4solutions2012

|                             | SEPTEMBER 2012<br>MHS - UNIT 4 TRIAL EXAM<br>SOLUTIONS  |                         |      |      |      |          |            |          |
|-----------------------------|---|-------------------------|------|------|------|----------|------------|----------|
| Penalties : the usual ones! | <ul> <li>* max<sup>m</sup> 1 mark off if incorrect numbers of significant figures are given</li> <li>* max<sup>m</sup> 1 mark off if symbols of state are omitted</li> <li>* 1 mark off each time a unit is omitted from answer that requires a unit</li> </ul> |                         |      |      |      |          |            |          |
| SECTION A                   | $\Sigma = 20$   |                         |      |      |      |          |            |          |
| 1.C                         | 2.B   | 3.D                     | 4.A  | 5.D  | 6.A  | 7.B      | 8.D        | 9.B      |
| 11.B                        | 12.A  | 13.D                    | 14.D | 15.D | 16.A | 17.A     | 18.C       | 19.A     |
| SECTION B                   |   | $\Sigma = 60 \text{ m}$ | arks |      | *    | = one ma | ark, */2 = | half mar |

1a

| Change from the conditions in the reference equilibrium system | Immediate effect on the<br>instantaneous rate of the<br>forward reaction | The concentration of<br>CO <sub>2</sub> (g) when equilibrium<br>is re-established |
|--|--|---|
| 1. Addition of some extra catalyst.                            | increase   | no change   |
| 2. Addition of some carbon monoxide.                           | no change  | increase  |
| 3. Addition of a small amount of argon                         | no change  | no change   |
| gas.   |  |   |
| 4. The temperature is raised by 100 °C.                        | increase   | decrease  |

b argon does not participate in the reaction in any way so there is no change in the amount, concentration or partial pressure of either reactant.\* As a consequence there is no change in the rate of the forward reaction or equilibrium position as the system remains

in equilibrium.\*  $[(8 \times \frac{1}{2}) + 2 = 6]$ 

2a. Advantage: Increase rate of reaction. \*

Reason: In an exothermic reaction, as temperature decreases - K increases, however, rate of reaction will be slow so a catalyst is used to speed up rate and not compromise the yield. \* (alternatively - lowers activation activation energy which saves energy required).

b Pressure increases favours the side with less mole \*, in this reaction it is to the right. \*/2 Thus [NO2] will increase. \*/2

=

$$\mathbf{K} = \frac{[N_2 O_4]}{[NO_2]^2} *$$

di.

с

|                              | $NO_2(g)$                  | N <sub>2</sub> O <sub>4</sub> (g) |
|------------------------------|----------------------------|-----------------------------------|
| Initial moles                | 0.132                      | 0                                 |
| Moles reacting               | 2 x 0.0400 = 0.0800*       | 0.0400                            |
| Moles at equilibrium         | X= 0.132 - 0.0800 = 0.052* | 0.0400                            |
| Concentration at equilibrium | 0.052 M                    | 0.040M                            |

dii

K =

14.8 M<sup>-1</sup> \* (unit not required) 0.040 (\* for working) =

As K decreased when temperature increased the reaction is exothermic. \* diii. As energy is a product, increasing temperature will cause reaction to move backwards. \*

0.052

2e Change: Temperature decreased \*

 $\frac{[N_2O_4]}{[NO_2]^2}$ 

Since the reaction is endothermic - as temperature decreases K decreases,\*/2 the reaction moves Explanation: backwards and more  $N_2O_4$  is produced. \*/2

[2+2+1+(2+2+2)+2=13]

10.C 20.C

v regard et avec en t 3a

b.

c.

4a bi ii.

с

di

dii.

