**2022 Unit 3 Chemistry trial exam solns**

**Section A: Multiple Choice section**

**Question 1**

D: Biodiesel is an ester of a fatty acid, usually the methyl ester.

**Question 2**

C: The fatty acid has 18 carbon atoms and 1 carbon-to-carbon double bond, matching oleic acid. Data book is useful here.

**Question 3**

B: As the temperature increases the area under the curve increases showing that a higher proportion of particles will react.

**Question 4**

B: Cu2+ is a stronger oxidant than water and I- is a stronger reductant than water

**Question 5**

D: Option A will not produce any metal. Silver is heavier than aluminium and sodium so option D produces a greater mass than B and C

**Question 6**

D: Aluminium is a stronger reductant than nickel so it will be oxidised and nickel reduced. A ratio of 2:3 is required to balance the electrons.

**Question 7**

A: Oxidation of aluminium occurs at the anode and the anode is negative. The electrochemical series shows a voltage difference of 1.41 V between aluminium and nickel.

**Question 6**

B: The key to this question is the very low K value. This means the concentration of products will be much less than the concentration of reactants.

**Question 7**

D: The addition of H+ will react with OH- ions and lower their concentration. The system moves forward to replace them but does not quite cover the impact of the initial acid addition.

**Question 8**

B: The ratio of particles is 5:4 so the forward reaction is favoured. However, the initial volume decreased increased the HI concentration and never quite gets back to where it was before the change.

**Question 9**

D: The mole ratio in D is 2:4, leading to units of M2

**Question 10**

C: The immediate change on the graph is an increase in NO

**Question 11**

B: The equation has been reversed and halved so *K* = 1/√64

**Question 12**

C. sulfur is + 6 in SO42- and -2 in H2S

**Question 13**

A: Al is reduced to Al and the ratio of aluminium to electrons is 1:3.

**Question 14**

C. The oxidation state of N in N2H4 is +2 and in elemental nitrogen it is 0

**Question 15**

C: Option C is the only balanced equation.

**Question 16**

A. Biodiesel is the largest molecule and also has some dipole bonding.

**Question 17**

A: The thermal energy is converted to kinetic energy of steam.

**Question 18**

B: alcohol groups have priority over halo groups so numbering is from the left side.

**Question 19**

D: Combustion of natural gas produces CO2, CO, some NO, O3 and particulates

**Question 20**

C: The thermometer reading is out by a predictable amount every reading.

**Section B: Short answer questions**

**Question 1** (7 marks)

**a.** MnO2 is the positive electrode. 1 mark

**b.** **i**. Anode: Zn(s) + 4OH-(aq) 🡪 Zn(OH)42-(s) + 4e- 1 mark

 Cathode: \_MnO2(s) + 4H+(aq) + 4e- 🡪 Mn2+(aq) + 2H2O(l) 1 mark

 **ii.** Zinc ions are forming at the zinc electrode. Less positive K+ ions are therefore required so they flow

 through the membrane to keep the charge balanced. 1 mark

**c. i.** Zn(OH)42-(s) **+** Mn2+(aq) + 2H2O(l) 🡪Zn(s) + 4OH-(aq) **+** MnO2(s) + 4H+(aq) 1 mark

  **ii**. The voltage used must be greater than 1.55 V to ensure the reaction is reversed. 1 mark

 **iii**. Mn2+ 🡪 Mn4+ 1 mark

**d**. The MnO2 half-cell utilises H+ ions while the zinc half-cell uses an alkaline environment. The cell would

 not function if the H+ and OH- ions could flow together and neutralise each other. 1 mark

