HSC CHEMISTRY

PAST HSC EXAM SOLUTIONS

Andrew Harvey

2007 - 2000

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If you have any queries on this document, I can be contacted at andrew.harvey4@gmail.com
I would appreciate and welcome your comments/corrections/suggestions, please send them to my e-mail.

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This is a draft edition.

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2006 HSC

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SECTION II:

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(a) (i):

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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).

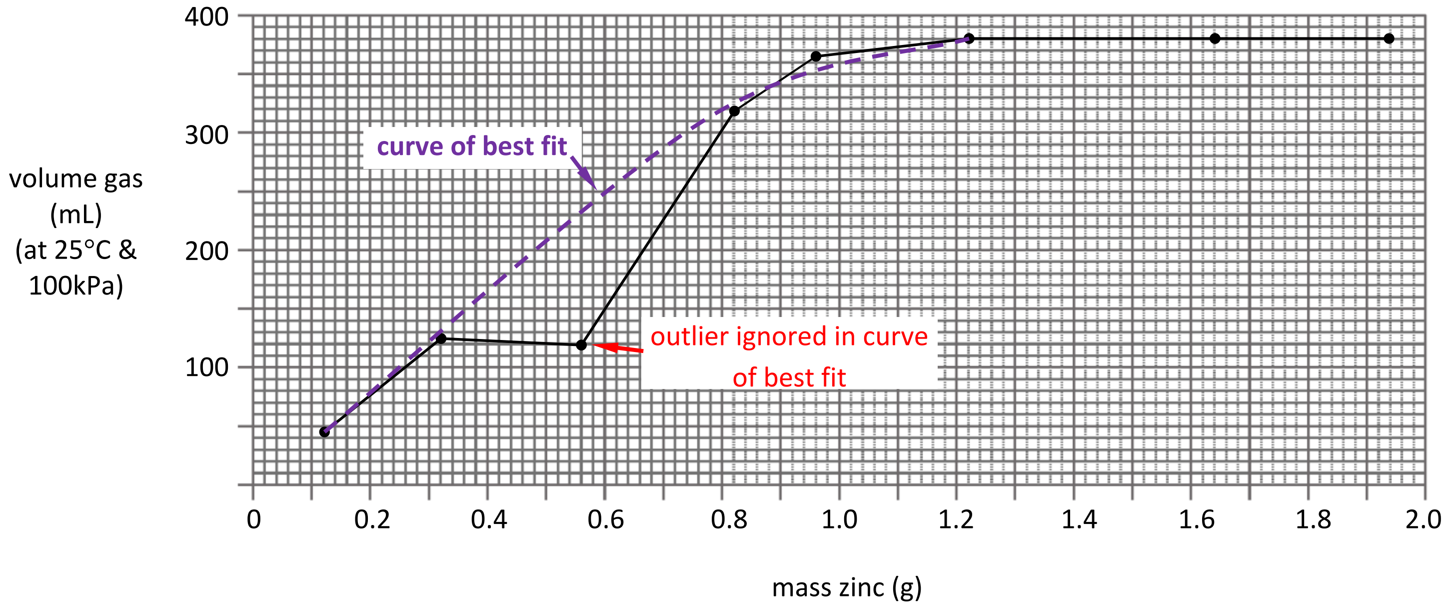
This gets pure ethanol which is used to produced ethyl butanoate in a process of esterfication. In esterfication, ethanol, concentrated sulfuric acid (used as a dehydrating agent) and butanoic acid is added to a flask which is heated. This mixture reacts forming ethyl butanoate. Refluxing is used in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

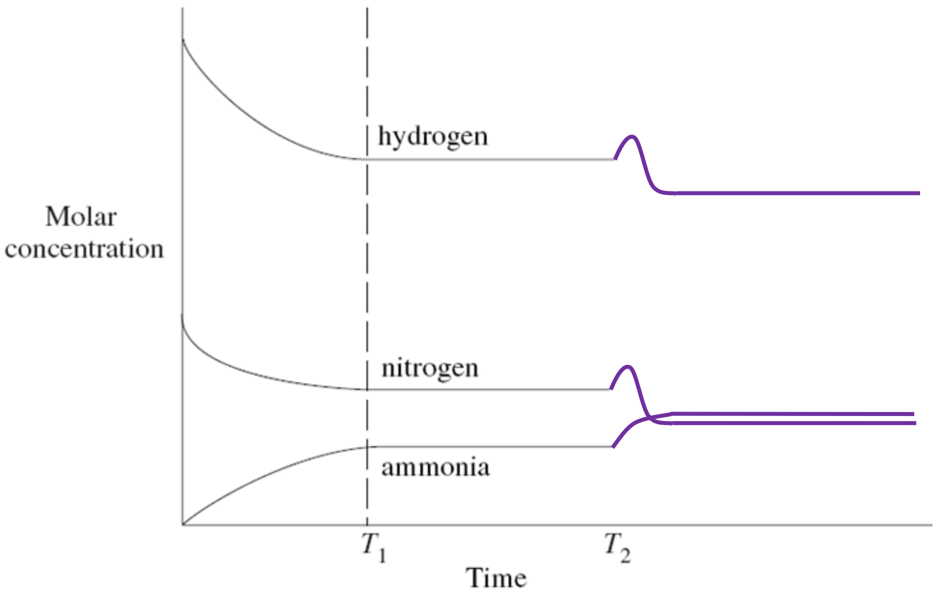
Question 26:
Sources of Contamination:
*Farm/Vegetable Patch - Pesticides, fertelisers, other chemicals, animal droppings and decomposing organic matter may be washed into the lake when it rains. This could contaminate the lake water with toxic chemicals (eg. presticides) and the decaying organic matter 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:
Question 31 – The Chemistry of Art:
Question 32 – Forensic Chemistry:

2004 HSC

SECTION I - Part A:

Question 1:

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Question 6:

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.

SECTION I - Part B:

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.

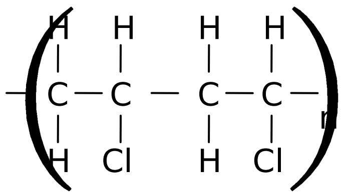
For full marks you need 2 uses and 2 properties.

(c)

Polymer made from the vinyl chloride monomer:

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

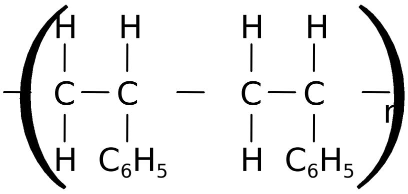
OR sometimes drawn as, (The above method is better though. See 2004 HSC Notes from the Examination Centre – Chemistry, p7.)



