Engage Education Foundation

Units 3 and 4 Chemistry

Practice Exam Solutions

Stop!

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

Any questions?

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

Section A – Multiple-choice questions

Question 1

The correct answer is B.

2.8/100.1= .028mol of $CaCO_3$

Ratio of $CaCO_3$ to $(NH_4)_2CO_3$ is 1:1.

0.028 x molar mass of $(NH_4)_2CO_3$ (96g/mol)= 2.69g

Question 2

The correct answer is C.

Question 3

The correct answer is D.

Option D has the highest acid and reactant concentrations, and the lowest product concentrations.

Question 4

The correct answer is D.

Number of mole of $BaCl_2$ = 0.0148 x 0.25= 0.0037mol

Ratio of $AgNO_3$:$BaCl_2$ is 2:1. Therefore .0074mol of $AgNO_3$ reacted with $BaCl_2$.

Initial amount of $AgNO_3$ is 5/169.9= .0294mol.

0.0294-0.0074=0.022mol of $AgNO_3$ that reacted with $Ca(OH)_2$.

Ratio of $AgNO_3$: $Ca(OH)_2$ is 2:1

Number of mole of $Ca(OH)_2$ is 0.011mol.

0.011/0.1 = 0.11M

Question 5

The correct answer is B.

pV=nrt → 101.3= nx8.31x373 → n=0.327mol

After the changes: px2= 0.327 x 8.31 x 323 → p= 438.86kPa

438.86/101.3= 4.3atm

Question 6

The correct answer is D.

Question 7

The correct answer is C.

Question 8
The correct answer is A.

6.02g of C= 0.5017mol of C

0.67g of H= 0.67mol of H

Ratio of C:H = 3:4

Question 9
The correct answer is D.

Question 10
The correct answer is A.

Question 11
The correct answer is C.

Question 12
The correct answer is A.

Question 13
The correct answer is A.

Question 14
The correct answer is B.

Question 15
The correct answer is D.

Question 16
The correct answer is B.

The wavelength that should be used should have the least interference from the absorption of compound 1. Therefore, the answer is 310nm.

Question 17
The correct answer is C.

Look at the mass of the heaviest peak, which will be the molar mass of the compound. Option A,B and D don't have a molar mass of 88g/mol. Therefore the answer is C.

Question 18
The correct answer is A.

Question 19
The correct answer is D.

The positions on the electrochemical series only describe whether a reaction will occur or not, and not the rate of that reaction.

Question 20
The correct answer is D.

In reaction 1: The lack of precipitate shows that the X(s) is being oxidised, and so is a stronger reductant then the $Y^{2+}(aq)$.

In reaction 2: The gas produced shows that the $Z^{-}(aq)$ is being oxidised, and so is a stronger reductant than the $Y^{2+}(aq)$.

In reaction 3: The precipitate shows that the $X^{+}(aq)$ is being reduced, and so X(s) is a weaker reductant than $Z^{-}(aq)$

Therefore, $Z^{-}(aq)$ is the strongest reductant.

Question 21
The correct answer is C.

The electrochemical series produced from the reactions are as follows

$Y^{3+}(aq) + e^{-} \rightarrow Y^{2+}(aq)$

$X^{+}(aq) + e^{-} \rightarrow X(s)$ E0= -0.29V

$Z_2(g) + 2e^{-} \rightarrow 2Z^{-}(aq)$

Only $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ has an E0 value greater than -0.29V. Therefore, the answer is Ag^{+}.

Question 22
The correct answer is A.

Question 23
The correct answer is D.

Proteins contain CHON and sometimes S.

Question 24
The correct answer is C.

Molar mass of Cysteine is 121.1g

121.1 x 10= 1211g.

9 water molecules are lost in the condensation reactions.

1211-(9 x 18) = 1049g

Question 25
The correct answer is C.

Question 26
The correct answer is C.

3 x 2.5 x 60 = 450J

450/8.3= 54.2

Question 27
The correct answer is A.

