**2022 Unit 3\_4 Chemistry trial exam solns**

**Section A: Multiple Choice section**

**Question 1**

B: Mass methane = 1000/55.6 = 17.8 g. Given only 52% efficient, mass = 17.8 ×100/52 = 34.6 g

**Question 2**

C: n(methane) = 34.6/16 = 2.16 = n(CO). V = nRT/P = 2.16 ×8.31×473/100 = 85 g

**Question 3**

A: Data book shows the energy per gram drops as the molecule gets longer but the mass of a mole increases so the molar heat of combustion rises.

**Question 4**

D: Plants produce more unsaturated fats than animals. The unsaturated fats are likely to have lower melting points due to kinks in the chain.

**Question 5**

C: The question asks for the reverse reaction, therefore the activation energy is the full vertical range.

**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**

A: The addition of an inert gas does not change the volume, nor does it change the amount of each species. Therefore the system does not have any change to try and oppose.

**Question 9**

B: A catalyst lowers the activation energy, so a higher proportion of particles have sufficient energy to react.

**Question 10**

C: The gold half-cell offers the biggest difference in potential of the options provided.

**Question 11**

D: Fe3+  will form Fe2+ in the right hand cell and Fe will form Fe2+  in the left cell.

**Question 12**

D. The overall reaction in both is methane + oxygen 🡪 carbon dioxide and water

**Question 13**

B: The difference in potential between the two metals is low. The voltage produced would be too small to be helpful.

**Question 14**

The half-equation occurring at the anode of an acidic methane fuel cell is

A. CH4(g) + 2H2O(g) 🡪 CO2(g) + 8H+(aq) + 8e all species balance correctly.

**Question 15**

C: The strongest oxidant is H+ and the strongest reductant H2O. H+ will form hydrogen and water will form oxygen.

**Question 16**

D. The first two options will not form any aluminium due to the aqueous solutions.

**Question 17**

B: The molecule shown is the ester ethyl propanoate.

**Question 18**

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

**Question 19**

C: The *trans* isomer is drawn here

**Question 20**

D: This produced propanoic acid. As an acid it can react with a carbonate ion to form CO2.

**Question 21**

A: This molecule has 4 H environments – none of the other molecules do

**Question 22**

D: n(NaOH) = 0.12 x 0.0146 = 0.00175 mol = n(benzoic acid). c(benzoic) = n/V = 0.00175/0.02 = 0.0876. concentration of the original solution is 5 times greater = 0.438 M

**Question 23**

n(benzoic acid in 20 mL = 0.00175 mol. n(benzoic in 100 mL) = 5 x 0.00175 = 0.00876. Mass = 0.0086 x 122 = 1.07 g

**Question 24**

C: The molecules contains fatty acids and monounsaturated fats but it is not a fatty acid, and as a whole it is not monounsaturated.

**Question 25**

B. Cellulose is the least soluble and amylose is less soluble than amylopectin. Glycogen has more crosslinks than amylopectin.

**Question 26**

D: The molecule is aspartic acid but it contains an extra proton, hence it is in acidic conditions.

**Question 27**

C: The energy content of both sweeteners is similar but aspartame is about 150 times sweeter.

**Question 28**

D: Given all the electronegative oxygen atoms this should be soluble. Fat-soluble vitamin D is the only vitamin synthesised in humans.

**Question 29**

B: energy = 4.18 x 6 x 12 = 401 J. Per gram = 401/0.46 = 872 J = 0.87 kJ g-

**Question 30**

B: The energy calculations rely on values of ∆T and not temperature itself. Since all values are out by the same amount, ∆T is still accurate.

**Section B: Short answer questions**

**Question 1** (9 marks)

**a. i**. Fossil fuel: formed over millions of years in the Earth’s crust from the remains of living things. 1 mark

  **ii**. Very low reserves – virtually exhausted. 1 mark

**b**. Petrol and petrodiesel are separated due to their different boiling points\*. Petrol is a smaller hydrocarbon, so the dispersion forces are lower and the boiling point lower. It will rise further in the column than petrodiesel before it condenses. \* 2 marks

**c**. **i**. the lower flashpoint: petrol has the lower flashpoint. 1 mark

  **ii**. the greater viscosity: petrodiesel, being a longer molecule, will have a higher viscosity. 1 mark

 **iii**. explain the viscosity difference between petrol and diesel. 2 marks

**d**. S(s) + O2(g) 🡪 SO2(g) 1 mark

**Question 2** (9 marks)

**a**. Anode: : Fe(s) + 2OH-(aq) 🡪 Fe(OH)2(s) + 2e Ox. number change 0 to +2

 Cathode: 2NiOOH(aq) + 2H2O(l) + 2e 🡪 2Ni(OH)2(aq) + 2OH-(aq) Ox. number change +3 to +2

**b**. x - -0.44 = 1.40 => NiOOH potential is 0.96 V 1 mark

**c**. The iron electrode is negative, nickel positive. 1 mark

**d**. The battery is connected to a power supply and a voltage over 1.4 volts is applied\*. The positive terminal of the battery is attached to the positive terminal of the charger. 2 marks

**e**. This cell is self-contained – it does not have a continuous supply of reactants. 1 mark

**Question 3** (8 marks)

**a**. This will not work\*. The reaction is reversible so all the reactant will not be used up.\* 2 marks

**b.** **i**. N2 change: 0.04 mol NH3 change: 0.08 mol 2 marks

 **ii**. Increased. The change favoured the reverse reaction so the temperature of the exothermic reaction must have increased. 1 mark