5a

b

6a

b

| $K_a = [OCI][H_3O]/[HOCI]*$  |   |  |
|--|---|--|
| Let $[H_3O^+] = [OCI^-]$ ( <i>ie</i> weak acid assumption)<br>$\therefore [H_3O^+]^2 = K_a \times [HOCI]$<br>$\therefore [H_3O^+]^2 = 5.01 \times 10^8 \times 1.00 \times 10^{-3}$<br>$\therefore [H_3O^+] = \sqrt{(5.01 \times 10^8 \times 1.00 \times 10^{-3})} M$<br>$= 7.08 \times 10^6 M$<br>$\therefore pH = -\log_{10}(7.08 \times 10^6) = 5.2 *$   | (* for working)   |  |
| $[H_3O^+] = (K_a \times [HOC1]) + [OC1^-]$<br>= (5.01 × 10 <sup>-8</sup> × 1.00 × 10 <sup>-3</sup> ) + (1.00 × 10 <sup>-3</sup> )<br>= 5.01 × 10 <sup>-8</sup> M<br>$\therefore$ pH = -log <sub>10</sub> (5.01 × 10 <sup>-8</sup> ) = <b>7.3</b> *   | (* for working)   | [1+2+2= <b>5</b> ]   |
| $S(s) \text{ or } S(l) + O_2(g) \rightarrow SO_2(g) *$   |   |  |
| oxygen <i>or</i> air *<br>For an exothermic reaction, the yield is maximised<br>of additional heat) but the rate is very low. Modera<br>economically acceptable. *   | by using low temperatures (hig<br>te temperatures are used for the  | h temperatures suppress the release<br>e rate of conversion to be  |
| Any two of: fertiliser production, lead/acid accumula<br>manufacture, pickling metals, pigment, dye and dru  | ators (car batteries), paper production, etc. **  | uction, household detergent  |
| The first is an acid/metal reaction where hydrogen i<br>being spectators whereas in the second the sulfate ic<br>$Zn(s) + 2H_2SO_4(1) \rightarrow SO_2(g) + ZnSO_4(aq) + 2H_2SO_4(aq) + 2H_2SO_4(ad) + 2H_2SO_4(ad) + 2H_2SO_4(ad) + 2H_2SO_4(ad) + 2H$ | ons are reduced to hydrogen gather that the second | s by zinc with the sulfate ions<br>the product is sulfur dioxide.* |
| Any reaction involving gaseous reactant(s), a comb   | ustion reaction, etc. *   | [1 + (1 + 1) + 2 + (1 + 1) = 7]                                    |
| reverse reaction required ⇒ enthalpy change is neg<br>n(ICl) = 4.571 + 162.4 mol (= 0.02815 mol) *<br>and 34.5 kJ = 2 mole of ICl(g)<br>∴  enthalpy change  = (34.5 × 4.571) + (2 × 162.4)<br>∴ enthalpy change = - 0.486 kJ = - 486 J   | ative<br>kJ = 0.486 kJ (* for working)<br>* (answer must be negative) (C  | Consequential marks possible)<br>[1 + 3 = <b>4</b> ]               |
| $\label{eq:deltaH} \begin{array}{l} \Delta H \ / \ molar \ mass = Energy \ per \ gram \\ Petrol \ 5460/114 = 47.9 \ KJ/g, \ Kerosene \ 10 \ 000/210 \\ Ethanol \ 1370/46 = 29.8 \ KJ/g \\ Hydrogen \ has \ greatest \ energy \ per \ gram \ * \end{array}$   | = 47.6 KJ/g, Hydrogen 285/2 =   | 142.5 KJ/g   |
|  |   |  |
| $V(H_2) = \frac{9276.5 \times 8.31 \times 298}{100}$<br>= 229720 = 2.30 x 10 <sup>5</sup> L *  |   |  |

- [1 + 2 = 3]
- 7a - The energy available through digestion and respiration of a peanut will be less the peanut's heat of combustion \*/2- Because some food components aren't digested or food is incompletely absorbed after digestion and some components are only partially oxidised.\*/2

- Peanut oil, however, is virtually pure and should be completely combusted.\*/2

- Thus for the same mass, the peanut oil releases most energy, the burnt peanut next and respired peanut least energy.\*/2

b - Primary cells cannot be recharged \*/2

- As at least one of the products diffuses away from it electrode so that the reverse reaction is unable to occur. \*/2 - In the Daniell cell, some of the Cu<sup>2+</sup> ions in the half cell solution are reduced to metallic copper which may (or may not!) adhere to the copper electrode, but the zinc metal anode is oxidised to  $Zn^{2+}$  ions which diffuse away into the electrolyte.\*/2 (Note: Reason why reverse reaction cannot occur).

