§

Engage Education Foundation

Units 3 and 4 Chemistry

Practice Exam Solutions

Stop!

Don't look at these solutions until you have attempted the exam.

Found a mistake?

Check the Engage Education website for updated solutions, then email practiceexams@ee.org.au.

Want to have your exam marked for you?

Visit www.engageeducation.org.au/exam-marking for more information.

Section A – Multiple-choice questions

Question 1
The correct answer is D.

Question 2
The correct answer is D.

Question 3
The correct answer is D.

Question 4
The correct answer is D.

Question 5
The correct answer is C.

Question 6
The correct answer is D.

Question 7
The correct answer is B.

Question 8
The correct answer is A.

Question 9
The correct answer is A.

Question 10
The correct answer is D.

Question 11
The correct answer is D.

Question 12
The correct answer is D.

Question 13
The correct answer is C.

Question 14
The correct answer is B.

Question 15
The correct answer is D.

Question 16
The correct answer is C.

Question 17
The correct answer is A.

Question 18
The correct answer is D.

Question 19
The correct answer is C.

Question 20
The correct answer is C.

Question 21
The correct answer is C.

Question 22
The correct answer is B.

Question 23
The correct answer is A.

Question 24
The correct answer is B.

Question 25
The correct answer is A.

Question 26
The correct answer is B.

Question 27
The correct answer is D.

Question 28
The correct answer is D.

Question 29
The correct answer is B.

Question 30
The correct answer is B.

Section B – Short-answer questions

Marks allocated are indicated by a number in square brackets, for example, [1] indicates that the line is worth one mark.

Question 1a

	Brief Description
Primary	The specific sequence of amino acids
Secondary	Hydrogen bonding between carboxy (C=O) and amine (N–H) groups of aligned amino acids forming alpha helices and beta sheets
Tertiary	Determines the overall 3D shape of the enzyme and is maintained by the interactions between the R-groups (includes hydrogen bonding, disulfide bridges, etc). The catalytic activity of an enzyme often depends on its tertiary structure.

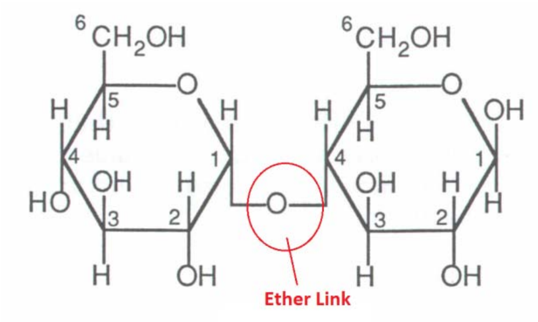
Question 1b

Experiment A: Heating an enzyme will increase the rate of reaction that the enzyme is catalysing but after 40° most enzymes in the human body will denature. Temperature affects the tertiary and secondary structure by breaking bonds between amino acids.

Experiment B: Each enzyme has its own optimum pH but most enzymes denature at very low pHs. The shape of their active site (tertiary structure) changes and they can no longer be functional.

Question 2a

Maltose is made from a condensation reaction between 2 glucose molecules:



Question 2b

H_2O – disaccharides are formed through condensation reactions so water has to be a product.

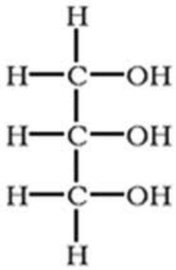
Question 2c

$M(C_6H_{12}O_6)$ = 180g/mol
When 9 molecules come together, 8 molecules of water are produced.
M(polysaccharide) = (9 x 180) – (8 x 18) = 1476g/mol
m(polysaccharide) = 1476 x 0.12 = 177.12g = 177g (correct to 3 sig figs)

Question 3a

Water is a polar. Fatty acids have a polar head (the carboxyl group) but a long non polar chain. This means that majority of the fatty acid molecule is hydrophobic. So it is unlikely that the long fatty acids will be soluble.

