TSFX TRIAL EXAMINATION 2018

VCE CHEMISTRY UNITS 3 & 4

SOLUTIONS

SECTION A – MULTIPLE-CHOICE QUESTIONS

QUESTION 1	Answer is A	**QUESTION 16**	Answer is B
QUESTION 2	Answer is B	**QUESTION 17**	Answer is B
QUESTION 3	Answer is C	**QUESTION 18**	Answer is D
QUESTION 4	Answer is D	**QUESTION 19**	Answer is B
QUESTION 5	Answer is A	**QUESTION 20**	Answer is C
QUESTION 6	Answer is B	**QUESTION 21**	Answer is A
QUESTION 7	Answer is C	**QUESTION 22**	Answer is B
QUESTION 8	Answer is B	**QUESTION 23**	Answer is C
QUESTION 9	Answer is B	**QUESTION 24**	Answer is D
QUESTION 10	Answer is C	**QUESTION 25**	Answer is A
QUESTION 11	Answer is D	**QUESTION 26**	Answer is A
QUESTION 12	Answer is C	**QUESTION 27**	Answer is A
QUESTION 13	Answer is C	**QUESTION 28**	Answer is D
QUESTION 14	Answer is B	**QUESTION 29**	Answer is B
QUESTION 15	Answer is B	**QUESTION 30**	Answer is C

QUESTION 1 Answer is A

Both half equations are reduction reactions. When the cell is discharging, the half cell with the most positive E^o will be the reduction reaction. Therefore, the discharge reactions are:

Cathode (+): $2NiO(OH)_{(s)} + H_2O_{(l)} + 2e^- \rightarrow 2NiO(OH)_{2(s)} + 2OH^-_{(aq)}$

Anode (-): $Cd_{(s)} + 2OH^-_{(aq)} \rightarrow Cd(OH)_{2(s)} + 2e^-$

QUESTION 2 Answer is B

Electrolysis of silver nitrate means that $Ag^+_{(aq)}$ and $H_2O_{(l)}$ are the only two possible reactants. Silver ions are the strongest oxidant and will therefore be reduced to form $Ag_{(s)}$ at the cathode. Water will be oxidised at the anode to produce H^+ ions which will lower the pH around the anode to below 7.

QUESTION 3 Answer is C

QUESTION 4 Answer is D

Using the overall balanced equation:

MnO_4^- is reduced and will therefore react at the cathode. Option A, however is incorrect as the balanced half equation should have $5e^-$, not six.

Cu is oxidised to Cu^{2+} ions which occurs at the anode.
The correct half equation is therefore D.

QUESTION 5 Answer is A

MnO_4^- is reduced at the cathode (electrode I), which is the positive electrode.

Cu is oxidised at the anode (electrode II), which is the negative electrode. Cu^{2+} ions are produced and hence the mass of copper decreases.

QUESTION 6 Answer is B

Electrode 1 cannot be made from $KMnO_4$ as it is soluble in water. Since the cathode electrode will not participate in the reaction, it could be made of carbon or platinum. Therefore, possible options are B or D.

Electrode II is the anode. Since copper is oxidised to copper ions at the anode, this electrode needs to be made from $Cu_{(s)}$. The correct answer is therefore B.

QUESTION 7 Answer is C

Electrons flow from the anode to the cathode i.e. from II to I. Possible answers include C and D.

Cations from the salt bridge will move to the cathode (Beaker X) and the anions will move to the anode (Beaker Y). Therefore, the correct answer is C.

QUESTION 8 Answer is B

There are no units for this equilibrium constant, as they cancel out:

$$\frac{M^4 \times M^3}{M^3 \times M^4} = \frac{M^7}{M^7} = 1$$

QUESTION 9 Answer is B

The equilibrium system when diluted will go to the side with the greatest number of particles. As both sides of the equation have the same number of particles, adding water will simply dilute the system with no net forward or back reaction. Hence the concentration of every species will decrease.

QUESTION 10 Answer is C

At the 4 minute mark, a net forward reaction occurred. As the forward reaction is endothermic, it will be favoured when there has been an increase in temperature.

At 14 minutes, the concentration of each species has decreased, which could only happen with an increase in volume. Hence option C is correct.

QUESTION 11 Answer is D

The equation describing the reaction has a forward arrow indicating that it isn't an equilibrium system. Therefore, option V in incorrect.

No mass was lost at time 0 minutes as the reaction had not yet started. Option I is therefore incorrect.

The mass loss is due to the loss of $CO_{2(g)}$, therefore, option II is incorrect.

