CHEMISTRY

Unit 4 – Written examination 2

2008 Trial Examination

SOLUTIONS

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

Question 1

Answer: C

Explanation:

A drop in temperature will lower the rate. Addition of water will dilute the reaction, causing a drop in concentration and therefore decreasing the number of collisions.

Question 2

Answer: A

Explanation:

The extra water will dilute the solution, making the rate of reaction lower. Therefore the rate of evolution of gas will decrease.

Question 3

Answer: D

Explanation:

For many reversible reactions, the yield drops as the temperature rises. Therefore the higher temperature might lead to less product. Usually exothermic reactions are involved.

Question 4

Answer: D

Explanation:

When the pH is 1 lower, the acid concentration is 10 times greater – this is the way that a log scale works. Beaker A has the higher concentration, because the pH is lower.

Question 5

Answer: B

Explanation:

This is an endothermic reaction – the yield increases with temperature. Increased pressure will also help the yield since there are less particles on the products side.

Question 6

Answer: A

Explanation:

The K value of the reverse reaction is the reciprocal of the forward reaction. The only way a number and its reciprocal are equal, is if the number is 1.

Question 7

Answer: A

Explanation:

The reaction is exothermic, so the back reaction is favoured. Therefore the nitrogen and oxygen have increased and the NO has decreased. The NO decreases by twice the amount due to the balancing of the equation.

Question 8

Answer: A

Explanation:

The reaction goes in reverse to lower the OH^- concentration but it does not go as low as it was before the addition. More OH^- means a higher pH.

Question 9

Answer: D

Explanation:

The particles will have a range of velocities. They will all have the same mass and they will have a range of kinetic energies.

Question 10

Answer: C

Explanation:

Natural gas contains a mixture of low molecular mass alkanes. Methane is the most likely.
Fuel cells can use gases other than hydrogen; nuclear power uses nuclear fission.

Question 11

Answer: A

Explanation:

The sequence is chemical energy to thermal energy of coal. This is converted to thermal energy of steam. Steam turns the turbine (mechanical energy) and electricity is produced.

Question 12

Answer: C

Explanation:

$$n(ethanol) = \frac{0.6}{46} = 0.013mol$$
$$energy = 0.013 \times 1364 = 17.79kJ$$
$$CF = \frac{energy}{\Delta T} = \frac{17790}{11.7} = 1520J\,^oC^{-1}$$

Question 13

Answer: D

Explanation:

$n(H_2) = \frac{2.4}{2} = 1.2mol$

The reaction requires 2 H_2 molecules to produce 484 kJ

$\frac{1.2}{2} = 0.6mol$

$energy = 0.6 \times 484 = 290kJ$

Question 14

Answer: D

Explanation:

The Fe^{3+} forms Fe^{2+} , while the iodide ions are converted to I_2. The iodide reaction is oxidation and it releases electrons.

$2I^- \rightarrow I_2 + 2e^-$

The electrons flow to the other cell.

Question 15

Answer: B

Explanation:

The strongest oxidant is always reduced. Reduction always occurs at the cathode.

Question 16

Answer: D

Explanation:

The only answer that could possibly work is D. $Q = It = 10 \times 145 \times 60 = 87000$ coulomb.

$\frac{87000}{96500} = 0.9mol$

In A, the voltage could be any value, it is the current that is more significant.

No metal would have an oxidation number that leads to 0.15 mole.

Question 17

Answer: A

Explanation:

The power supply pushes electrons to the negative electrode. The electrons will allow a reduction reaction to occur.

Question 18

Answer: B

Explanation:

Copper ions and iodide ions are the strongest oxidant and the strongest reductant in both cells. Therefore water will not react, so the products are the same in both cases, copper and iodine.
$Cu^{2+} + 2e^- \rightarrow Cu$ $2I^- \rightarrow I_2 + 2e^-$

Question 19

Answer: C

Explanation:

Reduction occurs at the cathode therefore cannot be B or D, and A is not a balanced half equations as it is has a charge of -8 on the left side and +8 on the right side of the equation

Question 20

Answer: C

Explanation:

Fuel cells require porous electrodes for the gases to pass through and they utilise a continuous supply of reactants.

SECTION B: Short answer questions

*An * indicates the allocation of a mark*

Question 1
Give concise explanations for each of the following.

a. Metals do not always form ions with the same charge.* Na^+, Ca^{2+} and Al^{3+} are three examples with different oxidation numbers. Each oxidation number requires a different number of electrons to form the metal i.e. 1 mole of electrons will only form ½ a mole of calcium $Ca^{2+} + 2e^- \rightarrow Ca$ *

2 marks

b. An increase in temperature often leads to a lower yield,* especially if the reaction is exothermic. The products might form quickly but the percentage yield might be much lower.*

2 marks

c. The calibration factor is determined from the formula $CF = \frac{energy}{\Delta T^*}$

The energy can be added by means other than electricity. A chemical reaction with a known ΔH can be used instead of electricity.*

2 marks

d. 1 mole of diesel contains more energy than 1 mole of ethanol but it also weighs significantly more than 1 mole of ethanol.* As fuel is sold per litre, the energy released per litre is fairly similar for both fuels.*

2 marks
Total 8 marks

Question 2

a. H – C ≡ C –H * 1 mark

b. For each space in the table, choose from **decrease**, **unchanged** or **increase**

change	value of K	equilibrium yield of ethyne	rate of reaction
decrease in temperature	decrease	decrease	decrease
increase in pressure	decrease	decrease	increase
addition of a catalyst	unchanged	unchanged	increase

