**Unit 3 Chemistry Trial Exam Solutions**

**Section A**

1. C. Ethanol can be sourced from either renewable or non-renewable sources.

2. D. Hydrogen has a much higher energy density than alkanes. Values from the Data book can be

 used to do this question.

3. B. The third column of the table shows the energy density drops with molecular mass.

4. C. 248 L = 10 mol at STP. n(propane) = 1/3 n(CO2) = 3.33 mol. Mass = 3.33 × 44 = 146 g

5. C. Petrodiesel does not contain oxygen or nitrogen atoms. Dispersion forces are the main

 intermolecular force present.

6. B. In NO2 the oxidation number of nitrogen is 4+. In NO3- it will be 5+ and in NO+ the nitrogen is

 3+.

7. A. The activation energy is always a positive value. For an endothermic reaction, the enthalpy will

 also be positive. The exact values can be read from the vertical axis.

8. A. In this cell Fe3+ will be reduced and Zn oxidised. Reduction occurs at the positive electrode/

9. D. The equations in D are balanced and reflect an alkaline environment.

10. D. The oxidation of Al produces electrons, making this the negative terminal.

11. C. K = 16 = => x = 0.8 M

12. B. The reaction has been reversed and halved so the new *K* will be 1/√16 = 0.25

13. D. When the temperature is increased the rate of the forward and back reaction will increase by

 the same amount.

14. C. The system in Reaction 1 opposes the increase in O by moving in the desired direction, the

 forward direction.

15. B. The electrochemical series will indicate if a reaction is likely to occur but gives no indication

 of the rate. In this case the rate is very low.

16. A. It is not obvious how much water is forming – the mass change is more likely to reflect the

 CO2 evolved.

17. D. *Q* = 30 × 10000 = 300000 or approx. 3 mole

 If 3 mole of electrons produces 1 mole of metal, the metal probably has a 3+ charge like Al.

18. A. The first cell will produce oxygen gas and copper metal. The second cell will see water react at

 both electrodes, forming oxygen and hydrogen.

19. C. From the left cell, 2.5 mole of oxygen will form from 10 mole of electrons. In the right cell a

 further 2.5 mole of oxygen will form and 5 mole of hydrogen.

20. B. The products will be copper, chlorine, sodium and chlorine. 5 mole of chlorine will form in

 each cell.

 **Section B Short answer**

**Question 1** (16 marks)

**a. i**. Animal waste\* and plant waste\* 2 marks

 **ii**. methane (60-75%)\* and CO2 (25 – 40%)\* 2 marks

  **iii**. A fuel that can be replenished at a sustainable rate. 1 mark

 **iv**. The burning of biogas still produces CO2 gas but it produced from biomass, a renewable fuel\*. The waste might produce methane anyway wherever it is disposed of. Methane is a worse greenhouse gas than CO2\*. 2 marks

**b**. **i**. CH4(g) + 2O2(g) 🡪 CO2(g) + 2H2O(l) 1 mark

 **ii**. Energy released = 5600 × 1000 × 55.6 = 3.11 ×108 kJ 1 mark

 **iii**. *n* = = 3.50 ×105 mol \*

 2 marks

 *V* = = 1.12 ×107 L \*

**c**. **i**. Anode: CH4(g) + 2H2O(l)🡪 CO2(g) + 8H+(aq) + 8e

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

 Overall equation: CH4(g) + 2O2(g) 🡪 CO2(g) + 2H2O(l) 3 marks

 **ii**. A fuel cell is more efficient as the methane content is higher\*. Fuel cell has less impurities in the gas\*. A fuel cell is more portable. 2 marks

**Question 2** ( 6 marks)

**a**. The rate in Reactor B will be higher than A\*. The graph shows that many of the particles will be moving faster at higher temperature. A higher percentage of the particles will have an energy greater than the activation energy required for a reaction to occur.\*

 2 marks

**b**. **i**. The catalyst lowers the activation energy.\* A higher proportion of particles will have the required activation energy to react.\*

 2 marks

 

 **ii.** The yield will be unchanged\* as the temperature is the same in both cases. Equilibrium will be reached faster but the yield will not be different.\*

 2 marks

**Question 3** (9 marks)

**a. i**. 2NO(g) + O2(g) ⇌ 2NO2(g) 1 mark

 **ii**. *K* =  1 mark



**b**. See blue lines.\*

 The trend is the same but the yield is lower.

 Each species changes by less.\*

 2 marks

**c**. 3 marks

|  |  |
| --- | --- |
|  | **New equilibrium compared to previous equilibrium** |
| **Value of *K*** |  *K* unchanged |
| **Amount of O2**  | Less as forward reaction favoured. |
| **Amount of NO2** | Less, forward reaction favoured but bigger drop due to some dissolving in water. |

**d**. If the volume is doubled, the back reaction is favoured (3 molecules compared to 2)\*. This will increase the amount of O2 but the concentration is still lower due to the volume being doubled. \* 2 marks

**Question 4** (6 marks)

**a**. anode: Li 🡪 Li+ + e 3 marks

 cathode: I2 + 2e 🡪 2I-

 overall: 2Li + I2 🡪 2Li+ + 2I-

**b**. 0.54 - -3.04 = 3.58 V 1 mark

**c**. **i**. 2Li(s) + 2H2O(l) 🡪 2LiOH(aq) + H2(g)

 1 mark

 **ii**. No – fuel cells usually involve oxygen and a continuous supply of reactants. 1 mark

**Question 5** (7 marks)

**a.**  2 marks



**b**. H2S + 4H2O(l) 🡪 SO42-(aq) + 10H+(aq) + 8e 2 marks

**c**. 2NH3(g) + 4H2O(g) ⇌ 2NO2(g) + 7H2(g) 3 marks

 start 2 2 0 0

 1.6 change 0.4

 equil 1.8\* 1.6 0.2\* 0.7\*

**Question 6** (12 marks)

**a**. anode: 2Cl-(l) 🡪 Cl2(g) + 2e 3 marks

 cathode: Mg2+(l) + 2e 🡪 Mg(l)

 overall: Mg2+(l) + 2Cl-(l) 🡪 Mg(l) + Cl2(g)

**b**. Mg(l) + Cl2(g) 🡪 MgCl2(s)\* vigorous reaction\* 2 marks

**c**. **i**. *Q* = *It* = 245×6×3600 = 5.29 × 106 C \*

 *n*(e) =  = 54.8 mol

  *n*(Mg) = 27.4 mol \* 3 marks

 mass = 27.4 × 24.3 = 666 g\*

 **ii**. 2 marks

 *V* = = 1170 L

**d**. hydrogen gas at the cathode and oxygen gas at the anode 2 marks

**Question 7** (8 marks)

**a. i.** Mg(s) + 2HCl(aq) 🡪 MgCl2(aq) + H2(g) 1 mark

 **ii**. As the reaction proceeds, HCl is consumed, lowering the acidity and increasing the

 pH 1 mark

**b**. **i**. the dependent variable pH 3 marks

 **ii**. the independent variable time

 **iii.** a controlled variable. Volume acid, mass Mg

**c.** The flaw in the design is that the HCl is the excess reagent\*. Therefore the solution will be acid when the reaction finishes no matter how long you leave it\*. The experiment could be changed to make Mg the excess reagent. \* 3 marks