

Energy changes in chemical and physical processes

1. (a) $\nabla H = \frac{120 \times 4.2 \times 4.5}{1000}$ ($\frac{1}{2}mk$)

$= + 2.268KJ$ ($\frac{1}{2}mk$)

(b) $RFM \text{ of } KNO_3 = 39 + 14 + 48 = 101$

$\frac{6g}{101g} \quad \frac{2.268KJ}{101 \times 2.268} \checkmark$ ($\frac{1}{2}mk$)

$\frac{6}{6} = +38.178KJ \text{ mol}^{-1} \checkmark$ ($\frac{1}{2}mk$)

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

(ii) RFM of $C_2H_5OH = 46$

Molar mass $\checkmark = 46g$

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

$$= 29.78 \text{ KJ/g } \checkmark \text{ (with units)}$$

3. $Ca(q) + C(q) + 3/2 O_2 (g)$

4. a) $C_2H_6O(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O$

b) $DH = MCDT$

$$\frac{200 \times 4.2 \times 32.5}{1000} = -27.3 \text{ KJ}$$

$$\frac{0.92g \text{ } C_2H_6O}{46g} \frac{-27.3 \text{ KJ}}{?}$$

$$\frac{46g \times 27.3 \text{ KJ}}{0.92} = -1365 \text{ KJ}$$

$$DHC \text{ } C_2 \text{ HSO}_4 = -1365 \text{ KJ mol}$$

5. i) U,V,Y,Z All the 4 or nay 3 exclusively correct penalize $\frac{1}{2}$ mk if wrong answer

ii) YZ is/are included any 2 correct $\frac{1}{2}$ mk

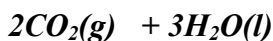
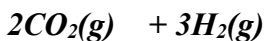
6. (a) $611-389 = +222 \text{ KJ}$

$$(b) H = +222 - (611 - 100) \quad \checkmark \frac{1}{2}$$

$$= -289 \text{ KJ}$$

(c) Exothermic reaction $\checkmark \frac{1}{2}$

7. $2C(s) + 3H_2(g) + \frac{1}{2} O_2(g) \quad \Delta H_f \quad CH_3CH_2OH(l)$



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

$$\therefore \Delta H_f = \Delta H_1 + \Delta H_2 - \Delta H_3 \quad \checkmark \frac{1}{2}$$

$$= -393 \times 2 + -286 \times 3 + 1386 \quad \checkmark$$

$$= -786 - 858 + 1386$$

$$= -1644 + 1386 \quad \checkmark$$

$$\Delta H_f = -258 \text{ KJmol}^{-1} \quad \checkmark \frac{1}{2}$$

8. a) i) the yield of NH_3 would be lowered $\checkmark \frac{1}{2}$ 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 $\checkmark \frac{1}{2}$. Equilibrium position is not affected by a catalyst $\checkmark \frac{1}{2}$

c)

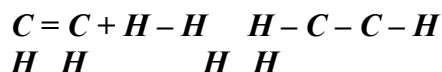
9. a) Breaking of 'C = C' = +610 KJ
 Breaking of 'Br - Br' = +193
 803✓

Formation of 2C - Br = -560
 Formation of c-c +243 KJ
 -346
 - 103KJ✓

2 marks

b) Addition reaction/ halogenation ✓

10. H H



Bond breaking

$$4 \text{ C-H} - 4 \times 410 = 1640$$

$$\text{C} = \text{C} - 1 \times 610 = 610$$

$$\text{H} - \text{H} - 1 \times 436 = \underline{436}$$

$$\text{H} = 2686 - 2805$$

$$= -119 \text{ Kj/Mol}$$

Bond formation

$$6 \text{ C} - \text{H} \quad 6 \times 410$$

$$= 2460$$

$$\text{C} - \text{C} - \quad \underline{345}$$

$$2805$$

11. (i) Graph

labeling - *TZM*

plotting - *TZM*

scale - *TZM*

line - *TZM*

total 5mks

(ii) Shown on the graph - *TZM*

(iii) Heat change = MCT

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

$$= 2.142 \text{ kJ}$$

(iv) RFM of $\text{KNO}_3 = 39 + 14 + 48$

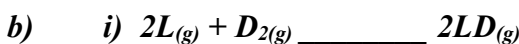
$$= 101$$

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

12. MCT = $\frac{100}{1000} \times 4.2 \times 6 = 2.52 \text{ KJ}$

Moles of $\text{NH}_4\text{NO}_3 = \frac{1.6}{1000} = 0.02 \text{ moles}$

$$\text{If } 0.02 \text{ mol } \frac{2.52 \text{ KJ}}{1 \text{ mol}} \times \frac{1 \times 2.52}{0.02} = +126 \text{ KJ/mol}$$



