

CHEMISTRY

PRACTICE EXAM SOLUTIONS 2019

Section A – Multiple-choice questions

Question	Answer	Notes
1	D	The forward reaction is exothermic. When temperature is increased the endothermic (reverse) reaction is favoured as the system tries to partially oppose the change. Since the reverse reaction is favoured $[\text{Cl}_2]$ will decrease.
2	B	During discharge oxidation occurs at the anode. Oxidation is the loss of electrons. Options C and D both show reduction half equations. Option A is incorrectly balanced.
3	B	$E(\text{protein}) = 17.4 \text{ g} \times 17.0 \text{ kJ g}^{-1} = 295.8 \text{ kJ}$ $E(\text{total}) = 295.8 \text{ kJ} + 13.3 \text{ g} \times 37.0 \text{ kJ g}^{-1} + 47.3 \text{ g} \times 16.0 \text{ kJ g}^{-1}$ $E(\text{total}) = 1544.7 \text{ kJ}$ $\% \text{protein} = \frac{295.8 \text{ kJ}}{1544.7 \text{ kJ}} \times 100\% = 19\%$ Many textbooks will say the energy content of carbs is 17.0 J g^{-1} . However, the data book provided by VCAA states it is 16.0 J g^{-1} .
4	C	A zwitterion has an protonated amino group, and a deprotonated carboxyl group. - Option A shows no ionisation - Option B shows a protonated carboxyl group - Option D shows a negative charge on the $=\text{O}$, which is incorrect
5	D	$\Delta H(\text{reverse reaction}) = \text{enthalpy of reactants} - \text{enthalpy of products}$ $\Delta H(\text{reverse reaction}) = 100 - 300 = -200$
6	A	$n(\text{O}_2) = \frac{5.2 \times 101 \times 0.150}{8.314 \times 298}$ $n(\text{O}_2) = 0.0318 \text{ mol}$ $m(\text{O}_2) = 0.0318 \text{ mol} \times 32.0 \text{ g mol}^{-1} = 1.0176 \text{ g} = 1.02 \text{ g}$
7	A	- II is incorrect since biodiesel has a higher cloud point than petrodiesel. - III is incorrect since biodiesel is considered to be more carbon neutral than petrodiesel - IV is incorrect as biodiesel is hygroscopic, petrodiesel is not
8	D	Need to use the Databook to identify these molecules.
9	C	- Option A is incorrect since coenzymes are often smaller than protein - Option B is incorrect since not all enzymes require coenzymes to function - Option D is incorrect as coenzymes do not denature enzymes
10	B	Whilst oxidation of a primary alcohol does at first produce an aldehyde, A is incorrect since the methyl groups are in the wrong position. Further oxidation will produce a carboxylic acid.