The reaction was complete at 75 minutes, as there was no more mass loss after that time. Therefore, option III is correct.

As the reaction rate $\propto$ concentration, the fastest reaction rate will occur when the concentration of reactants is at its greatest i.e. at the beginning of the reaction. Option IV is therefore correct.

QUESTION 12 Answer is C

Option I is incorrect as surface area doesn't apply to solutions.

Option II is correct. As the surface area of the calcium carbonate increases, the probability of an effective collision between reactant particles increases. Therefore, the reaction rate increases.

Option III is incorrect as pressure does not affect solid or aqueous reactants.

Option IV is incorrect, a decrease in pressure does not affect aqueous or solid reactants.

Option V is correct. As the concentration of HCl increases, the probability of an effective collision between reactant particles increases. Therefore, the reaction rate increases.

QUESTION 13 Answer is C

Biodiesel is formed by the reaction of fats with methanol (using potassium hydroxide as a catalyst) to form glycerol and biodiesel (fatty acid methyl esters).

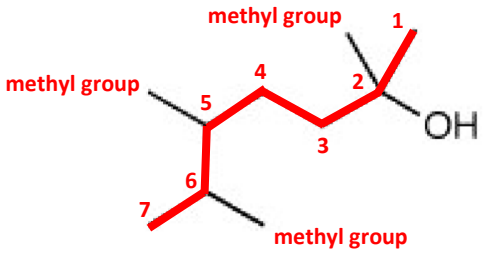
QUESTION 14 Answer is B

The products carbon dioxide and water are more stable than octane and oxygen as they have a lower enthalpy. The activation energy requirement is greater for the reverse reaction which means that the products have stronger bonds than the reactants. Hence the answer is B.

QUESTION 15 Answer is B

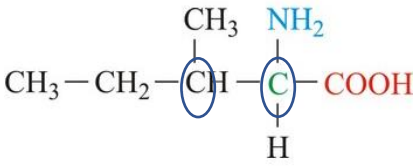
When the same amount, in mole of both fuels is used, more heat energy is produced from the incomplete combustion of propanol than ethanol.

QUESTION 16 Answer is B



QUESTION 17 Answer is B

Chiral centres are tetrahedral atoms that have four different substituents.
The chiral centres in isoleucine have been circled below.



QUESTION 18 Answer is D

Enantiomers are chiral molecules that are non-superimposable mirror images of one another. The mirror image of 3-methylpentane is the same molecule i.e. 3-methylpentane cannot form an enantiomer.

QUESTION 19 Answer is B

As the chain length increases, the amines become more hydrophobic and hence their solubility in hexane increases. As the molecules become larger, the total strength of dispersion forces acting between amine chains increases, meaning that higher temperatures are required to convert a liquid amine to its gaseous state. Therefore, the volatility decreases.

QUESTION 20 Answer is C

QUESTION 21 Answer is A

The carboxylic acid group in structure B would produce a peak between 9.0 and 13.0, which is absent. Therefore, the spectrum was not produced by structure B.

The peaks at about 4.1 ppm are most likely due to the ester functional group, which could have been produced by either structure A or C. C, however, would produce a singlet and a multiplet, neither of which is present in the spectrum.

The CH_2 groups display higher than expected chemical shifts suggesting they are located close to an electronegative element. The splitting patterns indicate that each CH_2 group is located next to a CH_3 group, therefore, the most likely structure to produce the given spectrum is A.

QUESTION 22 Answer is B

The peak at about 1720 cm^{-1} is due to the $C=O$ functional group. The broad peak between 2500 and 3500 cm^{-1} is due to the $O-H$ (acid) group. The compound is therefore a carboxylic acid.

QUESTION 23 Answer is C

Geometric isomerism may occur if there is restricted rotation somewhere in the molecule eg. along the carbon-carbon double bond. Therefore, all of the given options could potentially exhibit geometric isomerism. Geometric isomers, however, will not exist if there are two identical groups on one end of a double bond. Therefore, the answer cannot be A, B or D.

QUESTION 24 Answer is D

Vitamin D can be produced by the body upon exposure to sunlight.

QUESTION 25 Answer is A

As the equivalence point occurs at an acidic pH, the acid is of greater strength than the base. Therefore, the answer can't be C or D.

The indicator should change colour at or near the equivalence point, therefore, we would use methyl red instead of bromothymol blue.

QUESTION 26 Answer is A

QUESTION 27 Answer is A

Carbon dioxide and water are produced during combustion reactions.

QUESTION 28 Answer is D

Natural amino acids or 2-amino acids have the carboxyl, amino and Z group attached to the same carbon.