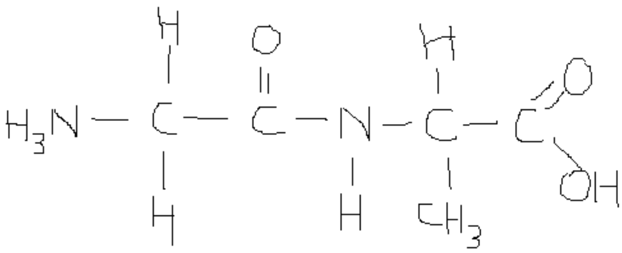
Question 3b
Glycerol

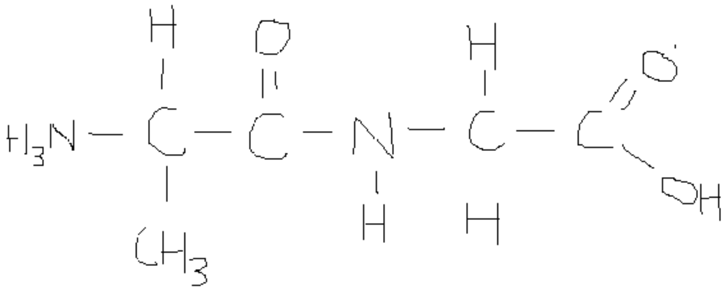


Question 4a
In a high pH environment amino acids act as acids. They do so by donating a hydrogen ion and developing an overall negative charge.

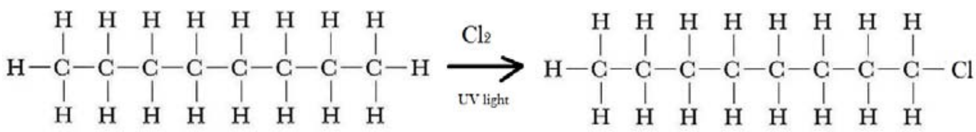
Question 4b
Zwitterion

Question 4c

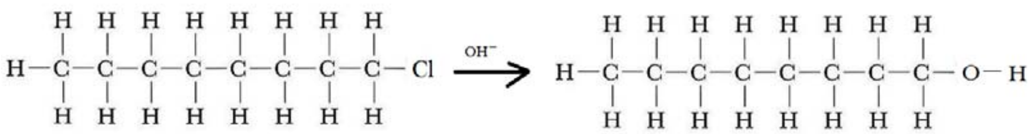




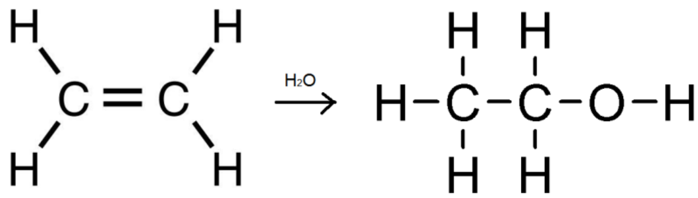
Question 5a
Octane + Cl_2 → 1-chloro-octance



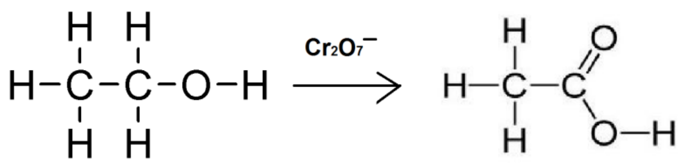
1-chloro-octance + OH^- → 1-Octanol



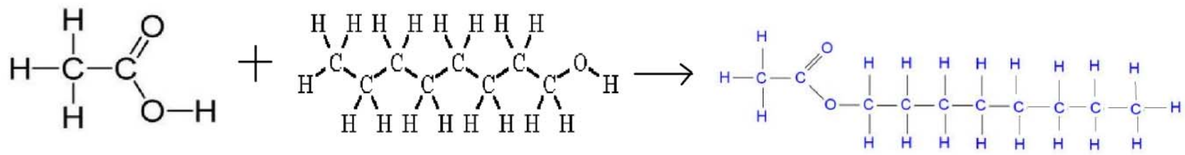
Ethene + H_2O → Ethanol



Ethanol + $Cr_2O_7^-$ →Ethanoic acid



Ethanoic acid + octanol → octyl ethanoate



Question 5b
Octyl Ethanoate

Question 6a
If the biscuit is 37% water then it has to 100-37= 63% biscuit.
63% of 5.6g = 3.528g = 3.5g (correct to 2 significant figures)

Question 6b
Table salt has the chemical formula NaCl. The metal element will therefore be sodium.

Question 6c
The reaction that takes place between NaCl and KNO_3 is as follows:
$NaCl\ (aq) + KNO_3\ (aq) \rightarrow NaNO_3\ (aq) + KCl\ (aq)$ [1]
The student has been successful in making a new compound of sodium but sodium nitrate is aqueous. This means that he will be unable to measure the amount of sodium as it does not precipitate. Therefore he will not be successful in calculating the amount of salt. [1]

Question 6d
Chlorine

Question 6e
$2NaCl\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow PbCl_2\ (s) + 2NaNO_3\ (aq)$

Question 6f
$m(PbCl_2) = 1.3g$
$M(PbCl_2) = 207.2 + 35.5 + 35.5 = 278.2$
$n(PbCl_2) = 1.3/278.2 = 0.0047$ mol (correct to 2 significant figures) [1]

