CHEMISTRY
Unit 3 – Written examination 1

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2010 Trial Examination

SOLUTIONS

SECTION A – Multiple-choice questions (1 mark each)

Question 1

Answer: C

Explanation:

The titre will still be 16 mL. The water added to the sodium hydroxide does not alter the number of mole of sodium hydroxide, so the volume of sulphuric acid is unchanged.

Question 2

Answer: C

Explanation:

Sulfuric acid is diprotic, hence the number of mole of sodium hydroxide needs to be double that of the sulphuric acid. For this reason option B is incorrect. Answer A is not correct as the equivalence point is about pH 7.

Question 3

Answer: A

Explanation:

$$n(\text{NaOH}) = \frac{m}{M} = \frac{0.000722}{40} = 1.81 \text{ x } 10^{-5}$$

$$\text{c} = \frac{n}{V} = \frac{1.81\times10^{-5}}{0.004} = 0.00451M$$

Question 4

Answer: B

Explanation:

$n(\text{Al}) = \frac{m}{M} = \frac{20}{27} = 0.741 mol$

$n(Al_2O_3) = ½\ n(\text{Al}) = 0.370 mol$

$m(Al_2O_3) = n \times M = 0.37 \times 102 = 37.7 g$

Question 5

Answer: A

Explanation:

A. 5 g = 2.5 mol

B. = 2.2 mol

C. $n = \frac{30}{22.4} = 1.34 mol$

D. $n = \frac{20}{24.3} = 0.82\ mol$

Question 6

Answer: B

Explanation:

Barium sulfate is insoluble. Therefore it does not form a solution, hence A and C are not correct. NaCl mentioned in D is irrelevant. Sodium sulfate could be mixed with barium nitrate to precipitate barium sulfate, making B a possible answer.

Question 7

Answer: D

Explanation:

The fragments must be positively charged, hence D is correct. The masses in D match each peak also.

Question 8

Answer: C

Explanation:

The fragments not passing through the spectrometer must have no charge on them, hence C is correct. CH_3 has a mass of 15. When it is subtracted from 58, the peak at 43 is obtained. CH_3CH_2 has a mass of 29. (58-29) = peak at 29.

Question 9

Answer: B

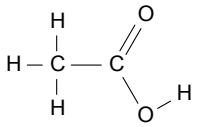
Explanation:

The S^{2-} accepts a proton making it a base. There is no change of oxidation state hence this is not redox.

Question 10

Answer: C

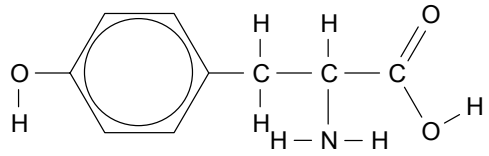
Explanation:



This molecule has 2 different hydrogen environments, hence 2 NMR peaks. There is no splitting of these peaks as there are no neighbouring hydrogen atoms.
The C=O and the O – H both give IR peaks, one at 3000 and the other 1700.
The mass spectrum has a peak at 15 due to CH_3^+ and a peak at 45 due to $COOH^+$

Question 11

Answer: A



hydroxyl amine carboxyl

Question 12

Answer: D

Explanation:

The benzene ring has 6 carbons not shown and 4 hydrogen atoms not shown. Add these on to the atoms visible gives D.

Question 13

Answer: C

Explanation:

Start from the right hand end as it is closest to functional groups. There are 4 carbons in a row, hence butane. Therefore 1-chloro-2-methylbutane

Question 14

Answer: A

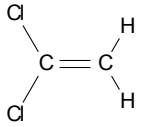
Explanation:

Carboxylic acids are formed most commonly from alkanol molecules. The NaOH can replace the NH_2 group with an –OH. The $Cr_2O_7^{2-}/H^+(aq)$ converts the alkanol to a carboxylic acid.

Question 15

Answer: B

Explanation:

The monomer is usually an alkene. In this case 

The orientation of this molecule can be adjusted to match the polymer shown.
The name of this molecule is 1,1-dichloroethene.

Question 16

Answer: D

Explanation:

Decane has a vastly different boiling point to pentane. There is no reason why one homologous series might vaporise before another. About all that can be stated is that the molecules will vaporise in order of boiling points, hence D.

Question 17

Answer: D

Explanation:

Maltose is a dissacharide like sucrose. Sucrose is shown in the data book. Counting the hydroxyl groups gives 8 and there are 3 ether groups counting the two in the rings themselves.

Question 18

Answer: B

Explanation:

A little bit of lateral thinking is required here – the question states that *amino acids* are separated and not proteins. Therefore the protein must be hydrolysed to amino acids first. C is wrong because it says separate the *proteins*. The protein is not fragmented to segments, rather it is hydrolysed to each individual amino acid. Hence A, C and D are incorrect. Amino acids form clear solutions; the ninhydrin makes them visible under UV light.