QUESTION 29 Answer is B

The formula for saturated fatty acids is $C_nH_{2n}O$. For every double bond that is introduced, the number of hydrogen atoms decreases by two. Therefore, nervonic acid is a monounsaturated fatty acid.

QUESTION 30 Answer is C

SECTION B

QUESTION 1 (10 marks)

a. Using the data book:

$$CH_3CH_2OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)} \quad \Delta H = -1360\ kJmol^{-1}$$

$H_{Reactants} = 1370\ kJmol^{-1}$ (0.5 marks)

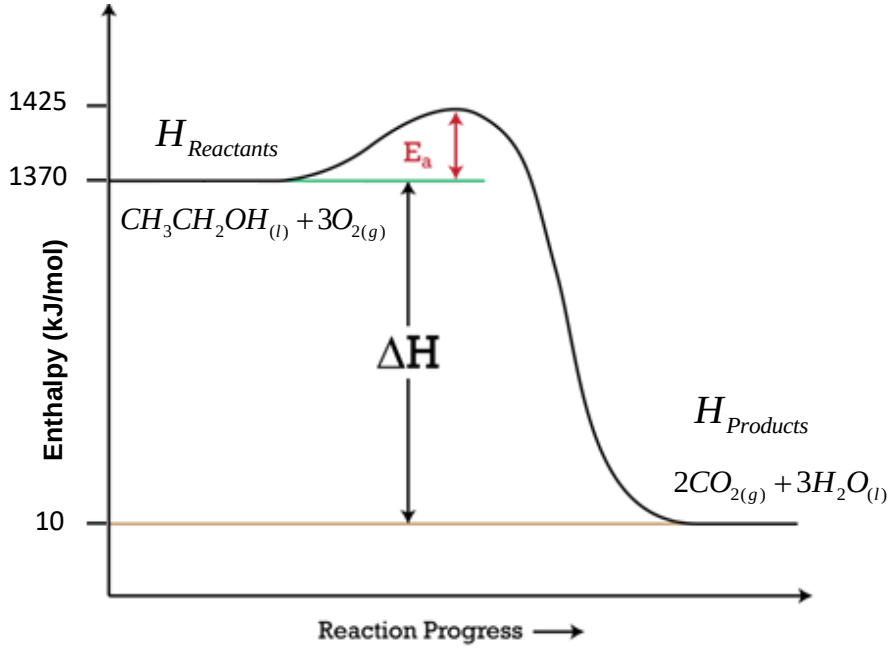
$H_{Products} = 1370 - 1360 = +10\ kJmol^{-1}$ (0.5 marks)

$\Delta H = -1360\ kJmol^{-1}$ (0.5 marks)

$E_a = 55\ kJmol^{-1}$ (0.5 marks)

Activated complex $= 1370 + 55 = 1425\ kJmol^{-1}$

Round down to the nearest integer.



b. **(i)** $5.00\,L$ of water weighs $5000 \times 0.9167 = 4583.5\,g$ at 0.00^oC

$$E = cm\Delta T = 4.18 \times 4583.5 \times (93.89 - 0) = 1,798,841\,J$$
$$= 1.80 \times 10^3\ kJ \quad \text{(1 mark, 3 significant figures)}$$

$1\ mole\ CH_3CH_2OH \rightarrow 1360\,kJ$

$x\ mole\ CH_3CH_2OH \rightarrow 1,798.841 kJ$

$x = 1.32268 = 1.32\ mol$ (1 mark, 3 significant figures)

$m(ethanol) = n \times M = 1.32268 \times 46 = 60.843 = 60.8\,g$ (1 mark, 3 significant figures)

(ii) According to the thermochemical equation, $1360\,kJ$ of energy is released when 2 mole of CO_2 is produced. Therefore, the production of 1 mole of CO_2 releases $\frac{1360}{2} = 680\,kJ$ of energy.

$$n(CO_2)_{produced} = \frac{5200}{680} = 7.6471 = 7.65\,mol$$

Using $PV = nRT$:

$$V(CO_2) = \frac{nRT}{P} = \frac{7.6471 \times 8.31 \times (273+5)}{100} = 176.662 = 1.8 \times 10^2\,L$$ (1 mark)

c. **(i)** Ethanol has a hydroxyl functional group which means that it can hydrogen bond with water, making it hygroscopic. (1 mark) Octane is a non polar molecule and hence is only attracted to water via weak dispersion forces. Therefore, it cannot hydrogen bond with water and isn't hygroscopic. (1 mark)