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:

Question 28 – Industrial Chemistry:
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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)

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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.

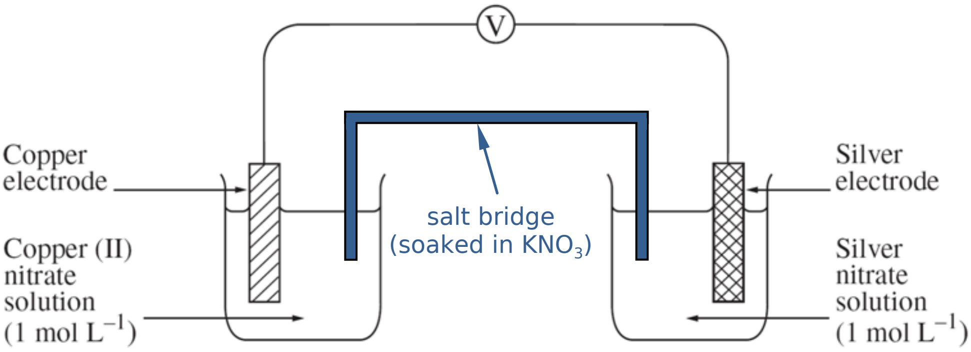
Question 17 (c):

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

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

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

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"

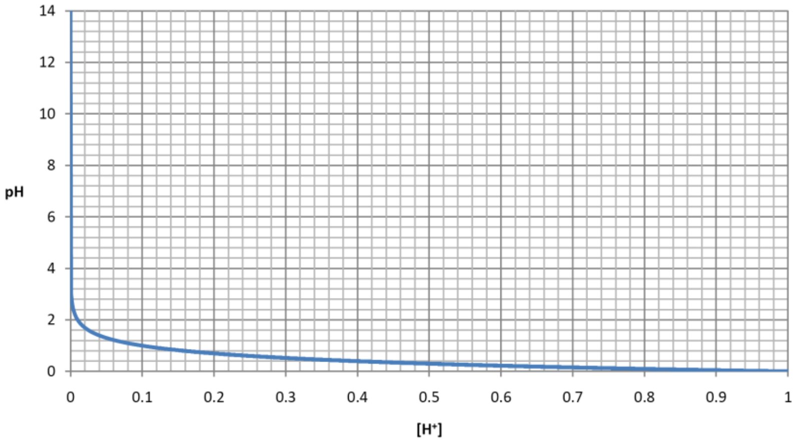
Question 18 (c):
(Not relevant to current syllabus)

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:

Question 2:

Question 3:

Question 4:

Question 5:

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:

Question 17:

Question 18:

Question 19:

Question 20:

Question 21:

Question 22:

Question 23:

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:

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SECTION I - Part A:

Question 1: A
Bromine water is used to test for the presence of an alkene.

Question 2:

Question 3: B
The total valency (charge) of the compound equals the sum of the oxidation states of the atoms. On the LHS of the equation the valency of MnO_2 is zero, $\mathrm{Mn} + 2(-2) = 0$. So Mn has an oxidation state of +4. On the RHS, $\mathrm{Mn} \times 2 + 3(-2) = 0$. So Mn has an oxidation state of +3. Hence the oxidation state of Mn has changed from +4 to +3, B.

Question 4: C
The two electrodes are Pb and Mg. So we go down the list of standard potentials and see which is higher.

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
$Mg^{2+} + 2e^-$	$\leftarrow$	$Mg(s)$	–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
$Pb^{2+} + 2e^-$	$\rightarrow$	$Pb(s)$	–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
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	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 Mg is higher and so it is oxidised, hence the Pb is reduced (we know the directions so from OIL RIG we know if it is oxidised or reduced). From RED CAT / AN OX, we know that reduction occurs at the cathode and so the reaction at the cathode is the Pb reaction and because it is lower on the list will be to the right, given by:

$$\mathrm{Pb}^{2+}(aq) + 2\mathrm{e}^- \rightleftharpoons \mathrm{Pb}(s)$$

Question 5: C
We are told that the Uup produced will have 115 protons and 173 neutrons. Now the atomic number is the number of protons, which is 115, so this rules out B. Now the mass number (i.e. superscript) is the number of protons + number of neutrons, which is $115 + 173 = 288$. This rules out A, leaving C or D. We can check which of these two equations is correct by simply adding up the superscripts (mass number) and subscripts (atomic number) and seeing which one has these two conserved. However if we do this you will notice that both are conserved for both equations, however the question specifies Ca-48, option D has Ca-40, which obviously does not represent the process described in the question, which leaves C as the correct answer.

Question 6:

Question 7:

Question 8: D

We can calculate the number of moles of NH_3 produced as follows,

$$n(\mathrm{NH_3}) = \frac{mass}{molar\ mass} = \frac{51.10}{1.008 \times 3 + 14.01} = 3.000\ \mathrm{mol}$$

From the mole ratios we know that 3 moles of H_2 has been used to produce 2 moles of NH_3. Therefore 1 mole = $\frac{3.000}{2} = 1.500\ \mathrm{mol}$, which we can multiply by 3 to get the moles of H_2 = 4.500 mol. Now we know that 1 mol equates to 24.79L, so 4.500 moles equates to $4.500 \times 24.79 = 111.6\ \mathrm{L}$.

Question 9: A

From the graph we can see that both the concentration of NO_2 and N_2O_4 has decreased at the same point of time. Option A proposes that this decrease in concentration was caused by the removal of NO_2. Now from the question we know that these two compounds are in equilibrium given by,

$$\mathrm{N_2O_4}(g) \rightleftharpoons 2\mathrm{NO_2}(g)$$

Now if NO_2 is removed then the moles of NO_2 will decrease and the volume will stay the same so concentration (which is $\frac{number\ \ of\ moles}{volume}$) will decrease, which is what is shown in the graph. Also according to Le Chatelier's principle if you decrease the concentration of NO_2 then the equilibrium will shift to the right to produce more NO_2 to minimise the effect of the change, which is shown in the graph by the concentration of the NO_2 slowly returning back to the original amount. So far this option A sounds right, but let's look at what happens to the N_2O_4. As concentration is given by $\frac{number\ \ of\ moles}{volume}$, if we remove NO_2 then the number of moles of N_2O_4 will not change and nor will the volume, this accounts as to why there is no spike for the N_2O_4. However we know that if NO_2 is removed then the equilibrium will shift to the right to produce more NO_2, but in doing so more N_2O_4 is used up, hence the number of moles decreases, and the volume stays the same this means that the concentration will decrease, which is what is shown in the graph, hence making A the correct answer.

