Energy changes in chemical and physical processes

1. (a) $\nabla H = \frac{120 \times 4.2 \times 4.5}{1000}$ *(½mk)*

$= +\ 2.268KJ$ ✓ *(½mk)*

(b) *RFM of* $KNO_3 = 39 + 14 + 48 = 101$

$6g \quad 2.268KJ$

$101g \quad \frac{101 \times 2.268}{6}$ ✓ *(½mk)*

$= +38.178KJ\ mol^{-1}$ ✓ *(½mk*

2. *(i) Heat evolved when one mole of a substance is completely burnt in oxygen*

(ii) RFM of $C_2H_5OH = 46$

Molar mass = 46g ✓½

Heating value = $\frac{1370\ KJ}{46g}$ ✓½

= 29.78KJ/g (with units)

3. *Ca(q) + C(q) + 3/2 O2 (g)*

4. *a) $C_2H_6O_{(l)} + 3O_{(g)} \longrightarrow 2CO_{2(g)} + 3H_2O$*

b) DH = MCDT

$\frac{200}{1000}$ X 4.2 X 32.5 = -27.3Kj

0.92g C_2H_6O ———— - 27.3Kj

46g " ———— ?

$\frac{46g}{0.92}$ X 27.3Kj = -1365Kj

DHC $C_2\ HSO_4$ = -1365Kj mol

5. *i) U,V,Y,Z All the 4 or nay 3 exclusively correct penalize ½ mk if wrong answer*

ii) YZ is/are included any 2 correct ½ mk

6. *(a) 611-389 = +222KJ*

(b) H = +222 – (611 – 100) ✓ ½

= -289KJ

(c) Exothermic reaction ✓ ½

7. *2C(s) + $3H_2$(g) + ½ O_2 (g) Δ Hf $CH_3CH_2OH(l)$*

$2CO_2$(g) + $3H_2$(g)

$2CO_2(g) + 3H_2O(l)$

$\Delta Hf + \Delta H_3 = \Delta H_1 + \Delta H_2$

$\therefore \Delta Hf = \Delta H_1 + \Delta H_2 - \Delta H_3$ ✓½

= -393 x 2 + -286 x 3 +1386 ✓1

= -786 – 858 + 1386

= -1644 + 1386 ✓1

ΔHf = -258 $KJmol^{-1}$ ✓½

8. *a) i) the yield of NH_3 would be lowered ✓½ any supply of heat makes NH_3 to decompose to N_2 and H_2*

ii)the yield of NH_3 would be increased

b)a catalyst accelerate the rates of both forward and reverse reactions equally✓½ . Equilibrium position is not affected by a catalyst✓½

c)

9. a) Breaking of 'C = C' = +610 KJ
Breaking of 'Br – Br' = +<u>193</u>
803✓
Formation of 2C – Br = <u>-560</u>
Formation of c-c +243 Kj
<u>-346</u>
- 103KJ✓ **2 marks**
b) Addition reaction/ halogenation ✓

10. H H
C = C + H – H H – C – C – H
H H H H

Bond breaking		*Bond formation*	
4 C-H – 4x410 = 1640		*6C – H*	*6x410*
C = C – 1 x610 = 610			*= 2460*
H – H – 1x436 = <u>436</u>		*C – C –*	*<u>3 45</u>*
2686			*2805*

H = 2686 – 2805
= -119 Kj/Mol

11. (i) Graph
*labeling -*TZM**
*plotting – *TZM**
*scale – *TZM**
*line – *TZM**
total 5mks
*(ii) Shown on the graph -*TZM**
(iii) Heat change = MCT