$n(NaCl) = 2 \times n(PbCl_2) = 2 \times .004672897 = 0.0093$ mol (correct to 2 sf) [1]
$m(NaCl) = 0.0094579439 \times (35.5 + 23) = 0.5467 = 0.55g$ (correct to 2 sf) [1]

m(biscuit) = 3.258g (from 7a)
% salt = (.5467/3.258) x 100 = 16.78% = 17% (correct to 2 sf) [1]

Question 6g
Other impurities in the biscuit solution were also precipitated. [1]
If the mass of the precipitate is higher the mol amount of salt will also be higher which would lead to a larger mass of salt, so a larger percentage of salt in the biscuit. [1]

Question 7a

Sample	Mean mass of sample (g)	Mean Absorbance	Iron Concentration (mg/L)
Fat Tony's concrete	0.4080	0.2695	38.83
Concrete Factory 1	0.4066	0.2002	28.63
Concrete Factory 2	0.4338	0.2730	39.35

1 mark is awarded for calculating the means, and 1 mark is awarded for calculating the concentrations.

Question 7b
Concrete Factory 2

Question 7c
c(Fe in CF1) = 28.63 mg/L
m(Fe) = 28.63 x 0.100mL = 2.863mg = 0.002863g [1]
m(original sample of concrete) = 0.4066g
%(Fe in concrete) = (0.002863/0.4066) x 100 = 0.704% [1]

Question 7d
The iron cathode lamp was used so that the photons of light emitted onto the concrete sample corresponded to the specific quanta of energy that could be absorbed by iron atoms to promote electrons to an excited state. [1]

After excitation, the electrons return from an excited state to their ground state. [1] When this occurs, light energy of a specific photon (in the case of iron, corresponding to an orange colour) is emitted. [1]

Question 8a
O_2 was added to the container. [1]

Question 8b
A = SO_3

B = SO_2 [1]

Students must identify both A and B to obtain the full mark.

Question 8c
As O_2 is added, the position of equilibrium moves to the right (there is a net forward reaction), so the amount and concentration of SO_3 (or A) increases [1] whereas the amount and concentration of SO_2 (or B) decreases. [1]

The concentration of O_2 decreases between 60 and 90 minutes but there is still a net increase in concentration of O_2 than its original concentration at 0 minutes. [1]

Question 8d
Between 60 and 90 minutes, there is a net forward reaction. The forward reaction is exothermic, [1] so the temperature of the mixture would increase. [1]

Question 9a
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

$Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$

Overall reaction - $Cu^{2+}(aq) + Ni(s) \rightarrow Cu(s) + Ni^{2+}(aq)$ [1]

Cell potential (E^o) = E^o cathode – E^o anode

= 0.34 – (-0.23)

= 0.57 [1]

Question 9b
m(Cu) = 0.395g

n(Cu) = 0.395/63.5 = 6.22×10^{-3}mol

n(Ni) lost = n(Cu) formed = 6.22×10^{-3}mol [1]

m (Ni) lost = $6.22 \times 10^{-3} \times 58.7$ = 0.365g [1]

m(Ni) final = 8.34g – 0.365 = 7.97g [1]

Question 9c
Initial amount of Ni^{2+} = 0.100 x 0.100 = 0.0100mol

n(Ni^{2+}) formed = 6.22×10^{-3}mol

n(Ni^{2+}) final = 0.0100 + (6.22×10^{-3}) = 0.01622 mol [1]

final concentration = 0.01622/0.100 = 0.162M [1]

Question 10a
Le Chatelier's principle states: if an equilibrium system is subjected to an external change the system will adjust itself to partially oppose the effect of the change. [2]

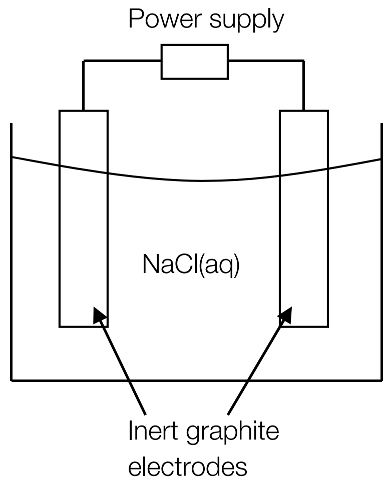
Question 10b
Step 1 – this is a very exothermic reaction, so low temperatures would shift equilibrium to the right. However this reaction is carried out at a higher temperature (900°C – rather than low) to ensure an acceptable reaction rate. To compensate for the higher temperature used, the reaction should be carried out at low pressure, as the product side has fewer molecules than the reactant side. An appropriate catalyst would also increase rate of reaction and should therefore be used. Removing NO(g) as it forms would also push equilibrium to the right.

