

Feedback  
Tue 27/11

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## NSW INDEPENDENT TRIAL EXAMS – 2002 CHEMISTRY - SUGGESTED ANSWERS

### SECTION I - PART A

1	A	2	B	3	A	4	C	5	D	6	C	7	B	8	B
9	D	10	A	11	C	12	D	13	C	14	C	15	B		

### SECTION I - PART B

16. (a) The ethanol molecule is polar (1 mk) and has strong dipole-dipole attractions with other molecules, acting as a solvent for a range of polar substances (1 mk)  
(Hydrogen bonding as an alternative) (1 mk)
- (b) Any two of: (2 mk)  
temperature in range 30-40°C  
dilute aqueous sugar solution  
yeast to provide enzymes  
anaerobic environment
- (c) As fermentation proceeds the reaction mixture decreases in mass due to the loss of carbon dioxide. (1 mk)  
$$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{O} + 2\text{CO}_{2(g)}$$
 (1 mk)
17. Advantage: any one of: (1 mk)  
water soluble (spills clean up and fire safety)  
easily ignited  
renewable
- Disadvantage: any one of: (1 mk)  
lower energy density  
flash point below ambient temperature
18. (a)  $\text{V}^{2+} \rightarrow \text{V}^{3+} + \text{e}^-$  (1mk)
- (b)  $\text{VO}_2^+ + 2\text{H}^+ + \text{V}^{2+} \rightarrow \text{VO}^{2+} + \text{H}_2\text{O} + \text{V}^{3+}$  (1 mk)
- (c) 1.26 V (1 mk)
- (d) The cell can be recharged. It has a long life. It is highly efficient. All reactions occur in solution, with inert electrodes. It is relatively inexpensive. It can be used for electric vehicles and thus reduce pollution from petrol driven cars. (2 marks for any one reason and relating it to society/environment) (2 mks)
19. Addition polymers are formed when unsaturated monomer units join without loss of atoms. (1 mk)  
Chloroethene has the structure  $\text{CH}_2=\text{CHCl}$  (1 mk)  
During polymerisation the double bonds open out, providing electrons for bonding to other monomer molecules. (1 mk)
20. (a)  ${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + \beta$  (1 mk)
- (b) Geiger-Muller tube, scintillation counter, photo film or cloud/bubble chamber (1mk)
- (c) Any valid example eg: Iodine-121 (1 mk) to treat hyperactive thyroid by destroying some cells, a less invasive treatment than surgery (1 mk) (2 mks)

21. Moles HCl (limiting reactant) =  $1.5/24.47 = 0.0613$  mol (1 mk)  
 Mass  $\text{NH}_4\text{Cl}$  formed =  $0.0613 \times \text{mol. mass} = 0.0613 \times 53.5 = 3.28$  g (1 mk)
22. eg: sodium hydrogen carbonate (or the hydrogen carbonate ion) (1 mk)  
 This species acts as a proton donor and acceptor, shown by:-  
 $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightarrow \text{H}_2\text{CO}_3 + \text{H}_2\text{O}$  (or  $\text{CO}_2 + 2\text{H}_2\text{O}$ ) (1 mk)  
 $\text{HCO}_3^- + \text{OH}^- \rightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$  (1 mk)
23. (a) (i) methyl propanoate (1 mk)  
 (ii)  $\text{CH}_3\text{CH}_2\text{COOCH}_3$  or expanded formula (1 mk)  
 (iii) any strong acid, phosphorus pentoxide etc (1 mk)  
 (iv) Heating under reflux increases the reaction rate (higher temperature) (1 mk)  
 while preventing loss of reactants or products by vaporisation to outside. (1 mk)  
 (b) The ester has low polarity resulting in much weaker intermolecular forces (1 mk)  
 than in pentanol and butanoic acid which both have polar OH groups. (1 mk)  
 With an additional O atom butanoic acid is still more polar OR  
 Pentanol and butanoic acid also form hydrogen bonds.  
 The boiling points reflect the strengths of these intermolecular forces. (1 mk)
24. (a) Opening the bottle causes a decrease in pressure causing the equilibrium to shift to the side of greatest number of gaseous molecules, therefore formation of more gaseous  $\text{CO}_2$  (2 mk)  
 (b) As lowering the temperature favours the formation of aqueous  $\text{CO}_2$ , this reaction is the reaction that produces heat, therefore the forward reaction as written is exothermic. (2 mk)
25. (a)  $\text{H}_2\text{SO}_4 + 2\text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$  (1 mk)  
 (b) no. of moles of KOH =  $2 \times \text{no. of moles of H}_2\text{SO}_4$   
 $25.0 \times [\text{KOH}] = 2 \times 0.200 \times 0.0200$  (1 mk)  
 $[\text{KOH}] = 0.320 \text{ mol L}^{-1}$   
 (c) Mass KOH = molarity  $\times$  volume  $\times$  mol. mass  
 $= 0.32 \times 5 \times 56.1$  (1 mk)  
 $= 89.8\text{g}$
26. (a)  $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightarrow 2\text{NH}_{3(\text{g})}$  (1 mk)  
 (b) (i) As the forward reaction occurs with a decrease in the number of gas molecules, Le Chatelier's principle states that increasing the pressure causes the equilibrium to move to the right, increasing the yield of ammonia. (1 mk)  
 (ii) As shown in the graph (or predicted by Le Chatelier) a higher temperature would reduce the equilibrium yield of ammonia, so that the reaction is carried out at the lowest temperature which affords an acceptably fast reaction. (1 mk)  
 (c) Any one of: (1 mk)  
 To maintain the 3:1 stoichiometric ratio of hydrogen:nitrogen, to prevent an excess of either in the chamber.  
 To ensure no oxygen is present, to avoid explosion with hydrogen.  
 To ensure no S compounds are present, to avoid inactivating the catalyst.  
 (d) One of fertilisers, production of nitric acid, dyes, explosives, Solvay process etc (1 mk)
27. (a) moles of oxygen =  $20 \times 0.2095/24.47 = 0.171$  mol (1 mk)  
 (b) moles of argon =  $200 \times 0.00934/24.47 = 0.0763$  mol (1 mk)  
 mass of argon = moles  $\times$  mol. mass =  $0.0763 \times 39.95 = 3.05$  g (1 mk)

