HSC CHEMISTRY

PAST HSC EXAM SOLUTIONS

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2007 - 2000

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I would appreciate and welcome your comments/corrections/suggestions, please send them to my e-mail.

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This document may contain errors. The solutions and answers have been tested (where applicable) and are correct to the best of the author's knowledge, however errors may be present. Please notify me if you find any errors so they can be fixed. Also some questions may be answer in a variety of ways. I would be happy to discuss any comments or suggestions you may have.

This is a draft edition.

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2006 HSC

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2005 HSC

SECTION I - Part A:

Question 1:

Question 2:

Question 3:

2676 kJ per (12.04*4 + 1.008*10 + 16.00) g = x kJ per 1 g

Therefore,

$x = \frac {2676}{12.01 \times 4 + 1.008 \times 10 + 16.00} = 36.10$

Question 4:

Question 5:

Question 6:
Ethyl Pentanoate is an ester. Esters are used for flavouring.

Question 7:

Question 8:

H₂SO₄

$pH = - \log_{10} \left (2 \times 0.1 \right) = 0.69897$
Question 9:

Question 10:

Question 11:
AAS is used to detect concentrations of ''metal'' ions.

Question 12:

Question 13:

Question 14:

Question 15:

SECTION I - Part B:

Question 16 (a):
Cyclohexene

Question 16 (b):
Cyclohexene is flammable. If it ignites it could injure people. To avoid this we made sure there was no open flames near the substances. We also wore safety goggles and a lab coat.

:"Responses that successfully linked the identified hazard and how it was addressed scored well. Responses that scored poorly did not identify a specific hazard for the first hand investigation and/or used vague or generic terms to outline how to address the hazard."¹

Question 16 (c):
The alkene and corresponing alkane were placed in sepearte beakers. Bromine water (diluted Br₂) was placed in each beaker. The colour change of the bromin water was observed.

:"Better responses indicated the key elements of a safe, experimental procedure and identified appropriate reactants for this investigation. Weaker responses incorrectly included results and presented contradictory data."¹

Question 17 (a):
Not all of the heat is produced by the combustion of the ethanol went into heating the water. Some of the heat was lost to the air, etc.

Question 17 (b):
$\frac {200 \times 4.18 \times 10^{-3} \times \left (45 - 21 \right)}{x} = \frac {1367}{1 \times \left (12.01 \times 2 + 1.008 \times 6 + 16.00 \right)}$

$x = \frac {200 \times 4.18 \times 10^{-3} \times \left (45 - 21 \right) \times \left (12.01 \times 2 + 1.008 \times 6 + 16.00 \right)}{1367}$

$x = 0.676 g$

Question 18:
Key Points:
Biopol.
Impacts on ''Environment'' because:
*100% Biodegradable
*Renewable Resource

Impacts on ''Society'' because:
*Biocompatable - Used in stuches and other things that are artificially put inside the human body. As it is biocompatable the body will not reject it.

Question 19:
Cell X
(a) Cannot be recycled or recharged therefore contributes to landfill.

:"Candidates are reminded that their answer should identify a specific impact rather than offer a general statement, such as the chemicals harm the environment."¹
(b)
:"Better responses included balanced half equations or an overall equation and included identification of the anode, cathode and electrolyte."¹

Cell Y
(a)

(b)

Question 20:
Glucose is fermented to produce a mixture containing ethanol.

Fermentation,

<!-- REACTION

, is preformed in the presence of a catalyst yeast, warm temperatures (approx 35ºC) and in the presence of CO_{2 (g)}. Over several days a mixture with ethanol in it forms. This mixture is fractionally distilled to extract the ethanol (as ethanol has a low boiling point).