11	A	Option B: Whilst discharging and recharging will decrease battery life over time, it is unlikely that this will cause such a significant impact so soon. Options C and D are also both incorrect																				
12	B	Amylose is a long chain carbohydrate whereas amylopectin is highly branched. Food B has the lowest amount of amylopectin, which is responsible for the quick increase in blood glucose levels.																				
13	D	First re-arrange the two reactions so that 2NO_2 is a product of the first reaction and that 2NO is a product of the second reaction. Then add the two reactions together and simplify.																				
14	D	$n(\text{CO}_2) = \frac{14 \text{ L}}{24.8 \text{ L mol}^{-1}} = 0.565 \text{ mol}$ $n(\text{O}_2) = 1.625 \times 0.565 \text{ mol} = 0.918 \text{ mol}$ $m(\text{O}_2) = 0.918 \text{ mol} \times 32.0 \text{ g mol}^{-1}$ $m(\text{O}_2) = 29 \text{ g}$																				
15	D	A non-essential vitamin must be obtained through the diet as we can't synthesise these. Vitamin D is the only vitamin we can synthesise. This is explicitly stated in the study design.																				
16	A	<table><tr><td></td><td>NH_3</td><td>NH_4</td><td>OH</td></tr><tr><td>Initial (mol)</td><td>0.9</td><td>0</td><td>0</td></tr><tr><td>Change (mol)</td><td>- 0.1</td><td>+ 0.1</td><td>+ 0.1</td></tr><tr><td>Equilibrium (mol)</td><td>0.8</td><td>0.1</td><td>0.1</td></tr><tr><td>Equilibrium (concentration)</td><td>0.53</td><td>0.067</td><td>0.067</td></tr></table> $K = \frac{0.067 \text{ M} \times 0.067 \text{ M}}{0.53 \text{ M}} = 8.3 \times 10^{-3} \text{ M}$		NH_3	NH_4	OH	Initial (mol)	0.9	0	0	Change (mol)	- 0.1	+ 0.1	+ 0.1	Equilibrium (mol)	0.8	0.1	0.1	Equilibrium (concentration)	0.53	0.067	0.067
	NH_3	NH_4	OH																			
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Equilibrium (mol)	0.8	0.1	0.1																			
Equilibrium (concentration)	0.53	0.067	0.067																			
17	C	Narrow band between 2800 – 3000 represents C-H bonds. The band at around 1750 indicates a C=O (aldehydes).																				
18	B	- Option A is incorrect since catalysts increase the rate of both the forward and reverse reaction. - Option C is incorrect as K is a measure of the extent of the reaction, a catalyst does not change the extent. - Option D is incorrect as increasing the rate of the reaction will result in a system reaching equilibrium faster																				
19	D	$n(\text{C}_8\text{H}_{18}\text{O}) = \frac{42 \text{ g}}{130 \text{ g mol}^{-1}} = 0.323 \text{ mol}$ $E = 5294 \text{ kJ mol}^{-1} \times 0.323 \text{ mol}$ $E = 1709.962 \text{ kJ}$																				
20	D	$E(\text{Half Cell}) = 2.43 \text{ V} - 0.77 \text{ V}$ $E(\text{Half Cell}) = 1.66 \text{ V}$ A common mistake may be to select A. This is written as a reduction half equation, and the voltage is incorrect. Oxidation occurs at the anode.																				
21	C	III is incorrect since HPLC is much more accurate than traditional volumetric analysis (titration)																				

22	A	Since the stationary phase is polar, the mobile phase must be non-polar. Hexane is the most non-polar.
23	C	$c(\text{diluted}) = 50 \text{ mg/L} \rightarrow$ from the graph $m(\text{caffeine in aliquot}) = 50 \text{ mg L}^{-1} \times 0.050 \text{ L}$ $m(\text{caffeine in can}) = 2.5 \text{ mg} \times 330 = 825 \text{ mg}$
24	B	An optical isomer exists when there is a chiral carbon. In option B, Carbon number 3 is bonded to four different substituents.
25	B	- Option A is incorrect since proteins are not always found in a quaternary structure. - Option C is incorrect since low temperature will not denature a protein (just slow down the reaction rate so that the enzyme appears inactive) - Option D is incorrect since proteins can be denatured by non-optimal pH
26	C	$q = 50 \text{ K} \times 4.17 \text{ J g}^{-1}\text{K}^{-1} \times 260 \text{ mL} \times 0.997 \text{ g mL}^{-1} = 65\,012 \text{ J}$ Heat of combustion = $65\,012 \text{ J} / 0.05 \text{ mol} = 1300 \text{ kJ}$ The question states a 2-carbon gas with a heat of combustion of 1300 kJ. Ethanol is a liquid at SLC and ethene is not provided in the data book. Ethyne is the correct answer.
27	A	Strongest reductant is oxidised at the anode. H_2O is the strongest reductant present in the cell
28	C	$Q = 4.2 \text{ V} \times 300 \text{ s} = 1260 \text{ C}$ $n(e^-) = 1260 \text{ C} / 96\,500 \text{ C mol}^{-1} = 0.013 \text{ mol}$ $n(\text{Cu}) = 0.5 \times 0.013 \text{ mol} = 0.0065 \text{ mol}$ $m(\text{Cu}) = 0.0065 \text{ mol} \times 63.5 \text{ g mol}^{-1} = 0.4 \text{ g}$
29	D	Option D is the correct answer as HPLC is the most effective technique at determining the composition of an unknown solution of metal ions
30	B	$n(\text{Ag}) = 4.3 \text{ g} / 107.9 \text{ g mol}^{-1} = 0.03985 \text{ mol}$ $n(e^-) = 0.03985 \text{ mol}$ $Q = 0.03985 \text{ mol} \times 96\,500 \text{ C mol}^{-1}$ $Q = 3845.69 \text{ C}$ $t = 3845.69 / 6.2 = 620 \text{ seconds}$