$$= \frac{50}{100} x\ 4.2\ x\ 10.2$$

= 2.142kJ
(iv) RFM of KNO_3 = 39 + 14 + 48
= 101

$$H = 2.142\ x\ \frac{101}{20.2} = -10.71 Kjmol^{-1}$$

12. $MCT = \frac{100}{1000} X\ 4.2\ X\ 6 = 2.52\ Kj$

Moles of NH4NO_3 = <u>1.6</u> = 0.02 moles

80

If 0.02 mol _________ 2.52 Kj

1 mol _______________ $\frac{1 \times 2.52}{0.02}$ *= +126KJ/ mol*

13. *a)* $2NaHCO_{3(g)} \longrightarrow Na_2CO_{3(g)} + H_2O_{(1)} + CO_{2(g)}$

b) *i)* $2L_{(g)} + D_{2(g)} \longrightarrow 2LD_{(g)}$

ii) Amphoteric oxide

iii) Element H has a giant atomic structure with strong covalent bonds throughout its structure while D has simple molecular structure with weak Vander wall forces (2 m)

iv) - Used in advertising signs (Advertisements)

- Used in florescent tubes (Any two correct use)

v) C has a smaller atomic radius than B because it has stronger nuclear charge// more number of protons which attract the outer energy level electrons more firmly (2 mks)

vi) $4L_{(s)} + O_{2(g)} \longrightarrow 2L_2O_{(g)}$

Moles of L = $\frac{11.5}{23}$ *= 0.5 moles*

Moles of O2 = $\frac{0.5}{4}$ *= 0.125 moles*

Volume of O_2 *= 0.125 mol X 24 = 3* dm^3

$4L_{(s)} + O_{2(g)} \longrightarrow 2L2O_{(s)}$

*If 4 x23g ________________ 24*dm^3

11.5g of L ________ $\frac{11.5 \times 24}{4 \times 23}$ *=* $3dm^3$

14. *(a) Drawn on the graph*

A = ½ mk

S = ½ mk

P = ½ mk

C = ½ mk

b) $32.5^oC \pm 1$ *Read from the student's correctly plotted graph.*

c) $20^oC \pm O.5$ *Line is extrapolated downwards from the student's correct graph.*

d) It is end point/ complete neutralization.

e) The reaction is exothermic hence as reaction proceeded more heat was produced.

f) Reaction was complete hence solution lost heat through radiation to the surrounding.

g) 10.2 $cm^3 \pm 0.1$. *Read from the student's correct graph.*

h) Moles = $\frac{M \times V}{1000}$

$= \frac{10.2 \times 4}{1000}$ √½ *= 0.0408 moles* √½

i) Moles = $\frac{M \times V}{1000}$

$= \frac{2 \times 20}{1000}$ √½ *= 0.04 moles* √½ *j) HBr : NaOH*

0.0408 : 0.04

$\frac{0.0408}{0.04} : \frac{0.04}{0.04}$

1 : 1

$HBr_{(aq)} + NaOH \qquad NaBr_{(aq)} + H_2O(l)$

k) $\Delta H = MC\ \Delta t$

$= \frac{-30.2g \times 4.2J \times 16.3}{g^0c}$

$= -2067.49J$ √½

Ans. in (h) = -2067.49 J.

$\therefore$ *1 Mole* $= \frac{1 \times 2067.49J}{\text{Ans in "h"}}$ √½ *e.g.* $\frac{1 \times 2067.49}{0.0408}$

= -Ans. *e.g 50673.82 J* mol^{-1}

Or 50.67382KJ mol^{-1} √½

15. a)(ii) Max. temperature attained : 29^0c

(iii) Temperature change o the reaction $= (29-115)^0c$

$= 14^0c$

Mass of NaOH used = (114.35 – 108 .15)g

= 6.2g

R.F.M of NaOH = 40g

Moles of NaOH used = $\frac{6.2}{40}$ *moles*

= 0.155moles

(v) Heat released = Mass X Specific Heat capacity X Temperature change

Mass of water used = (108.15 – 8)g

= 100.15g

$\therefore$ *Heat released =* $\frac{100.15}{1000} \times 4.18 \times 14$ *kj*

=100.15kj

0.155 moles NaOH 5.861 kj

1 mole NaOH $\frac{1x\ 5.861}{0.155}$ *kj* $mole^{-1}$

$= -37.8\ kjmol^{-1}$

(b) i) ΔH_3 *and* ΔH_4

ii) Condensation

iii) $\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4$

iv) Exothermic.