For option B, we know by the + value of $\Delta\mathrm{H}$ that the reaction is endothermic, thus can be written as,

$$\mathrm{N_2O_4}(g) + heat \rightleftharpoons 2\mathrm{NO_2}(g)$$

So by Le Chatelier's principle if we increase the temperature then the equilibrium will shift to the right to use up the heat, this shift to the right would result in higher concentration of NO_2 and lower concentration of N_2O_4. This is obviously not is what is happening in the graph so this is not the correct answer. Option C is again, by the same reasoning not correct. Option D, an increase in volume can be thought of in terms of a decrease in pressure, which would, due to Le Chatelier's principle shift the equilibrium to the right to increase the pressure (as the right has 2 moles whereas the left has a lower, 1 mole) to minimise the effect of the change. As explained above a shift to the right is not represented by the graph, hence meaning that D is incorrect.

Question 10: B

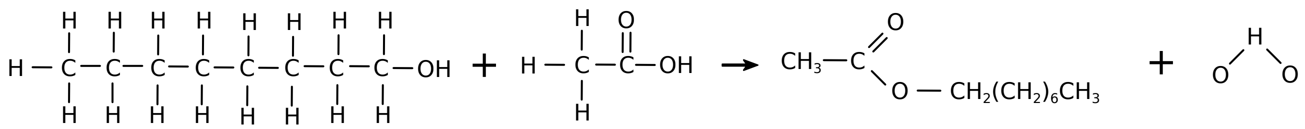
We know that,

alkanol + alkanoic acid → alkyl alkanoate (ester)
(alkanol) (alkanoic acid)

Hence an ester of octyl ethanoate is produced from octanol and ethanoic acid.

Now we can rule out C as CH_3CH_2OH is the alkanols and only has two carbons so is obviously octanol, which has eight carbons.

Now if we draw the graphical structural formula of the reaction,



$CH_3(CH_2)_6CH_2OH$ CH_3COOH $CH_3COOCH_2(CH_2)_6CH_3$ H_2O

We can see exactly what is going in on, and hence the correct answer is B.

Question 11: C

Question 12: B
We know that the test for carbonate is to add an acid, and observe any bubbling which is CO_2 gas given by the following reaction,

$$2H^+ + CO_3^{2-} \rightarrow CO_2 + H_2O$$

As we are testing for carbonate, chloride and sulfate ions, and as the first step is the only step to use an acid, the first step must be producing CO_2 gas. This rules out option C and A, leaving B and D. We also know that the test for sulfate is to add barium ions and if sulfate is present then a white precipitate will form, given by the reaction,

$$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$$

So in the second step barium sulfate forms, which means B is the correct answer. Finally to test for chloride ions, silver nitrate ions are added and form a white precipitate if chloride ions are present, given by the reaction,

$$Ag^+ + Cl^- \rightarrow AgCl$$

So the product in the third step is silver chloride.

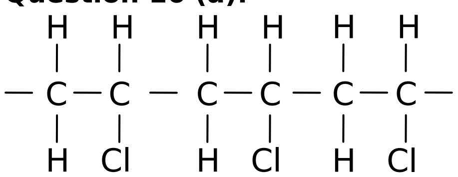
Question 13: C
A flocculate binds together suspended solids into larger solids. This would result in much of suspended solids (i.e. not dissolved) to be left in the water, resulting in turbid water. Remembering that turbidity is the amount of undissolved solids in the water.

Question 14: D
An oxygen free radical is an uncombined O. An oxygen atom is also just O. There is no difference in their electron arrangement.

Question 15:

SECTION I - Part B:

Question 16 (a):



Question 16 (b):
It is used as electrical conduit as it is a non-conductor.
OR
It is used in water pipes as it is tough OR ductile, meaning easily drawn into long tubes during manufacture.
OR …

Question 17 (a):

$$C_2H_4(g) + H_2O(g) \xrightarrow{conc.\,H_2SO_4} C_2H_5OH(g)$$

Question 17 (b):

$$C_6H_{12}O_6(aq) \xrightarrow{yeast} 2C_2H_5OH(aq) + 2CO_2(g)$$

Question 17 (c):
Ethanol can be produced by fermentation of hydration of ethylene. Production by fermentation is a renewable process as it is made from sugar cane plant. The sugar cane plant also consumes the CO_2 gas that is produced from the combustion of ethanol when used as a fuel. Disadvantages of production by fermentation are that lots of land space is required to grow the crops.

Production by hydration requires ethylene which is produced industrially from the thermal cracking of ethene, a fraction of petroleum…

Question 18:

Question 19:

Question 20:

Question 21:

Question 22:

Question 23:

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:

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SECTION I - Part A:

Question 1: B
This is even a dot point "identify that ethylene, because of the high reactivity of its double bond, is readily transformed into many useful products"

Question 2: B

Question 3: C

$\Delta H = -mc\Delta T$

$\Delta H = -500 \times 10^{-3} \times 4.18 \times 10^{3} \times (38 - 24)$

mass of water — sp. heat capacity of water — ΔT

$\therefore \Delta H = -29\ 260$ J per $(68.0 - 66.5) = 1.5$ g

As 1 mole of ethanol equals $12.01 \times 2 + 1.008 \times 6 + 16.00 = 46.068$ g $(m = MM \times n)$

$$\frac{-29\ 260}{1.5} = \frac{x}{46.068}$$

$x = -898\ 633.12$ J

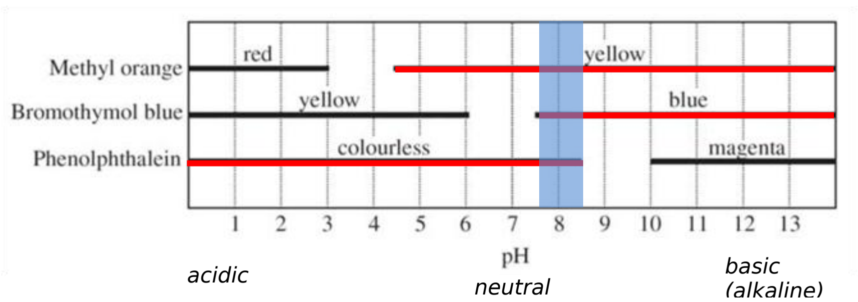
$\therefore \Delta H = -899$ kJ mol^{-1}

Question 4: B

Question 5: A
Half life is the time for half of the substance to decay. Hence when 50% of Strontium-90 is remaining, which is at 30 yrs.

