**2023 Unit 3 Chemistry trial exam solns**

**Section A: Multiple Choice section**

**Question 1**

B: If this cell is connected to a zinc half-cell, the half-equations are **Fe3+** + e 🡪 Fe2+

 Zn2+ + 2e 🡪 **Zn**

Fe3+ would be reduced at the positive cathode.

**Question 2**

C: Administering oxygen forces the reaction between Hb4 and oxygen to proceed, lowering the [Hb4]. This helps reverse the CO poisoning equation.

**Question 3**

D: This reaction has 9 particles on the left and 10 on the right, leading to units of M

**Question 4**

D: A catalyst lowers the activation energy. Therefore the particles in area A can now react as well as the particles in area B.

**Question 5**

A: The relevant half-equations are **Cu2**+ + 2ee 🡪 Cu 0.34

 2H + 2e 🡪 **H2** 0.00

Copper ions are reduced at the positive cathode to copper metal. Hydrogen gas is oxidised to hydrogen ions at the anode. The voltage will be low 0.34 V

**Question 6**

B: See solution to Question 5

**Question 7**

C: KCl(aq): water will react at both electrodes, forming oxygen at the anode and hydrogen at the cathode. 4.0 M NaCl is not correct as it will form chlorine at the anode.

**Question 8**

D: 49.6 L at SLC is 2 mol of oxygen. The n(Ag) will be 4 times the n(O2) as Ag+  + e, compared to O2 + 4e

**Question 9**

A: The reaction is N2O4(g) ⇌ 2NO2(g). If the pressure increased, the particles are closer together so the concentrations increase. The system opposes this by moving in the back direction.

**Question 10**

B: The increased pressure leads to a higher reaction rate but the temperature has not changed so the value of K is unchanged.

**Question 11**

C: Option C has both the hydrogen ions and the charge balanced correctly.

**Question 12**

B. The reaction has been reversed and halved. K = 1/√25 =1/5 = 0.2

**Question 13**

A: To maintain constant pressure the volume of the container would need to be increased. This would impact the equilibrium position.

**Question 14**

C. The electrons flow from the site of oxidation to the site of reduction in both cases.

**Question 15**

D: Flashpoint order will be the same as boiling point order. Ethane has the lowest boiling point on this list.

**Question 16**

A. When a fatty acid is converted to an ester, the fatty acid loses a H and gains a CH3 group – net increase of 14.

**Question 17**

B: 1 mol butane = 2880 kJ

**80 g octane = 80 x 47.9 highest**

2 mol methane = 890 x 2

10 mol H2 = 10 x 282

**Question 18**

D: This is the reverse reaction so the activation energy is the entire hump on the graph.

**Question 19**

C: Biogas of ten has about 25% CO2. Biogas still produces emissions when it burns and these emissions will impact the environment.

**Question 20**

A: The burettes might have residue levels of different chemicals that will led to random impact upon student results.

**Section B: Short answer questions**

**Question 1** (8 marks)

**a. i**. Name the fuel produced in this process: biogas 1 mark

 **ii**. It is renewable as animal waste can be collected regularly. 2 marks

 **iii**. pig manure, human sewerage, food waste 1 mark

 **iv**. Biogas is produced from the action of microorganisms. Their action is maximised at 35 ˚C.

 1 mark

**b**. CH4(g) + 2O2(g) 🡪 CO4(g) + 2H2O(l) 1 mark

**c**. It is made from a renewable fuel unlike coal or gas. CO is absorbed in its manufacture to compensate for its emissions during combustion. 2 marks

**Question 2** (14 marks)

**a**. **i**. Anode: Li 🡪 Li+ + e -ve electrode 4 marks

 Cathode: S8 + 16e 🡪 8S2-

 Overall: 16Li + S8 🡪 16Li+ + 8S2-  or 8Li2S

 **ii**. Li+ ions flow from positive anode to the negative cathode. 2 marks

 **iii.** What is the oxidation state change of sulfur atoms during discharge? 0 to 2- 1 mark

 **iv.** Lithium metal cannot be used in aqueous environments due to its violent reaction with water.

 2 marks

**b**. **i**. Anode: 4NH3(g) + 12OH-(aq) 🡪 2N2(g) + 12H2O(g) + 12e 2 marks

 Cathode: O2(g) + 2H2O(l) + 4e 🡪 4OH-(aq)