16. I – a – Latent heat of fusion is the heat change that occurs when one mole of a solid substance changes into liquid at constant temperature.

- Latent heat of vapourization is the heat change that occurs when one mole of liquid

substance changes into gas at constant temperature.

b – BC – The liquid loses heat as it cools hence decrease in kinetic energy of the particles

- CD - The liquid changes to solid as temperature remains constant at freezing point.

*II. (i) Scale – *TZM**

*Plot – *TZM**

Line

(ii) Should be shown on the graph – if not shown penalize (½ mk)

(iii) Heat change = m x c x ΔT

Where m = (vol. of acid (20cm^3) + volume of bas in (b) above) x 1g/cm^3

ΔT-as read form the graph

(iv) moles of acid

Moles of base = $\frac{0.5 \text{ x volume}}{1000}$ in (b) above

Mole ratio acid: Base = 1:1

Moles of acid   heat change in (iii)above

1mole   ?

Molar heat change = $\frac{1 \text{ x heat in (iii)}}{\text{Moles of acid}}$

17. *Q = 40000 x 60 x 60 = 144000000c*

Mass of Al = $\frac{144000000 \times 27}{3 \times 96500}$ ✓ 1

= 13.43kg ✓ 1

18. *(a) (i) Contains methane which is a fuel or contains methane which can burn*

(ii) Pass a known volume of biogas through Sodium hydroxide (Potassium hydroxide) solution to absorb Carbon (IV) Oxide. Measure the volume of remaining gas ✓

% = $\frac{\text{Volume of methane}}{\text{Volume of Biogas}}$ x 100

19. *a) No effect – Reaction is not accompanied by volume changes/ similar volumes of reactants and products*

20. *a) – carbon IV Oxide;*

- Sulphur IV Oxide;

- Lead;

(b) Availed low sulphur diesel/ availed unleaded petrol

21. *(a) Heat change that occurs when one mole of hydrogen combines with one mole of hydroxide ions. //Heat evolved when one mole of water s formed during reaction of H^+ and OH^- ions*

(b) HCl produces a higher temperature rise than oxalic acid;

HCl is a stronger acid than oxalic acid;

22. *$H_2O_{(l)}$ ΔH_2 $H_2O_{(g)}$*

ΔH_2 = - ΔH_1 + ΔH_3 ✓ ½

= $\Delta H_3 - \Delta H_1$ ✓ ½

= -242 - $^-$286 ✓ 1

✓ 1

= -242 + 286
= +44KJ/mol ✓ 1 *(No units of sign = ½mk)*

23. ***(a) Chemical substance that burns to produce useful amount of heat.***
(b) (i) Its cheap
(ii) Its readily available (½mk)
(iii) It burns slowly (½mk)
(iv) Does not produce poisonous gas. (½mk)

24. ***a) Metallic beaker would make most of the heat be lost to the environment***
b) - Thermometer reading increased
- The reaction is exothermic

25. ***a) A substance that produce heat energy when burnt***

b) 1. Availability
2. ease of transport

26. ***a) 1 mole Fe (56) required ______________ 15.4 + 354***
= 396.5Kj
10,000 (10 kg) _____________ ?

$$\frac{10{,}000g}{56g} \times 369.5\ Kj$$

= 6596.285Kj

b) $\frac{-68Kj}{2}$ ***= - 34 Kj*** √ ½

27. ***a)*** $\triangle H_1$ ***– Lattice energy*** ✓1
$\triangle H_2$ ***– Hydrogen energy*** ✓1
b) $\triangle H_3 = \triangle H_2 + \triangle H_1$ ✓1