Comments:
I do not believe that this is in the syllabus.

Question 6: D
I don't like this question as you need to memorise useless facts about the colours of indicators. If we are given the table,



As we can see from the graph, it is slightly basic, that is, slightly alkaline.

Question 7: D

$$\text{pH} = -\log_{10}[\text{H}^+]$$

$$\therefore [\mathrm{H}^+] = 10^{-\mathrm{pH}} = 10^{-3} = 0.001 \text{ mol L}^{-1}$$

So the concentration of a substance is 0.1 mol L^{-1} which is made up of 0.001 mol L^{-1} of hydrogen ions, so the concentration of molecules will be $0.1 - 0.001$. Their percentatge is then given by $\frac{0.1-0.001}{0.1} \times 100 = 99\%$.

Question 8: C
Adding the acid to a base is a titration and as such would produce a titration curve, A or C. Initially there is no acid added so the pH will be basic, that is large, as the acid is added, the pH drops. So C must be the correct answer.

Question 9: A

Question 10: C

$$\mathrm{C_2H_5OH}(l) + 3\mathrm{O_2}(g) \rightarrow 2\mathrm{CO_2}(g) + 3\mathrm{H_2O}(l) + energy$$

$$\frac{1 \text{ mol}}{24.79 \text{ L}} = \frac{n(O_2(g)) \text{ mol}}{74.4 \text{ L}}$$

$$n(\mathrm{O_2}(g)) = 3.001 \text{ mol}$$

From the mole ratio's of the above reaction, we know that 3 moles of $\mathrm{O_2}(g)$ will give you 2 moles of $2\mathrm{CO_2}(g)$. So 3.001 moles of $\mathrm{O_2}(g)$ gives

$$\frac{3}{2} = \frac{3.001}{n(\mathrm{CO_2}(g))}$$

$$n(\mathrm{CO_2}(g)) = \frac{3.001 \times 2}{3} = 2.001 \text{ mol}$$

$$n = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{mass}(\mathrm{CO_2}(g)) = 2.001 \times (12.01 + 16.00 \times 2) = 88 \text{ g}$$

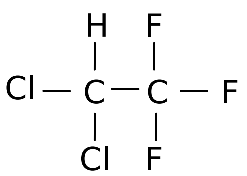
Question 11: D
Iron oxide is the catalyst used in the Haber process.

Question 12: B
This is just another fact that you need to remember. That if you add acid to a carbonate carbon dioxide gas forms which is the bubbling.

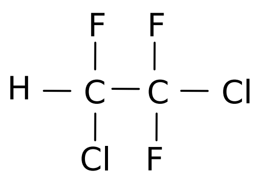
$$2\mathrm{H}^+ + \mathrm{CO_3}^{2-} \rightarrow \mathrm{CO_2} + \mathrm{H_2O}$$

Question 13: D

Question 14:
For this it is best to draw their graphical structural formulae.



$\mathrm{CHCl_2CF_3}$



$\mathrm{CHClFCClF_2}$

Now we know that isomers are elements with the same molecular formula but different structural formula. If we count up the number of C, F, H & Cl in each, they are the same, so these must be isomers.

They are not isotopes, because for a start, isotopes are single atoms. They are not CFC's because they have hydrogen atoms. And they are not allotropes.

Question 15:

(A) ✓

(B) ✓

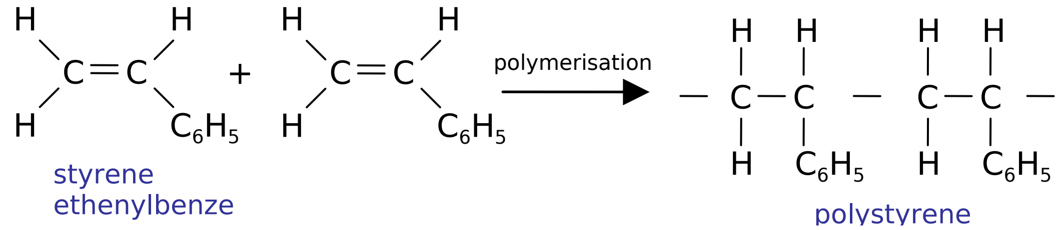
(C) ✗

(D) ✓

It is important to note that chlorine and chloride are not the same. It is chlorine that is added to kill bacteria in water, not chloride.

SECTION I - Part B:

Question 16 (a):



Question 16 (b):
Used: Foam Cups
Property: Good insulator of heat.

OR

Used: Packaging
Property: Absorbs impact. Strong in compression.

Question 17 (a):
RED CAT: Reduction occurs at the cathode.
AN OX: Oxidation occurs at the anode.

OIL: Oxidation is loss of electrons.
RIG: Reduction is gain of electrons.

So the cathode is where reduction occurs, which is the gain of electrons. As copper is higher on the table, the reactor will be ←, so copper is losing electrons, hence silver is gaining electrons. So Silver is the cathode.

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

Question 17 (b):
0.46V

Question 18:

Question 19:

Question 20:

Question 21:

Question 22:

Question 23:

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:

2005 CSSA

SECTION I - Part A:

Question 1:

Question 2:

Question 3:

Question 4:

Question 5:

Question 6:

Question 7:

Question 8:

Question 9:

Question 10:

Question 11:

Question 12:

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Question 15:

SECTION I - Part B:

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Question 19:

Question 20:

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SECTION II:

Question 28 – Industrial Chemistry:
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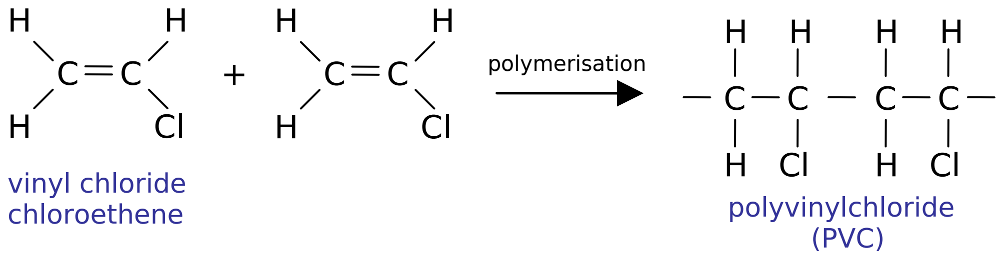
2004 CSSA

SECTION I - Part A:

Question 1: B

Vinyl chloride (chloroethene) is the monomer used to make the polymer polyvinylchloride, PVC.
common name systematic name



Question 2: A

Alkanes and alkenes react differently when mixed with bromine water, and so it can be used to test if a substance is an alkene or alkane. Bromine water is Br_2 however it has water added to dilute it. The alkane (which has a single bond) will only decolourise the bromine water in the presence of UV light and it takes a long time. The alkene (which has a double bond) will turn the bromine water colourless after about 1 minute, this is due to the highly reactive double bond.