28. (a) Wash the precipitate with distilled water (1 mk)  
 Dry the precipitate (1 mk)
- (b) Moles of ppt. =  $0.125/\text{mol. mass} = 0.125/222.56 = 5.62 \times 10^{-4}$   
 Moles of P present = 2 x moles ppte (1 mk)  
 $= 1.123 \times 10^{-3} \text{ mol}$   
 $\% \text{ P in detergent} = 1.123 \times 30.97 \times 100/2.85 = 1.22\%$  (1 mk)
- (c) Excess nutrients such as nitrates and phosphates can cause excessive growth of algae and other organisms in waterways. (1 mk) One type of alga that may grow excessively is blue/green algae which is toxic to livestock and can affect humans. The algal growth blocks the entry of sunlight, and increases BOD (1 mk) creating an anoxic environment leading to death of aquatic organisms. (1mk) (3 mks)
29. (a)  $[\text{Fe}] = 2.6 \times 50/10 = 13 \text{ ppm}$  (1 mk)  
 (b) Mass of Fe in 260 g =  $13 \times 260 \times 10^{-6} = 3.38 \text{ mg}$  (1 mk)  
 (c)  $\% \text{ daily allowance} = 3.38 \times 100/18 = 18.8\%$  (1 mk)  
 (d) The undiluted drink has a concentration beyond the calibration scale for the spectrometer used. (1 mk)

## SUGGESTED ANSWERS TO OPTIONS

### QUESTION 30 – INDUSTRIAL CHEMISTRY

- (a) (i)  $k = [\text{CH}_3\text{OH}]/([\text{H}_2]^2 \times [\text{CO}])$  (1 mk)  
 (ii) Concentrations = 1.0/10, 0.9/10 and 0.1/10  
 $k = 0.01/(0.09^2 \times 0.1) = 12.3$  (1 mk)  
 (iii) As the forward reaction is exothermic the equilibrium constant would increase, with the equilibrium shifting to the right. (1 mk)
- (b) (i) Raw materials: brine (sodium chloride) & calcium carbonate (limestone) (1 mk)  
 Products: sodium carbonate & calcium chloride (solution) (1 mk)  
 (ii) Proximity to seawater or salt deposit  
 Proximity of limestone deposit  
 Means of disposal of calcium chloride waste  
 Energy supply  
 Proximity to markets and/or workforce Any two (2 mk)
- (c) Soap is manufactured by the saponification of fats and oils with sodium hydroxide solution to form glycerol and the sodium salts of fatty acids (soaps). (2 mk)  
 The anion of the soap is the cleaning agent, consisting of a long hydrophobic alkyl chain joined to the hydrophilic carboxyl group. ~~~~~COO<sup>-</sup> (1 mk)  
 Greasy 'dirt' particles become dissolved into the alkyl chains of a collection of soap molecules, the hydrophilic carboxyl groups allowing the assembly (a micelle) to disperse in the water.  
 (Alt; a suitable diagram and short description) (2 mk)
- (d) (i)  $\text{SO}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \rightarrow \text{SO}_{3(g)}$  (1 mk)  
 (ii) Increase the oxygen concentration  
 Lower the temperature  
 Increase the pressure  
 (Use a catalyst to reach equilibrium more quickly) Any two (2 mk)
- (iii) Sulfuric acid is a very strong acid, oxidising agent and dehydrating agent. (1 mk)  
 The acid must be handled only with protective glasses and gloves. (1 mk)  
 Dilution must be carried out by slowly adding the acid to water, with stirring. (1 mk)

