CHEMISTRY

Units 3 & 4 - Written examination

TSSM™
Creating VCE Success

(*TSSM's 2009 trial exam updated for the current study design*)

SOLUTIONS

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

Question 1

Answer: A

Explanation:

If we assume a volume of 1 L then we have a 4.95 g of the compound.
n (compound) = PV/RT = ((1020/760 x 101.3) x 1)/(8.31 x (-35 +273))
= 0.069 mol
M (compound) = m/n = 4.95/0.068 = 72 g/mol

Question 2

Answer: D

Explanation:

Paracetamol contains an alkanol, amide and an alkene functional group. It does not contain an ester or carboxylic acid group.

Question 3

Answer: A

Explanation:

There are no chiral centres present in the paracetamol molecule.

Question 4

Answer: C

Explanation:

E = c x m x T
c = E/(m x T) = 5.02 kJ/ (2000 x (40.0 - 20.0) = 1.26 x 10^{-4} kJ/(g °C)

Question 5

Answer: C

Explanation:

Oxidising agents or oxidants can be found on the left hand side of the electrochemical series. They become stronger as you move up the table, therefore the highest one will be the strongest. I_2 is the highest.

Question 6

Answer: A

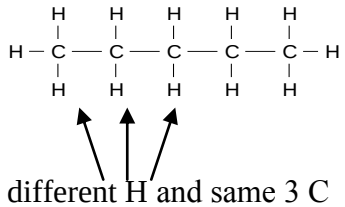
Explanation:

The term chiral is used to describe an object that's non-superimposable on its mirror image.

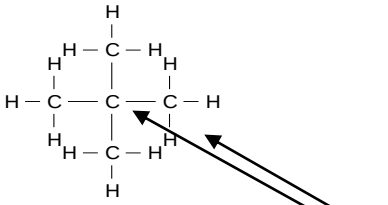
Question 7

Answer: C

Explanation:



3 different H and same 3 C



All H's same and 2 different C

Question 8

Answer: A

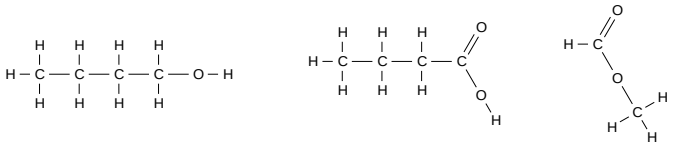
Explanation:

Molecule B does not have any $-CH_2-$ groups. This weighs 14 and CH_3CH_2 – weighs 29. Molecule A should have these peaks but not B.

Question 9

Answer: C

Explanation:



1-butanol to specify the location of the –O-H
butanoic acid does not have a 1, as the carboxylic group can only go on the one spot
the ester is from methanol and methanoic acid = methyl methanoate

Question 10

Answer: C

Explanation:

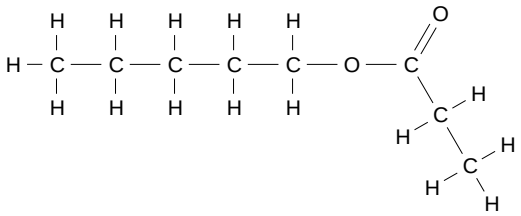
The molecule is a polymer due to the large value of M. It is not a carbohydrate because it has N and S. It is a protein, due to the S, and an enzyme is an example of a protein.

Question 11

Answer: A

Explanation:

This requires pentanol and propanoic acid. The propanoic acid can be formed from propanol using dichromate ions.



Question 12

Answer: A

Explanation:

The NH_2 is an amine, -COOC- ester, O – H alkanol, -CO-NH - amide

Question 13

Answer: C

Explanation:

A mass spectrum is an intensity vs. m/z (mass-to-charge ratio) plot representing a chemical analysis.

