Solution Pathway

NOTE: This task is sold on condition that it is NOT placed on any school network or social media site (such as Facebook, Wikispaces etc.) at any time.

NOT FOR PRIVATE TUTOR USE.

Below are sample answers. Please consider the merit of alternative responses.

Note: *Teachers will need to provide the VCAA data booklet, unmarked, for student use during this Exam.*

SECTION A: Multiple Choice Answers

Question 1 Answer: B

Question 2 Answer: C

n = pV / RT = 110.5 x 3.55 / 8.31 x 303 = 0.1558 mol

N = n x N_A = 0.1558 x 6.02 x 10^{23} = 9.38 x 10^{22} molecules of nitrogen molecules.

Question 3 Answer: B

Question 4 Answer: C

Both $CH_3(CH_2)_3OH$ and $(CH_3)_3OH$ are alcohols, so the 2nd statement is correct. $CH_3(CH_2)_3OH$ is a primary alcohol (1-butanol) and can be oxidised to butanoic acid with acidified $K_2Cr_2O_7$(aq). However, $(CH_3)_3OH$ is a tertiary alcohol and cannot be oxidized with acidified $K_2Cr_2O_7$(aq). Therefore, statement 1 is incorrect.

Question 5 Answer: D

This reaction is a redox reaction. Both half equations are needed to determine the coefficient for each species; the Cl^-(aq) ions are spectator ions.

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ /x3

$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$ /x2

Full equation: $3\,Mg(s) + 2Fe^{3+}(aq) + 6Cl^-(aq) \rightarrow 3Mg^{2+}(aq) + 2Fe(s) + 6Cl^-(aq)$

Question 6 Answer: A

73.0 / 56.1 = 1.30 mol 178 kJ x 1.30 mol = 231 kJ

The question asks for energy released and not ΔH. The value has to be positive.

Question 7 Answer: C

Fuels cells convert chemical energy directly into electrical energy, answer A correct. The two half equations are:

Cathode / Reduction: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$
Anode / Oxidation: $H_2(g) \rightarrow 2H^+(aq)$
Full equation: $O_2(g) + H_2(g) \rightarrow 2H_2O(l)$

Answer B and D are correct as water is produced and hydrogen being oxidised acts as a reducing agent. Reduction happens at cathode and NOT anode, therefore, answer C is incorrect statement.

Question 8 Answer: B

Hexane and 3-methylpentane have the same molecular formula but different chemical structures. Both have NO chiral centre and therefore are no stereoisomers, nor enantiomers nor diastereomeres.

Question 9 Answer: A

The molecule has 2 hydroxy groups and one aldehyde functional group. Only the middle carbon has four different R-groups and therefore has only one chiral centre. Due to its polar functional groups the molecule is soluble in water.

Question 10 Answer: D

Question 11 Answer: D

n monomers alanine forming 1 polymer + (n-1) water
n x (89) = 1580 + (n-1) x 18 = 89n – 18n = 1580 – 18 = 71n = 1562
n = 1562 / 71 = 16

Question 12 Answer: A

Question 13 Answer: B

Both structures are in the data book. Sucrose is a carbohydrate and a disaccharide whilst aspartame has an ester, amide and amine functional group and is therefore not a saccharide. Even so it is metabolised in the human body it releases much less energy than sucrose.

Question 14 Answer: C

Q = n x z x F $Q_{Cu} = Q_{Ag}$, therefore n_{Ag} x 1 x 96500 = n_{Cu} x 2 x 96500
n_{Cu} = 12.7 / 63.55 = 0.1998 mol
n_{Ag} = 0.1998 x 2 /1 = 0.3997 mol
m_{Ag} = 0.3997 x 107.9 = **43.2 g**

Question 15 Answer: B

Vitamin C has several hydroxy functional groups which make it soluble in water (A incorrect). It is a natural antioxidant and has two chiral centres, at adjacent carbon atoms (C, D are incorrect). Vitamin C has an ester functional group (B correct).

Question 16 Answer: B

Question 17 Answer: C

3-methyl-butan-2-ol is a secondary alcohol and is oxidised to a ketone. It will keep its methyl sidechain at the third carbon.

Question 18 Answer: B

Question 19 Answer: C

Question 20 Answer: D

According to the electrochemical series, the reaction between $CuSO_4$ and Fe(s) will be spontaneous as the strongest oxidant reacts with the strongest reductant.

Question 21 Answer: A

Question 22 Answer: A

Question 23 Answer: C

Galvanic cell, oxidation reaction: $Mg \rightarrow Mg^{2+} + 2e^-$, reduction reaction: $Ag^+ + e^- \rightarrow Ag$
negative nitrate ions will migrate to anode (Mg) (ox reaction) and positive ions will migrate to cathode (Ag).

