**Unit 3&4 Chemistry Trial Exam Solutions**

**Section A**

1. D. South Australia does not use coal. Its % renewable energy is higher than that of Victoria.

2. D. The amount of energy from butane is 50 × 49.7 = 2485 kJ. The mass of ethanol required is

 2485/29.6 = 83.9 g

3. B. Mass of methane =  =1.07 × 1017 g = 1.07 × 1014 kg

4. D. Biodiesel molecules typically have higher viscosity and melting points than petrodiesel. The

 presence of two oxygen atoms in each biodiesel molecule will add a little solubility in water.

5. B. *n*(CO2) =  = 6 mol. By trial and error, if ethane is the fuel the *n*(ethane) will be half

 *n*(CO2) = 3 mol. 3 mol of ethane = 90 g so ethane works.

6. D. Silver ions are being reduced to silver metal in this cell. This is reduction and reduction occurs

 at the cathode. The cathode will be positive.

7. B. Electrons flow from the anode to the cathode in all cells.

8. A. The half equations in acidic conditions are different from alkaline conditions but the overall

 equation is the same.

9. C. The molecular formula of ethanol is C2H6O and of ethanoic acid is C2H4O2.

10. C. The standard definition of a catalyst is that it lowers the activation energy required by offering

 an alternative pathway for a reaction.

11. B. Increasing oxygen concentration pushes the first reaction in the forward direction while the

 mask serves as a barrier to lower CO concentration favouring the reverse equation of reaction 2.

12. B. The amount of N2O4 drops by 0.2 mol, therefore the amount of NO2 increases by 0.4 mol. (1:2

 ratio)

13. D. The concentration was halved – this was caused by the volume being doubled. This change will

 favour the forward reaction (1:2 particle ratio) so the concentration of N2O4 drops further.

14. D. The strongest oxidant is copper ions and the strongest reductant is copper metal. Copper metal

 reacts at the anode and copper ions react at the cathode.

15. A. Since copper ions enter the solution at the anode and leave at the cathode the net concentration

 of copper ions is unchanged.

16. B. Numbering needs to start from the right-hand end and the longest chain has 7 carbons – hence

 it is a heptane derivative.

17. A. Butan-2-ol could be formed from a hydroxyl group bonding to either but-1-ene or but-2-ene.

18. C. Alkanes have much lower boiling points than functional group equivalents. Alcohols have

 higher boiling points than aldehyde or ketone equivalents.

19. C. With a polar stationary phase, a polar molecule will be slow emerging. Butan-1-ol is highly

 polar.

20. A. Ethanoic acid is a weak acid and ethanamine a weak base. One of the reasons for not titrating

 weak acids and bases is the difficulty of judging an endpoint.

21. D. Molecule will be propanoic acid. Propanoic should have 3 sets of peaks and the acid group is

 responsible for the large shift value. The splitting pattern also matches.

22. D. *n*(NaOH) = 0.02 × 0.12 = 0.0024 mol = n(diluted ethanoic) c= 0.0024/0.0148 =0.162 M.

 Undiluted = 0.162 × 250/10 = 4.05 M

23. B. Molecule is propan-1-ol. The molar mass is 60 matching the spectrum, the peak at 31 suggests

 a primary alcohol and a peak at 29 could be an alkyl group.

24. D. CH3CH2NH2(aq) + HCl(aq) 🡪 CH3CH2NH3Cl(aq) (HCl acts as an acid)

25. D. The Data book can be used to identify the amino acids as valine, glycine and alanine.

26. C. As the temperature approaches 400C the enzyme functions very well and the reaction rate

 increases. A fast reaction means a low time for a colour change.

27. A. The formula of glucose is C6H12O6. When glucose molecules join, water is formed, leaving

 C6H12O6.

28. D. Folic acid has several -OH groups. This will lead to its solubility in water. Vitamin A is fat

 soluble.

29. C. Q = 4.18 x 60 x 80 = 20060 J = 20.1 kJ; energy per gram = 350/30 = 11.6 kJ g-1. M = 20.1/11.6

30. C. The duration is an independent variable. The mass obtained will depend upon the time the cell

 runs for.

 **Section B Short answer**

**Question 1** (11 marks)

**a. i**. C6H12O6(aq) 🡪 2C2H6O(aq) + 2CO2(g) (1 mark)

 **ii**. Bioethanol is renewable whereas petrol is not. Although bioethanol produces CO2

 when used, the production of the bioethanol source absorbs CO2. The net production of

 CO2 is less for bioethanol than petrol. (2 marks)

**b**. **i**. Cellulose is a natural polymer, made from many glucose monomers. To obtain glucose

 from cellulose, the glycosidic bonds between glucose monomers needs to broken.

 Enzymes such as cellulase increase the rate of hydrolysis reactions. (2 marks)

 **ii**. Cellulose could be obtained from forest waste or wheat husks – sources that are

 generally considered waste. When food crops like sugar or corn are used to produce fuel,

 the amount of food present to the world is lowered. (1 mark)

**c**. **i**. C2H6O(l) + 3O2(g) 🡪 2CO2(g) + 3H2O(l) (1 mark)

 **ii**. *n*(ethanol) =  = 21700 mol

 *n*(CO2) =2 *n*(ethanol) = 43500 mol

 *V* =  = 2.27 × 106 L (3 marks)

 **iii**. *E* = 29.6 × 1000000 = 2.96 × 107 kJ (1 mark)

**Question** **2** (11 marks)

**a. i**. 2Li + O2 🡪 Li2O2 (1 mark)

 **ii**. -1 (1 mark)

**b**. Li2O2 🡪 2Li+ + 2e- + O2 (1 mark)

**c**. The cell does not run in an aqueous environment, it uses a conducting polymer

 electrolyte. This is an expensive material, as are the high tech electrode. (2 marks)

**d**. *n*(Li) =  = 0.841 mol

 *n*(e) = *n*(Li) = 0.841 mol

 *Q* = *n*(e) × 96500 = 0.841 × 96500 = 81100 C

 *E* = *VQ* = 3.5 × 81100 = 284000 J (3 marks)

**e**. cathode: Li+(l) + e- 🡪 Li(l) (3 marks)

 anode: 2Cl-(l) 🡪 Cl2(g) + 2e-

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

**Question** **3** (9 marks)

**a. i**. N2(g) + 3H2(g) ⇌ 2NH3(g) (1 mark)

 **ii**. From the graph, [H2] = 2 M, [N2] = 0.66, [NH3] = 0.66 M

 *K* =  = 0.083 M-2  (3 marks)

 **iii**. *K* for this reaction =  = 12 M2 (1 mark)

**b. i**. Some NH3 has been removed from the system. The system partially opposes this

 change and moves in the forward direction to replace some of the NH3. The concentrations

 of N2 and H2 will drop. (2 marks)

 **ii**. *K* will be the same as the temperature has not changed. It is only temperature that

 changes *K*. (2 marks)

**Question 4** (8 marks)

**a. i**. propane and chlorine or propene and HCl. (2 marks)

 **ii**. C3H8(g) + Cl2(g) 🡪 C3H7Cl(g) + HCl(g) (1 mark)

 or C3H6(g) + HCl(g) 🡪 C3H7Cl(g)

**b**. (1 mark)

**c**. **i**. (1 mark)



 **ii**. ethanoic acid (1 mark)

**d**.

 **i**.

 (1 mark)

 **ii**. Cr2O72- (aq) + 14H+(aq) + 6e- 🡪 2Cr3+(aq) + 7H2O(l) (1 mark)

**Question** **5** (10 marks)

**a**. Sucrose is a disaccharide formed from the reaction between glucose and fructose. The

 purple structure shown is the enzyme invertase (sucrase). Sucrose fits nicely onto the

 enzyme, weakening the glycosidic linkage between glucose and fructose. The diagram is

 illustrating the way the shape of an enzyme facilitates a particular reaction. The

 glycosidic linkage breaks, forming fructose and glucose. (3 marks)

**b. i**. glycosidic (or ether) (1 mark)

 **ii**. glucose and fructose (1 mark)

 **iii**. Yes. Once one disaccharide is hydrolysed, the site becomes vacant for the process to

 be repeated. (1 mark)

**c**. A pH of 1 is a very acidic environment. It is likely that the enzyme will be denatured,

 losing its shape. It will not be effective once denatured. (2 marks)