Section B – Short-answer questions

Question 1 a.

Answer:

The major component in petrodiesel is a non-polar straight chain alkane, whereas the major component in biodiesel contains two polar hydroxyl groups. This means that biodiesel has stronger intermolecular forces due to its hydrogen bonds, compared to the weaker dispersion forces in petrodiesel. This results in biodiesel displaying greater viscosity than petrodiesel.

Notes:

- 1 mark for biodiesel will display greater viscosity than petrodiesel
- 1 mark for explanation of intermolecular forces of biodiesel
- 1 mark for explanation of intermolecular forces of petrodiesel

Question 1 b. i.

Answer:

$$E(\text{biodiesel}) = 62 \text{ L} \times 47 \text{ MJ L}^{-1} = 2914 \text{ MJ}$$

$$V(\text{petrodiesel}) = 2914 \text{ MJ} / 52 \text{ MJ L}^{-1} = 56 \text{ L}$$

$$m(\text{petrodiesel}) = 56 \text{ L} \times 1 \text{ kg L}^{-1} = 56 \text{ kg}$$

Notes:

- 1 mark for volume of petrodiesel
- 1 mark for mass of petrodiesel

Question 1 b. ii.

Answer:

$$V(\text{biodiesel}) = 395 \text{ MJ} / 47 \text{ MJ L}^{-1} = 8.4 \text{ L}$$

$$\text{Cost}(\text{biodiesel}) = 8.4 \text{ L} \times \$1.05 \text{ L}^{-1}$$

$$\text{Cost}(\text{biodiesel}) = \$8.82 \text{ per } 100 \text{ km}$$

$$V(\text{petrodiesel}) = 395 \text{ MJ} / 52 \text{ MJ L}^{-1} = 7.6 \text{ L}$$

$$\text{Cost}(\text{petrodiesel}) = 7.6 \text{ L} \times \$1.21 \text{ L}^{-1}$$

$$\text{Cost}(\text{petrodiesel}) = \$9.19 \text{ per } 100 \text{ km}$$

Therefore, biodiesel is cheaper

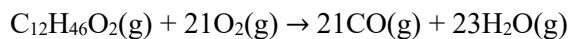
Notes:

- 1 mark for calculating volume
- 1 mark for calculating cost
- 1 mark for biodiesel is cheaper

Note: you may show the cost for 880 km, however anything that shows biodiesel is cheaper than petrodiesel per any distance is equally acceptable.

Question 1 c.

Answer:

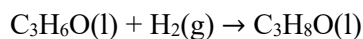


Notes:

You must include correct states, however water may be a liquid or a gas.

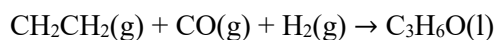
Question 2 a. i.

Answer:



Question 2 a. ii.

Answer:



Question 2 b.

Answer:

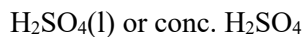
It must be propan-1-ol, a primary alcohol. When a primary alcohol undergoes oxidation, it can produce an aldehyde.

Notes:

- 1 mark for must be a primary alcohol
- 1 mark for oxidation forms aldehyde

Question 2 c. i.

Answer:



Question 2 c. ii.