- 30.(e) The mercury cell electrolyses sodium chloride solution with an inert anode, where chlorine is produced, and a mercury pool cathode into which sodium metal dissolves. The mercury amalgam flows into a tank of water into which the sodium dissolves forming sodium hydroxide and hydrogen. Thus the main products are sodium hydroxide, chlorine and hydrogen. (3 mk)

Technical considerations:

Proximity to electric power, transport facilities, workforce, raw materials.

Skilled staff monitoring operation to prevent release of toxic substances (chlorine, mercury, sodium hydroxide) or explosion (hydrogen); a very high level of plant safety is needed.

Any 2 (2 mk)

Environmental:

Minimise impact of plant (noise, light, emissions) and transport operations on surrounding population.

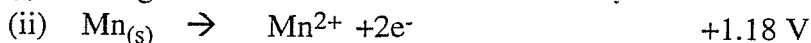
Need to remove all mercury from waste discharge to waterways.

Release of chlorine to be kept below maximum permitted level.

Any 2 (2 mk)

### QUESTION 31 - SHIPWRECKS & SALVAGE

- (a) (i) manganese (1 mk)



Criteria	Marks
Correct net equation and correct voltage calculation	2
Either correct net equation OR Correct voltage calculation	1

- (b) (i) Zinc metal electrode is the Anode. Reference to an  $E^0$  Potential Table indicates that zinc is more readily oxidised than iron. (2 mk)

Criteria	Marks
Zinc electrode identified as ANODE AND a correct supporting piece of information eg. reference to $E^0$ Table	2
Zinc electrode identified as Anode, no justification or an incorrect justification	1

- (ii) Bubbles of a gas (most likely to be oxygen gas) forming around the location of the anode and at the cathode, copper metal is electroplating the electrode. (2 mk)

Criteria	Marks
Correct observation occurring at the Anode AND Correct observation occurring at the Cathode	2
A correct observation occurring at one electrode	1

- (c) Preparing (5 mk)

Removal of any calcareous deposits by physical means such as chipping with a small drill as other methods of chemical treatment such as acid baths would damage the wood. Long immersion in fresh water with repeated water changes to permit removal of soluble salts so as to prevent damage from rapid drying out of the wood

Preserving: Impregnation the timber with an inert chemical material to fill the empty spaces inside the wood that were filled previously with the sea water as the wood will shrink and distort without this preservative step. Maintain the timber in conditions of controlled humidity, temperature and light as this will minimize any further degradation of the wood.

31. (c)

Criteria	Marks
Detailed descriptions of all processes At least TWO methods of preparing and TWO methods of preserving of wooden artifacts ...	4 - 5
At least ONE method of preparation AND ONE method of preserving wooden artifacts ... One description to be detailed	2 - 3
A method of preparing wood OR preserving wooden artifacts after long immersion in the sea.	1

- (d) (i) Any suitable passivating metal e.g. aluminium (1 mk)
- (ii) Organise and weigh multiple pieces of equal sized masses of magnesium, iron and lead.  
Place a single sample of each metal into a single test-tube.  
Use similar shaped & sized test-tubes. Add equivalent amounts of water to each tube.  
Leave some tubes with only metal & water.  
To some tubes add 5 droplets of and to others add 10 drops of 2M  $\text{H}_2\text{SO}_4$ .  
Leave all test-tubes for a similar specified period of time e.g. 7 days  
Wash and dry all pieces of metal then reweigh to determine any metal loss through corrosion.  
Determine if any relationship exists between the degree of corrosion and the acidity of the conditions in which they were placed. (2 mk)