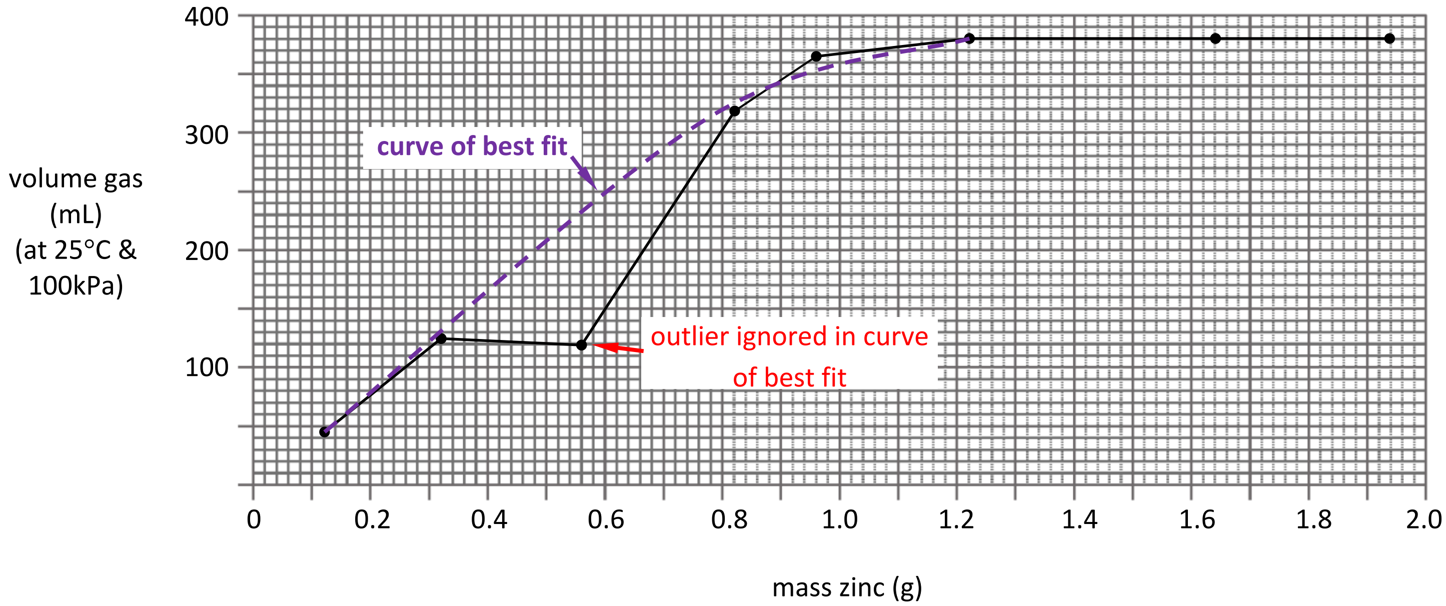
This gets pure ethanol which is used to produced ethyl butanoate in a process of esterfication. In esterfication, ethanol, concentrated sulfuric acid (used as a dehydrating agent) and butanoic acid is added to a flask which is heated. This mixture reacts forming ethyl butanoate. Refluxing is used in this process to prevent these volatile substances evaporating.

(this solution needs another equation and 2 diagrams for a chance of full marks)

For 6-7/7 marks:
*Provides characteristics and features of the chemistry of fermentation and esterification¹
*Includes two correct balanced chemical equations¹
*Describes procedures in each of three steps including at least one diagram¹

Question 21:
(in chronologial order)
*Lavoiser hypotheised that all acids contain oxygen.
*Davy showed all acids contain hydrogen, rather than oxygen as Lavoiser hypotheised.
*Arrehenius showed that acids ionise in water producing H⁺ ions as the only charged ions and bases ionise in water producing OH⁻ ions as the only charged ions.
*Bronsted-Lowry therory says that acids are proton donors and bases are proton acceptors.

Question 22:
(a)



To recieve 2/3 marks.
*Points plotted correctly¹
*Axes labelled with units¹
*Linear scale used on axes¹

To recieve 3/3 marks:
*Outlier plotted but not included in graph (line of best fit)¹ (but the question never asks for a line of best fit)
*Intersection point indicated¹
*Lines connecting data points are straight¹ (but question never asks for linear interpolation of data???)
*Points plotted correctly¹

*Axes labelled¹
*Linear scales used on axes¹

:"Better responses identified the independent and dependent variables and labelled the axes correctly. They ensured that axes had linear scales that used the extent of the grid provided. Most candidates plotted the points correctly by marking the point with a cross or a circle. The better candidates used a pencil and ruler to draw two lines of best fit that intersected at a point and left out the outlier point from the line of best fit."¹

(b) 380mL. Once the volume of gass produced reaches 380mL all the H<sub>2<sub> has been used up. HCl is the limiting reagent. So no matter how much more zinc there is, there is not enough HCl for the reaction to occur.