Question 19

Answer: C

Explanation:

Possible answers are LL, PP, LP and PL; hence C is the correct answer.

Question 20

Answer: D

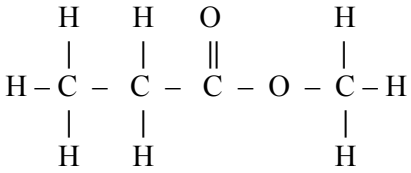
Explanation:

Fermentation does not involve oxygen. Nor does it go to completion – the alcohol eventually kills the yeast. Distillation does not occur until after fermentation.

SECTION B – Short answer questions

*An * indicates the allocation of 1 mark*

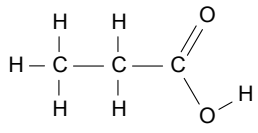
Question 1

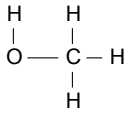


a. methylpropanoate *

1 mark

b. i. & ii. A = propanoic acid* B = methanol*

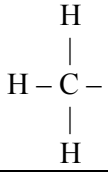
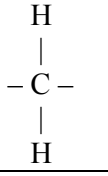
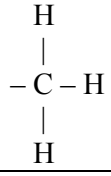




**

2 + 2 = 4 marks

c.

			
Area	3	2	3*
Number of hydrogen atoms on neighbouring atoms	2	3	0*
Number of splits	3	4	0*

1 + 1 + 1 = 3 marks

d. **i**. Pure samples of each ester could be run to determine the retention times*. The mixture could then be run. Ester could be identified if their retention times matched the pure samples.*

ii. A series of standards of known concentrations could be prepared. The area of the peaks could be graphed to obtain a calibration curve.* The sample to be analysed could then be run and the area plotted on the calibration curve.*

Question 2

a. addition reaction*

1 mark

b. Could be done through trial and error. Product could be dichloroethane or dichloropropane.
Working for dichloropropane:

$$n(Cl_2) = \frac{1}{71} = 0.0141 mol$$

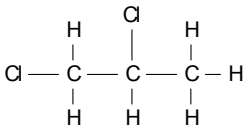
*n(*dichloropropane*)=n(*Cl_2*)=0.0141**

*mass(*dichloropropane*) = n* x *M = 0.0141* x *M(*$C_3H_6Cl_2$*) = 0.0141* x *113 = 1.59 g**

Therefore, this is the correct answer since the mass matches the mass given in the question. *

3 marks

c. **i**. *



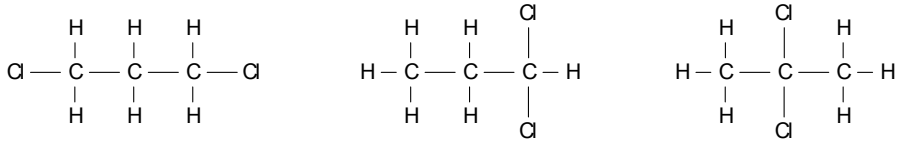
ii. 1,2-dichloropropane*

iii. No possible isomers as the two chlorine atoms are added on either side of the double bond.*

1 + 1 + 1 = 3 marks

d. **i.** $C_3H_6Cl_2$*

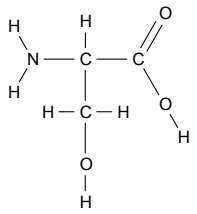
ii.



1 + 3 = 4 marks
Total 11 marks

Question 3

a. **i**. *

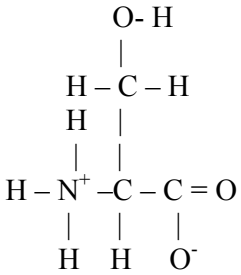


ii. serine*

iii. carboxyl, hydroxyl, amine *

1 + 1 + 1 = 3 marks

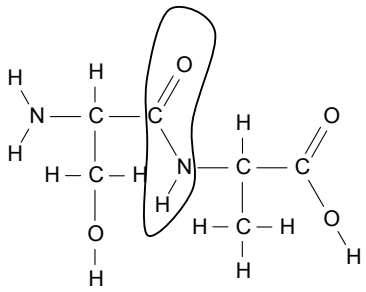
b.



*

2 marks

c. **i**.