Answer:

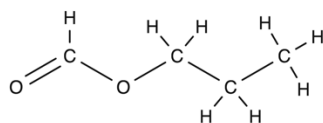


Notes:

- 1 mark for correctly balanced equation
- 1 mark for states

Question 2 c. iii.

Answer:



Propyl methanoate

Notes:

Any suitable answer that matches **part ii** is acceptable.

Question 3 a.

Answer:

	SO ₂	O ₂	SO ₃
Initial (mol)	0.200	0.900	0
Change (mol)	- 0.150	- 0.075	+ 0.150
Equilibrium (mol)	0.050	0.825	0.150
Equilibrium (concentration)	0.033 M	0.55 M	0.1 M

$$K = \frac{[0.1M]^2}{[0.033M]^2[0.55M]}$$
$$K = 17 \text{ M}^{-1}$$

Notes:

- 1 mark for correct concentrations at equilibrium
- 1 mark for correct K equation
- 1 mark for correct K value
- 1 mark for 2 sig figs

Question 3 b.

Answer:

1. Decrease the volume of the vessel. This will increase the pressure and the side with less gas particles will be favoured (the forwards reaction).
2. Continually remove product. This will favour the forwards reaction as the system tries to partially oppose the change by adding product

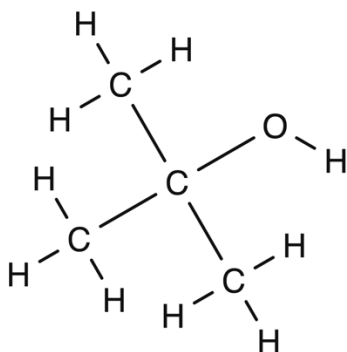
Notes:

- 1 mark for each appropriate answer
- 1 mark for each suitable explanation

Other potential answers include adding more reactants, and increasing pressure.

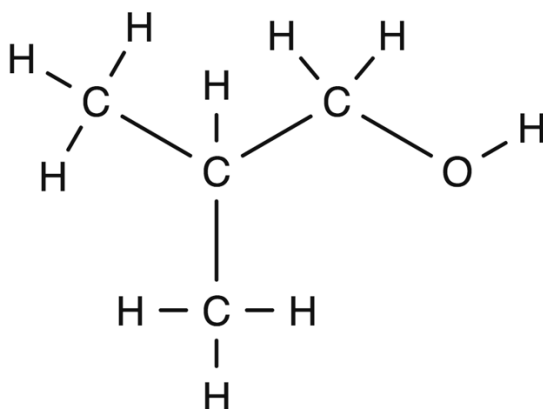
Question 4 a. i.

Answer:



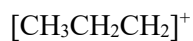
Question 4 a. ii.

Answer:



Question 4 b. i.

Answer:



Notes:

You must include the positive charge to get the mark here.

Question 4 b. ii.

Answer:

The isomer is likely butan-1-ol since it has a molar mass of 74 g mol^{-1} which corresponds to peak at 74 m/z .

Notes:

- 1 mark for Identifying butan-1-ol
- 1 mark for 74 m/z and 74 g mol^{-1}

Question 4 b. iii.

Answer:

A butan-1-ol consisting of a ^{13}C instead of a ^{12}C .

Question 4 c.

Answer:

Butan-1-ol

Any of:

- 4 peaks correspond to 4 different carbon environments
- Shift at approx. 63ppm corresponds to $\text{R-CH}_2\text{-OH}$
- 5 peaks correspond to 5 different hydrogen environments (HNMR)
- Peak at 3.6 ppm corresponds to $\text{R-CH}_2\text{-OH}$ (HNMR)

Question 5 a. i.