:"Most candidates identified the correct volume; however, many did not use the correct unit for volume, milliliter (mL), although it was indicated in the table. The better responses identified that hydrochloric acid (HCl) was the limiting reagent."¹

(c) 106.15 mL

Question 23:
(a) Incomplete combustion results when there is a lack of oxygen.¹

(b) $3CH_{4 \left (g \right)} + \frac {9}{2} O_{2 \left (g \right)} \rightarrow C_{\left (s \right)} + CO_{\left (g \right)} + CO_{2 \left (g \right)} + 6H_2O_{\left (l \right)}$

Question 24:
(a) $CaCO_{3 \left (s \right)} + 2HCl_{\left (l \right)} \rightarrow CaCl_{2 \left (aq \right)} + H_2O_{\left (l \right)} + CO_{2 \left (g \right)}$

(b)

$c = \frac {n}{v}$

$0.6 = \frac {n}{25 \times 10^{-3}}$

$n = 0.6 \times 25 \times 10^{-3} = 0.015$ moles

(c) 0.6796 g

Question 25:
(a)

This question is asking for the percentage of total dissolved solids in the creek sample. Therefore any solids colled by filtration are not dissolved and therefore not total dissolved solids. Only the mass left behind after evaporation is of total dissolved solids.

$\frac {45.59 - 45.33}{500} \times 100 = 0.052% \frac {w}{v}$

(b)

Precipitation. Add iodine ions. The lead and iodine ions will form a bright yellow precipitate.
$Pb^{2+} + I^- \rightarrow PbI_{2 \left (s \right)}$

OR

Atomic Absorbsion Spectroscopy (AAS). Where the substance is placed in a flame and the emmision spectra is either observed by the human eye or by a machine. Each metal ion has its own 'signature' emmision spectra.

(c) Lead ions in waterways need to be monitored. If lead is present in drinking water, even at low concentrations, can be harmful to humans. Also lead in non-drinking waterways may need to be monitored to ensure that the marine life will not be affected adversly.

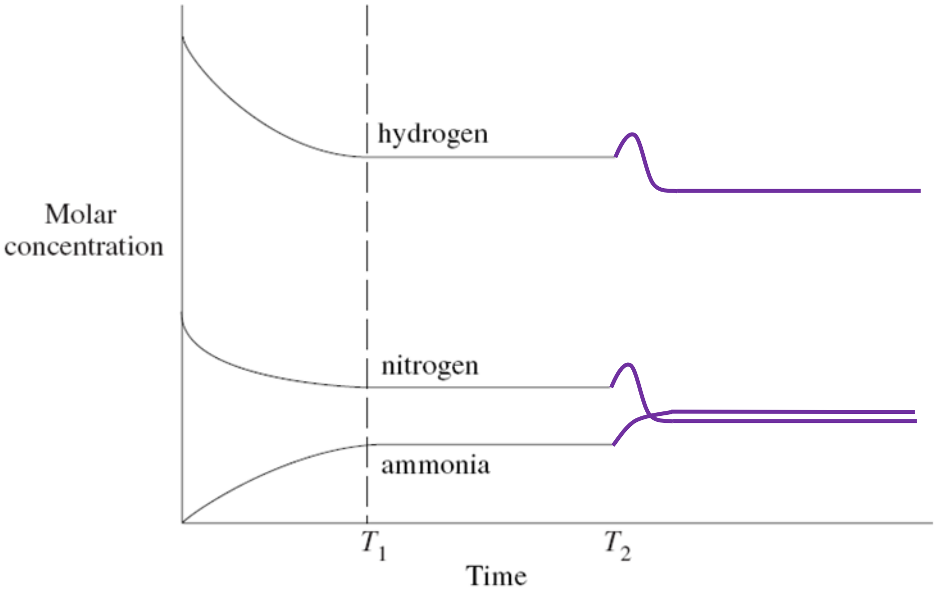
Question 26:
Sources of Contamination:
*Farm/Vegetable Patch - Pesticides, fertelisers, other chemicals, animal droppings and decomposing organic matter may be washed into the lake when it rains. This could contaminate the lake water with toxic chemicals (eg. presticides) and the decaying organic matter could raise the biochemical oxygen demand (BOD).
*Boats - Dirt and algue/weeds, etc from the bottom of the boat (that could have came from other rivers) could fall into the river and contaminate it. The dirt could raise the turbidity and total dissolved solids (TDS) of the water and the algue could be deadly or dangerous to humans to drink (eg. ecoli bacteria).