Question 28
The correct answer is B.

5 x 2 x 60= 600C.

600/96500= .0062mols of electrons

Ratio of electrons: M deposited is 2:1

Question 29
The correct answer is D.

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

Reduction half equation: $I_2 + 2e^- \rightarrow 2I^-$ [1]

Full equation: $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ [1]

Question 1b

$n = cv$

$n = 0.200 \times \frac{25}{1000} = 0.00500 \text{ mol}$ [1]

Question 1c

Mole of S_2O_3 in titre:

$n = cv$

$n = 0.100 \times \frac{15}{1000} = 0.0015 \text{ mol}$ [1]

From full equation, 2 mol S_2O_3 for each I_2, thus

Mole I_2 = 0.00075 mol [1]

Question 1d

0.00075 mol I_2 came from excess 0.00075 mol ICl [1]

Thus,

$n(ICl) \text{ used} = 0.00500 - 0.00075 = 0.00425 \text{ mol}$ [1]

Question 1e

$n(ICl) = 0.00425 = n(I_2)$ that would have reacted with C=C [1]

$m(I_2) = n \times Molar\ Mass = 0.00425 \times 253.8 = 1.079 \text{ g}$ [1]

This is for 5.00 g of margarine, so per 100g:

Iodine number = $\frac{1.079}{5.00} \times 100 = 21.6$ [1]

Question 1f

One mark for each of the correct answers:

	No effect	Increase Iodine Number	Decrease Iodine Number
0.500M ICl was used, not 0.200M			X
The titration overshot by 2.0 ml			X
The burette used for the titration was washed with water and not dried			X
100ml of 1.0 M KI solution was added not 50ml	X		

Question 2a

$K_a = \frac{[H^+][OBr^-]}{[HOBr]}$ [1]

Question 2b

A conjugate base is the deprotonated form of the acid [1]

Question 2c

$K_2 = \frac{1}{K_a} = \frac{1}{2.4\times10^{-9}} = 4.2 \times 10^8 M^{-1}$ [1]

The difference in values between K_a and K_2 indicate that HOBr does not easily lose a proton (therefore is a weak acid), however the conjugate base (OBr^-) readily reforms HOBr. [1]

Question 2d

A catalyst is a compound that is not used up in the reaction [1], which speeds up the reaction. [1]

Question 2e

No effect on acid strength.[1] Acid strength is influenced by the K_a value, and as a catalyst speeds up the forward reaction to the same extent as it speeds up the reverse reaction, it has no effect on K_a. [1]

Question 2f

$[OBr^-] = \frac{0.00200}{5.00} = 0.0004M$[1] $= [H^+]$ [1]

$$2.4 \times 10^{-9} = \frac{0.0004 \times 0.0004}{[HOBr]}$$

$[HOBr] = 67M$ [1]

Question 2g

$n(HOBr)_{equilibrium} = c \times V = 67 \times 5.00 = 333.33mol$ [1]

$n(HOBr)_{reacted} = n(OBr^-)_{formed} = 0.00200mol$ [1]

$n(HOBr)_{initial} = n(HOBr)_{equilibrium} + n(HOBr)_{reacted} = 333.33 + 0.00200 = 333.335mol = 3.3 \times 10^2 mol$ [1]

Question 3a
W=2, X=7, Y=4, Z=6

[1] mark for W and X, [1] mark for Y and Z. (also accept W=1, X=3.5, Y=2, Z=3)

Question 3b
Carbon monoxide [1]

Carbon [1]

Question 3c
20.0L [1]

Question 4a
$E = V \times I \times t = 2.0 \times 3.5 \times 1 \times 60 = 420J$[1]

$CF = \frac{E}{\Delta T} = \frac{420}{1.38} = 304J°C^{-1}$ [1] for correct answer, [1] for correct units.