 **ii**. NH3 is the negative electrode. 1 mark

 **iii**. What is oxidation state change of the nitrogen atoms in this cell? 3- to 0 1 mark

 **iv**. No – as a fuel cell a continuous supply of fuel is used instead of a recharge. 1 mark

 **Question 3** (12 marks)

**a.** left electrode +ve, right -ve 1 mark

**b.** Faraday’s First Law of electrolysis: mass is proportional to charge. Weigh the cathode. Run the cell for a set time at a fixed current. Dry and reweigh the electrode. Repeat for longer time periods. Draw a graph of mass vs charge 3 marks

**c**. Faraday’s Second Law of electrolysis: number of mole electrons: number of mole of metal will be a whole number ratio. Weigh the copper and silver electrodes. Run the cell for a set time. Dry and reweigh the electrodes. The number of mole of silver should be double that of copper. 3 marks

**d**. Q = 1000 x 96.5 = 96500 C = 1 faraday. 3 marks

 n(Ag) = 1 mole = 107.9 g n(Cu) = 0.5 as Cu2+ mass = 63.5 x 0.5 = 31.8 g mass Al = 0

 (Aluminium is not formed in this cell as water is a stronger oxidant than Al3+)

 **ii**. Each cell produces oxygen gas at the anode. The aluminium cell produces hydrogen at the cathode.

 2H2O(l) 🡪 O2(g) + 4H+ + 4e n(O2) in each cell = 1/4n(e) = 0.25 mol. 3 cells = 0.75 mol

 N(H) = 1/2 n(e) = 0.5 mol => no mol gas = 1.25 mol 2 marks

**Question 4** (9 marks)



N2, H2O

NH3, O2

**a**. **i**. 4NH3(g) + 3O2(g) 🡪 2N2(g) + 6H2O(l) ∆H = -255 kJ mol-1 1 mark

 **ii**. 75 - - 225 = 300 kJ 1 mark

**b**. see red line on graph 1 mark

**c**. **i**. n(Al) = 1000/17 = 58.8 mol energy released = 58.8 x 255/4 = 3750 kJ 3 marks

 ii. Determine the volume of nitrogen formed at 320 0C and 120 kPa from this combustion. 3 marks

 n(N) = ½ n(ammonia) = 19.4 mol

 V = nRT/P = 19.4 x 8.31 x 593/120 = 797 L

**Question 5** (10 marks)

**a**. The oxygen is going from 0 to -2, Cl from -1 to 0 1 mark

**b**. 3 marks

|  |  |  |
| --- | --- | --- |
| **Change made** | **Impact on *K*c** |  **Impact on [HCl] once equilibrium re-established** |
| temperature increased | increased | decreased |
| volume decreased | unchanged | decreased |
| some H2O removed | unchanged | decreased |

**c**. 4.0 mol of HCl and 1.0 mol of O2 are added to a 10 L reactor. When equilibrium is reached, the amount

 of Cl2 is measured as 0.44 mol.

 Determine the value of *K*c at this temperature. 4 marks

 4HCl(g) + O2(g) ⇌ 2Cl2(g) + 2H2O(g)

 4 1 0 0

 4-0.88 1-0.22 0.44 0.44

 3.12 0.78 0.44 0.44

 C 0.312 0.078 0.044 0.044

 K = (0.044)4/ (0.312)4(0.078) = 0.00508 M-1

 **d**. Advantage: both rate and yield increased 2 marks

 Disadvantage: expensive and dangerous

**Question 6** (12 marks)

**a**. **i**. 2H2O2(l) 🡪 2H2O(l) + O2(g) 1 mark

 **ii**. It is easy to lose gas and accuracy getting the stopper in place. Using the string allows you to mix the chemicals and get the stopper in quickly. 1 mark

**b**. i. Add 40 mL of 2H2O2 to the flask. Put catalyst in place. Record temperature. Mix chemicals. Record how long it takes for 50 mL of gas to form. Repeat at several temperatures. Plot time taken against temperature. 3 marks

 **ii**. Independent variable: temperature 2 marks

 Dependent variable: rate gas volume changes

**c. i**. Temperature increases kinetic energy and most particles move faster. They collide more frequently and there is a higher proportion of successful collisions. 2 marks

 **ii**. No, the final volume is determined by the amounts of chemicals 2 marks

 **iii**. Circle the one of the following that manganese dioxide impacts? activation energy of the reaction 1 mark