Purifying Methods:
*Screening - Removes large solid objects (eg. large branches, dead animals, rocks, etc.).
*Sand Filtration - Removes smaller objects (eg. dirt)
*Chemical Treatment - eg. Chlorine is added to kill bacteria, and fluride is added to strenghten teeth of people drinking the water.
*Microscopic membrane filter - Can remove very fine particles from the water.

Question 27:
(a) Equlibrium has been reached.

(b)

(i)



(I'm not sure if the two overlap as shown.)

(ii)
The spike in molar concentration at T₂ is because of the decrease in volume. As $c = \frac {n}{v}$, an decrease in ''v'' results in an increase in ''c''. This is the spike, however then Le Chatelier's prinicple kicks in. A decrease in volume results in an increase of pressure. As the reaction is $N_{2 \left (g \right)} + 3H_{2 \left (g \right)} \leftrightarrow 2NH_{3 \left (g \right)}$ the total moles on the left is 4 and 2 on the right. Due to Le Chatelier's principle an increase in pressure will shift the equlibrium to the right to minimise the effect of the pressure increase. This decreases the concentration of H₂ and N₂ and increases the concentration of NH₃. The system then reaches equlibrium and the concentrations will not change.

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SECTION II:

Question 28 – Industrial Chemistry:

Question 29 – Shipwrecks, Corrosion and Conservation:
Question 30 – The Biochemistry of Movement:
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Question 32 – Forensic Chemistry:

2004 HSC

SECTION I - Part A:

Question 1:

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Question 7:

Question 8:

Question 9:

Question 10:
As Δ H is negative, this means the reaction is exothermic, which means heat is given off. So +heat can be added to the right hand side of the equation. Now using Le Chatelier's Principle, to get more yield of phosgene, use '''low temperatures''' for the reaction to shift to the right to produce more heat. Also them total moles on the LHS is 1+1 = 2, and 1 on the RHS. So '''high pressures''' are used so that the equlibrium shifts to the side with less moles to reduce the pressure.
Question 11:

*C1 - Meth
*C2 - Eth
*C3 - Prop
*C4 - Bute
*C5 - Pent
*C6 - Hex
*C7 - Hept
*C8 - Oct

Therefore the order of molar masses of the substances from lowest to highest is 1-pentanol, 1-hexanol, 1-heptanol, 1-octanol.

It is given in the question that lower molecular weights are detected quicker so the first spike is 1-pentanol, the second is 1-hexanol, etc. Therefore X is 1-hexanol, A.

Question 12:

Question 13:

$200 \times 4.18 \times 10^{-3} \times \left (T_f - 21 \right)$ kJ per $\frac{0.6}{12.01 \times 3 + 1.008 \times 8 +16.00}$ (moles of 1-propanol, C₃H₇OH)

equals

2021 kJ per 1 mol
$$

Equating this ratio,

$2021 \times \frac {0.6}{12.01 \times 3 + 1.008 \times 8 +16.00} = 1 \times 200 \times 4.18 \times 10^{-3} \times \left (T_f - 21 \right)$

$T_f - 21 = \frac {2021 \times \frac {0.6}{12.01 \times 3 + 1.008 \times 8 +16.00}}{200 \times 4.18 \times 10^{-3}}$

$T_f = \frac {2021 \times \frac {0.6}{12.01 \times 3 + 1.008 \times 8 +16.00}}{200 \times 4.18 \times 10^{-3}} + 21$

$T_f = 45.14 \degrees C$

(I don't know why its different to the given options, but it closest to C (45.2))

Question 14:

The anode is the negative terminal. The anode is the more reactive metal of the two and is above the other metal on the relative activity series of metals. Therefore ''x'' must be below Pb on the relative activity series and ''y'' and ''z'' must be above Pb.