Question 3: D

OIL RIG → Oxidation is loss of electrons, and reduction is gain of electrons.
RED CAT / AN OX → Reduction occurs at the cathode, and oxidation occurs at the anode.

So the reaction at the cathode will be the reduction reaction, which is the gain of electrons, and hence will be the → on the table below. As Cu is lower on the table it will be the reduction reaction.

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
$Zn^{2+} + 2e^-$	$\leftarrow$	$Zn(s)$	–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
$Cu^{2+} + 2e^-$	$\rightarrow$	$Cu(s)$	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
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	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

So the reaction at the cathode will be,

$$Cu^{2+} + 2e^- \longrightarrow Cu$$

Question 4: C

$$\mathrm{C_6H_{12}O_6}(aq) \xrightarrow{yeast} \mathrm{2C_2H_5OH}(aq) + \mathrm{2CO_2}(g)$$

Question 5: A
Exothermic means that the forward reaction gives off heat, making + heat appear on the RHS.

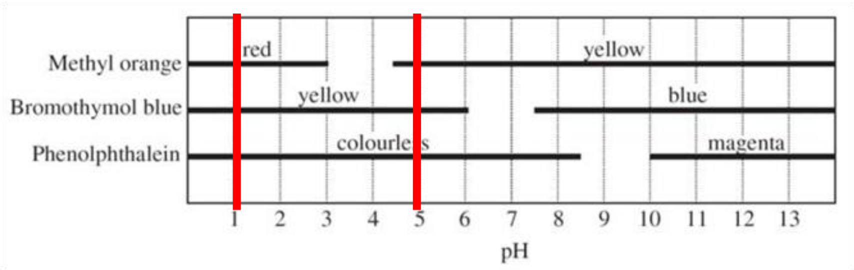
combustion of ethanol	$C_2H_5OH(l) + 3O_2(g) \rightarrow CO_2(g) + H_2O(l) + heat$	exothermic
fermentation of glucose	$\mathrm{C_6H_{12}O_6}(aq) \xrightarrow{yeast} \mathrm{2C_2H_5OH}(aq) + \mathrm{2CO_2}(g) + heat$	exothermic
dehydration of ethanol	$\mathrm{C_2H_5OH}(g) \xrightarrow{conc.\,\mathrm{H_2SO_4}} \mathrm{C_2H_4}(g) + \mathrm{H_2O}(g)$	neither
cracking of petroleum	$C_2H_6 \xrightarrow{steam} C_2H_4 + H_2$	neither
reaction of a galvanic cell	$Cu^{2+}{}_{(aq)} + Zn_{(s)} \rightarrow Zn^{2+}{}_{(aq)} + Cu_{(s)}$	neither

The only two reactions from those listed are the combustion of ethanol and fermentation of glucose.

Question 6: D
Rain water is usually slightly acidic, about pH = 5.
0.1 molL^{-1} HCl, has a $\mathrm{pH} = -\log_{10} 0.1 = 1$.

Litmus can only show if a substance is acid or base, as both these substances are acidic, litmus is not the best indicator.

I don't like this question because there is no way of working it out. It is simply a matter of memorising useless facts that are not very important and can be looked up on a table if need be. If we were given the table that was given in various HSC exams, then we could see that **methyl orange** would be the best indicator to use as you get a different colour for pH 1 and pH 5.



Question 7: B

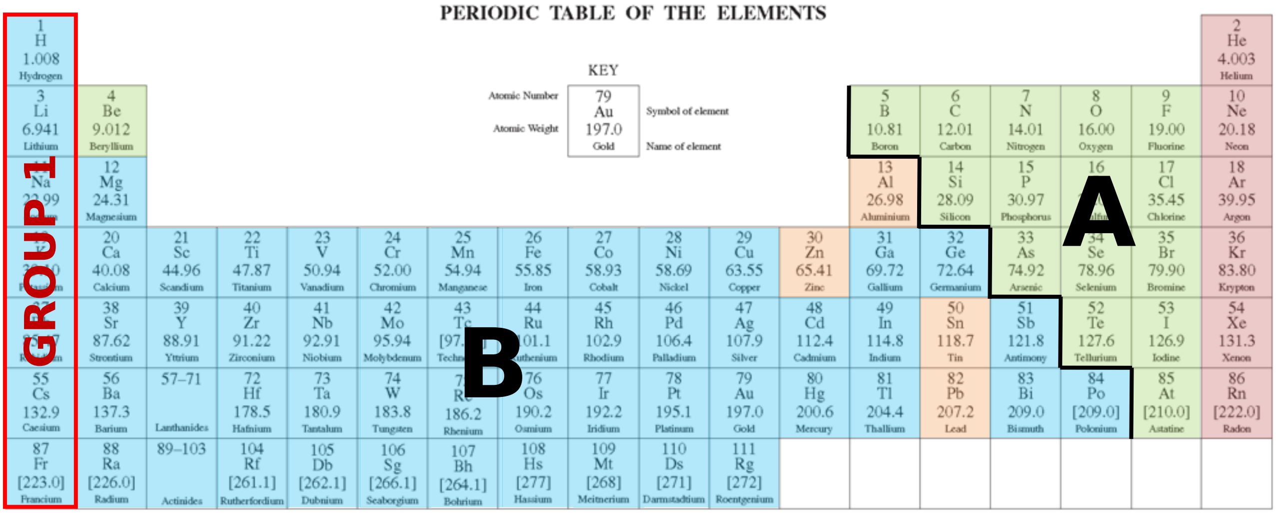


Diagram adapted from NSW Board of Studies, Chemistry Periodic Table of Elements

Dissolved oxides are **basic**

Dissolved oxides are **acidic**

No oxides

Dissolved oxides are **amphoteric**

Question 8: C

Because the ionisation reaction of H_2SO_4 is,

$$H_2SO_{4(aq)} \leftrightharpoons 2H^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

$$\text{pH} = -\log_{10}(2 \times 0.0115) = 1.6$$

Question 9: B

A base accepts a proton to form its conjugate acid.

$$HPO_4^{2-} + H^+ \rightarrow H_2PO_4^-$$

Question 10: A

Carbon Chain	IUPAC Name
C1	**Methanol**
C2	**Ethanol**
C3	**Propanol**
C4	**Butanol**

We can infer that propanol will have a boiling point between ethanol and butanol, that is, between 78 and 120. That rules out B, C & D, leaving A as the only possible correct answer. A similar process can be done for the propanoic acid, which again rules out B, C & D.