Question 24 Answer: A

Question 25 Answer: D

The fatty acid is an omega-3 fatty acid, which contains a carboxylic acid group at the first carbon (α-carbon) and due to its high degree of unsaturation is an oil at room temperature.

Question 26 Answer: C

Removing a product will favour the forward reaction leading to an increase of mol in Y (1 correct). Increasing the volume of the container will not affect the equilibrium as both sides of the reaction have the same number of particles (2 incorrect). The reaction is an endothermic reaction. An increase of the temperature will add additional energy to the system and therefore the forward reaction is favoured trying to compensate for the increase of heat (3 is correct). Answer C with 1 and 3 correct.

Question 27 Answer: D

Question 28 Answer: C

Fatty acids are partially soluble in water due to the presence of -COOH group, which are able to form hydrogen bonds with the water molecules. The hydrocarbon chain of the fatty acids are completely insoluble in water, therefore with increasing chain length, the fatty acid becomes less soluble.

Question 29 Answer: C

Question 30 Answer: A

SECTION B

Question 1 (5 marks)

a. $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **(2)**

1 mark for correct reactant and product.
1 mark for states.
1 mark only if correct full equation is given.

b. *$n(BaCl_2) = 3.18 / 208.2 = 0.0153$ mol* **(1)**
$n(BaCl_2) = n(BaSO_4) = 0.0153$ mol
$m(BaSO_4) = 0.0153 \times 233.4$ g/mol = 3.57 g **(1)**

c. *%yield = m(practical) / m(theoretical) x 100% = 3.37 / 3.57 x 100 = 94.4%* **(1)**

Question 2 (6 marks)

a. *True* **d.** *False*
b. *True* **e.** *False*
c. *False* **f.** *True*
½ mark each for correct answer. **(6)**

Question 3 (9 marks)

a. *A.According the electrochemical series, the magnesium ion (Mg^{2+}) is a stronger oxidant */2 than Ca^{2+} and Na^+, and therefore is preferentially reduced */2 over Ca^{2+} and Na^+.*

(1)

b. $Mg^{2+}(l) + 2e^- \rightarrow Mg(l)$ Note no marks if state is (aq) or (s). **(1)**

c. $2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$ Note no marks if state is (aq) or (s). **(1)**

d. *It = n x z x F*

*$n(Mg) = 1 \times 10^6$ g / 24.3$gmol^{-1}$ = 4.12×10^4 mol ** **(1)**
*t = $4.12 \times 10^4 \times 2 \times 96\,500 / 30000$ * = 2.65×10^5 seconds = **73.5 hours *** * **(2)**

e. *<u>At the cathode</u>: water*/2 would be reduced instead of Mg^{2+} because it has a higher E^0 value / is a stronger oxidant*/2 than Mg^{2+} and is therefore preferentially reduced*/2 to hydrogen gas and $OH^-(aq)$ ions*

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ */2 4 x ½ mark = **(2)**

<u>At the anode</u>: water would be oxidised instead of Cl^- because it has a lower E^0 value / is a stronger reductant/2 than Mg^{2+} and is therefore preferentially oxidised to oxygen gas and $H^+(aq)$ ions*

$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ */2 2 x ½ mark = **(1)**

Question 4 (13 marks)

a. $C_6H_5COOH(s) + 7.5O_2(g) \rightarrow 7CO_2(g) + 3H_2O(g)$ $\Delta H = -3227$ kJ mol^{-1} ***or***

$2C_6H_5COOH(s) + 15O_2(g) \rightarrow 14CO_2(g) + 6H_2O(g)$ $\Delta H = -6454$ kJ mol^{-1}

1 mark for correct balanced equation including states.
1 mark for correct ΔH value. **(2)**

b. $\Delta T = 36.81 - 20.00 = 16.81$ °C or K **(1)**
$CF = E/\Delta T = 3227 / 16.81 = 192.0$ kJ K^{-1} $= 1.92 \times 10^5$ J K^{-1} **(1)**

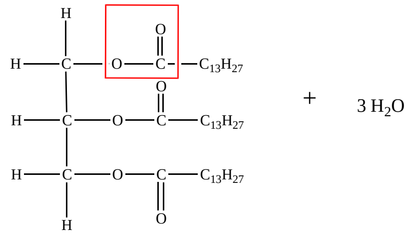
c. *Cereal 'X': (27.43 – 25.24) = 2.19 K x 1.92 x 10^5 J K^{-1}/ 10 = 42.0 kJ g^{-1}* **(1)**
Cereal 'Z': (25.25 – 23.22) = 2.03 K x 1.92 x 10^5 J K^{-1}/ 10 = 39.0 J g^{-1} **(1)**

d. *No*, because some of the heat could have come from compounds in food other than fat (carbohydrates, proteins) *.*

(2)

e. *Saturated fatty acids have hydrocarbon chains that contain only <u>single carbon–carbon</u> bonds**
(1)

f. i.



1 mark for correct structure of triglyceride
1 mark for **3 H_2O**
Total: **(2)**

ii. See diagram above */2, Name: *ester group**/2 **(1)**
iii. *Condensation / esterification reaction* **(1)**

Question 5 (10 marks)

a. $C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$ **(1)**

½ mark for correct reactants and products.

½ mark for correct states and equilibrium arrow.

b. *$[C_2H_4]$ = 0.060 M $[C_2H_6]$ = 0.16 M $[H_2]$ = 0.10 M* **(1)**

c. *K = $[C_2H_4]$ x $[H_2]$ / $[C_2H_6]$ * = (0.06 x 0.10) / 0.16 = 0.0375 M** **(2)**

d. *Some hydrogen gas has been added to the equilibrium system.* **(1)**

e. At t = 50 min, $[C_2H_6]$ = 0.18 M and $[H_2]$ = 0.12 *, because the temperature has not changed K at 25 min = K at 50 min , therefore *$[C_2H_4]$ = (K x $[C_2H_6]$) / $[H_2]$*

*$[C_2H_4]$ = (0.0375 x 0.18) / 0.12) = 0.056 M** **(2)**

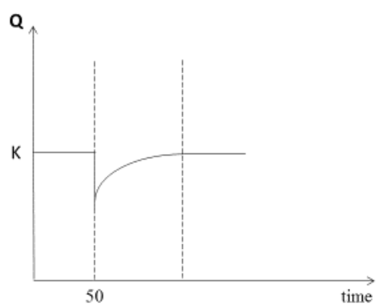
f. *The addition of a catalyst <u>does not affect the position</u>*/2 of the equilibrium. It only <u>speeds</u> <u>up the forward and back reaction at the same rate</u>*/2.* **(1)**

g. See graphs below. 1 mark per graph, total = **(2)**

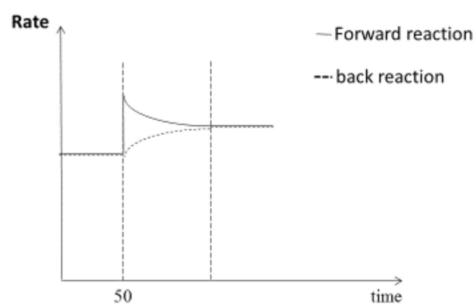
½ mark each for initial change (Q decreasing, forward reaction increasing).

½ mark for gradual changes to re-establish equilibrium (K_1 must be equal to K_2) and rate of forward and back reaction at new equilibrium needs to be higher than before adding of C_2H_6.

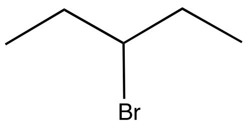
Graph 1



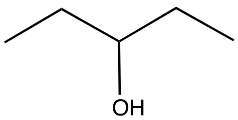
Graph 2



Question 6 (6 marks)

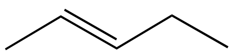
a. 

(1)

b. **i.** 

(1)

ii. *Substitution reaction* **(1)**

c. **i.**  **(1)**

Name: *pent-2-ene* **(1)**

ii. *steam* $(H_2O(g))^{*/2}$*, catalyst /* H_3PO_4*, 300°C* $^{*/2}$ **(1)**

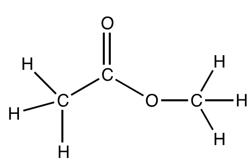
Question 7 (19 marks)

a. ***A:*** *2* ***B:*** *3* ***C:*** *3* ***D:*** *3* **(4)**

b. **i.** *Compound C *, has two different H – environments,*

according to data book: CH_3-COOR at 2 ppm$^{*/2}$ and R-COOCH_3 at ~3.7 ppm$^{*/2}$

(2)

ii. Structure: 

*

name: *methyl ethanoate** **(2)**

c. $HOCH_2CH_2CH_2OH^+ \rightarrow HOCH_2^+ + \bullet CH_2CH_2OH$ **(2)**

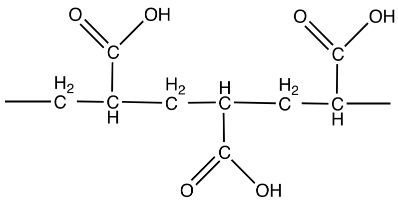
the molecular ion and the fragment $HOCH_2^+$ must have a positive charge.

d. **i.** $2CH_3CH_2CO_2H + Na_2CO_3 \rightarrow 2CH_3CH_2OCONa + H_2O + CO_2$ **(2)**