**d**. The Glycaemic Index refers to the influence of a food on the glucose concentration in the

 blood. The higher the value, the faster glucose is being released into the blood during

 digestion. Sucrose has to only undergo one simple reaction to produce glucose, therefore

 it is considered high GI (2 marks)

**Question 6** (9 marks)

**a**. (4 marks)

C14H28O2

C12H24O2

C16H32O2

C3H8O3

**b**. CnH2n+1COOH or CnH2nO2  (1 mark)

**c**. Triglycerides and fatty acids contain long hydrocarbon chains. These chains are non-polar

 and the molecule as a whole is non-polar. It will not mix readily with the aqueous

 contents of the stomach so digestion usually starts in the small intestine. (2 marks)

**d**. Bile acts as an emulsifier. It contains molecules that contain both polar and non-polar

 segments. The emulsifiers break the large blobs of fats into much smaller drops. The

 lipase enzymes can contact the triglycerides better due to the increased surface area.

 (2 marks)

**Question 7** (8 marks)

**a**. (3 marks)





propanoic acid methyl ethanoate ethyl methanoate

 molecule 1 molecule 2 molecule 3

**b**. Molecule will not be propanoic acid as there is no broad absorption around 3000 cm-1.

 Nor will the molecule be an alcohol – it could be one of the esters. (2 marks)

**c**. The molecule could be methyl ethanoate but not ethyl methanoate (ethyl methanoate

 would have 3 hydrogen environments and some splitting). Methyl ethanoate however

 has only two hydrogen environments and no splitting as each environment has no

 neighbouring hydrogen atoms. (3 marks)

**Question 8** (9 marks)

**a**. **i**. C2H2O4(aq) 🡪 2CO2(g) + 2H+(aq) + 2e- (1 mark)

 **ii**. MnO4-(aq) + 8H+(aq) + 5e- 🡪  Mn2+ + 4H2O(l) (1 mark)

 **iii**. 5C2H2O4(aq) + 2MnO4-(aq) + 6H+(aq) 🡪 10CO2 + 8H2O(l) (1 mark)

 **iv.** *n*(MnO4-) = *c* × *V* = 0.120 × 0.025 = 0.003 mol

 *n*(oxalic acid) = 0.003 × 5/2 = 0.0075 mol

 c =  = 0.507 M (2 marks)

**b**. **i**. C2H2O4(aq) + 2NaOH(aq) 🡪 Na2C2O4(aq) + 2H2O(l) (1 mark)

 **ii**. *n*(NaOH) = *c* × *V* = 0.50 × 0.020 = 0.010 mol

 *n*(oxalic acid) = 0.01 × ½ = 0.005 mol

 *c* =  = 0.368 M (3 marks)

**Question 9** (7 marks)

**a**. **i**. The heating apparatus is used to calibrate the calorimeter. Electrical energy is used to

 heat the calorimeter during calibration. (1 mark)

 **ii**. For complete combustion of the food sample excess oxygen must be provided. Adding

 the oxygen under pressure ensures the oxygen is in excess. (1 mark)

**b**. Burning food items under a solution calorimeter often provides poor results as a

 significant percentage of the thermal energy is lost to the surroundings. Burning the food

 in a bomb calorimeter limits heat losses. (1 mark)

**c**. **i**. *CF* =  =553 J 0C-1 (2 marks)

 **ii**. *E* = *CF* ×*ΔT* = 553 × 5.8 = 3210 J = 3.12 kJ

 Δ*H* = 3.12/0.873 = 3.68 kJ g-1  (2 marks)

**Question 10** (9 marks)

**a**. **i**. mass of magnesium (1 mark)

 **ii**. time (or temperature) (1 mark)

 **iii**. volume HCl, concentration (1 mark)

**b**. (1 mark)



**c. i**. The time drops (1 mark)

 **ii**. No, the rate of the reaction is increasing. Rate and the time taken to produce 80 mL are

 not the same thing, they are virtually the reciprocal of each other. A low time means a fast

 rate (1 mark)

**d**. The temperature readings indicate the reaction must be very exothermic. This introduces

 an unexpected complication – the heat produced in the experiment will be affecting the

 rate. The student had assumed the temperature was controlled. This may be the reason a

 linear relationship was not found. (3 marks)