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V	
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V	
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V	
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V	
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V	
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V	
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V	
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V	
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V	y, z
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V	
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V	
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V	
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V	
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V	
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V	
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V	
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V	
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V	x
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V	
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V	
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V	
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V	
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V	
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V	
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V	
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V	
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V	
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V	
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V	
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V	

The higher the metal is on the series the greater the ease of oxidation. Therefore, going from the bottom of the series to the top we will have "x", Pb, "z", "y" OR "x", Pb, "y", "z". Only one of these options is on the list of choices so it must be "x", Pb, "y", "z".

Question 15:

(Here is how I would solve this question (there are probably better methods)):

Looking at Diagram A we can see that it is a dry cell. On a standard battery we know that the end with the part raised is positive and the flat part is negative. So 3 must be negative terminal. So the answer is either A or B. Now we know that electricity flows from cathode to anode, positive to negative, therefore 1 must be the cathode. Hence the answer is B.

<u>SECTION I - Part B:</u>

Question 16:

(a)

A mass of solid sodium hydrogen carbonate must be accurately weighted. This solid sodium hydrogen carbonate must be transferred into a volumetric flask, which is then filled with water to the calibration line. ''The moles of solid sodium hydrogen carbonate can be calculated (mass / molar mass), and the volume of solution is known from the volumetric flask used. So concentration can be calculated (concentration = number of moles of sodium hydrogen carbonate / total volume). As the concentration is known accurately it is a standard solution.'' (The italics may not be required as it is not part of outlining the procedure.)

(b)

$c= \frac {n}{v}$

$0.12 = \frac {n}{250 \times 10^{-3}}$

''n'' = 0.03 moles

$n = \frac {m}{MM}$

$m = 0.03 \times \left (22.99 + 1.008 + 12.01 + 16.00 \times 3 \right)$ (NB: this assumes the equation is NaHCO₃, which I am not sure of. Please check it.)

''m'' = 2.52 g

Question 17:
(a) The left one is "vinyl chloride" and the right is "styrene".

(b)

Polyvinylchloride (PVC) (made from the vinyl chloride monomer):

Used in electrical wire coating because it is an electrical insulator, tough and flexible. Also used in water pipes as it is a non-metal it does not corrode or rust.

OR

Polystyrene (made from the styrene monomer):

Used for foam cups as it is a good insulator of heat. Also used for packaging as it is easy to mould to various complex shapes.

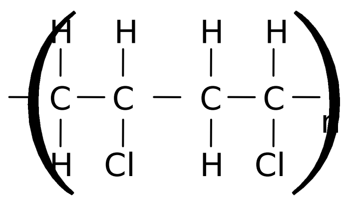
For full marks you need 2 uses and 2 properties.

(c)

Polymer made from the vinyl chloride monomer:

[[Image:sci_chem_pastpapers_2004hsc_17c_1.png|Polyvinylchloride (PVC)]]

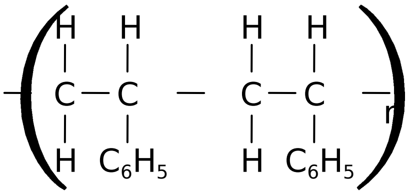
OR sometimes drawn as, (The above method is better though. See 2004 HSC Notes from the Examination Centre – Chemistry, p7.)



Polymer made from the styrene monomer:

[[Image:sci_chem_pastpapers_2004hsc_17c_3.png|Polystyrene]]

OR sometimes drawn as, (The above method is better though. See 2004 HSC Notes from the Examination Centre – Chemistry, p7.)



Question 18:

Question 19:

Question 20:

Question 21:
(a) Qualitative analysis refers to observing qualities, properties or observations and making a judgement based on these observations. Quantitative analysis refers to performing numerical calculations based on data from experiment or other to make a judgement.

(b)

(c)
Question 22:
(a) Amphiprotic substances are able to act as both proton donors and proton acceptors.