(ii) One of:

- Some of the mass of the fuel is water, which does not combust. Hence less energy is produced per gram of fuel. (1 mark)
- Some of the heat released from the combustion of the ethanol is absorbed by evaporating the water rather than released as useful energy. (1 mark)

QUESTION 2 (7 marks)

a. Electrode A: $2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$ (1 mark)

Electrode B: $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$

Electrode C: $Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^-$

Electrode D: $Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$ (1 mark)

b. $Q = It = 5.00 \times 10.0 \times 60 = 3000 = 3.00 \times 10^2$ *Coulombs* (1 mark)

c. Using Faraday's Laws:

$Q = It = n(e^-) \times F$

$n(e^-) \times 96,500 = 3,000$

$n(e^-) = \dfrac{3,000}{96,500} = 0.031088\ mol$ (1 mark)

As $n(Ni) = \dfrac{1}{2} \times n(e^-) = 0.015544\ mol$

$m(Ni) = n \times M = 0.015544 \times 58.7 = 0.9124 = 0.912\ g$

Electrode D increases in mass by $0.912\ g$. (1 mark)

d. Volume of oxygen gas formed at electrode A:

$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

$n(e^-) = 0.031088\ mol$

$\therefore n(O_2) = \dfrac{1}{4} \times n(e^-) = 0.007772\ mol$ (1 mark)

Using $V = n \times V_M = 0.007772 \times 24.8 = 0.19275$

$= 0.193\ L\ or\ 193\ mL\ or\ 1.93 \times 10^2\ mL$ (1 mark)

QUESTION 3 (6 marks)

a. $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \quad E^o = +0.34V$
$Pb^{2+}_{(aq)} + 2e^- \rightarrow Pb_{(s)} \quad E^o = -0.13V$

Therefore, the reactions that occur are:

Cathode: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \quad E^o = +0.34V$
Anode: $Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2e^- \quad E^o = +0.13V$

Electrons flow from the anode to the cathode, therefore, V = anode and X = cathode.

Lead is a stronger reductant than copper metal and therefore will react at the anode (electrode V).

W is a solution containing $Pb^{2+}_{(aq)}$ ions, which acts as the electrolyte for the lead electrode. i.e. W is lead (II) nitrate solution.

X is copper metal.

Y is a solution containing $Cu^{2+}_{(aq)}$ ions, which acts as the electrolyte for the copper electrode. i.e. Y is copper (II) nitrate solution.

(0.5 marks each = 2 marks. Round down to nearest integer)

b. $EMF = 0.34 - (-0.13) = 0.47V$ (1 mark)

c. If the porous pot is removed, both the $Cu^{2+}_{(aq)}$ and $Pb^{2+}_{(aq)}$ ions would be present in the same electrolyte. The flow of electrons will occur directly between the $Cu^{2+}_{(aq)}$ and $Pb_{(s)}$ and will bypass the external circuit, and a current will not be produced. (1 mark)

This means that electrode X would not receive the electrons it needs to produce copper metal on its surface. Instead, the $Cu^{2+}_{(aq)}$ will migrate to the lead electrode (V) and will precipitate on the surface as $Cu_{(s)}$. (1 mark)

d. Answer is $AgNO_3$

The reactions occurring are:

Cathode: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \quad E^o = +0.34V$
Anode: $Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2e^- \quad E^o = +0.13V$

CH_3OH is not an electrolyte and could not be used in the salt bridge.

Ag^+ will migrate from the salt bridge to cathode. As Ag^+ is a stronger oxidant than Cu^{2+}, it will react, interfering with cell processes. Therefore, cannot use $AgNO_3$.

K^+ is a very weak oxidant – therefore, it will not interfere with reactions. OH^- will move into the anode where it reacts with Pb^{2+} to form a precipitate. Therefore, KOH cannot be used.

$NH_4(NO_3)$ consists of a very weak oxidant and reductant which will not interfere with cell reactions when the ions migrate into the half cells. Furthermore, $NH_4(NO_3)$ will not form precipitates with the species in each half cell and can therefore be used as an electrolyte in the salt bridge of this galvanic cell.