Step 2 – this reaction is not as exothermic as step 1 so a lower temperature will not have a large impact on yield, though it will still push equilibrium to the right. High pressure would also favour the forward reaction as the product side has fewer molecules. A suitable catalyst should be used and NO2 should be continuously removed to keep the reaction proceeding in the forward direction.

Step 3 – this is not an equilibrium reaction, so changes in temperature and pressure will not affect yield, despite the reaction being exothermic. However, increase in temperature will increase the rate of reaction.

Students were awarded [2] for each separate point they made for each step, as a number of points could be made.

Question 11a



[1 for drawing both electrodes in the same container, 1 for labels]

Question 11b
At low concentrations of NaCl, water is preferentially oxidised and reduced.

Positive electrode (anode):

$H_2O(l) \rightarrow \frac{1}{2} O_2(g) + 2H^+ (aq) + 2e^-$ [1]

Bubbles are observed because oxygen gas is produced. The litmus paper is red because hydrogen ions are produced (acidic environment). [1]

Negative electrode (cathode):

$H_2O(l) \rightarrow \frac{1}{2} H_2(g) + OH^-(aq)$ [1]

Bubbles are observed because hydrogen gas is formed. The litmus paper is blue because hydroxide ions are produced (basic environment). [1]

Question 11c
An electrolytic cell requires a power source to operate and converts electrical energy into chemical energy. [1]

A galvanic cell operates spontaneously and converts chemical energy into electrical energy. [1]

Question 12a
Aluminium is a more reactive metal than silver. When both metals are in contact in an electrolyte, the solution forms a galvanic cell. [1]

The tarnish on the cutlery is a silver compound so it is converted back to solid silver according to the following equations:

$Al (s) \rightarrow Al^{3+} (aq) + 3e^-$ [1]

$Ag^+ (aq) + e^- \rightarrow Ag (s)$ [1]

Overall: $Al (s) + 3 Ag^+ (aq) \rightarrow Al^{3+} (aq) + 3Ag (s)$ [1]

Question 12b
This method does not wear away the silver surface [1], as other polishing methods do. Additionally, the materials needed are readily available in a domestic environment (sodium hydrogen carbonate (sodium bicarbonate) is baking soda).

Question 13a
$K = [OH^-][H_3BO_3]/[B(OH)_4^-]$ [1]

Question 13b
$pH = -\log_{10}[H^+]$

$[H^+] = 10^{-pH} = 10^{-11.11} = 7.76 \times 10^{-12}$ M [1]

$[OH-] = 10^{-14}/10^{-11.11} = 1.29 \times 10^{-3}$M [1]

Question 13c
$[H_3BO_3] = [OH^-] = 1.29 \times 10^{-3}$M [1]

Question 13d
$K_a = 7.76 \times 10^{-12} \times 0.100 / 1.29 \times 10^{-3} = 6.01 \times 10^{-10}$ M [1]

Question 14a
$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$; $\Delta H = -1364$ kJ mol^{-1}

[1] for the balanced equation with states, [1] for the change in enthalpy value

Question 14b
Total energy needed = 8 x 200 x 10^3 kJ = 1.6 x 10^6 kJ [1]

$n(CH_3CH_2OH)$required = 1.6 x 10^6 /1364 = 1173.02mol [1]

$m(CH_3CH_2OH)$required = 1173.02 x 46 = 53958.94g = 54.0kg [1]

Question 14c
Anode reaction = $CH_3CH_2OH(aq) + 3H_2O(l) \rightarrow 2CO_2(g) + 12H^+(aq) + 12e^-$ [1]

Cathode reaction = $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ [1]

Question 14d
Q = n(e-) x F = 12 x 96500 = 1158000 [1]

Energy = V x Q = 1.15 x 1158000 = 1.33 x 10^6 J [1]

Question 14e
A fuel cell is more efficient at producing energy [1]. It also produces less pollution.

Question 15a
Anode reaction: $2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$ [1]

Cathode reaction: $Na^+(l) + e^- \rightarrow Na(l)$ [1]

Question 15b
The iron mesh prevents chlorine gas formed at the anode coming into contact with sodium formed at the cathode. If the two were allowed to come into contact, they would spontaneously react to reform NaCl. [1]

Question 15c
Q = t x I = 1.00 × 10^4 x 96.5 = 9.65 x 10^5C [1]

$n(e^-)$ = 9.65 x 10^5/96500 = 10

$n(Cl_2)$ = ½ $n(e^-)$ = 5 mol [1]

$V(Cl_2)$ = 5 x 22.4 = 112L [1]