(b)

H₂PO₄[–] + H₂O → H₃O⁺ + HPO₄²⁻

H₂PO₄[–] + H₃O⁺ → H₂O + H₃PO₄

Question 23:

Question 24:
(a)

$n = cv$

$n = 0.01 \times 10 = 0.1$

$c = \frac {n}{v} = \frac {0.1}{10 + 90} = 0.001$ mol L⁻¹

$pH = -log_10 0.001 = 3.00$

(b) They are used as food additives as they

(c)
Question 25:

Question 26:

Question 27:

SECTION II:

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2003 HSC

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SECTION I - Part B:

Question 16:
(b) C₆H₁₂O₆(aq) → 2CO₂(g) + 2C₂H₅OH(l)

Question 17:
(a) Ethanol

(b)

(c)
Question 18:

Question 19:
(a) Silver electrode

(b) 2Ag⁺(aq) + Pb(s) → 2Ag(s) + Pb²⁺(aq)
:E^o = 0.13 + 0.8 = 0.93 V
Question 20:

Question 21:
(a) Butyl propanoate and water

(b)

(c)
Question 22:
(a) C₂H₆O(l) + 3O₂(g) → 2CO₂(g) + 3H₂O(l)

(b) 78.1 L
Question 23:
(a) Ba(OH)₂(aq) + 2HNO₃(aq) → Ba(NO₃)₂(aq) + 2H₂O(l)

(b) 0.33 mol L⁻¹

Question 24:

Question 25:

Question 26:

Question 27:
(a) 74%

(b)

SECTION II:

Question 28 – Industrial Chemistry:
(a)
(i)

(ii)

(b)
(i)
(ii)

(c)

(d)
(i) Temperature
(ii)
(iii)
Question 29 – Shipwrecks, Corrosion and Conservation:
(a)
(i)
(ii)

(b)
(i)
(ii)

(c)

(d)
(i) Iron
(ii)
(iii)

Question 30 – The Biochemistry of Movement:
(a)
(i)
(ii)

(b)
(i)
(ii)

(c)

(d)
(i)
(ii)
(iii)

Question 31 – The Chemistry of Art:
(a)
(i) Two

(ii)

(b)

(i)

(ii)

(c)

(d)

(i) d block

(ii)

(iii)

Question 32 – Forensic Chemistry:
(a)
(i) Carbohydrate
(ii)

(b)
(i)
(ii)

(c)

(d)
(i) F2
(ii)
(iii)

2002 HSC

SECTION I - Part A:

Question 1:

Question 2:

Question 3: ''(Not relevant to current syllabus)''

Question 4:

Question 5: ''(Not relevant to current syllabus)''

Question 6:

Question 7:

Question 8:

Question 9:

Question 10:

Question 11:

Question 12:

Question 13:

Question 14:

Question 15:

SECTION I - Part B:

Question 16:
(a) Cyclohexene

(b)
The alkane and alkene were placed in separate beakers of bromine water. It was observed that the alkene decolourised the bromine water quickly, however the alkane took several days and UV light to decolourise the bromine water.

(c)
Question 17:

Question 18:
(a) Condensation Polymerisation

(b) ''(Not relevant to current syllabus)''
Question 19:
(a) Ammonia OR Cleaning Agent OR ...

(b)

Question 20:

Question 21:

Question 22:
(a) pH = -log₁₀ 0.01 = 2

(b)

(c)
Question 23:
(a) Carbon dioxide (CO₂)

(b) 5.56 L
Question 24:

Question 25:
(a) 1,2-dichloro-1,1,2,2-tetafluroethane

(b)

(c)
Question 26:
(a) ''(Not relevant to current syllabus)''

(b)
Question 27:

SECTION II:

Question 28 – Industrial Chemistry:
(a)
(i)

(ii)

(b) 133 (calculations needed)

(c)
(i)

(ii)

(d)
(i)
(ii)

(e)
Question 29 – Shipwrecks, Corrosion and Conservation:
(a)
(i) Galvanic cell
(ii)

(b)
(i)
(ii)

(c)

(d)
(i)

(ii)
(iii)
Question 30 – The Biochemistry of Movement:
(a)
(i) Amino acids

(ii)

(b)

(c)
(i) Lactic acid

(ii)

(d)
(i)

(ii)

(e)
Question 31 – The Chemistry of Art:
(a)
(i) Sodium

(ii)

(b)

(c)
(i)

(ii)

(d)
(i) 1s² 2s² 2p⁶ 3s² 3p⁶ 4s² 3d⁵

(ii)

(iii)

(e) ''(Not relevant to current syllabus)''