Question 11: B

$$octane + oxygen \rightarrow carbon\ dioxide + carbon\ monoxide + carbon + water + hydrocarbon$$
$$C_8H_{18}\ +\ 6O_2\ \rightarrow\ CO_2\ +\ CO\ +\ 6C\ +\ 9H_2O$$

The undesirable substances are carbon monoxide and carbon.

Question 12: A
With these kinds of questions that ask for which is not. It is best to go though the options marking then with a ✓ or ✗.

(A) Ozone is less reactive than normal oxygen ✗
(B) Ozone is a pollutant in the lower atmosphere ✓
(C) Ozone contains a co-ordinate covalent bond ✓
(D) Ozone acts as an upper atmosphere UV radiation shield ✓

Ozone is more reactive than normal oxygen, not less.

Question 13: D
Chlorine is added to water to kill bacteria, that is, disinfect it.

Question 14: C
Sea water has salt dissolved in it, whereas fresh water does not. By analysing the amount of total dissolved solids in the water it can be determined if the water is sea water or fresh water.

Question 15: D

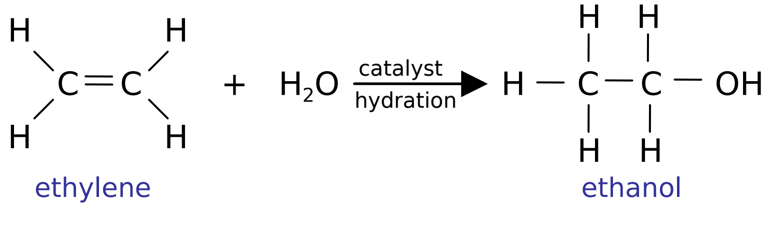
$$\underbrace{3H_{2(g)} + N_{2(g)}}_{4} \rightleftharpoons \underbrace{2NH_{3(g)}}_{2}$$

There is a ratio of a total of 4 moles on the LHS to 2 moles on the RHS, hence to favour the production of NH_3 the pressure is increased, **the volume is decreased**, the concentration of N_2 is increased.

SECTION I - Part B:

Question 16 (a):
Water

Comments:



$$C_2H_4(g) + H_2O(g) \xrightarrow{dil.\,H_2SO_4} C_2H_5OH(g)$$

Question 16 (b):
Ethanol dissolves in both polar and non-polar substances due to its structure. It has a non-polar CH_3 end on one side and a hydroxyl group at the other end. The **CH_3** end can dissolve **non-polar** substances (such as pentane) due to **dispersion forces**, and the **OH** end can dissolve **polar** substances (such as water) due to **hydrogen bonding**.

Question 17 (a):

$$^{199}_{78}Pt \rightarrow ^{199}_{79}Au + ^{y}_{z}X$$
$$199 = 199 + y$$
$$\therefore y = 0$$

$$78 = 79 + z$$
$$\therefore z = -1$$

So X can be written as $_{-1}^{0}e$, an electron.

Question 17 (b):
Geiger Muller Tube works through a sealed tube which contains argon gas. When radiation enters the tube it ionises the gas and this creates an electric signal. This is converted into sound and amplified and this allows you to hear a tone when a particle is detected.

Question 18:
Biopol,

- is a renewable resource → positive impact on environment → less dependency on non-renewable resources
- Is biodegradable → positive impact on environment → less landfill
- Is biocompatible → positive impact on society → used in skin grafts, stitches
- Is more expensive than current polymers that come from the petrochemical industry → negative impact on society because it is more costly

In general, the use of Biopol is beneficial to the environment and society.

Question 19:
These standard potentials are measured under standard conditions of **25°C**, **100kPa** and using **1 mol L^{-1}** solution. These conditions are necessary as a change in these conditions results in a change in the measured value of E^{Θ}.

Question 20 (a):

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Question 20 (b):
A spirit burner with an alkanol in it was lit and the heat produced from its combustion was directed into a beaker of water. After the temperature of the water stabilised we measured the mass change of the alkanol and temperature change of the water. We then calculated the molar heat of combustion from the data.

In this procedure we placed the beaker of water close to the heat source so that minimal heat was lost and so that most of the heat from the combustion of the alkanols went into heating the water.

Question 21 (a):

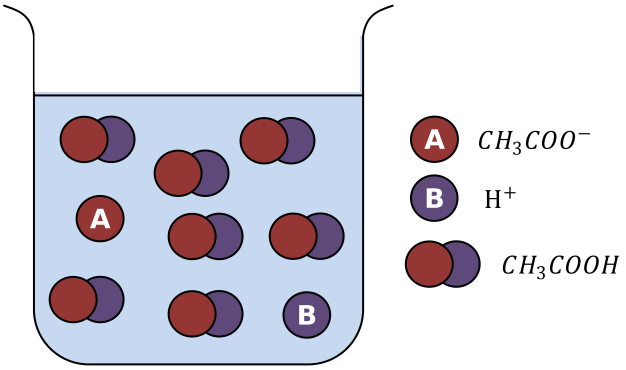
- Ethanol
- Butanoic Acid
- Concentrated Sulfuric Acid

Question 21 (b):
Ethyl Ethanoate is an ester and it is used as a solvent in nail polish remover.
OR
Octyle Ethanoate is an ester which is orange flavour. It is used in flavouring additives to processed foods.

Question 22 (a):

$$CH_3COOH_{(aq)} \leftrightharpoons CH_3COO^{-}{}_{(aq)} + H^{+}{}_{(aq)}$$

Question 22 (b):



Comments:
Notice that the degree of ionisation is low. That is, the ratio of ions to molecules is small.