Question 4b
$E = CF \times \Delta T = 304 \times (24.78 - 20.33) = 304 \times 4.45 = 1352.8J = 1.35kJ$ [1]

$n(propene) = \frac{pV}{RT} = \frac{101.3 \times 0.100}{8.31 \times (273+20.33)} = 0.00416mol$ [1]

$\Delta H = \frac{E}{n} = \frac{1.35}{0.00416} = 326kJ\ mol^{-1}$ [1] and [1] mark for correct units

Question 4c
$n(propene) = \frac{V}{V_M} = \frac{20.0}{24.5} = 0.816mol$ [1]

$E = \Delta H \times n = 326 \times 0.816 = 266kJ$ [1]

Question 4d
$\Delta T = 100 - 20 = 80$℃ [1]

$m(water) = \frac{E}{specific\ heat\ capacity \times \Delta T} = \frac{266122}{4.18 \times 80} = 796g$ [1]

$V(water) = \frac{mass}{density} = \frac{796}{1} = 796ml$ [1]

Question 4e
Because not all of the heat would be transferred from the burning propene to the water, 20.0L of propene would practically not be enough to heat up 796ml of water to boiling point from 20°C. [1]

Question 5a
More than one answer is acceptable for this question.

One such answer is:

Advantage: Coal is relatively easy to access [1]

Disadvantage: Coal is not renewable [1]

Question 5b
Because biochemical fuels are derived from plants which capture carbon dioxide from the atmosphere, their burning is said to be 'carbon neutral'. 1 mark for "carbon neutral", 1 mark for explanation

Question 6a
Bases are (from left to right): thymine, cytosine, adenine [1]

Question 6b
Adenine, guanine, thymine [1]

Question 6c
Hydrogen bonding [1]

Question 6d
2 [1]

Question 6e
Uracil has a similar structure to thymine, with a hydrogen where the methyl group in thymine is. [1]

Due to the similar structures they will have similar reactivity – both bonding with deoxyribose to form a nucleotide, and forming two hydrogen bonds with adenine in double-stranded DNA. [1]

Question 7a
$2Ni(OH)_{2\,(aq)} + Cd(OH)_{2\,(aq)} \rightarrow 2NiO(OH)_{(aq)} + 2H_2O_{(l)} + Cd_{(s)}$

[1] for correctly combining the reactions, [1] for having the reactants and products on the correct sides

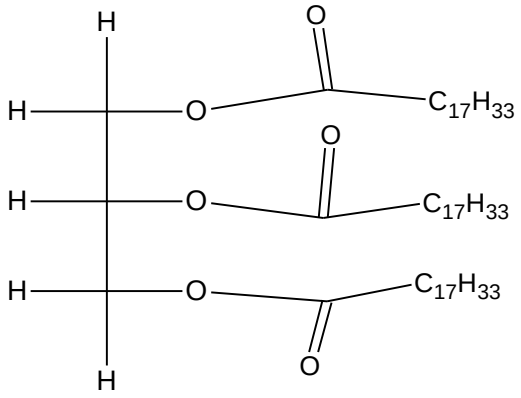
Question 7b
More than one answer is acceptable for this question. One possible answer is:

Electrolyte: KOH [1]

NiO(OH) electrode: Graphite [1]

Question 7c
The battery can be recharged because the products of discharge stay in contact with the electrodes at which they were formed [1]

Question 8a

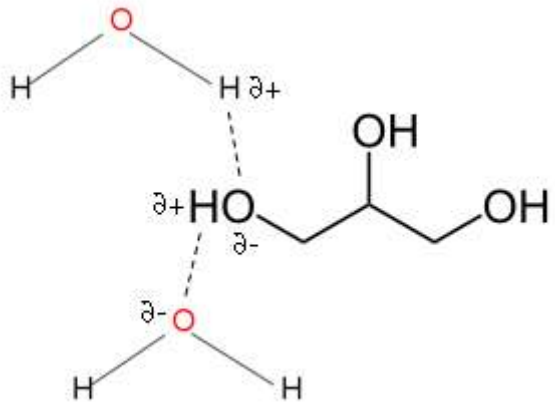


[1] for a correct structure.