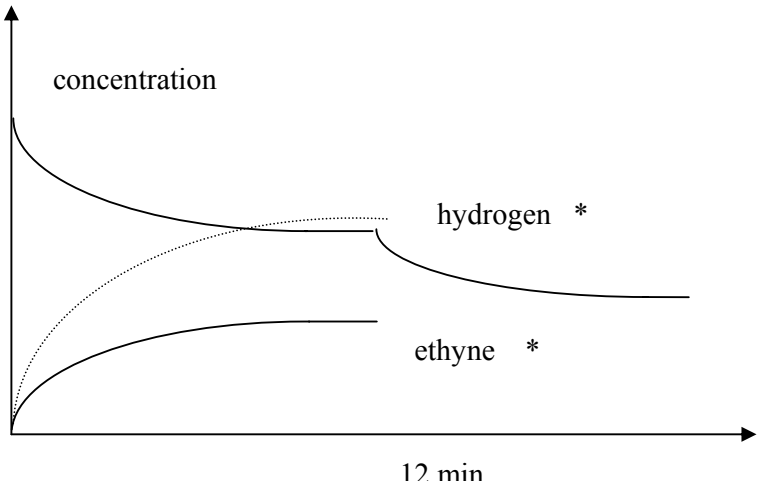
3 marks

* 1 mark for each row – the whole row must be correct

c.

i. And

ii.



iii. The amount of ethane has dropped after the 12 min mark. Therefore the amount of ethyne has increased. For an endothermic reaction, an increase in temp must have occurred. *

3 marks

d. Fuel cell – reacting with oxygen to form water. Rocket propulsion.*

1 mark

e. $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$*

1 mark

Total 9 marks

Question 3

(1 mark for each response)

a. All neutral solutions have a pH of 7. **False**, temperature dependant.

Neutral solutions contain neither acid nor base. **False**, they might contain an equal amount of each

The product, $[H_3O^+][OH^-]$, is always 10^{-14} **False**, temperature dependant.

In pure water, $[H_3O^+]$ will always equal $[OH^-]$ **True**

20.0 mL of 0.1 M ethanoic acid can neutralize the same volume of 0.2 M NaOH as 20.0 mL of 0.1 M hydrochloric acid. **True,** in a titration against a strong base, it does not matter if the acid is strong or weak.

b. Complete the table below for samples of pure water held at different temperatures

Temp $^\circ C$	$[H_3O^+]$	$[OH^-]$	K_w
0	$10^{-7.5}$	$10^{-7.5}$	10^{-15}
25	10^{-7}	10^{-7}	10^{-14}
50	$10^{-6.6}$	$10^{-6.6}$	$10^{-13.2}$

3 marks

c. $C_6H_5OH(l) + H_2O(aq) \Leftrightarrow H_3O^+(aq) + C_6H_5O^-(aq)$*

1 mark

Question 4

a.

i. A and C*

ii. The activation energy in Graph A is lower. It represents the same equation with the use of a catalyst*

2 marks

b.

i. A, B, C and D. * The activation energy is always positive.

ii. D*

2 marks

c. $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g) \quad \Delta H = -2803 \text{ kJ mol}^{-1}$

$$n(O_2) = \frac{4.8}{32} = 0.15mol*$$

6 mole of oxygen produces 2803 kJ

Therefore $\frac{0.15}{6} = \frac{x}{2803}$

Therefore x = 70 kJ.

3 marks

Total 7 marks

Question 5

a. polarity
-ve
+ve*

1 mark

b. $V_2O_5(aq) + 2VO(aq) \rightarrow 2VO_2(aq) + V_2O_3(aq)$

1 mark

c. VO +2 V_2O_3 +3 V_2O_5 +5 VO_2 +4

½ mark each 2 marks

d.

i. $E = VIt = 1.4 \times 3.5 \times 8 \times 60 \times 60^* = 141000$ * joule

ii. $Q = It = 3.5 \times 8 \times 60 \times 60 = 101000$ coulomb

$$n(e) = \frac{101000}{96500} = 1.04mol *$$

$$n(VO) = ne(e) = 1.04mol *$$

$$mass(VO) = n \times M = 1.04 \times 66.9 = 69.9g *$$

4 marks
Total 8 marks

Question 6

a.

i. anode $4OH^-(l) \rightarrow O_2(g) + 2H_2O(g) + 4e^-$ *

cathode $K^+(l) + e^- \rightarrow K(l)$*

ii. anode +ve * cathode -ve *

2 + 2 = 4 marks

b. Potassium is very reactive in air and water*. A naked flame might be used to keep the potassium hydroxide molten. A naked flame near oxygen and liquid potassium is very dangerous. *

2 marks

c. $Q = It = 6.2 \times 4 \times 60 = 1488 *$

$$n(e) = \frac{1488}{96500} = 0.0154$$

$$n(K) = n(e) = 0.0154$$

$$mass(K) = n \times M = 0.0154 \times 39.1 = 0.603g *$$

2 marks

d.

i. Some molten potassium and the oxygen are still in contact with their respective electrodes.* These can react spontaneously producing a galvanic cell.*

ii. $K(l) \rightarrow K^+(l) + e^-$ *

iii. –ve *

4 marks
Total 12 marks

