**Unit 3&4 Chemistry 2020 Trial Exam Solutions**  Total 120 marks

**Section A**

1. D. The main energy generation is from the combustion of coal which is mainly carbon.

2. B. The burning of coal does form some gases like SO2 and NO2 but it produces far greater amounts of CO2.

3. D. This is a molecule of biodiesel as it is a fatty acid bonded to methanol. The bond formed is an ester.

4. C. 7.75 × 107 tonnes = 7.75 × 1013 g. Energy per g methane = 55.6 kJ => 7.75 × 1013 ×55.6 = 4.31 × 1015

5. C. n(methane) = 7.75 × 1013/16 = 4.84 × 1012 = n(CO2). V = n × 24.8 = 1.2 × 1014

6. D. Increasing the temperature causes both more collisions and a higher proportion of successful collisions.

7. A. The activation energy refers to the maximum amount of energy needed to initiate a reaction and the enthalpy

 change is the final enthalpy – the initial enthalpy.

8. C. Lithium is oxidised to Li+ and Mn4+ is reduced to Mn3+.

9. B. Adding both half-equations provides the overall equation Li(s) + MnO2(s) 🡪 LiMnO2(s).

10. A. The electrochemical series shows silver is the weakest reductant.

11. A. Reduction occurs at the cathode, ruling out options C and D. Option B is not a correctly balanced half-

 equation.

12. B. Aluminium metal forms from Al3+ ions. This is reduction and will be at the cathode.

13. C. Q= It = 10 × 10000 = 1 × 105. n(e) = 100000/96500 = 1.04 n(CO) = ¼ n(e) = 0.259 mol

 V = n × 24.8 = 6.42 L

14. D. Concentrated KCl will be the same outcome as a brine cell, where water reacts at the cathode to produce

 hydrogen gas and chlorine reacts at the anode instead of the expected oxygen gas.

15. B. The equation has been reversed and halved. The new K = 1/√K = 1/√225 = 0.067

16. C. An increase in temperature for an exothermic reaction will favour the back reaction, increasing the brown

 intensity.

17. A. Hydroxyl groups have precedence over halo groups so naming starts from the right hand end.

18. D. The molecule shown is an ester which will be formed from the reaction of an alcohol and a carboxylic acid.

19. D. The two monosaccharides emerged first from the column so they have the lower retention times.

20. A. This molecule has a number of carbon atoms that are equivalent and a number of hydrogen atoms that are

 equivalent. There are only two different hydrogen environments and two different carbon environments.

21. C. n(NaOH) = 0.02 × 3 = 0.06 n(Ox) = 0.03 C=n/V = 0.03/0.015 = 2 M

22. C. The molecule has a carbonyl absorption around 1700 cm-1 but no alcohol absorption.



23. D. Methyl ethanoate will have two singlets only, matching this spectrum.

24. C. The first (same as third) fatty acid is monounsaturated, the second is a polyunsaturated fatty acid.

25. B. The amine group on lysine’s R group can accept a proton, acting as a base and forming an ion.

26. A. The first amino acid is threonine and the second serine.

27. A. Bile emulsifies large fat blobs to smaller ones that lipase can attack and hydrolyse. After transport around the

 body, new triglycerides can be formed.

28. B. Look carefully at the structure of isoleucine in your Data book to confirm this formula.

29. B. q= 4.18 × 60 × 8 = 2006 J energy g-1 = 2006/0.64 = 3140 J = 3.14 kJ g-1

30. C. The aliquot of base has a lower number of mole than expected so the titre will be lower than it should be. This

 leads to a high concentration for the acid.

 **Section B Short answer**

**Question 1** (13 marks)



**a. i**. 1 mark ester bond correct, 1 mark complete structure

 **ii**. molecule length – the longer the molecule the stronger the dispersion forces 1 mark each reason

 degree of saturation – the melting point drops as the number of carbon-to-carbon double bonds increases.