Question 8b

1 double bond per oleic acid molecule [1]

Question 8c

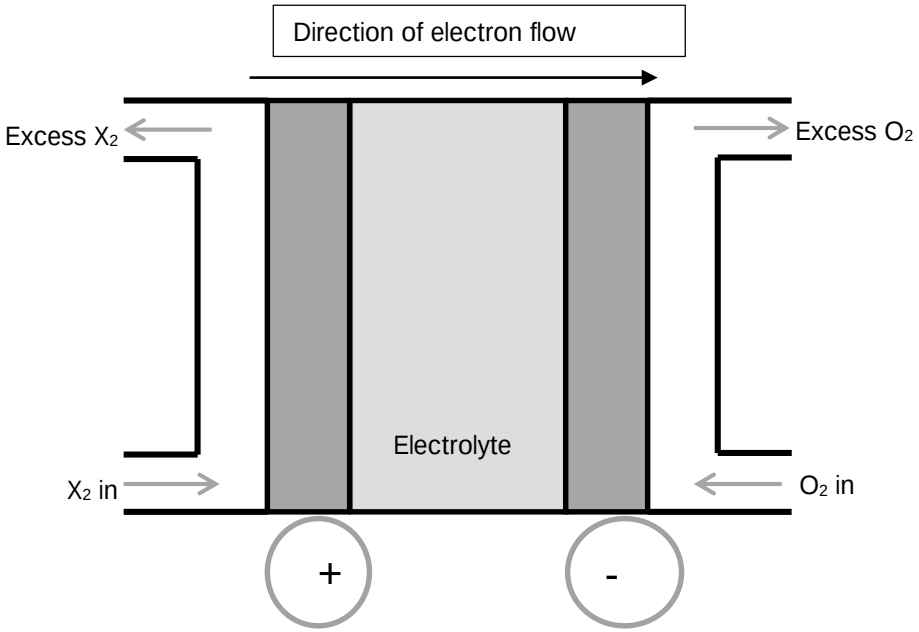


[1] for a diagram showing hydrogen bonding between glycerol and water.

Although Triglyceride X is slightly polar, it has three long non-polar hydrocarbon chains that prevent the lipid from being strongly attracted to water. [1]

However, glycerol has three OH groups which may form strong hydrogen bonds with water, making it very soluble. [1]

Question 9a



[1] for the polarity

[1] for the direction of flow

Question 9b

Voltage= Energy/Charge

For every mole of X_2 there are 2 moles of electrons. **[1]**

Charge in 2 moles of electrons is 2 x 96500C= 193000C **[1]**

1.03V x 193000C= 198.79kJ of energy

198.79kJ/mol **[1]**

Question 9c

More energy is released from the fuel cell per mole of X_2, (198.79kJ), than in the combustion of X_2 (138kJ). [1]

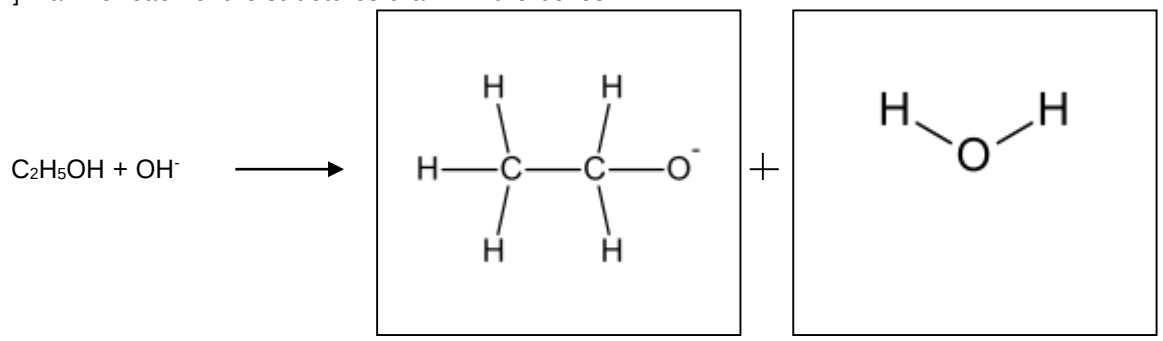
This is because during combustion, energy is also released in the form of light and sound, and not just heat. The energy of combustion only measures the energy released in the form of heat. [1]