QUESTION 4 (7 marks)

a. The rate of reaction increased with the finely ground platinum, as the surface area increased, increasing the likelihood of an effective collision, resulting in a faster reaction rate. (1 mark) Reaction rates, however, have no bearing on the change in enthalpy of a reaction. ΔH is dependent upon the energy of the reactants and products. (1 mark)

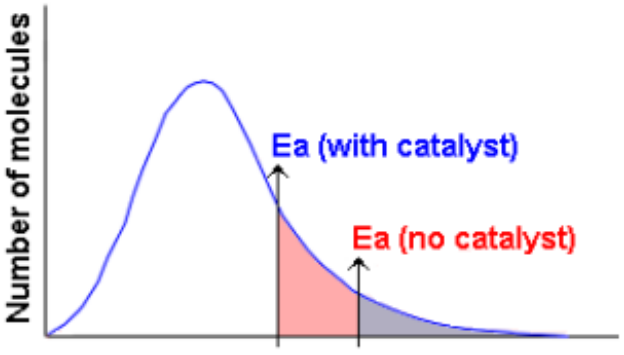
b. **(i)** E_a, the activation energy, is the minimum amount of energy needed to break the bonds in the reactants so they can rearrange into products. (1 mark)

(ii) T_1 is at a lower temperature than T_2 which means that the average kinetic energy of particles at T_1 is less than that at T_2.

Raising the temperature causes the curve to skew to the right, increasing the most probable velocity. The higher the curve, the greater the number of gas molecules moving at that speed. (1 mark)

The area under the curves after E_A represent the number of particles with sufficient energy to overcome the activation energy barrier. Hence the graph T_2 will have more particles with sufficient energy to react. (1 mark)

(iii) If a catalyst is introduced, an alternative reaction pathway with a lower activation energy barrier will become available, increasing the reaction rate. (1 mark)



(1 mark)

QUESTION 5 (10 marks)

a. **(i)** $K_c = \dfrac{[CH_3OH_{(aq)}]}{[CO_{(g)}][H_{2(g)}]^2}\, M^{-2}$ (1 mark)

(ii) $[CO] = \dfrac{51.5}{200} = 0.2575M$

$[H_2] = \dfrac{153}{200} = 0.765M$

$\dfrac{[CH_3OH_{(aq)}]}{(0.2575 \times 0.765^2)} = 26$ (1 mark)

$[CH_3OH_{(aq)}] = 5.1M$ (1 mark)

b.

Changes	Yield of Methanol (mole)	Equilibrium Constant
Add $CO_{(g)}$	Increases	Stays the same
Remove $H_{2(g)}$	Decreases	Stays the same
Increase Pressure	Increases	Stays the same
Increase Temperature	Decreases	Decreases

0.5 marks per cell. Round down to the nearest integer.

c. **(i)** Reactants are continuously fed into the fuel cell whereas galvanic cells use a fixed amount of reactants that are not replenished. (1 mark)

(ii) $O_{2(g)} + 4H^+_{(aq)} + 4e^- \rightarrow 2H_2O$ (1 mark)

(iii) $CH_3OH_{(l)} + H_2O_{(l)} \rightarrow CO_{2(g)} + 6H^+_{(aq)} + 6e^-$ (1 mark)

QUESTION 6 (12 marks)

a. **(i)** To ensure there is sufficient oxygen for the complete reaction of the benzoic acid. (1 mark)

(ii) The calorimeter contents are at a higher temperature than the surrounding environment and the calorimeter is continually losing heat to the environment due to inefficient insulation.

b. **(i)** $2C_6H_5COOH_{(s)} + 15O_{2(g)} \rightarrow 14CO_{2(g)} + 6H_2O_{(g)} \quad \Delta H = -6454\ kJmol^{-1}$

or

$C_6H_5COOH_{(s)} + 7.5O_{2(g)} \rightarrow 7CO_{2(g)} + 3H_2O_{(g)} \quad \Delta H = -3227\ kJmol^{-1}$

1 mark for the correct equation, 1 mark for the correct ΔH .

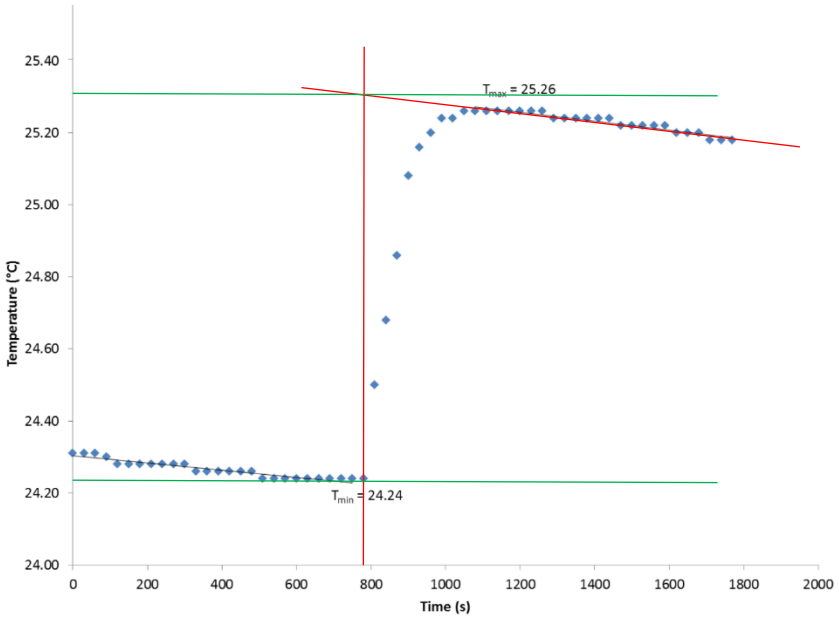
(ii) $n(benzoic\ acid) = \dfrac{m}{M} = \dfrac{1.890}{122.0} = 0.01549\ mol$ (1 mark)

$1\ mole \rightarrow -3227\ kJ\ energy$
$0.01549\ mole \rightarrow x\ kJ\ energy$

$x = -49.9920\ kJ\ energy$ (1 mark)

$$CF = \frac{E}{\Delta T}$$

Maximum $\Delta T = 25.31 - 24.24 = 1.07\ K$
Minimum $\Delta T = 25.26 - 24.24 = 1.02\ K$



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When $\Delta T = 1.07\,K$:

$$CF = \frac{E}{\Delta T} = \frac{49.9920}{1.07} = 46.7215 = 46.7\ kJK^{-1}$$

When $\Delta T = 1.02\,K$:

$$CF = \frac{E}{\Delta T} = \frac{49.9920}{1.02} = 49.012 = 49.0\ kJK^{-1}$$

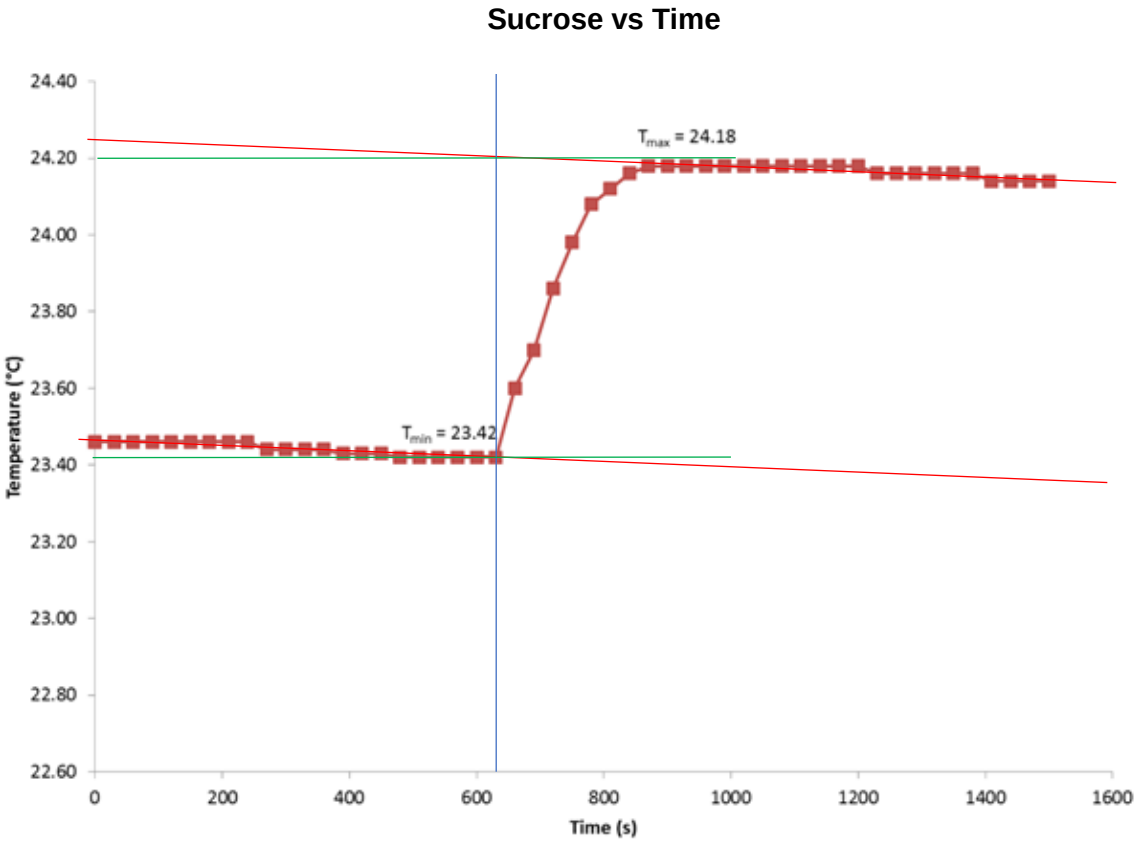
Acceptable range for calibration factor: $46.7 - 49.0\ kJK^{-1}$

(1 mark for calculation of the calibration factor. Value must fall within the acceptable range)

(iii) A lower volume means that the temperature change recorded will be higher. (1 mark) The calibration factor would decrease in value. (1 mark)

$$CF = \frac{E(J)}{\Delta T} = \frac{Cons\tan t}{\Delta T\ will\ be\ higher} = \downarrow CF$$

c.



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Maximum $\Delta T = 24.20 - 23.42 = 0.78\,K$
Minimum $\Delta T = 24.18 - 23.42 = 0.76\,K$

Using the maximum $\Delta T's$:

$E = CF \times \Delta T = 46.7215 \times (0.78) = 36.4428 = 36\,kJ$ (1 mark)

$n(sucrose) = \dfrac{m}{M} = \dfrac{2.00}{342} = 5.84795 \times 10^{-3}$ (1 mark)

$5.84795 \times 10^{-3}\,mol \rightarrow -36.4428\,kJ$
$1mol \rightarrow x\,kJ$

$x = -6,231.7223 = -6.2 \times 10^{3}\ kJmol^{-1}$ (1 mark)

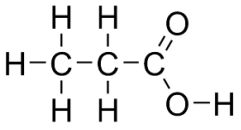
Acceptable range for molar enthalpy is $-6.1 \times 10^{3}\ kJmol^{-1}$ to $-6.5 \times 10^{3}\ kJmol^{-1}$.

QUESTION 7 (8 marks)

a. H_3PO_4 catalyst, 300^oC, $H_2O_{(g)}$ (1 mark)

b. 1 mark for each correct structure

D



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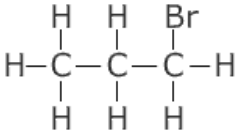

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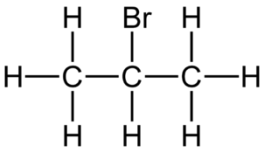

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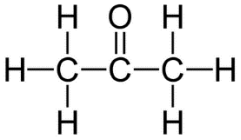


c. $C_3H_7Br_{(aq)} + NaOH_{(aq)} \rightarrow C_3H_7OH(aq) + NaBr(aq)$

(1 mark)

$$Atom\ Economy = \frac{Molar\ mass\ of\ desired\ product}{Molar\ mass\ of\ all\ reactants} = \frac{M(C_3H_7OH)}{M(C_3H_7Br) + M(NaOH)}$$

$$= \frac{60}{122.9 + 40} = 36.8\%$$ (1 mark)

d. Option 3 (1 mark)

QUESTION 8 (11 marks)

a. (i) Hydrophobic interactions or dispersion forces (1 mark)

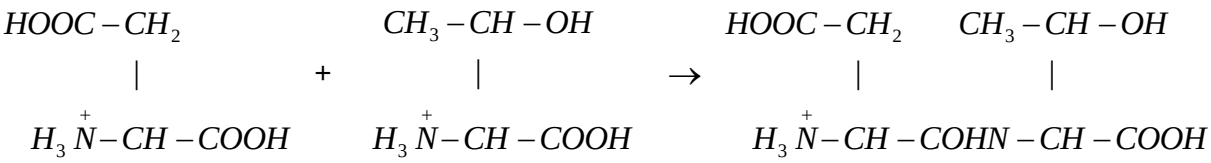
(ii) Hydrogen bonds b, c, e, h (1 mark)

(iv) Ionic bond (1 mark)

b. (i) At low temperatures, the enzyme and substrate have low kinetic energies. As the temperature increases, the kinetic energy of the system increases (1 mark), resulting in more frequent and more energetic collisions between the enzyme and substrate. Therefore, the reaction rate increases. (1 mark)

(ii) The increased kinetic energy of the molecules disrupts the intermolecular forces responsible for maintaining the tertiary and quaternary structure. (1 mark) This change in 3-D shape of the enzyme means that the active site can no longer effectively catalyse the reaction, so the reaction rate decreases. (1 mark)

c.



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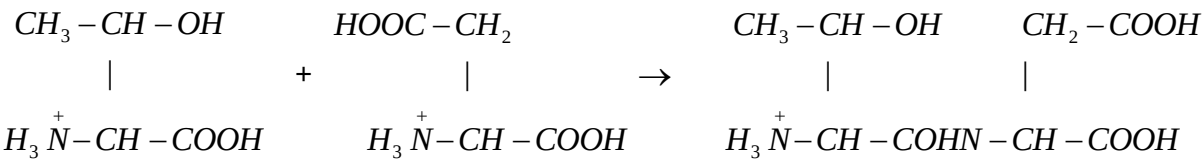


1 mark for correct dipeptide, 1 mark for correct charges

d. 20 water molecules were removed to form chain A. Mass = $360\ gmol^{-1}$

29 water molecules were removed to form chain B. Mass = $522\ gmol^{-1}$

2 hydrogen atoms were removed to form each disulphide link = $4\ gmol^{-1}$

Total removed is $886\ gmol^{-1}$. (1 mark)

Therefore, total molar mass of the individual amino acids is $5808+886=6694\ gmol^{-1}$ (1 mark)

QUESTION 9 (10 marks)

a. **(i)** Oxidation: $C_6H_8O_{6(aq)} \rightarrow C_6H_6O_{6(aq)} + 2H^+_{(aq)} + 2e^-$ (1 mark)

Reduction: $I_{2(aq)} + 2e^- \rightarrow 2I^-_{(aq)}$ (1 mark)

(ii) $C_6H_8O_{6(aq)} + I_{2(aq)} \rightarrow C_6H_6O_{6(aq)} + 2H^+_{(aq)} + 2I^-_{(aq)}$ (1 mark)

b. **(i)** $n(ascorbic\ acid) = n(iodine) = cV = 0.0150 \times 0.01160 = 1.74 \times 10^{-4}$ (1 mark)

(ii) $m = n \times M = 1.740 \times 10^{-4} \times 176.14 = 0.03064836 = 0.0306\ g$ (1 mark)

(iii) Mass in $250.00\ cm^3$ is $0.0306 \times 10 = 0.306\ g$ (1 mark)

Mass in two tablets is $0.306\ g$

Mass in one tablet is $0.15324 = 0.153\ g$

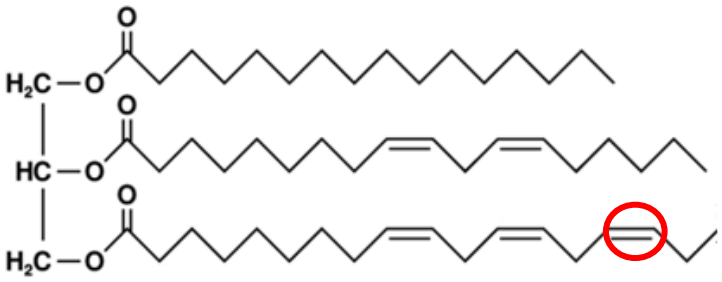
$$\%\ Vitamin\ C = \frac{Mass\ Vitamin\ C}{Mass\ Tablet} \times 100\%$$

$$= \frac{153}{700} \times 100 = 21.857 = 21.9\% \quad \text{(1 mark)}$$

(iv) The percentage of Vitamin C by mass in the tablet would be higher than the true value. (1 mark)

c. **(i)** Due to the exposed and available OH groups that can form hydrogen bonds with water. (1 mark)

(ii) 1 mark for circling the indicated bond



QUESTION 10 (10 marks)

a. **(i)** The stationary phase is non-polar. (1 mark) As the fatty acid becomes larger, it becomes more non-polar and exhibits a stronger affinity for the stationary phase. Hence the retention time increases. (1 mark)

(ii) The biodiesel with the weakest intermolecular forces of attraction will have the lowest cloud point. (1 mark) Biodiesel made from capric acid will have the weakest intermolecular bonding since it has the shortest hydrocarbon chain. (1 mark)

b. Palmitic acid (1 mark)

c. After hydrogenation, the fatty acid molecules will become more saturated. (1 mark) Stronger interactions would form with the stationary phase and therefore, the retention times would increase. (1 mark)

d. The unspiked margarine sample does not contain a peak that corresponds with the peak generated by elaidic acid.

e. A peak area of 625 units corresponds to a concentration of $0.0175 g / 100 ml$ in the diluted sample of rice bran oil. Therefore, the concentration of linolenic acid in the undiluted rice bran oil is $0.35 g / 100 ml$ or $3.5 g L^{-1}$. (1 mark)