 **iii**. The increased temperature will increase the rate of the forward reaction. 1 mark

**c**. The volume of an equilibrium mixture of the above gases is halved.

 **i**. No, the concentrations will all be halved but this will cause a different size change to each species. It would only be the same if all reactants and products had equal concentrations. 1 mark

 **ii**. The volume drop will favour the forward reaction. When the system establishes equilibrium again, will the

 concentration of nitrogen gas be higher or lower than it was before the volume change? 1 mark

**Question 4** (9 marks)

**a** **i**. C4H8(g) + HCl(g) 🡪 C4H9Cl(g) states not required. 1 mark

 **ii**. 2 marks

 1-chlorobutane 2-dichlorobutane



**b**.

 2-methylpropan-2-ol 2 marks

**c**. different degrees of substitution

 3 marks

**d**. Many possible answers – look for a chiral carbon 1 mark

**Question 5** (6 marks)

**a**. Lactose is a disaccharide. It is a sugar in milk that is a source of energy\*. Lactase is an enzyme that helps the body process lactose.\* As an enzyme, it is a protein with a very particular 3-D structure that works for lactose.\* 3 marks

**b**. Denaturing means the enzyme has lost its tertiary and secondary structures\*. Its shape changes and it no longer functions as an enzyme\* Hydrolysis is more drastic as the primary structure of the protein has been broken and it returns to the amino acids it was formed from.\* 3 marks

**Question 6** (11 marks)

 **a**. **i**. C4H10O2 as the parent ion has m/z of 90 1 mark

  **ii**. [CH2OH]+ 1 mark

**b**. Absorption at 3330 suggests -OH(alcohol) 2 marks

 No absorption at 1750 makes C=O unlikely

**c**.  2 marks

**d**. 

Molecule will be \*. The lack of peaks on both NMRs suggests a significant amount of symmetry in the molecule. The molecule drawn has that symmetry – other isomers of it will have a lot more peaks.\*

This molecule has only 2 different carbon environments\* and it has 3 different hydrogen environments\*. 4 marks

**Question 7** (10 marks)

**a**. **i**. The electrolyte is molten lithium chloride,\* prepared by heating lithium chloride crystals\* 2 marks

 **ii**. Anode: oxygen gas Cathode: hydrogen gas 2 marks

**b**. Anode: 2Cl-(l) 🡪 Cl2(g) + 2e Cathode: Li+(l) + e 🡪 Li(l) 2 marks

**c**. Fe(s) 🡪 Fe2+(l) + 2e 1 mark

**d**. Q = It = 3 × 20 × 60 = 3600 C. n(e) = 3600/96500 = 0.037 mol \*

 n(Cl) = ½ n(e) = 0.0187 mol \*

 V = nRT/P = 0.0187 × 8.31 × 693/150 = 0.716 L\* 3 marks

**Question 8** (10 marks)

**a**.  **i**. peptide link 1 mark

 **ii**. hydrolysis 1 mark

 **iii**. The amino acids can be reassembled to make a new protein\* or they can be converted to glucose to produce energy.\* 2 marks

**b**. **i**. starch (or glycogen) 1 mark

 **ii**. glycogen is stored in the liver\* – it is an energy source for animals \* 2 marks

**c. i**. C18H36O2(l) + 26O2(g) 🡪 18CO2(g) + 18H2O(l) 2 marks

 **ii**. Lipase helps break the ester bonds in fats to hydrolyse them to fatty acids and glycerol. 1 mark

**Question 9** (10 marks)

**a**.  **i**. independent variable beaker diameter 1 mark

 **ii**. dependent variable temperature change 1 mark

**b**. The student could use the Data Book and work out what % of 29.6 that 16.4 is. 2 marks

**c**. If the student repeated each trial several times she could compare the results for each particular beaker size.

 1 mark

**d**. One of the steps the student uses in her method is to run the burner for 3.0 minutes for each trial.

 **i**. Ethanol burners do not provide a consistent flame.\* The mass of ethanol burnt each 3 minutes might be quite different, making the results invalid. \*2 marks

 **ii**. Weigh the burner before and after heating. In this way the mass of ethanol is known accurately.

 1 mark

**e**. Initially, the energy transfer seems more efficient as the beaker gets larger but then it starts to drop\*. It looks like there might be an optimum diameter for the beaker. \* 2 marks

**Question 10** (8 marks)

**a**. Perform each experiment in a flask with a single-holed stopper. The gas produced is collected in a gas syringe. Record the time it takes for a set volume of gas to be produced – this would be the indicator of reaction rate.\*

Set up a series of flasks with a fixed volume of H2O2. Sit two in each water-bath that is at increasing temperatures.\*

Add a set amount of MnO2 to one flask and a set amount of catalase to the other. Time how long it takes to get the designated volume of O2.\* Graph the results on a graph of reaction time against temperature.\*

 4 marks

**b**. MnO2 is an inorganic catalyst. The H2O2 is probably adsorbed on its surface where the bonds are weakened.\* Catalase also weakens the H2O2 bonds but it does this by providing a site that is specific to H2O2.\* Catalase is an enzyme. The H2O2 attaches to that site until the reaction is finished and the products detach\*. It is likely that catalase will lose its effectiveness as the temperature increases due to denaturation but MnO2 will not.\* 4 marks

Mark section A: /30

Mark section B: /90

Total: /120