Question 32 – Forensic Chemistry:
(a) ''(Not relevant to current syllabus)''
(i) -OH group
(ii)

(b) ''(Not relevant to current syllabus)''

(c)
(i) enzymes
(ii)

(d)
(i) Spectroscope
(ii)
(iii)

(e)

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SECTION I - Part A:

Question 1:

Question 2:

Question 3: ''(Not relevant to current syllabus)''

Question 4:

Question 5:

Question 6:

Question 7:

Question 8:

Question 9:

Question 10:

Question 11:

Question 12:

Question 13:

Question 14:

Question 15: ''(Not relevant to current syllabus)''

SECTION I - Part B:

Question 16:
Americium-241 is used industrially in smoke alarms in factories as a safety device. It has a **large half life** meaning that it will last for many years and thus reducing the chance that it will fail when it is needed to work. It emits **alpha radiation** due to its natural radioactive decay. The alpha radiation ionises the air in the fire alarm and this ionisation can be detected. If smoke is present then eh air will not ionise and the alarm is set off.

Question 17 (a):
Heat was lost to the air, the tripod and other surroundings.

Question 17 (b):
The experiment could be repeated several times.

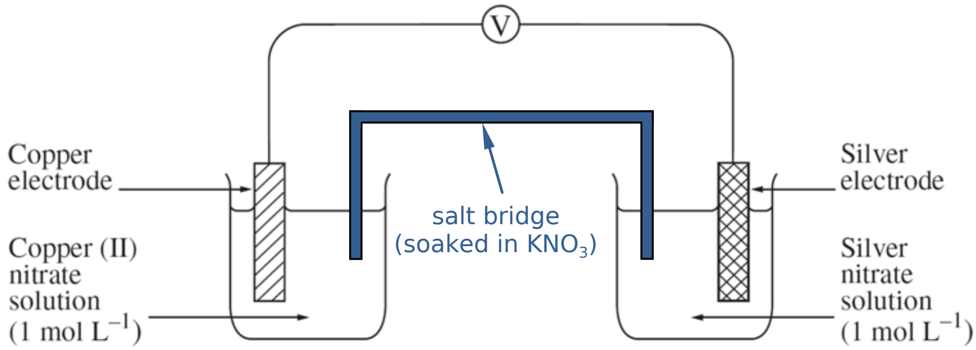
Question 17 (c):

$$\Delta H = -mC\Delta T = -(250 \times 10^{-3}) \times (4.18 \times 10^{3}) \times (59 - 19) = -41\ 800 \text{ J per } 2.3 \text{ g.}$$

$$\frac{-41\ 800}{2.3} = \frac{x}{1.008 \times 6 + 16.00 + 12.01 \times 2}$$

$$x = -837\ 235.826\ \mathrm{J\ mol^{-1}} = -837\ \mathrm{kJ\ mol^{-1}}$$

Question 18 (a):



“Correctly places salt bridge between the beakers and dipping into each solution”

Question 18 (b):
The two electrodes are Cu(s) and Ag(s). So we go down the list of standard potentials until we find one of these. The Cu(s) comes before the Ag(s), so we will start with the Cu(s) equation. Note that Cu(s) appears twice on the list, as Copper (I) and Copper (II). The question starts that Copper (II) is used so we will use that first equation.

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\leftarrow$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightarrow$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Because the Cu(s) is higher than Ag(s), the Cu will undergo oxidation, i.e. ←, and the Ag will undergo reduction, i.e. →. So now we can construct the two half equations and then the net equation by balancing the electrons and then adding them together. Because we reverse the Cu reaction we change the sign of its voltage. To find the net voltage we just add the two voltages together. Note that although we double the second equation, the voltage is NOT doubled.