1 mark for correct reactants and products.
1 mark for correctly balanced, states are not required.

ii. *acid-base reaction* **(1)**

e. **(2)**



f. To obtain full marks, students should focus on functional groups only which are present in the molecules, recognition of C-H or C-C bond should not receive marks as all organic compounds contain these bonds. **(4)**

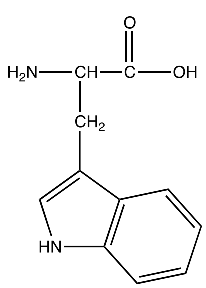
Compound A	*Alcohol - shows only a broad peak at ~ 3200 – 3600 cm^{-1} for -OH group*
Compound B	*Carboxylic acid – strong C=O peak at ~1700 cm^{-1} and broad peak at ~3000 cm^{-1} for O-H (acid)*
Compound C	*Ester – shows only a strong C=O peak at ~1700 cm^{-1}*
Compound D	*Carboxylic acid with a C-C double bond: strong C=O peak at ~1700 cm^{-1} and broad peak at ~3000 cm^{-1} for O-H (acid) as well as strong C=C peak at around 1650 cm^{-1}*

Question 8 (5 marks)

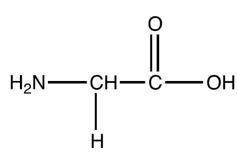
a. Peptide link*: -CO-NH-** **(1)**
Condensation reaction occurs between the -COOH group of one amino acid and the -NH_2 group from another amino acid/2, forming the peptide / amide bond and water*/2.* **(1)**

b. *Hydrolysis reaction using enzymes or acid.* **(1)**

c. Amino acids t*ryptophan* and *glycine* are in the data book and must be drawn correctly to obtain full marks. **(2)**



tryptophan



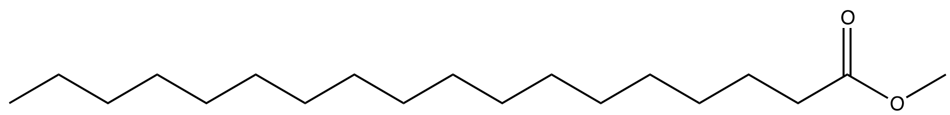
glycine

Question 9 (11 marks)

a. *O_2(g)* is reduced as its oxidation number decreases * from 0 in O_2 to -2 in O_2 / H_2O* **(2)**

b. *1.00 kg = 1.00 x 10^3 g*
*n(CO_2) = 1.00 x 10^3 / 142 = 7.04 mol **
V(CO_2) = nRT / p = (7.03 x 8.31 x 278K) / 100 kPa = 163 L (3 sig fig) ** **(3)**

c. **(2)**



Also accept semi-structural formula or condensed formula: *$CH_3(CH_2)_{16}COOCH_3$, $CH_3(CH_2)_{16}OCOCH_3$ or $CH_3OOC(CH_2)_{16}CH_3$*

d. *Biodiesel* will float on top as it is less dense then glycerol.*
*Glycerol (structure available from the data book) has a short carbon chain and 3 hydroxyl groups (-OH). Each -OH group can form strong hydrogen bonds to -OH groups of other glycerol molecules resulting in a tight packing and being more dense then esters.*OR
Methyl esters of fatty acids also have a polar ester group however in addition they have a very long non-polar carbon chain making the molecules overall non-polar. Intermolecular forces between methyl ester molecules are weak dispersion forces and therefore packing is much less dense.
1 mark for correct identification of biodiesel floating on top.
½ mark – identifying polarity of glycerol and methyl ester molecules.
½ mark – linking packing arrangement to density. Total: **(2)**

e. Advantage: Any **one** of the following: *Produces less toxic pollutants or less greenhouse gases; produced from renewable resources; grown, produced and distributed locally; biodegradable and less toxic etc.* **(1)**

Disadvantage: Any **one** of the following: *Not suitable for use in lower temperature; solidifies at low temperature; food shortage; fuel distribution; more biodiesel is required to produce the equivalent amount of energy than petrodiesel.* **(1)**

Question 10 (6 marks)

a. Independent: *Time* **(3)**
Dependant: *Concentration of glucose*
Control: any **one** of the following*: Temperature, concentration of enzyme, concentration of green pea solution / raffinose solution etc.*

b. *Calibrating the glucometer*/2 by measuring a series of glucose solutions with known concentrations and plotting a standard curve*/2.* **(1)**

c. ONE of: *Using more accurate measuring devices such as measuring cylinders, repetition of tests, use mass for peas rather than counting, accurate volumes of water, liquid from soaked split peas etc*.
(1)

d. ONE of: *Not leaving half the test tubes outside the water bath but rather keeping them all at a constant temperature, measuring the temperature of each test tube etc*. **(1)**