Answer:

Glucose

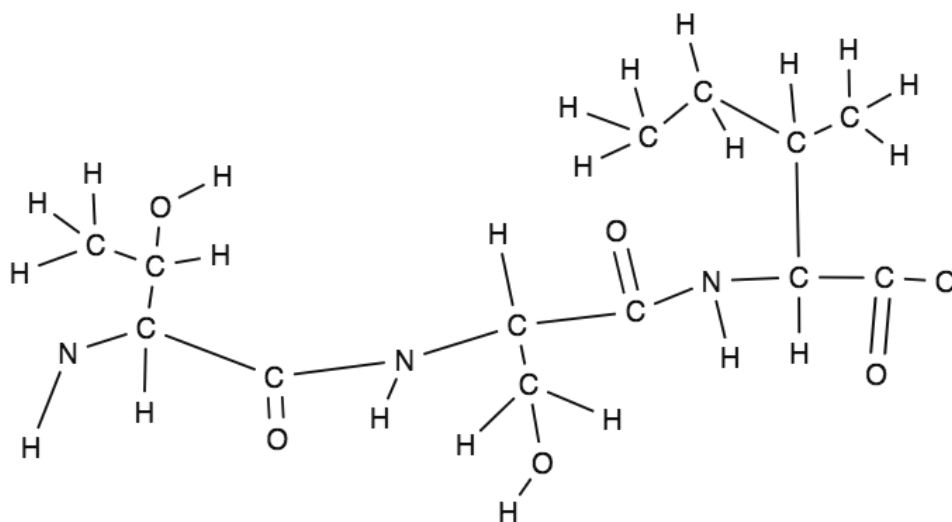
Question 5 a. ii.

Answer:

Glycosidic linkages

Question 5 b. i.

Answer:



Notes:

- 1 mark for the Threonine segment, with only 1 hydrogen on the nitrogen
- 1 mark for the Serine segment
- 1 mark for the Isoleucine segment with only one hydrogen on the terminal oxygen

Note: empty bonds may be shown on the end of the nitrogen and oxygen as well, or anything else that indicates this is part of a larger segment

Question 5 b. ii.

Answer:

The primary structure consists of covalent intramolecular bonds between carbon and nitrogen that form the peptide linkages. The secondary structure is determined by hydrogen bonding between O ($-C=O$) and H (N-H) on different peptide groups in the alpha-helix or beta-pleated sheet.

Notes:

- 1 mark for primary structure consists of covalent bonds
- 1 mark for secondary structure consists of hydrogen bonds
- 1 mark for secondary structure as either alpha-helix or beta-pleated sheets

Question 5 b. iii.

Answer:

Non-essential amino acids can be synthesised in the body. Whereas, essential amino acids can't be synthesised in the body and so must be obtained through diet.

Notes:

- 1 mark for explanation of essential
- 1 mark for explanation of non-essential

Question 6 a. i.

Answer:

Both palmitic acid and lauric acid are capable of hydrogen bonding and dispersion forces. However, since palmitic acid is a longer molecule it has stronger dispersion forces than lauric acid, resulting in a higher boiling point.

Notes:

- 1 mark reference to structure (size)
- 1 mark reference to bonding (intermolecular forces, dispersion)

Question 6 a. ii.

Answer:

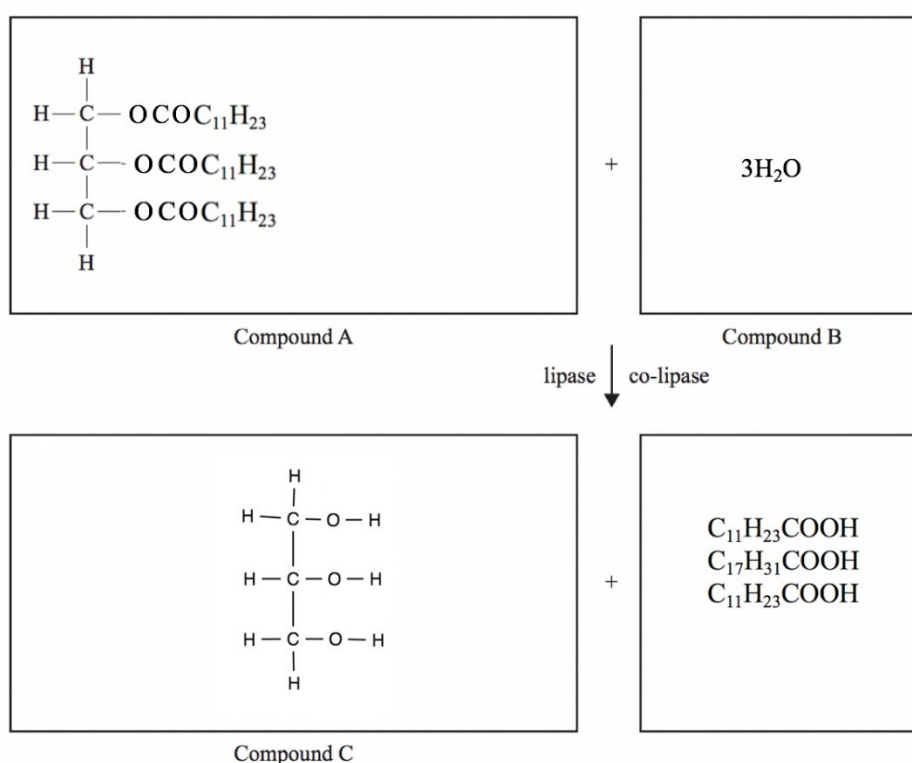
Both lauric acid and linolenic acid are capable of hydrogen bonding and dispersion forces. However linoleic acid is an unsaturated fatty acid. This double bond alters the shape of the molecule, preventing it from packing as tightly as lauric acid, resulting in a lower boiling point.

Notes:

- 1 mark reference to structure (double bond)
- 1 mark reference to bonding (intermolecular forces, hydrogen and dispersion)

Question 6 b.

Answer:



Question 6 c.

Answer:

Enzymes, such as lipase, are biological catalysts. Coenzymes, such as colipase, bind to the enzyme and alter the shape of its active site. This then allows for the substrate to bind to the enzyme, thus speeding up the rate of reaction.

Notes:

- 1 mark coenzymes alter shape of active site
- 1 mark this allows substrate to bind

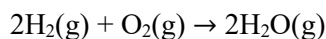
Question 7 a.

Answer:

An electrolyte facilitates the movement of ions from one electrode to another.

Question 7 b.

Answer:



Notes:

Note: all states must be (g).

Question 7 c.

Answer:

- Air in the atmosphere is not pure oxygen. This means that the car is receiving impurities along with its oxygen as an input into the fuel cell, this results in a lower than expected voltage.
- The voltage was based off of the electrochemical series, which is determined at SLC. If the concentration of fuels in the fuel cell was lower than 1 M, the voltage may be lower.
- The electrolyte may have not been suitable. This means that hydrogen ions were not able to sufficiently transfer across to the other electrode, preventing the cell from operating efficiently.

Notes:

Any of the above examples would be acceptable.

Question 7 d.

Answer:

Advantage:

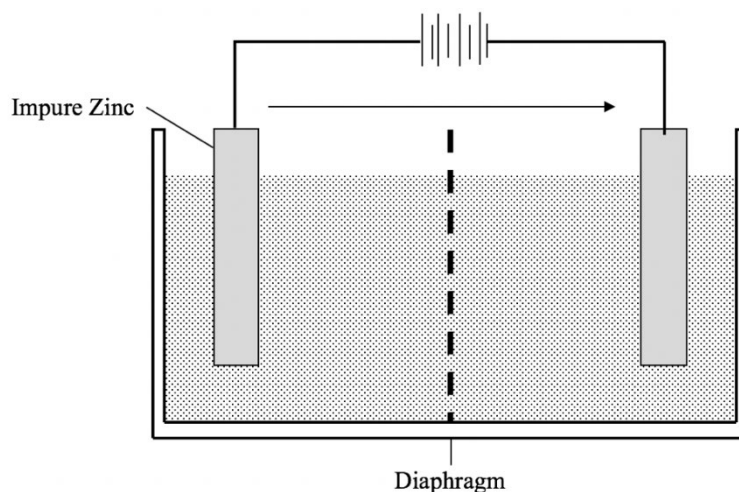
- H_2O is produced instead of CO_2 or CO
- Greater energy efficiency

Disadvantage:

- H_2 is dangerous and difficult to store
- Existing infrastructure is designed for petrol and not H_2

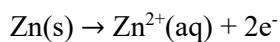
Question 8 a.