Criteria	Marks
Main features of a feasible method described AND the concept of controlling all features except acidity and possibly the metal type described	2
Main features of a feasible method described	1

- (iii) The dilemma exists because recent research is conflicting with traditionally accepted chemistry thinking.  
Traditional thinking was that at the bottom of the ocean, it is absolutely dark and extremely cold (almost 0 °C) and conditions of low oxygen levels, these conditions would lower reaction rates thereby reducing the rate of corrosion of iron in shipwrecks.  
Recent discoveries are showing that the waste products of particular types of chemosynthetic bacteria are acidic in nature, these acidic conditions cause acceleration of the rate of corrosion of steel in the very deep ocean. (3 mk)

Criteria	Marks
Discusses why a dilemma exists Mentions a reason for slow corrosion e.g. low temps slowing reaction rates OR Mentions a reason for newly discovered corrosion rates i.e. bacterial wastes causing acidic conditions which speed corrosion	3
Mentions a reason for slow corrosion e.g. low temps slowing reaction rates AND Mentions a reason for newly discovered corrosion rates i.e. bacterial wastes causing acidic conditions which speed corrosion	2
Mentions a reason for slow corrosion e.g. low temps slowing reaction rates OR Mentions a reason for newly discovered corrosion rates i.e. bacterial wastes causing acidic conditions which speed corrosion	1

31.(e) Possible Corrosion Protection Alternatives

(7 mk)

Painting to prevent water & oxygen reacting with the iron in steel.

Painting with special resins to prevent water & oxygen reacting with the iron in steel.

Impressed Electrical Currents run through the metal of the hull as one electrode from the ships generators and another electrode external to the ship sets up a circuit to reduce the oxidation of the hull.

Sacrificial Anodes where pieces of more reactive metal e.g. zinc are attached to the ship so that they are corroded in preference to the metal of the ships hull.

Comparisons

Painting is the cheapest and lowest technology approach.

Sacrificial anodes are more expensive as they require regular replacement of the more active metal which has been corroded away. Not a viable option for extremely large vessels.

Impressed current systems are very expensive to establish but are fairly cost effective over the lifetime of the vessel and have the advantage of weighing less than sacrificial anode systems.

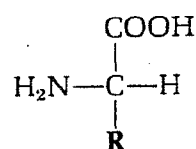
Recommendation

The recommendation to the Silver Star Line is to paint the vessels with special resin based paints as these form hard abrasion resistant surfaces that protect the steel from the conditions which cause corrosion. This choice is done because it is cost effective (relatively cheap), it is simple to apply and provides a good initial level of protection to the metal.

Criteria	Marks
Chooses a preferred method of corrosion protection and gives one or more reasons to justify that choice	4 - 5
Makes a COMPARISON of the TWO or more methods of corrosion protection for steel	2 - 3
Outlines at least TWO methods of corrosion protection for steel	1

**QUESTION 32 - BIOCHEMISTRY OF MOVEMENT**

- (a) (i) for drawing the correct structure



(1 mk)

R represents the side chain or an R group which is different in each amino acid

- (ii) identifying and explaining the four kinds of interacting forces. (2 mk)

$\alpha$  is the hydrophobic forces between the hydrophobic R groups of some non-polar amino acids like phenylalanine, leucine, isoleucine, methionine, valine, tryptophan.

$\beta$  is the electrostatic forces between oppositely charged R groups, e.g. the negatively charged  $\text{COOH}^-$  of a glutamic acid residue with the  $-\text{NH}_3^+$  of a lysine residue in an adjacent loop.

$\chi$  is the disulfide bonds formed from a cysteine residue with another cysteine residue in an adjacent loop. This is the strongest of all the four factors.

$\delta$  is the hydrogen bonding forces between the hydroxyl group of a serine, for example with a ring nitrogen atom of a histidine residue in an adjacent loop of the same chain.

These non-covalent interactions ( $\alpha$ ,  $\beta$  and  $\delta$ ) are individually weak but collectively strong.

$\chi$  is a covalent cross-linkage which is strong in force.

(Although the native tertiary conformations of globular proteins are the stablest forms their polypeptide chains can assume, the tertiary conformation of globular proteins must not be regarded as absolutely rigid and fixed. Many globular proteins normally undergo changes in their conformation in the course of their biological function, e.g. enzyme molecules can change their conformation when they bind their substrate.)