  **iii**. transesterification – there is an ester bond in the triglyceride. Methanol replaces glycerol but an ester bond is

 retained in the structure. 1 mark

**b**. Glycerol is polar due to -OH bonds – it will dissolve in water. Biodiesel is non-polar (1 mark). The glycerol will

 not mix with the biodiesel – they will form two layers. The bottom layer can be tapped off the mixture. (1 mark)

**c. i**. C7H14O2 1 mark

  **ii**. C7H14O2(l) + 9.5O2(g) 🡪 7CO2(g) + 7H2O(l) 1 mark for correct products and states, 1 mark balancing

|  |  |
| --- | --- |
| **Property**  | **Which is higher? Biodiesel or petrodiesel.** |
| Viscosity | Biodiesel |
| Energy density | Petrodiesel |
| Melting point | Biodiesel  |

**d**. 3 marks

**Question 2** (11 marks)

**a** Anode: 4OH-(l) 🡪 O2(g) + 2H2O(g) + 4e-

 Cathode: K+(l) + e- 🡪 K(l)

 Overall equation: 4K+(l) + 4OH-(l) 🡪 O2(g) + 2H2O(g) + 4K(l) 1 mark each (H2O(l) ok)

 **b**. Potassium is a very reactive metal. Producing potassium, oxygen and water at high temperatures could lead to a

 dangerous explosion. (1 mark)

 2K(l) + 2H2O(l) 🡪 2KOH(aq) + H2(g) (1 mark - or K + O2)

**c**. Q = It = 0.23 × 20 × 60 = 276 C 1 mark

 n(e) = 276/96500 = 0.00286 mol = n(K) 1 mark

 mass = 0.00286 × 39.1 = 0.11 g 1 mark

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

 Cathode: 2H2O(l) + 2e- 🡪 H3(g) + 2OH-(aq)

 Overall: 2H2O(l) 🡪 2H2(g) + O2(g) 3 marks

**Question 3** (9 marks)

**a**. The molecule contains an -OH (alcohol at 3300 cm-1) and no C=O bond (no peak 1700 cm-1)

 2 marks



**b**. 2 marks

**c**. The molecule is 2-methylpropan-1-ol or named simply as methylpropane-1-ol. (1 mark)

 It is not butano-1-ol or butan-2-ol as they would have 4 carbon environments. (1 mark)

 The two circled carbon environments are equal, making

 a total of 3 environments. The shifts match the Data book.

 (1 mark)

**d. i**. 1 mark

 **ii**. Cr2O72-(aq)/H+(aq) or other oxidant

**Question 4** (8 marks)

**a**. ethanol -ve, oxygen +ve. 1 mark

**b. i**. Oxygen half-equation: O2(g) + 2H2O(l) + 4e- 🡪 4OH-(aq) 1 mark

 Overall equation: C2H5OH(aq) + 4OH-(aq) + 3O2(g) 🡪 2CO32-(aq) + 5H2O(l) 1 mark

 **ii**. 0.4 - - 0.74 = 1.14 V 1 mark

 **iii**. 1 mol of ethanol = 12 mol electrons.

 Q = 12 × 96500 = 1.16 × 106 C 1 mark

 Energy = VQ = 1.14 × 1.16 × 106 = 1.32 × 106 J 1 mark

**c**. Fuel cell is not releasing CO2 and its efficiency will be higher than that of a combustion reaction.

 2 marks

 **Question 5** (9 marks)

**a**. **i**. butan-1-ol dimethylethanol (1,1 not needed) 2 marks

 **ii**. butan-1-ol can be oxidized by dichromate ions in acid conditions. Dimethylethanol will not react as

 it is a tertiary alcohol. 2 marks

 **iii**. Either NMR - the carbon or hydrogen environments differ 1 mark

**b**. Bromine test (1 mark). Cyclohexene will decolourise bromine but cyclohexane is saturated and will not.

 1 mark

**c**. An indicator and base could be added. (1 mark) Ethanoic acid will neutralise base but ethanal is not very

 acidic. (1 mark) Alternatively, dichromate ions will oxidize ethanal but not ethanoic acid.