*

ii. peptide (or amide) link

1 + 1 = 2 marks
Total 7 marks

Question 4

a. **i**. +6*

ii. 6*

iii. gaining *

iv. reduction *

v. $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$ *

1 + 1 + 1 + 1 + 1 = 5 marks

b. **i**. The green colour will persist. Orange colour of $Cr_2O_7^{2-}$ is gone. *

ii. Ratio of electrons is 6:1, therefore 6 x 5400 = 32400 *

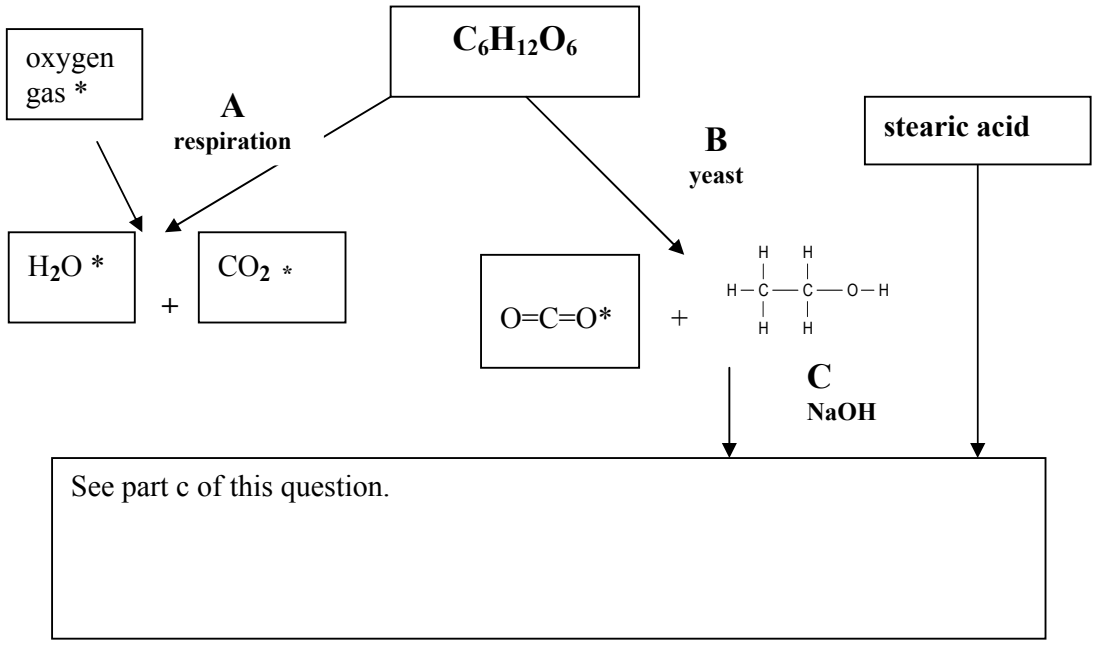
1 + 1 = 2 marks

c. **i**. The original $Cr_2O_7^{2-}$ solution is orange. This means it absorbs blue light but reflects yellow and red. Hence the wavelength is set to blue- a colour that the $Cr_2O_7^{2-}$ is sensitive to. *

ii. As the reaction proceeds, the absorption should drop because the concentration of the $Cr_2O_7^{2-}$ is decreasing. *

1 + 2 = 3 marks
Total 10 marks

Question 5



a. **i**. See diagram

ii. See diagram

2 + 1 = 3 marks

b. **i**. $C_6H_{12}O_6(aq) \rightarrow 2CH_3CH_2OH(aq) + 2CO_2(g)$ *

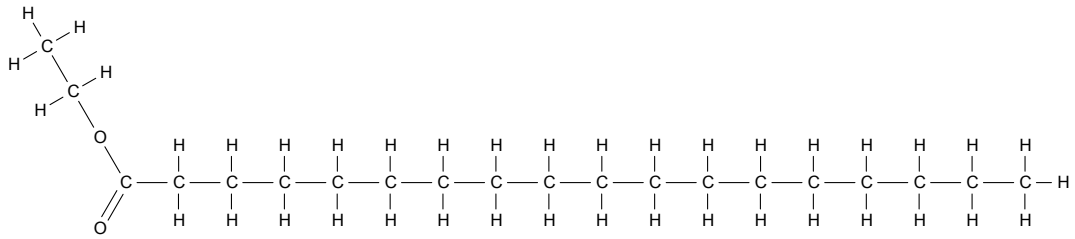
ii. See diagram

iii. Enzymes in yeast act as a catalyst*

iv. The enzymes in yeast are heat sensitive. Their ability to function is destroyed by heat. *

1 + 2 + 1 + 1 = 5 marks

c. **i**.