$Cu(s) \rightarrow Cu^{2+} + 2e^-$	–0.34 V
$2Ag^+ + 2e^- \rightarrow 2Ag(s)$	+0.80 V
$Cu(s) + 2Ag^+ \rightarrow Cu^{2+} + 2Ag(s)$	+**0.46 V**

"Both half equations/values correct and final calculation correct"

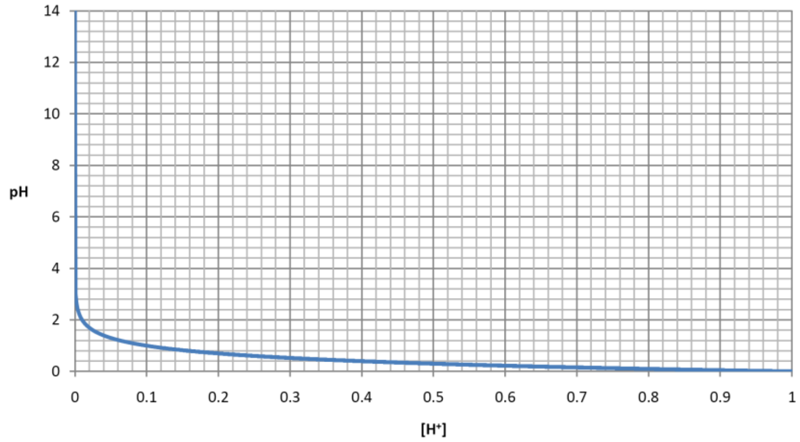
Question 18 (c):
(Not relevant to current syllabus)

Question 19:
"Evaluates both named cell types in terms of chemistry and impact on society
Answer illustrated with selected balanced symbol equations"

Question 20 (a):
Indicators OR pH meter OR …

Question 20 (b):
Upon first glance my answer would be:
They have different pH values as HCl is a strong acid and CH_3COOH is a weak acid. HCl is a strong acid because it is completely ionised in solution forming H^+ and Cl^-. Because it completely ionises the H^+ concentration will be 0.1 mol L^{-1} and so the pH = $-\log_{10} 0.1 = 1$. CH_3COOH only partially ionises forming only about 8% ionised solution. This means that the H^+ concentration will be less than 0.1 meaning that the pH will be less.

However after seeing the marking guidelines I would answer this question as”
pH equals negative logarithm of base ten of the hydrogen ion concentration.



pH 1 is higher hydrogen ion concentration than pH 1.6 and HCl ionises more than citric acid.

“Explains the relationship between $[H^+]$ and pH
Indicates that pH 1 means higher $[H^+]$ than pH 1.6
Explains that HCl ionises more than citric acid”

Question 21:
(a) Neutralisation OR acid base

(b) ''(Not relevant to current syllabus)''
Question 22:

Question 23 (a):
A base is a proton acceptor.

Question 23 (b):
(b) 82.0 g mol⁻¹

Question 24:
(a) Production of fertilisers OR production of explosives OR production of $NaCO_3$ OR ...

(b)

(c)
Question 25:

Question 26:

Question 27:

SECTION II:

Question 28 – Industrial Chemistry:
(a)
(i)

(ii)

(b)
(i) $CO(g) + Cl_2(g) \rightleftharpoons COCl_2 \ + \ heat$
(ii)
The yield of phosgene could be increased by decreasing the temperature. Because the reaction is exothermic, it produces heat. According to Le Chatelier's principle if you decrease the heat then the reaction will shift to the right to produce more heat to minimise the effect of the change and in the process producing more phosgene.

Note that only one factor and an explanation was needed.

(c)

(d)
(i) Saponification
(ii)
(iii)
Question 29 – Shipwrecks, Corrosion and Conservation:
(a)
(i) Iron OR Steel
(ii)

(b)
(i) Zinc OR ...
(ii)

(c)

(d)
(i)
(ii)
(iii)
Question 30 – The Biochemistry of Movement:
Question 31 – The Chemistry of Art:
Question 32 – Forensic Chemistry:
(a)
(i)
(ii)

(b) ''(Not relevant to current syllabus)''
(i) Tallow
(ii)
(iii)

(c)

(d)
(i) Gel electrophoresis OR ...
(ii)
(iii)

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SECTION I - Part A:

Question 1:

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Question 4:

Question 5:

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Question 15:

SECTION I - Part B:

Question 16:

Question 17:

Question 18:

Question 19:

Question 20:

Question 21:

Question 22:

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Question 24:

Question 25:

Question 26:

Question 27:

SECTION II:

Question 28 – Industrial Chemistry:
Question 29 – Shipwrecks, Corrosion and Conservation:
Question 30 – The Biochemistry of Movement:
Question 31 – The Chemistry of Art:
Question 32 – Forensic Chemistry: