CHEMISTRY

Unit 4 – Written examination 2

2009 Trial Examination

SOLUTIONS

SECTION A – Multiple-choice questions (1 mark each)

Question 1

Answer: D

Explanation:

All three measurements give an indication of the reaction rate. H^+ ions are formed by the reaction, hence pH will decrease as the reaction proceeds.

Question 2

Answer: C

Explanation:

As the reaction proceeds, the Br_2 is used up. This makes the mixture lighter and the cross will become visible

Question 3

Answer: D

Explanation:

The time taken for the cross to appear will get shorter as the reaction goes faster.

Question 4

Answer: A

Explanation:

The reaction is endothermic so high temperature helps the yield. Low pressure will also favour the forward reaction.

Question 5

Answer: C

Explanation:

The system will move to lower the pressure by favouring the reverse reaction. The reverse reaction is exothermic hence the temperature will rise.

Question 6

Answer: A

Explanation:

At 200ºC the value of K must be over 0.8. The alternative that gives a greater K value is A.

Question 7

Answer: C

Explanation:

The OH^- concentration drops when the acid is added. The system moves to oppose this but the concentration will not get up to the original value.

Question 8

Answer: B

Explanation:

The equation has been reversed and halved; hence the value of K will be the reciprocal of the square root $=1/\sqrt{K}$

Question 9

Answer: B

Explanation:

The HCl is a strong acid. Its pH will be 2. This is a higher value than the two weak acids will produce.

Question 10

Answer: D

Explanation:

The value of K is very low meaning that the concentration of the reactants is high but the products low. This is option D.

Question 11

Answer: A

Explanation:

The silicon in the PV cells is doped with impurities. Light striking it generates a flow of electrons without a turbine.

Question 12

Answer: C

Explanation:

0.16 g is 0.01 of a mol. From data book, this is 8.89 kJ = 8890 J

$$CF = \frac{energy}{\Delta T}$$
$$= \frac{8890}{11.7}$$
$$= 760 \text{ J}^{o}\text{C}^{-1}$$

Question 13

Answer: B

Explanation:

The values in the data book are per mole but the equation has a coefficient of 2. Therefore the 484 has to be divided by 2.

Question 14

Answer: D

Explanation:

Take the data book value per mol for each and divide by the molar mass. Hydrogen has the highest figure 246/2 = 123 kJ

Question 15

Answer: B

Explanation:

The Cu^{2+} ions are reduced to Cu at the positive electrode and H^{+} ions are formed at the negative electrode.

Question 16

Answer: C

Explanation:

The electrons flow from the negative hydrogen electrode to the positive copper electrode.

Question 17

Answer: A

Explanation:

The copper and iodide ions will react before water does, so the products are the same whether the cell is aqueous or molten.

Question 18

Answer: D

Explanation:

8042 coulomb is 1/12 of a mol (0.0833). The aluminium with a charge of 3+ will match this 0.0278 x 3 = 0.0833

Question 19

Answer: D

Explanation:

The anode is the oxidation reaction; this is the methane reaction. The charge in A. is not balanced.

Question 20

Answer: C

Explanation:
It does not produce a continuous flow of electrons if switched off. It is not recharged – it just has more reactant supplied. It can run as long as reactants are supplied.

SECTION B: Short answer questions

*An * indicates the allocation of 1 mark*

Question 1

a. **i**. This would not usually be true – only if they were added to the reactor in ratio 1:2 *

ii Wrong. In a reversible reaction the reactants will not run out.*

iii. True. The reverse reaction will occur at first.*

1 + 1 + 1 = 3 marks

b. **i**. No, the charge on the metal influences the amount obtained*

ii. Yes, this is the principle of electric circuits*

iii. No*, because 1 mol of Cl_2 requires 2 mol of electrons

1 + 1 + 1 = 3 marks

c. **i**. No, this reaction would occur at the cathode not the anode*

ii. Not necessarily, it might be a hydrogen fuel cell*

1 + 1 = 2 marks

d. **i**. this will only be the case if it is a strong acid*

ii. true, as pH is from hydronium ion*

1 + 1 = 2 marks

Total 11 marks

Question 2

a. **i**. lower*

ii. it takes less energy to heat up 90 mL of water*

1 + 1 = 2 marks

b. **i**. the same *

ii. careful experimentation should lead to the same result.*

1 + 1 = 2 marks

c. **i**. higher*

ii. the contents of the calorimeter will not heat as much as expected*

1 + 1 = 2 marks

d. higher* 1 mark

e. $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$*

1 mark

f. $energy = CFx\Delta T = 455x5.3 = 2412J$ * where $n = m/M = 0.25/24.3 = 0.0103mol$

$\Delta H = E/n = 2412/0.0103 = -234kJ$ *

2 marks

g. This should not change the result* as the HCl is in excess. The temperature might rise faster but it should still reach the same value*

2 marks
Total 12 marks

Question 3

a. **i**. oxidation half equation $H_2O_2(aq) \rightarrow O_2(g) + 2H^+(aq) + 2e^-$ *

reduction half equation $H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$*

overall equation $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$ *

ii. The reaction is spontaneous but the rate is very slow*

iii. Refrigeration ensures the temperature is low so the average kinetic energy of the particles is low. The black plastic stops light penetrating the container where it might lead to increasing the energy of the particles. *

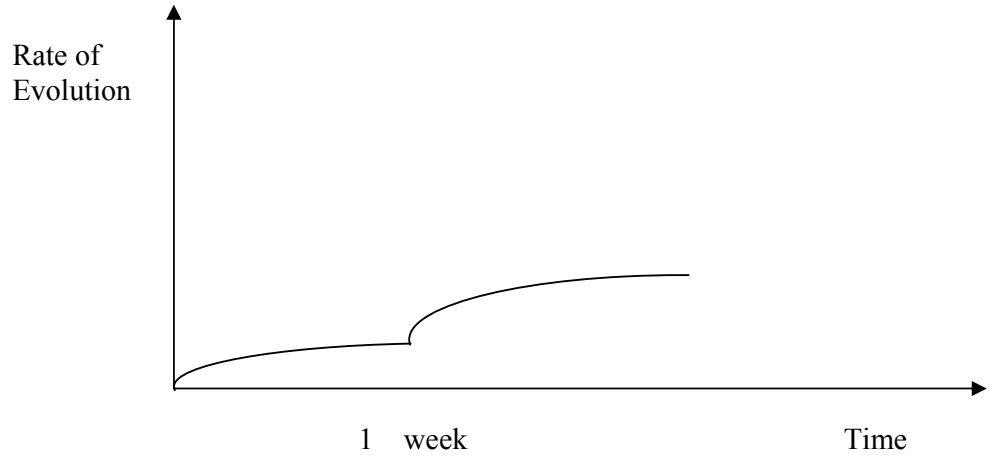
3 + 1 + 1 = 5 marks

b. **i.** It is a catalyst, speeding the reaction up but being unchanged*

ii. None, as a catalyst it is unchanged *

1 + 1 = 2 marks

c.



1 mark
Total 8 marks

Question 4

a. Since the reaction is endothermic, high temperatures* improve the yield. Closer to the engine should favour the forward reaction. *

2 marks

b. 4 particles are converted to 3 by the forward reaction. The reaction going forward would be .favoured by higher pressures*

1 mark

c. Air contains nitrogen. If the nitrogen content is increased, the system will oppose this by moving to the left*, bad for yield*

2 marks

d. $K = \frac{[N_2][CO_2]^2}{[NO]^2[CO]^2}$ *

1 mark

e.

$2NO(g)$	+ $2CO(g)$	$\Leftrightarrow$	$N_2(g)$	+ $2CO_2(g)$	
0.30	0.44		0	0	start
				0.12	change
0.30 – 0.12 = 0.18	0.44 - 0.12 = 0.32		0.06	0.12	

NO 0.18* CO 0.32 * N_2 0.06 *

3 marks

Total 9 marks

Question 5

a.

	Half Equation	Polarity
anode	$Li \rightarrow Li^+ + e$ *	-ve *
cathode	$Fe^{4+} + 4e \rightarrow Fe$ *	+ve *

4 marks

b. Lithium reacts too vigorously with water *

1 mark

c. Most commercial cells are 1.5 volts, therefore the cells can be used interchangeably *

1 mark

d. One of the reactants is all consumed, therefore one of the half equations stops*

1 mark

e. **i**. $E = VIT = 1.4x8x60x60x3.5 = 141kJ$ **

ii.

$Q = It = 8x60x60x3.5 = 100800C$

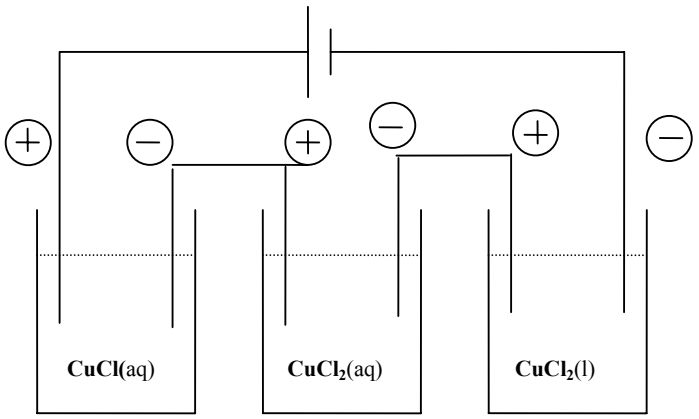
. $n(e) = Q/96500 = 100800/96500 = 1.04mol$ *

$mass(Li) = 1.04x6.9 = 7.18g$

*

2 + 2 = 4 marks
Total 11 marks

Question 6



a. 3 marks

b. **i**. How many mol of electrons passes through each cell?
CuCl(aq) 4
$CuCl_2$(aq) 4
$CuCl_2$(l) 4 *

ii. How many mol of chlorine gas is produced in each cell?
CuCl(aq) 0 *
$CuCl_2$(aq) 0 *
$CuCl_2$(l) 2 *

iii. How many mol of metal is produced in each cell?
CuCl(aq) 4
$CuCl_2$(aq) 2
$CuCl_2$(l) 2 *

iv. $P = \frac{nRT}{V} = \frac{2x8.31x1073}{100} = 178kPa$
* * *

1 + 3 + 1 + 3 = 8 marks
Total 11 marks

Question 7

pH of HCl = 1 as strong acid

K_a for HCN = 6.3 x 10^{-10} K_a for CH_3COOH = 1.7 x 10^{-5}

$6.3x10^{-10} = \frac{x^2}{0.1}$ * $1.7x10^{-5} = \frac{x^2}{0.1}$ *

$x = \sqrt{6.3x10^{-11}} = 7.94x10^{-6}$ * $x = \sqrt{1.7x10^{-6}} = 1.3x10^{-3}$ *

pH =5.1 * pH = 2.88 *

6 marks