Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) **M1** The enthalpy / heat energy change when 1 mol (of a substance / compound / product) is formed from its (constituent) elements

__M1__ energy change is not sufficient – must refer to enthalpy change or heat energy change

1

M2 with (all) reactants and products / all substances in standard states

__M2__ or with (all) reactants and products / substances in normal states under standard conditions / 100 kPa and any specified temperature (usually 298 K)

Ignore reference to 1 atmosphere

If enthalpy of combustion given rather than formation, then mark __M1__ and __M2__ independently, and __M2__ could score.

1

(b) **M1** ΔH = [sum $\Delta_f H$ products] – [sum $\Delta_f H$ reactants]

or –114 = [3(–130) – 972] – [3X – 339]

or 3X = 3(–130) – 972 + 339 + 114

–303 scores 3 marks (+303 scores 2 marks)

–909 scores 2 marks (+909 scores 1 mark)

ignore units

1

M2 3X = –909

__M2__ No ECF from __M1__ (except +909 or arithmetic error)

1

M3 X = –303 (kJ mol^{-1})

__M3__ ECF from __M2__, ie __M3__ ÷ 3

1

(c) **M1** provides energy to break (covalent) bond in chlorine / Cl_2 or to form chlorine free radicals

1

M2 $CH_3CH_2CH_3 + \bullet Cl \rightarrow \bullet CH_2CH_2CH_3 + HCl$

1

M3 $\bullet CH_2CH_2CH_3 + Cl_2 \rightarrow ClCH_2CH_2CH_3 + \bullet Cl$

__M2__ and __M3__:

- *must show structure of $\bullet CH_2CH_2CH_3$ in at least one of the equations to score both marks (dot must be on or around the end CH_2*

Downloaded from www.merit-minds.com

group), but only penalise •C_3H_7 once across both equations if both equations otherwise correct

- *on this occasion, molecular formula of propane can be allowed for **M2***
- *on this occasion, molecular formula of 1-chloropropane can be allowed for **M3***
- *penalise absence of radical dots once*
- *allow equations in either order*

1

(d) the ability/power of atom to attract/withdraw the 2/pair of electrons in a covalent bond

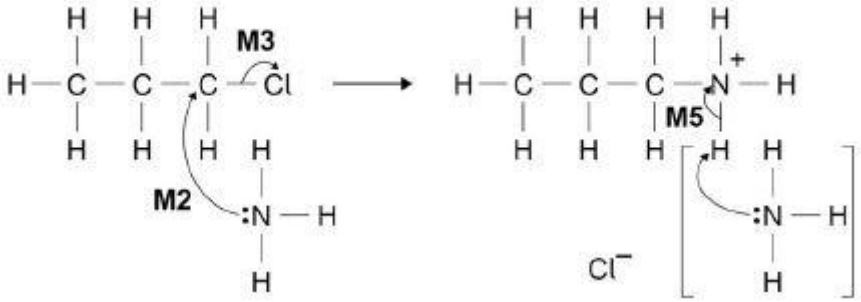
allow nucleus in place of atom

1

(e) **M1** nucleophilic substitution

1

M4 Structure



M2 curly arrow from lone pair on N of NH_3 to the correct C atom

*Penalise **M2** if negative charge on ammonia*

1

M3 must show the movement of a pair of electrons from the C−Cl bond to the Cl atom; mark **M3** independently provided it is from their original molecule

*Penalise **M3** for formal charge on C and/or Cl of C–Cl or incorrect partial charges on C–Cl; ignore other partial charges on uncharged atoms*

*Penalise **M3** for any additional arrow(s) to/from the Cl to/from anything else*

1

M4 is for the structure of the alkylammonium ion, which could be a condensed formula; a positive charge must be shown on, or close to, the N atom

1

M5 is for an arrow from the N−H bond to the N atom

*The second molecule of NH_3 is not essential for **M5**, but penalise **M5** if used incorrectly (but only penalise once in **M2** and **M5** for negative charge on ammonia)*

1

SN1 mechanism alternative (loss of Cl first followed by attack by NH_3) :

***M2** curly arrow from C–Cl bond to the Cl*

***M3** curly arrow from lone pair of NH_3 to correct C on the correct carbocation*

[14]

Downloaded from www.merit-minds.com

Q2.

(a) **M1** reaction of nitrogen/N_2 and oxygen/O_2 from the air

Must be at least one reference to air.

NOT reference to nitrogen/oxygen from the fuel.

Allow equation plus a reference to the air.

Allow combustion of nitrogen plus reference to the air.

NOT M1 if reference to reaction taking place in the catalytic converter.

1

M2 at high temperatures

Allow high energy/heat or very hot.

Allow heat/energy in the engine <u>provides Ea</u>

IGNORE references to pressure/spark

1

(b) Formation of acid rain / causes respiratory problems

Allow (contributes to) <u>ground level</u> ozone / (photochemical) smog / toxic / poisonous

Allow makes water acidic / reacts with water to form nitric acid / (NO_x gases are) acidic

IGNORE greenhouse gases / global warming / damages ozone layer

IGNORE vague answers such as 'harmful to environment'/polluting/harmful

NOT reference to pH rising

1

(c) **M1** $NO_2 = (+)4$ $NH_3 = -3$ $N_2 = 0$

1

M2 $3NO_2 + 4NH_3 \rightarrow 7/2N_2 + 6H_2O$

ALLOW multiples/fractions
($6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$ OR
$1½NO_2 + 2NH_3 \rightarrow 1¾N_2 + 3H_2O$)

1

(d) **M1** Catalyst in different phase/state (to reactants)

*NOT (catalyst in different phase/state to) products allow catalyst in different phase/state to reactants **and** products*

1

M2 Speeds up reaction without being used up

ALLOW speeds up the reaction by (providing alternative route for reaction and) lowering E_a

NOT does not take part in the reaction

1

(e) incomplete combustion

***ignore** equations*

ALLOW description of incomplete combustion (e.g. not enough oxygen)

Allow O_2 but NOT O for oxygen

1

[8]

Downloaded from www.merit-minds.com