3 - Recharging would require oxidation of the copper that had been produced (which may be possible) and reduction of the zinc ions which isn't possible as they aren't now in contact with the electrode to receive electrons from it \*/2 Thus the Daniell cell is a primary cell. - The only species present in any appreciable concentration in 1 M Na<sub>2</sub>SO<sub>4</sub> solution are Na<sup>+</sup> SO<sub>4</sub><sup>2</sup> and H<sub>2</sub>O \*/2 7c - The possible anode reactions are the oxidation of  $SO_4^{2}$  ions or H<sub>2</sub>O. Water is oxidised to O<sub>2</sub> (along with the production of  $H^+$  ions) at the anode as  $SO_4^{2-}$  ions already have sulfur in its highest oxidation state. \*/2 - Both H<sub>2</sub>O and Na<sup>+</sup> ions could be reduced at the cathode but Na<sup>+</sup> ions are a weaker oxidant compared to water \*/2- sodium  $E^{\circ}$  = -2.71V compared to water -0.83V \*/2 (Reason why water is stronger oxidant)  $(\frac{1}{2} \text{ mark per relevant point})$  [2+2+2=6]HgO(s) \* 8a anode:  $Zn(s) + 2OH(aq) \rightarrow Zn(OH)_2(s) + 2e^{-1}$ b cathode:  $HgO(s) + H_2O(l) + 2e^- \rightarrow Hg(l) + 2OH^-(aq) *$ One mark off if the half equations are beside the wrong label but are otherwise correct.  $K^+$  ions are spectator ions  $\Rightarrow$  no change in their amount. OH ions are consumed at the anode in the same numbers as с they are produced at the cathode  $\Rightarrow$  no change in their amount either. Thus, there is no change in the overall amount of KOH present. \* d Any one of: leakage of corrosive KOH electrolyte, toxicity of Hg and HgO, small size so easily swallowed \* etc. [1+2+1+1=5] $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^{-*}$ 9a Anode: Cathode:  $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO4(s) + 2H_2O(1) *$ One of - concentration decreases/ density decreases/ pH increases \* b Advantage: one of - rechargable/ delivers large amounts of energy etc \* с Disadvantage: one of - bulky/ acid spillage/ heavy/ toxic \* [(1+1)+1+2=5]10a Oxidation:  $2Cl^{-}(aq) \rightarrow Cl_{2}(aq) + 2e^{-} (Accept Cl_{2}(g))^{*}$ Reduction:  $2H_2O(1) + 2e \rightarrow H_2(g) + 2OH(aq) *$ Overall:  $2CI^{(aq)} + 2H_2O(I) \rightarrow Cl_2(aq) + H_2(g) + 2OH^{(aq)} * (consequential possible)$ Oxidation and reduction reaction separation is not required just 2 half equations. Consequential 1 mark if half equations are incorrect but it is a correct addition of the half equations, provided that the half equations contain electrons and that they are not frivolous. b Acid neutralises the hydroxide ions produced during the electrolysis. ci a structure to ensure that the hydrogen and chlorine do not mix. \* cii. contamination due mixing of the gases or reaction of the hydrogen, chlorine and hydroxide ions are possible but these are commercially undesirable. Potentially a volatile reaction may occur. \* [3+1+(1+1)=6]11a O2(g) \*  $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l) **$ b [1+2=3]END of ANSWERS