Question 23:
The sulfur that is in the coal will burn as given by the reaction,

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

$$n(S) = \frac{\text{mass}}{\text{molar mass}} = \frac{\frac{0.1}{100} \times 10 \times 10^6 \times 10^3}{32.07} = 311\,818 \text{ mol}$$

As, $n(SO_2) = n(S)$ (from the mole ratios of 1:1), $n(SO_2) = 311\,818$ mol.

A $1 \text{ mol} = 24.79 \text{ L}$,
$311\,818 \text{ mol} = 311\,818 \times 24.79 \text{ L} = 7\,729\,965.7 \text{ L}$ of $SO_2(g)$ released, which is approximately 7.7 million litres.

Comments:
Please not that the Sample Answer given in the CSSA Marking Guidelines uses 0.01% not the 0.1% told in the question. I think this is a mistake in the sample answer.

Question 24:

Question 25:
I use LDAB to remember the order of the scientists.

Lavoisier hypothesised that all acids contained oxygen. Note that H_2SO_4 contains O. Davy proposed that all acids contained hydrogen not oxygen. Note that H_2SO_4 contains H. Arrhenius proposed that an acid is a substance which produces hydrogen ions in water.

$$H_2SO_{4(aq)} \leftrightharpoons 2\boldsymbol{H^+}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

Bronsted-Lowry theory states that an acid is a substance that donates a proton (hydrogen ion), and a base is a substance that accepts a proton. The H_2SO_4 is donating the proton to the water,

$$H_2SO_{4(aq)} + H_2O \rightarrow H_3O^+{}_{(aq)} + HSO_4^-{}_{(aq)}$$

Question 26:

Question 27:9

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:

2003 CSSA

SECTION I - Part A:

Question 1: D
Bromine water is used to distinguish between alkanes and alkenes.

Question 2: D
We know that metals higher on the table will displace metal ions which appear lower on the list. As magnesium, zinc and iron all appear higher than lead, they will all displace lead from a solution of lead (II) nitrate.

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	magnesium
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–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	zinc
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V	iron
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V	
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V	
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V	**lead**
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	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	
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	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	

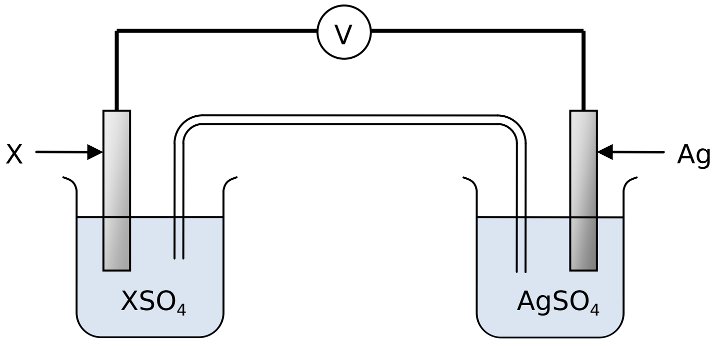
Comments:
You don't really need to know this to work out this question. Just be looking at the locations of the metals relative to lead you will see that the metals listed in option D are the only group where all the metals appear either all above of all below the lead. All the other options have some above lead and some below lead. So this makes D the odd one out and so you can assume it to be the correct answer without even applying any chemistry at all.

Question 3: C

(A) The alpha radiation is too damaging to the body and gets stopped by the body.
(B) The half life of 6.2 minutes is too small. Several hours is idea.

(C) The half life of 6 hours is ideal and it emits gamma radiation which can penetrate the body and can be easily detected.
(D) We can rule out D as the half life is way too large.

Question 4: B



We know that the silver half cell will have a voltage of 0.8 (from the table of standard potentials). We are told that the total voltage is 1.24. We know that 0.8 + x = 1.24. So x must equal 0.44, which is the voltage of iron. Hence metal X must be iron.

Question 5: B

$$n = \frac{m}{MM} = \frac{11.5}{12.01 \times 2 + 1.008 \times 6 + 16.00} = 0.250 \text{ mol}$$

$$\frac{1360 \text{ kJ}}{1 \text{ mol}} = \frac{x \text{ kJ}}{0.250 \text{ mol}}$$

$$x = 340 \text{ kJ}$$

Question 6: A
Orange juice naturally contains acidic acid, hence it is acidic.

Question 7: D
We know that A is wrong as metals tend to form basic oxides.

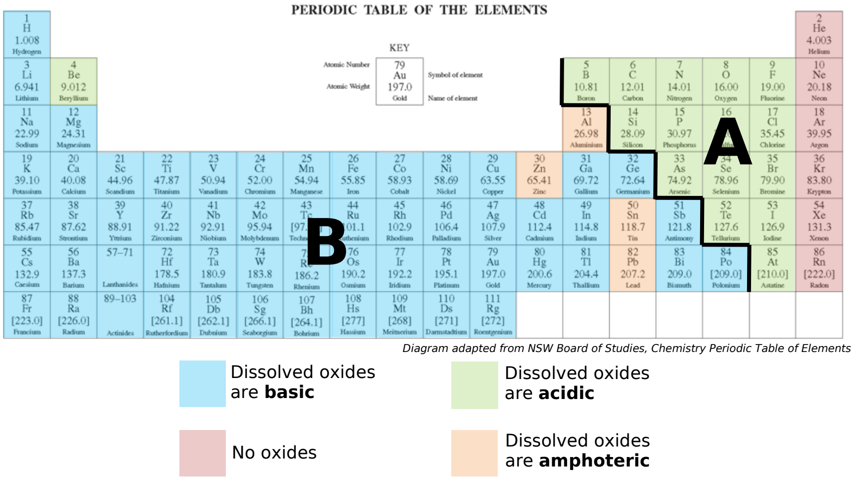
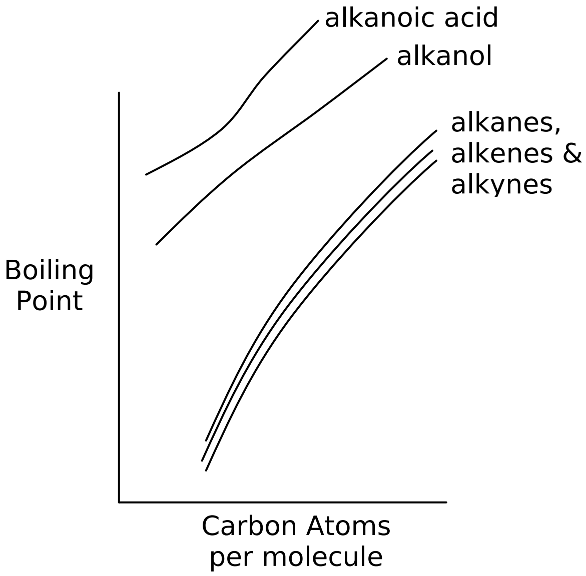


Diagram adapted from NSW Board of Studies, Chemistry Periodic Table of Elements

Similarly as Mg is a metal, it will form a basic oxide. Option C, basic oxides do not neutralise basic solutions, that is like adding base to base, neutralisation is acid + base. Option D is correct, non-metals tend to form acidic oxides.