**Question 2** (9 marks)

**a. i**. CO2 emissions from the combustion of fuels are causing climate change. Any system that cleans up

 some of this CO2 is of interest. 1 mark

 **ii**. C8H18(l) + 12.5O2(g) 🡪 8CO2(g) + 9H2O(l) 1 mark

 **iii**. C(s) + O(g) 🡪 CO2(g) 1 mark

**b**. **i**. CO2(g) + 4H+(aq) + 4e- 🡪 CO(g) + H2(g) + H2O(l) 1 mark

 **ii**. cathode 1 mark

 **iii**. 2HO(l) 🡪 O(g) + 4H(aq) + 4e- 1 mark

**c**. An electrolytic cell requires electrical energy to run. The solar array could produce this energy without

 contributing more CO2 1 mark

**d. i**. Hydrogen could be used in a fuel cell in a vehicle for electrical energy. 1 mark

 **ii**. 2H2(g) + O2(g) 🡪 2H2O(l) *∆H* = -282 kJ mol-1 1 mark

**Question 3** (9 marks)

**a**. mass = 1000000/29600 = 33.8 g 1 mark

**b**. n(ethane) = 500/30 = 16.7 mol \*

 n(CO2) = 2n(ethane) = 2 x 16.7 = 33.4 mol \*

 mass(CO2) = 33.4 x 44 = 1.47 kg \* 3 marks

**c**. n(butane) = 50/58 = 0.862 mol

 n(O2) = 6.5 x 0.862 (C4H10 + 6.5O2 🡪) = 5.60 mol \*

 V = nRT/P = 5.6 x 8.31 x 673/220 = 142 L \*\* 3 marks

**d**. mass octane = 90 g. Energy from octane = 90 × 47.9 = 4310 kJ \*

 mass ethanol = 10 g. Energy from ethanol = 10 × 29.6 = 296 kJ Total 4610 kJ \* 2 marks

**Question 4** (10 marks)

**a**. 2HCl(aq) + CaCO3(s) 🡪 CaCl2(aq) + H2O(l) + CO2(g) 1 mark

**b**. i. As the reaction proceeds the volume of CO produced increases\*. The student is plotting a graph of

 volume released against time.\* 2 marks

 **ii**. The rate of reaction slows with time as the concentration of the reactants is dropping leading to less

 collisions. 1 mark

**c**. It is possible that it is caused by a lower concentration leading to less collisions and a slower rate\*. This

 would assume that the HCl was the excess reactant in both cases\*. If it was not, the total volume of

 CO2 evolved would be less in experiment 2. 3 marks

**d**. It is hard to average or even measure the surface area of marble chips – they vary in size and shape.

 1 mark

**e**. The pH will rise\*. The experiment is using up acid so the pH will rise. It should not go over 7 however.\*

 2 marks

**Question 5** (6 marks)

**a. i**. It will lower the value of the activation energy. 1 mark

 **ii**. No effect 1 mark

 **iii**. A catalyst usually provides a surface that one or both reactants adsorb on, allowing the reactant

 bonds to be weakened. Thus an alternative pathway for the reaction is formed. 1 mark

**b**.  **i**. what is the value of *∆H*? -890 kJ mol-1 1 mark

 **ii**. The cell will produce the same amount of energy\*, but it might produce it more slowly\*. 2 marks

**Question 6** (10 marks)



concentration

**a.**  **i**. O2 is the higher added graph above 2 marks

 **ii**. *K*c = $\frac{[SO\_{3}]^{2}}{[O]\_{2}[SO\_{2}]^{2}}$ \* = (0.75)2/(1.625)(1.25)2 \* = 0.221M -1 \* 3 marks

**b.**  **i**. T up favours the back reaction 3 marks

 **ii**. The rate of the back reaction is higher\*. An increase in temperature will increase the energy of all

 particles and lead to an increased rate in both the forward and back reaction. \* 2 marks

**Question 7** (6 marks)

 **a**. Anode: 2H2O(l) 🡪 O2(g) + 4H+(aq) + 4e- 2 marks

 Cathode: 2H2O(l) + 2e 🡪 H2(g) + 2OH-(aq)

**b**. Q=It = 4.2 x 3 x 60 x 60 = 45360 C \*

 n(e) = 45360/96500 = 0.47 mol \*

 n(H2) = 0.47/2 = 0.235 n(O2) = 0.47/4 = 0.118 mol \*

 total n(gas) = 0.353 mol

 V=nRT/P = 0.353 x 8.31 x 298/130 = 6.72 L \*

 4 marks

Mark section A: /30

Mark section B: /58

Total: /78