Answer:



Question 8 b.

Answer:



Question 8 c. i.

Answer:



Question 8 c. ii.

Answer:

$$Q = 10 \times 6 \times 9.5 = 570 \text{ C}$$

$$n(\text{e}^{-}) = 570 \text{ C} / 96\,500 \text{ C mol}^{-1} = 0.00591 \text{ mol}$$

$$n(\text{Zn}) = 0.00591 \text{ mol}$$

$$m(\text{Zn}) = 0.00591 \text{ mol} \times 64.5 \text{ g mol}^{-1} = 0.39 \text{ g}$$

Notes:

- 1 mark calculate charge
- 1 mark calculate mol of zinc
- 1 mark calculate mass of zinc

Question 8 d.

Answer:

Pure zinc could be used at the cathode. This would allow for the zinc from solution to deposit on the zinc cathode. This will result in a larger piece of pure zinc. Whereas use of other metals would result in a cathode electroplated in zinc that would need to be further refined.

Notes:

- 1 mark correctly identify zinc as the cathode
- 1 mark zinc from solution will deposit at the cathode
- 1 mark other cathodes would need to be further refined

Question 9 a.

Answer:

Concentration of hydrogenase

Question 9 b.

Answer:

Temperature, as it may increase the reaction rate or denature the enzyme.

Question 9 c.

Answer:

There may have been insufficient substrate. This would result in less collisions between the substrate and the enzyme, resulting in a lower reaction rate.

Question 9 d.

Answer:

1. Random error in the pressure sensor may result in decreased accuracy
2. The volume of the tube was not recorded with the volume of the chamber. This will result in decreased accuracy as there will be gas in the tube that is not correctly measured.

Notes:

- You would get 1 mark for each correctly identify factor (2 marks in total)
- You would get 1 mark for each suitable explanation (2 marks in total)

Question 9 e.

Answer:

The concentration of hydrogenase was increased in fairly large increments. This could be addressed by increasing it smaller increments for better precision.

Notes:

- 1 mark correctly identify limitation
- 1 mark suitable solution to address limitation

Question 9 f.

Answer:

As H_2 is a highly flammable gas, no naked flames should be present around the experimental set up, as this may result in an explosion/fire.

Notes:

- 1 mark correctly identify safety hazard
- 1 mark suitable precaution to safety hazard

Question 10 a.

Answer:

Any one of the following would get you 1 mark:

- Fuel cells used to power electric engines are more efficient than combustion engines
- Significantly less greenhouse gas emissions in electric vehicles (both fuel cells and secondary cells)
- Secondary cells take a while to recharge, whereas petrol engines can be filled up quickly
- Secondary cell battery life will decrease over time (will need to be replaced whereas a fuel tank in a petrol-powered car doesn't need to be replaced)
- Infrastructure already in place for petrol engines, not yet widely available electric engines
- Battery life of electric cars will decrease in cold temperatures, petrol engines not affected as greatly
- Dangers of storing hydrogen for hydrogen fuel cell powered cars
- Hydrogen is colourless and odourless, if there was to be a hydrogen leak from a car it would be hard to detect, which pose a risk of fire/explosion. Whereas you can see and smell petrol if it is leaking from a car.

Question 10 b.

Answer:

Any one of the following would get you 1 mark:

- Use biofuels to generate electricity to charge cars
- Use solar power, wind turbines, hydro etc
- Use hydrogen fuel cells