Question 8: A
If you remember the graph shown below, you will see that the boiling points are in the order of alkane, alkanols, alkanoic acid. This leaves options A and B. Although the gap between alkanoic acids and alkanols is small relative to the gap between alkanols and alkanes, 2°C is not a large enough gap, so A is the correct answer.



Question 9: A
We can construct the equation,

$$CaCO_3 + 2HCl \rightarrow CO_2(g) + CaCl_2 + H_2O$$

To calculate the volume of carbon dioxide we need to know the moles of carbon dioxide. This can be calculated using the mole ratios. However it should be noted that we will have a limiting reagent as amounts of both reacts are specified.

$$n(CaCO_3) = \frac{m}{MM} = \frac{10.0}{40.08 + 12.01 + 16.00 \times 3} = 0.0999 \text{ mol}$$

$$n(HCl) = cv = 1.00 \times (50 \times 10^{-3}) = 0.05 \text{ mol}$$

However as the mole ratios of the reactants are 1:2, you will have 0.1 moles of HCl. So as you can see you will have 0.0001 moles of HCl unreacted. However as this number is so small, I think it will not make a difference to the final answer.

Using the mole ratios of $CaCO_3 : CO_2(g) \equiv 1:1$, we know that 0.01 moles of $CO_2(g)$ will be produced. As,

$$\frac{1 \text{ mol}}{24.79 \text{ L}} = \frac{0.01 \text{ mol}}{x \text{ L}}$$

$$x = 2.48 \text{ L}$$

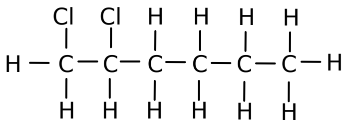
Question 10: D
pH is a measure of the hydrogen ion concentration ($pH = -\log_{10}[H^+]$). If two substances have the same pH, then they both have the same hydrogen ion concentration. The terms weak/strong base reflect the degree of ionisation. That is, how much of the molecules ionise and how many stay as intact molecules. If the degree of ionisation increases, the pH will increase, but if at the same time the substance is diluted by the same amount then the pH will be unchanged, even though the degree of ionisation changes. As such substances with the same pH do not necessarily have the same degree of ionisation. This rules out option A.

In a similar way to about, B is also incorrect. If the degree of ionisation is different then the concentrations can differ to result in the same pH.

Also as both have a $pH > 7$, they are both basic and as such much have OH^- ions. This means that C is incorrect, which leaves D, which by the process of elimination must be correct.

Question 11: C

Question 12: A
The graphical structural formula of 1,2–dichlorohexane is,



1,2–dichlorohexane

We know that isomers are molecules with the same molecular formula but different structural formulae. So an isomer of 1,2–dichlorohexane is a molecule with 6 carbons, 2 chlorines & 12 hydrogen's, but must not have the same structural formula as 1,2–dichlorohexane (which is shown above).

This means that C is wrong, as it has the same structural formula as above. D only has 5 carbons and B has 8 carbons, meaning that they are also both wrong. A is the correct answer as it has 6 carbons, 2 chlorines & 12 hydrogen's and it has a different structure than the structure of 1,2–dichlorohexane.

Question 13: B
The fact that $\Delta H < 0$ tells us that the reaction will be exothermic.

Question 14: D
The diagram below shows microscopic membrane filters. Because there are so many of these tiny tubes the surface area is quite large and hence the filtration rate is high. So D is the correct option and C is incorrect. Also A is incorrect as microscopic membrane filters can filter out dissolved solids. As they do not remove biological matter, microscopic membrane filtering is usually done before chemical treatment.

(Photo by Tim Reid)

Question 15: B
A coordinate covalent bond is a covalent bond in which one atom provides both the shared electrons.

SECTION I - Part B:

Question 16 (a):
Mass number: $238 + A = 239$, $\therefore A = 1$
Atomic number: $92 + Z = 92$, $\therefore Z = 0$

So the element X is, ${}^{1}_{0}X$. A particle with no protons but a mass of 1, a **neutron**, ${}^{1}_{0}n$.

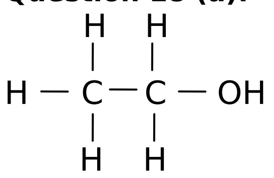
Question 16 (b):
Protons are fired into the nucleus of large atoms, usually in particle accelerators. However isolating large samples of the element have generally been unsuccessful as these large elements are unstable and decay very quickly into smaller elements.

Question 17:
The reaction to produce polyethylene (i.e. polymerisation of ethylene) is addition polymerisation.

$$CH_2CH_2 + CH_2CH_2 \rightarrow CH_2CH_2CH_2CH_2$$

Cellulose is produced from the glucose monomer by condensation polymerisation, that is,

$$\cdots + \text{glucose} + \text{glucose} + \cdots \rightarrow \text{cellucose} + \text{water}$$

Question 18 (a):


Question 18 (b):
Use of ethanol as an additive will lower dependency of current fuels obtained from petroleum. And increase the use of the renewable and environmentally friendly ethanol. Ethanol is a suitable fuel as it has a relatively high molar heat of combustion.

Question 19 (a):
Balance

Question 20 (a):
Any one of:
- Methyl Orange
- Litmus
- Phenoplhalein
- Bromothyl Blue

Question 20 (b):
It is affected by the colour of the substance you are testing.
OR
It has a low accuracy.

Question 20 (c):
Higher accuracy.
OR
Not affected by colour of substance.

Question 20 (d):
The pH metre needs to be rinsed several times in water prior to use to remove any substances that are on it from previous use. Also the metre needs to be calibrated. That is placing it in substances of known pH to set these values.

Question 21:

Question 22:

Question 23:

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Question 27:

SECTION II:

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

(a) (ii):

(b) (i):

(b) (ii):

(c) (i):

(c) (ii):

(d) (i):

$$K = \frac{[\mathrm{NH_3}]}{[\mathrm{N_2}][\mathrm{H_2}]}$$

(d) (ii):

(e):

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2002 CSSA

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