**Question 6** (8 marks)

**a**. **i**. the value of the equilibrium constant will be unchanged as temperature has not changed 1 mark

 **ii**. the concentration of HI gas will increase (1 mark) as the same amount of material is in a smaller

 volume 1 mark

 **iii**. the amount of HI gas will not change (1 mark) as neither the forward or back reaction is favoured.

 1 mark

 **iv**. the rate of the forward reaction will be greater (1 mark) as more collisions will occur in the

 smaller volume 1 mark

**b**. H2(g) + I2(g) ⇌ 2Hl(g)

 0 0 0.6 start

 0.15 0.15 0.3 equilibrium 1 mark

 *K* =  = 4 2 marks

**Question 7** (8 marks)

**a**. q= 4.18 × 80 × 26 = 8700 kJ 1 mark

 energy per gram = 8700/0.42 = 21 kJ g-1 ( 1 mark for answer, 1 mark for units)

 3 marks

**b**. **i**. 70% × 37 + 30% × 16 = 30.7 kJ g-1 1 mark

 **ii**. Burning an item under a test-tube will lead to significant heat losses – the transfer of heat of

 combustion to water is not very efficient. Getting the nut to burn completely can also be an issue.

 2 marks

**c**. C6H12O6(s) + 6O2(g) 🡪 6CO2(g) + 6H2O(l) 2 marks

**Question 8** (8 marks)

**a**. **i**. cellulose: we do not produce cellulase or large microbial sacs. 1 mark

 **ii**. lactose: some humans do not produce lactase. 1 mark

**b**. 3 marks

|  |  |  |
| --- | --- | --- |
|  | Building block(s) | Enzyme aiding metabolism |
| Carbohydrate | Monosaccharides like glucose | Amylase or maltase |
| Protein  | 2-amino acids | Pepsin or trypsin |
| Triglyceride  | Fatty acid and glycerol | Lipase  |

**c.** The curdling of milk is an example of denaturation. Denaturation is when the 3-D structure of a protein

 is disrupted, often by acid or heat. When a protein is hydrolysed it breaks up to the individual amino

 acids. The peptide linkages are broken and the primary structure of the protein is lost. The protein test

 utilizes hydrolysis. 3 marks

**Question 9** (8 marks)

**a**.  **i**. independent variable: temperature of vinegar solution 1 mark

 **ii**. dependent variable: time for egg to cook 1 mark

 **iii**. a controlled variable. Volume or conc of solution 1 mark

**b**. This experiment uses eggs – you can’t assume all eggs are the same. The size and age will vary. 1 mark

**c**. Heat is causing the protein to denature. During denaturing the most of the tertiary and secondary

 structure of the protein is disrupted and the protein shape changes. (1 mark) The primary structure of

 the protein is unchanged, so it still the same protein. (1 mark)

**d**. The student’s experiment is flawed. She is considering the action of enzymes in an experiment where

 the protein is not acting as an enzyme. The protein is simply denaturing and the rate it denatures will

 increase with temperature. The process of boiling an egg is not related to enzyme functioning.

 2 marks

**Question 10** (8 marks)

**a**. This is a polyunsaturated fatty acid

 as it has 3 carbon-to-carbon double

 bonds in its chain. Each double bond introduces a

 kink in the structure, lowering the melting point as the molecules will not pack together as tightly.

 3 marks

**b**. Proteins are polymers of amino acids. There are about 20 different amino acids, some of which are

 not made in the human body. Hemp seeds contain every amino acid. If humans consume the seeds their

 bodies should be able to synthesise any protein needed.

 3 marks

**c**. Fibre is often cellulose. Humans cannot digest fibre very well as we do not have the enzyme cellulase or

 a large microbial mechanism. We need to consume fibre to keep food waste moving through our

 system. 2 marks