Question 14

Answer: D

Explanation:

$C_{18}H_{32}O_2$ For C_{18}, H 36 would be all single bonds – hence two double bonds. All fatty acids have a long non polar part with a small polar part. The polar part has a C=O

Question 15

Answer: D

Explanation:

Fructose has the same molecular formula and mass as glucose, $C_6H_{12}O_6$ mass 180.
2200 monomers will release 2199 water molecules.
Mass = $2200x180 - 2199x18 = 356418$

Question 16

Answer: D

Explanation:

All three measurements give an indication of the reaction rate. H^+ ions are formed by the reaction, hence pH will decrease as the reaction proceeds.

Question 17

Answer: C

Explanation:

As the reaction proceeds, the Br_2 is used up. This makes the mixture lighter and the cross will become visible

Question 18

Answer: A

Explanation:

The reaction is endothermic so high temperature helps the yield. Low pressure will also favour the forward reaction.

Question 19

Answer: C

Explanation:

The system will move to lower the pressure by favouring the reverse reaction. The reverse reaction is exothermic hence the temperature will rise.

Question 20

Answer: A

Explanation:

At 200ºC the value of K must be over 0.8. The alternative that gives a greater K value is A.

Question 21

Answer: A

Explanation:

Infrared radiation has an energy capable of exciting bond vibration.

Question 22

Answer: D

Explanation:

The value of K is very low meaning that the concentration of the reactants is high but the products low. This is option D.

Question 23

Answer: A

Explanation:

The silicon in the PV cells is doped with impurities. Light striking it generates a flow of electrons without a turbine.

Question 24

Answer: C

Explanation:

0.16 g is 0.01 of a mol. From data book, this is 8.89 kJ = 8890 J

$$CF = \frac{energy}{\Delta T}$$
$$= \frac{8890}{11.7}$$
$$= 760 \text{ J}^{o}\text{C}^{-1}$$

Question 25

Answer: D

Explanation:

Take the data book value per mol for each and divide by the molar mass. Hydrogen has the highest figure 286/2 = 123 kJ

Question 26

Answer: B

Explanation:

The Cu^{2+} ions are reduced to Cu at the positive electrode and H^{+} ions are formed at the negative electrode.

Question 27

Answer: C

Explanation:

The electrons flow from the negative hydrogen electrode to the positive copper electrode.

Question 28

Answer: A

Explanation:

The copper and iodide ions will react before water does, so the products are the same whether the cell is aqueous or molten.

Question 29

Answer: D

Explanation:

8042 coulomb is 1/12 of a mol (0.0833). The aluminium with a charge of 3+ will match this
0.0278 x 3 = 0.0833

Question 30

Answer: D

Explanation:

The anode is the oxidation reaction; this is the methane reaction. The charge in A. is not balanced.

SECTION B – Short answer questions

** indicates 1 mark*

Question 1

Each technique can only be used once.

Task	Method chosen	Justification
Identification of amino acids present in a health bar	TLC*	Amino acids will move different speeds – develop with ninhydrin*
Concentration of a solution of lithium hydroxide	Acid/base titration*	Standard way to find the concentration of a base*
Distinguish between two isomers of butane	NMR*	Different peak shifts and different splitting patterns*
Concentration of lead ions in waste water	AAS*	Lead can be analysed by AAS*
Chloride ion concentration in mineral water	Precipitation*	Addition of silver nitrate solution*
Empirical formula of a hydrocarbon molecule	Mass spec*	The exact mass of parent ion will match a particular carbon:hydrogen ratio*

Total 12 marks

Question 2

a. $I_2(aq) + 2e^- \rightarrow 2I^-(aq)$ *

1 mark

b. $C_6H_4O_2(OH)_4(aq) + I_2(aq) \rightarrow C_6H_4O_2(OH)_2(aq) + 2H^+(aq) + 2I^-(aq)$ *

1 mark

c. **i.** The blue colour will linger* when iodine is finally in excess*

ii. This is not an acid/base indicator hence the K value is irrelevant *

2 + 1 = 3 marks

d.

$$n(I_2) = 0.02x0.104 = 0.00208mol$$

$$c(ascorbic) = \frac{0.00208}{0.01856} = 0.112M \quad **$$

2 marks

e. The concentration of an iodine solution does not remain stable*

1 mark

f.

