACCEPT annotated diagram

*If the explanation about van der Waals' forces is given here allow it in (i) UNLESS incorrect intermolecular force mentioned in (i)*

1

- (b) (i) Reagent with a lone pair of electrons

OR

Pair of electrons which it can use to make a bond

OR

Reagent which attacks species with a  $(\delta)^+$  charge

NOT "attacks nucleus" on its own

NOT "species with a negative charge"

1

- (ii) C-I bond is weaker than C-Cl

Must say which bond is weaker

1

- (c) (i) Use ethanolic KOH/KOH in alcohol/KOH in ethanol/ ethanol as solvent (and raise temperature)

1

- (ii) Elimination **(1)**

IGNORE comment on what is eliminated

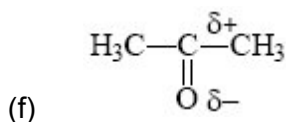
IGNORE qualification eg electrophilic

1

- (d) (i)
- $$\begin{array}{c}
 \text{H} \quad \text{H} \\
 | \quad | \\
 \text{H}-\text{C}-\text{C}-\text{H} \\
 | \quad | \\
 \text{H} \quad \text{OSO}_3\text{H}
 \end{array}$$
- ALLOW C bonded to HSO<sub>4</sub> anywhere  
 ALLOW C<sub>2</sub>H<sub>5</sub><sup>+</sup> HSO<sub>4</sub><sup>-</sup> HCCH
- Need not be displayed  
 NOT "C<sub>2</sub>H<sub>5</sub><sup>+</sup>" on its own 1
- (ii) Electrophilic (addition)  
 ALLOW electrophile / electrophylic 1
- (iii) React with water / hydrolysis  
 ALLOW Steam 1
- (e) Cheaper, because ethene comes from crude oil / alkanes / is readily available / no separation of by-products required OWTTE  
 OR  
 Cheaper because halogenoalkanes are expensive to make / do not occur naturally / need 2 stages in synthesis  
 OR  
 Faster because only one stage  
 OR  
 Safer because halogenoalkanes more toxic / more irritant / damage ozone layer or other specific reason. 1

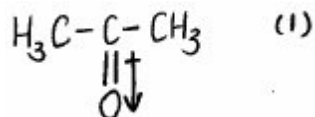
[11]

4. (a) Species / particle / entity / group / atom / molecule having unpaired / odd electron/odd number of electrons  
 NOT ion/element/chemical  
 NOT a lone electron / lone pair of electrons  
 NOT atom with an incomplete shell of electrons  
 If a diagram is given an explanation is also needed 1
- (b) Homolytic (fission) 1
- (c) UV /UV radiation / UV light / (sun)light / hv / photons  
 NOT protons  
 IGNORE references to heat 1
- (d) C<sub>2</sub>H<sub>6</sub> + 2Cl<sub>2</sub> → C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub> + 2HCl  
 Correct dichloroalkane, C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub> or displayed (1) balanced with HCl (1)  
 C<sub>2</sub>H<sub>6</sub>+Cl<sub>2</sub> □ C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub> + H<sub>2</sub> 1 (out of 2)  
 C<sub>2</sub>H<sub>6</sub>+Cl<sub>2</sub> □ C<sub>2</sub>H<sub>5</sub>Cl + HCl 1 (out of 2) 2
- (e)
- $$\begin{array}{cccc}
 \text{F} & \text{F} & \text{F} & \text{F} \\
 | & | & | & | \\
 -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\
 | & | & | & | \\
 \text{F} & \text{F} & \text{F} & \text{F}
 \end{array}$$
- ACCEPT "FI" for "F"  
 IGNORE brackets and n as long as at least 2 monomer units shown.  
 MUST have continuation bonds at both ends 1



ALLOW indication that C = O is polar eg circled.  
If charges or dipole arrow shown must be correct. H

Structure of propanone must be correct  
d/δ is needed not just "+" and "-"



1

- (g) Examiners will need to consider each answer for (i) key points and (ii) style and use of English. Candidates should have recorded their word total at the end of their answer, and this should be checked.

up to 115 words: no penalty

116 – 120 words: -1

121 – 125 words: -2

126 – 130 words: -3

and at a rate of -1 penalty for every 5 words excess thereafter, up to a maximum penalty equal to the number of key points included by the answer.

Note that words appearing in the title to the summary do not count in the word total. Normally hyphenated words, numbers and chemical formulae count as one word. The question does not ask for equations in the summary, but if included they should be counted in the word total. Do not count subheadings "Advantages" and "Disadvantages".

mono-, di-, tri- and tetra-chlorinated products 6 words

poly(ethene) 1 word

PTFE 1 word

acid- or base-sensitive reagents 4 words

tributyltin 1 word

150 °C 2 words

### Marking for key points

One mark should be awarded for every key point clearly identified in an answer, up to a maximum of 6 marks. A tick should be made in the script at which the examiner decided to award each mark e.g. <sup>3</sup>(1). The total marks for key points should be placed in the body of the script at the end of the answer, out of 6.

To gain the mark for a key point the wording used by the candidate must make clear the essential chemistry of the point.

#### Key points

Maximum of 6 marks available.

- 1 Radical reactions are often unselective / low yielding / difficult to control/ uncontrollable (1)
- 2 Mixtures/products/by-products may be difficult to separate. (1)
- 3 Radicals may produce polymers of varying chain lengths / degrees of branching. (1)
- 4 Radicals form under mild conditions / at low temperatures / neutral conditions (1)
- 5 .....so reagents less likely to decompose in radical reactions (than in ionic reactions). (1)
- 6 Radical reactions are not very sensitive to changes in solvent  
OR  
Radicals are generally not solvated  
OR  
Changing solvent is not important  
NOT Radicals are neutral (1)
- 7 Reactivity of radicals makes them useful in reactions which are difficult to achieve  
OR  
Radicals will carry out reactions that ions will not.  
NOT "Radicals are highly reactive" *UNLESS qualified* (1)
- 8 **Tributyltin** radicals/hydride are expensive and neurotoxic. (1)

Any six 6



## Quality of Written Communication

2

These should *be impression* marked on a scale 2-1-0, and the mark out of 2 should be recorded in the body of the script at the end of the answer. This mark can not be lost as a result of a word penalty.

Candidates are expected to:

- show clarity of expression;
- construct and present coherent argument;
- demonstrate effective use of grammar punctuation and spelling.

The aspects to be considered are:

- use of technical terms; the answer should convey a correct understanding by the writer of the technical terms used in the passage which are involved in the key points.
- articulate expression; the answer should be well-organised in clear, concise English, without ambiguity. It should read fluently, with the links between key points in the original maintained.
- legible handwriting; the reader should be able to read the answer without difficulty at normal reading pace, with only the occasional difficulty with a word.
- points must be in a logical order.

Good style and use of English, with only infrequent minor faults, no use of formulae **(2)**

Frequent minor or a few major faults in style and use of English **(1)**

Very poor style and use of English **(0)**

NB: The quality of written communication mark cannot be lost through word penalties.

[15]