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)



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

$$\text{Moles of O}_2 = \frac{0.5}{4} = 0.125 \text{ moles}$$

$$\text{Volume of O}_2 = 0.125 \text{ mol} \times 24 = 3 \text{ dm}^3$$



$$\text{If } 4 \times 23\text{g} \longrightarrow 24\text{dm}^3$$

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

14. (a) Drawn on the graph

$$A = \frac{1}{2} \text{ mk}$$

$$S = \frac{1}{2} \text{ mk}$$

$$P = \frac{1}{2} \text{ mk}$$

$$C = \frac{1}{2} \text{ mk}$$

b) $32.5^\circ\text{C} \pm 1$ Read from the student's correctly plotted graph.

c) $20^\circ\text{C} \pm 0.5$ 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.

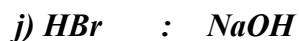
g) $10.2 \text{ cm}^3 \pm 0.1$. Read from the student's correct graph.

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

$$= \frac{10.2 \times 4}{1000} \sqrt{1/2} = 0.0408 \text{ moles } \sqrt{1/2}$$

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

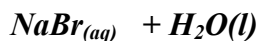
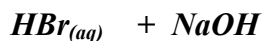
$$= \frac{2 \times 20}{1000} \sqrt{1/2} = 0.04 \text{ moles } \sqrt{1/2}$$



$$0.0408 : 0.04$$

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

$$1 : 1$$



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

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

$$= -2067.49J \sqrt{1/2}$$

Ans. in (h) = -2067.49 J.

$$\therefore 1 \text{ Mole} = \frac{1 \times 2067.49J}{\text{Ans in "h"}} \sqrt{1/2}$$

$$= -\text{Ans.}$$

e.g. $\frac{1 \times 2067.49}{0.0408}$

e.g. $50673.82 J \text{ mol}^{-1}$

Or $50.67382KJ \text{ mol}^{-1} \sqrt{1/2}$

15. a)(ii) Max. temperature attained : $29^{\circ}c$

(iii) Temperature change o the reaction = $(29-115)^{\circ}c$
 $= 14^{\circ}c$

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 = $\frac{100.15 \times 4.18 \times 14}{1000}$ kj

= 100.15kj

0.155 moles NaOH

1 mole NaOH

5.861 kj

$\frac{1 \times 5.861}{0.155}$ 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 – *TQM*

Plot – *TQM*

Line

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

(iii) Heat change = $m \times c \times \Delta T$

Where $m = (\text{vol. of acid } (20\text{cm}^3) + \text{volume of bas in (b) above}) \times 1\text{g/cm}^3$

ΔT -as read form the graph

(iv) moles of acid

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

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. $Q = 40000 \times 60 \times 60 = 144000000\text{c}$

$$\begin{aligned} \text{Mass of Al} &= \frac{144000000 \times 27}{3 \times 96500} \quad \checkmark 1 \\ &= 13.43\text{kg} \quad \checkmark 1 \end{aligned}$$

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

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

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

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

HCl is a stronger acid than oxalic acid;



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

$$= \Delta H_3 - \Delta H_1$$

$$= -242 - (-286)$$

✓ 1

✓ 1

$$= -242 + 286$$

$$= +44\text{KJ/mol} \checkmark 1 \quad (\text{No units of sign} = \frac{1}{2}\text{mk})$$

23. (a) *Chemical substance that burns to produce useful amount of heat.*
 (b) (i) *Its cheap*
 (ii) *Its readily available* ($\frac{1}{2}\text{mk}$)
 (iii) *It burns slowly* ($\frac{1}{2}\text{mk}$)
 (iv) *Does not produce poisonous gas.* ($\frac{1}{2}\text{mk}$)
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* _____ $15.4 + 354$
 $= 396.5\text{Kj}$
 $10,000 (10 \text{ kg})$ _____ ?
 $\frac{10,000\text{g} \times 369.5 \text{ Kj}}{56\text{g}}$
- b) $\frac{-68\text{Kj}}{2} = -34 \text{ Kj} \quad \checkmark \frac{1}{2}$
 $= 6596.285\text{Kj}$
27. a) ΔH_1 – *Lattice energy* $\checkmark 1$
 ΔH_2 – *Hydrogen energy* $\checkmark 1$
 b) $\Delta H_3 = \Delta H_2 + \Delta H_1 \checkmark 1$