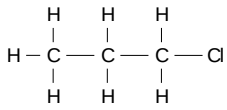
functional group	frequency	
hydroxyl	3400 *	
carbonyl (C=O)	1700 *	(or C = C)

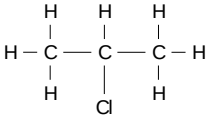
2 marks

Total 10 marks

Question 3

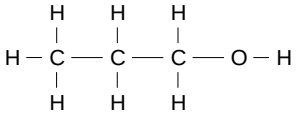
a. A B

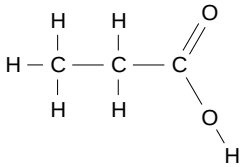




1-chloropropane * 2-chloropropane *

C D





1-propanol (propan-1-ol)* 10propanoic acid*

4 marks

b. Name the type of reaction that is responsible for

$C_3H_6 \rightarrow A$ addition *

$A \rightarrow C$ substitution *

$C \rightarrow D$ oxidation *

3 marks

c. **i**. ^1H NMR*

ii. 2-chloropropane has more identical hydrogen atoms – 6* It has one less peak* and the area under the peaks will reflect the 6 equal hydrogens

1 + 2 = 3 marks

d. **i**. 60 *

ii. 43 * - OH fragment off *

15 CH_3 - fragment *

1 + 2 = 3 marks

Total 13 marks

Question 4

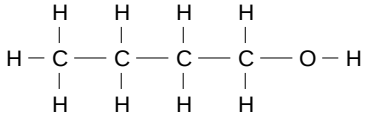
a. mass oxygen = 4.111 – 2.667 – 0.555 = 0.889 g

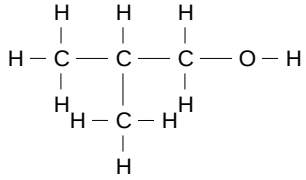
$$\frac{2.667}{12} : \frac{0.555}{1} : \frac{0.889}{16} \qquad * = C_4H_{10}O *$$
$$0.2220 : 0.555 : 0.055$$

3 marks

b. $C_4H_{10}O$ * 1 mark

c. * *





2 marks

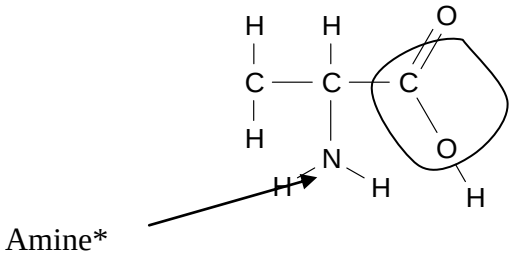
d. That is contains an alkanol group but no carbonyl (C=O) group *

1 mark

e. This matches the molecule above on the right: 2-methylpropan-1-ol**

2 marks

Total 9 marks



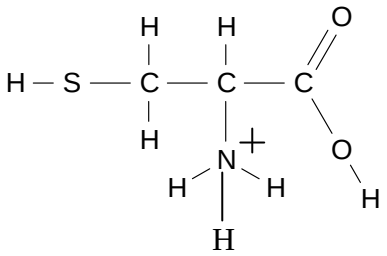
Question 5

a.
(The S—H is also a functional group)

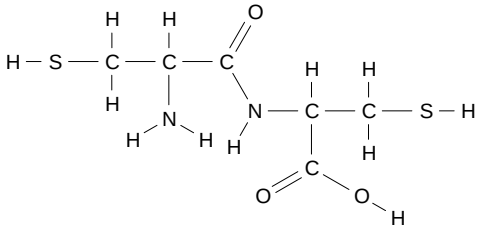
2 marks

b. cysteine * 1 mark

c.