Question 10a

i.) CH3CH2Cl **[1]**
ii.) NaOH **[1]**
iii.) NaCl **[1]**

Question 10b

[1] mark for each of the structures drawn in the boxes:



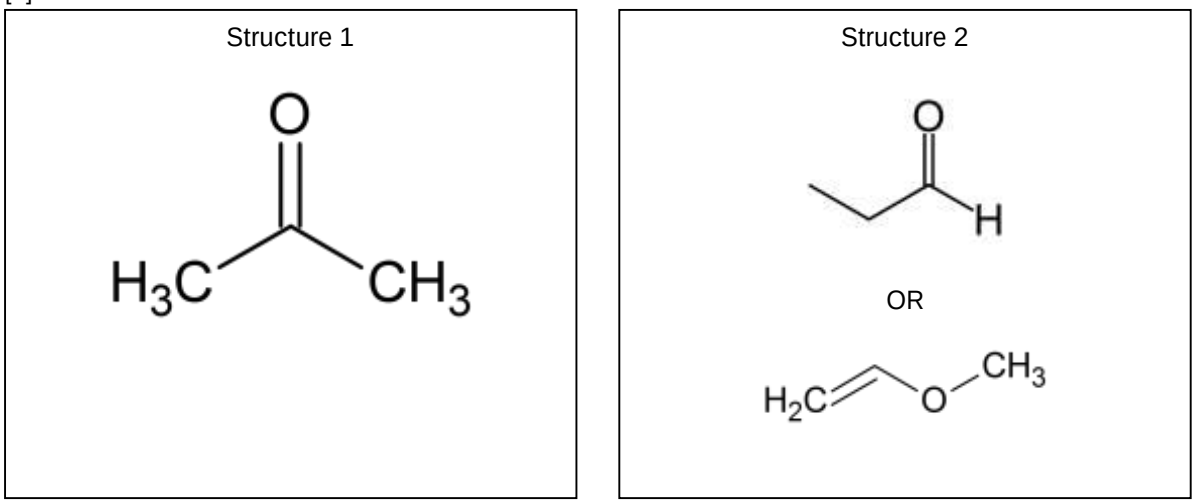
Question 10c

The IR spectrum contains a sharp peak at around 1600cm^{-1} which corresponds to a carbonyl (C=O) group, which is not present in the proposed structure. [1]

Also, the proposed structure should show a broad peak around 3200cm^{-1} for the hydroxyl (O-H) stretch. This peak is not present on the spectrum. [1]

Question 10d

[1] mark for each of the structures drawn in the boxes:



Question 10e

Structure 1 corresponds to acetone. [1]

The ^{1}H NMR spectrum shows one hydrogen environment which structure 1 has, whereas structure 2 has three different hydrogen environments and should show three peaks on the spectrum. [1]

The ^{13}C NMR spectrum shows two carbon environments which structure 1 has, whereas structure 2 has three different carbon environments and should show three peaks on the spectrum. [1]

Question 11a

From graph, the [Cu^{2+}] = 5.3 ppm [1]

Thus, in sample, mass of Cu = 1.33 mg [1]

Question 11b

$1.33 \text{ mg Cu} = 1.33 \times \frac{95.5}{63.5} = 2.0 \text{ mg}$ [1]

$\%\ \text{CuS in ore} = \frac{2.00 \times 10^{-3}}{0.060} \times 100 = 3.3\%$ [1]

Question 11c

620 nm is the red end of the spectrum. Cu^{2+} solution is pale blue and so absorbs its complementary colour, red, well. [1]

420 nm is the blue end of the spectrum and Cu^{2+} solution would mainly let this wavelength pass through. [1]