*

ii. The reactant is sourced from plant material, hence it is renewable. *

iii. $M(\text{stearic acid}) = M(C_{17}H_{35}COOH) = 12 \times 17 + 35 + 12 + 32 + 1) = 284$

$$n = \frac{100000}{284} = 352.1mol \text{ *}$$

$n(\text{stearic acid}) = n(\text{biodiesel}) = 352.1mol$

$\text{mass} = nxM = 352.1 \times 312 = 110kg$ *

1 + 1 + 2 = 4 marks

Total 12 marks

Question 6

a.

	MgF_2	Mg^{2+}	F^-
concentration, M	0.05 *	0.05 *	0.10 *

1 + 1 + 1 = 3 marks

b. **i**. concentration of F^- ions is 0.1 M or 0.1 mole per litre
Therefore $mass = n \times M = 0.1 \times 19 = 1.9g$ *
concentration = 1.9 g L^{-1}

ii. mass in 10 mL is $\frac{1.9}{100} = 0.019g$ = 19 mg*

1 + 1 = 2 marks

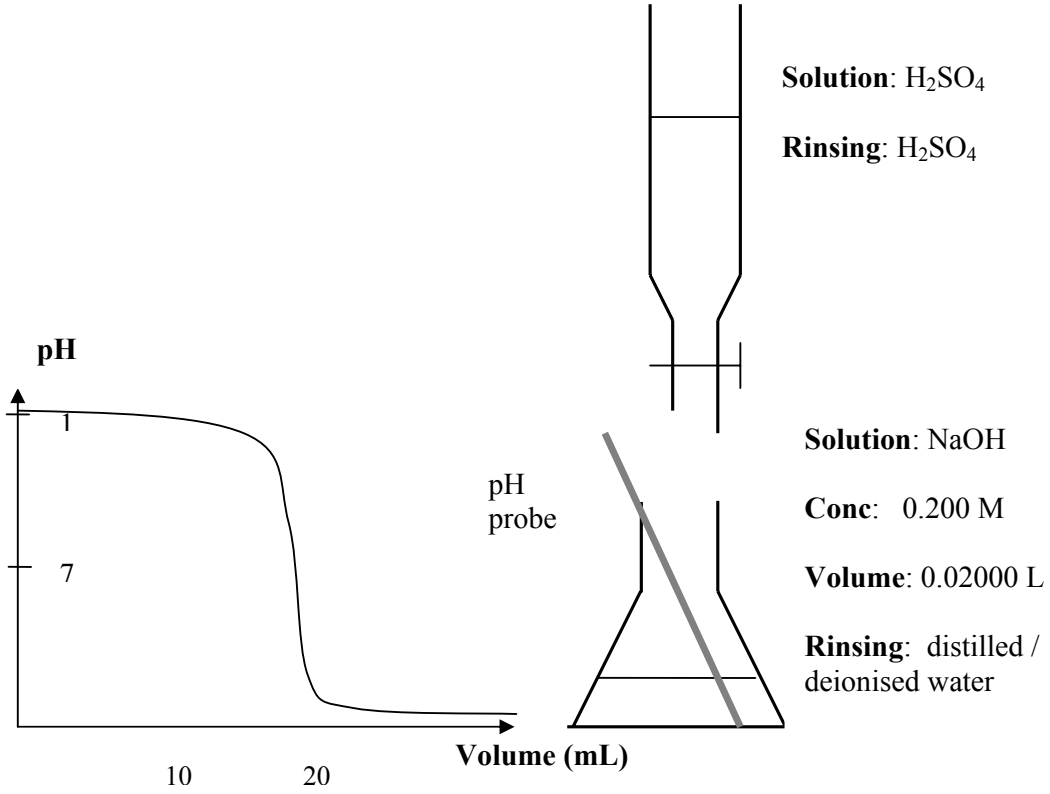
c. mass = 2 mg.
mass in 10 mL is 19mg => volume = $\frac{2}{19} \times 10 = 1.1mL$ *

1 mark

d. $n = \frac{2.34 \times 10^{20}}{6.023 \times 10^{23}} = 3.89 \times 10^{-4} mol$ *
The number of mole of Mg^{2+} = ½ $n(F^-)$ = 0.000195 *mol** or 1.95×10^{-4}

2 marks
Total 8 marks

Question 7



a. $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ *

1 mark

b. see diagram

1 mark

c. see diagram

½ + ½ + ½ + ½ = 2 marks

d. **i**. see diagram

ii. 7 *

iii. phenol red, bromothymol blue *

1 + 1 + 1 = 3 marks

e. **i**. No,* they react in the ratio 2:1, therefore the sulfuric acid is half the concentration of the sodium hydroxide. *

ii. No effect *as the number of mole of sodium hydroxide to be neutralised has not changed. *

iii. No effect * as the titre depends upon the concentration of the base, not whether it is strong or weak. *

2 + 2 + 2 = 6 marks Total 13 marks