1 mark



d. * + H – O – H *

2 marks

e. **i**. 3.8 ÷x 0.43 = 8.84 cm *

1 mark

ii. stationary phase: silica gel* mobile phase: isobutanol*

2 marks

Total 9 marks

Question 6

a. $2C_{16}H_{34}$ (l) + $49O_2$ (g) → $32CO_2$ (g) + $34H_2O$ (g)
1 mark for correct structure, 1 mark for correct balancing

2 marks

b. Biofuel advantages: Renewable, reduce greenhouse gases, lower pollution, reduce dependence on oil
Biofuel disadvantages: High production cost, food shortages, water use, fertilisers
Any 1 of each for 1 mark each.

2 marks

c. m (hexadecane) = 0.832 kg/L x 60.0 L = 49.9 kg*
n ($C_{16}H_{34}$) = m/M = 49900/(16 x 12.0 + 34 x 1.0) = 221 mol*
1 mol of $C_{16}H_{34}$ produces 10699.1 kJ of energy*
221 mol of $C_{16}H_{34}$ produces = 10699.1 x 221 = 2.36×10^6 kJ*

4 marks

d. 1 mol of biofuel produces 11690.1 kJ of energy
x mol of biofuel produces 2.36×10^6 kJ
x = 2.36×10^6/11690.1 = 202 mol*
m (biodiesel) = n x M = 202 x (19 x 12.0 + 34 x 1.0 + 2 x 16.0) = 5.94×10^4 g*
V (biodiesel) = 5.94×10^4 g/0.875 g/mL = 6.79×10^4 mL = 67.9 L*

3 marks

e. 1 hectare needed to produce 600 litres
x hectares for 67.9 L*
x = 67.9/600 = 0.113 hectares*

2 marks

Total 13 marks

Question 7

a. **i**. This would not usually be true – only if they were added to the reactor in ratio 1:2 *

ii Wrong. In a reversible reaction the reactants will not run out.*

iii. True. The reverse reaction will occur at first.*

1 + 1 + 1 = 3 marks

b. **i**. No, the charge on the metal influences the amount obtained*

ii. Yes, this is the principle of electric circuits*

iii. No*, because 1 mol of Cl_2 requires 2 mol of electrons

1 + 1 + 1 = 3 marks

c. **i**. No, this reaction would occur at the cathode not the anode*

ii. Not necessarily, it might be a hydrogen fuel cell*

1 + 1 = 2 marks

Total 8 marks

Question 8

a. **i**. oxidation half equation $H_2O_2(aq) \rightarrow O_2(g) + 2H^+(aq) + 2e^-$ *

reduction half equation $H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$*

overall equation $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$ *

ii. The reaction is spontaneous but the rate is very slow*

iii. Refrigeration ensures the temperature is low so the average kinetic energy of the particles is low. The black plastic stops light penetrating the container where it might lead to increasing the energy of the particles. *

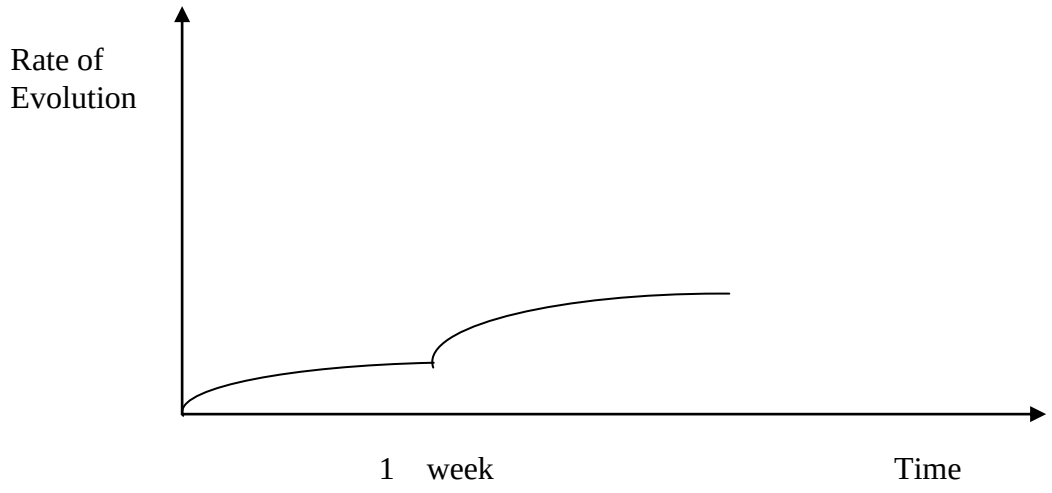
3 + 1 + 1 = 5 marks

b. **i.** It is a catalyst, speeding the reaction up but being unchanged*

ii. None, as a catalyst it is unchanged *

1 + 1 = 2 marks

c.



