Energy changes in chemical and physical processes

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

   = + 2.268KJ P (½mk)

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

   6g 2.268KJ

   101g $\frac{101 X 2.268}{6}$ P (½mk)

   = +38.178KJ mol^{-1} P

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

(ii) RFM of C_2H_5OH = 46

P ½

Molar mass = 46g

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

P ½

= 29.78KJ/g (with units)

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

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

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) P ½

= -289KJ P1

(c) Exothermic reaction P 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

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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>345</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
$= \frac{50}{100} \times 4.2 \times 10.2$

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= 2.142kJ

(iv) RFM of KNO_3 = 39 + 14 + 48

= 101

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

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

Moles of $NH4NO_3 = \underline{1.6} = 0.02$ *moles*

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80

If 0.02 mol ________ 2.52 Kj

1 mol ______________ $\frac{1 X 2.52}{0.02}$ = +126KJ/ mol

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

b) i) $2L_{(g)} + D_{2(g)}$ ________ $2LD_{(g)}$

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

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

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

If 4 x23g _______________ 24dm^3

11.5g of L ________ $\frac{11.5x24}{4x23}$ = 3dm^3

14. *(a) Drawn on the graph*

A = ½ mk

S = ½ mk

P = ½ mk

C = ½ mk

b) 32.5°C $\pm$ 1 Read from the student's correctly plotted graph.

c) 20°C $\pm$ 0.5 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 = $\frac{MxV}{1000}$

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

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

$= \frac{2 \times 20}{1000}$ √ ½ = 0.04 moles √ ½

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j) HBr : NaOH

0.0408 : 0.04

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

1 : 1

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

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.

∴ 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

\ Heat released = $\frac{100.15}{1000}$ X 4.18 X 14 kj

=100.15kj

0.155 moles NaOH 5.861 kj

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

(b) i) DH_3 and DH_4

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ii) Condensation *= -37.8 kjmol^{-1}*

iii) $DH = DH_1 + DH_2 + DH_3 + DH_4$

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

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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

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

Mole ratio acid: Base = 1:1
Moles of acid heat change in (iii)above
1mole ?

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

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

$$\text{Mass of Al} = \frac{144000000 \times 27}{3 \times 96500} \quad \text{P 1}$$
$$= 13.43\text{kg} \quad \text{P 1}$$

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 P 1

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

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*

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

22. $H_2O_{(l)}$ ΔH_2 $H_2O_{(g)}$

$\Delta H_2 = -\Delta H_1 + \Delta H_3$ P ½
$= \Delta H_3 - \Delta H_1$ P ½
$= -242 - {}^{-}286$ P 1

P 1

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= -242 + 286

= +44KJ/mol P 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* ö ½

27. *a)* ΔH_1 *– Lattice energy* p1

ΔH_2 *– Hydrogen energy* p1

b) $\Delta H_3 = \Delta H_2 + \Delta H_1$ p1

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