1 mark

Total 8 marks

Question 9

a. Since the reaction is endothermic, high temperatures* improve the yield. Closer to the engine should favour the forward reaction. *

2 marks

b. 4 particles are converted to 3 by the forward reaction. The reaction going forward would be .favoured by higher pressures*

1 mark

c. Air contains nitrogen. If the nitrogen content is increased, the system will oppose this by moving to the left*, bad for yield*

2 marks

d. $K = \frac{[N_2][CO_2]^2}{[NO]^2[CO]^2}$ *

1 mark

e.

$2NO(g)$	+ $2CO(g)$	$\rightleftharpoons$ $N_2(g)$	+	$2CO_2(g)$	
0.30	0.44	0		0	start
				0.12	change
0.30 – 0.12 = 0.18	0.44 - 0.12 = 0.32	0.06		0.12	

NO 0.18M* CO 0.32M * N_2 0.06M *

3 marks

Total 9 marks

Question 10

a.

	Half Equation	Polarity
anode	$Li \rightarrow Li^+ + e$ *	-ve *
cathode	$Fe^{4+} + 4e \rightarrow Fe$ *	+ve *

4 marks

b. Lithium reacts too vigorously with water *

1 mark

c. Most commercial cells are 1.5 volts, therefore the cells can be used interchangeably *

1 mark

d. One of the reactants is all consumed, therefore one of the half equations stops*

1 mark

e. **i**. $E = VIT = 1.4x8x60x60x3.5 = 141kJ$ **

ii.

$Q = It = 8x60x60x3.5 = 100800C$

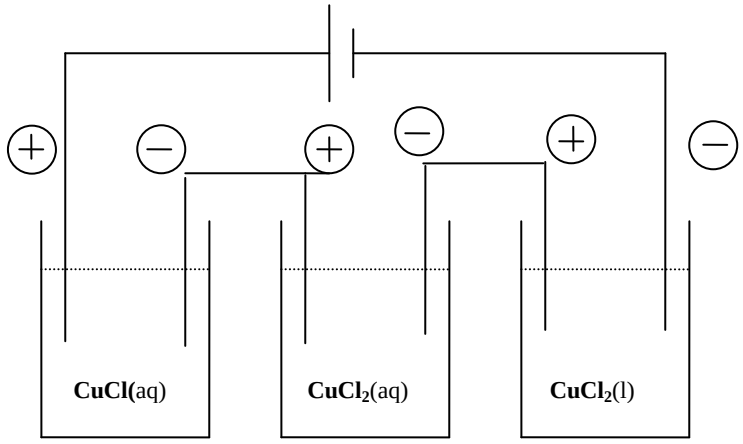
. $n(e) = Q/96500 = 100800/96500 = 1.04mol$ *

$mass(Li) = 1.04x6.9 = 7.18g$

*

2 + 2 = 4 marks
Total 11 marks

Question 11



a. 3 marks

b. **i**. How many mol of electrons passes through each cell?
CuCl(aq) 4
$CuCl_2$(aq) 4
$CuCl_2$(l) 4 *

ii. How many mol of chlorine gas is produced in each cell?
CuCl(aq) 0 *
$CuCl_2$(aq) 0 *
$CuCl_2$(l) 2 *

iii. How many mol of metal is produced in each cell?
CuCl(aq) 4
$CuCl_2$(aq) 2
$CuCl_2$(l) 2 *

1 + 3 + 1 = 5 marks
Total 8 marks