Neap:

Trial Examination 2008

VCE Chemistry Unit 2

Written Examination

Suggested Solutions

SECTION A: MULTIPLE-CHOICE QUESTIONS

1	**A**	B	C	D
2	A	B	**C**	D
3	A	B	C	**D**
4	A	**B**	C	D
5	**A**	B	C	D
6	A	**B**	C	D
7	A	B	**C**	D
8	**A**	B	C	D
9	A	B	**C**	D
10	A	B	C	**D**

11	A	**B**	C	D
12	**A**	B	C	D
13	A	B	C	**D**
14	A	B	C	**D**
15	**A**	B	C	D
16	A	B	**C**	D
17	A	B	**C**	D
18	A	**B**	C	D
19	A	**B**	C	D
20	A	B	C	**D**

Question 1 **A**

NO_2 reacts with rain water to form HNO_3, a component of acid rain. NO_2 is a brown gas. NO_2 reactions in the presence of sunlight lead to the formation of ozone. Statements **B**, **C** and **D** are therefore correct. While N_2O is an infrared absorber that functions as a greenhouse gas, NO_2 is not.

Question 2 **C**

$pV = nRT \therefore V \propto \frac{T}{p}$

For **A**, $\frac{T}{p} = \frac{273}{1.1} = 248$ For **B**, $\frac{T}{p} = \frac{283}{3.5} = 81$

For **C**, $\frac{T}{p} = \frac{298}{4.1} = 73$ For **D**, $\frac{T}{p} = \frac{308}{2.0} = 154$

Question 3 **D**

All three gases are odourless and colourless (**A** and **B** are incorrect). A glowing splint will be extinguished by both nitrogen and carbon dioxide (**C** is incorrect). Carbon dioxide will form an acidic solution (pH < 7). Nitrogen and oxygen produce neutral solutions (although both gases have low solubility in water).

Question 4 **B**

The relevant half equations are

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

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

Electrons travel from the zinc to the lead. Pb^{2+} ions move towards the Pb electrode where they deposit as Pb atoms.

Question 5 **A**

Minimising toxic chemical use and waste product formation are key green chemistry principles. Minimal waste is achieved with maximum atom efficiency, i.e. the incorporation of as many reactant atoms into the product as possible. The aim is for minimal energy use, not maximum (**A** is not a correct green chemistry principle).

Question 6 **B**

Ionisation is the formation of ions from non-ionic reactants, e.g. $NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$. In **A** and **D**, both the reactants and products are ionic. No ions are involved in **C**.

Question 7 **C**

C contains the greatest mass of NaCl and so the greatest number of Na^+ ions.
The relevant calculations are

A. 10 ppm means 10 mg in 1 L
$\therefore$ 10 × 200 mg in 200 L
$\therefore$ $10 \times 200 \times 10^{-3} = 2.0$ g of NaCl

B. 5.0% m/v means 5 g in 100 mL
$\therefore 5 \times \frac{30}{100}$ g in 30 mL
$\therefore$ 1.5 g of NaCl

C. $n(\text{NaCl}) = c \times V = 0.50 \times 0.250$ mol
$m(\text{NaCl}) = n \times M = 0.50 \times 0.250 \times 58.5$
$= 7.3$ g of NaCl

D. $m(\text{NaCl}) = n \times M = 0.035 \times 58.5$
$= 2.0$ g of NaCl

Question 8 **A**

Boyle's Law $p \propto \frac{1}{V}$ at constant T and n.

Question 9 **C**

pH is a logarithmic scale. A change of one pH unit represents a 10-fold change in $[H^+]$. A change of two pH units is therefore a 100-fold change in $[H^+]$.

Question 10 **D**

O_3 is an ultraviolet light absorber, not an infrared absorber. The ozone layer is important in reducing UV radiation reaching the Earth's surface. **D** is an incorrect statement, and is therefore the required response. **A**, **B** and **C** are true.

Question 11 **B**

Z is the least reactive as it does not even react with acid. X is the most reactive as it reacts spontaneously with cold water. The order of reactivity is $X > W > Y > Z$.

Question 12 **A**

Spontaneous redox reactions occur between a metal and the ions of less reactive metals. Thus X will react with the ions of W, Y and Z. Z will not react with the ions of X, W or Y. Y will not react with the ions of X or W.

Question 13 **D**

$$n(\text{NaOH}) = \frac{m}{M} = \frac{10.0}{40.0} = 0.250 \text{ mol}$$

$$[\text{NaOH}] = \frac{n}{V} = \frac{0.250}{0.2500} = 1.0 \text{ M}$$

$$[OH^-] = [\text{NaOH}] = 1.0 = 10^0 \text{ M}$$

$$[H_3O^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{10^0} = 10^{-14}$$

$$\text{pH} = -\log[H_3O^+] = -\log(10^{-14}) = 14$$

Question 14 **D**

$pV = nRT$. For the two gases, SO_2 and SO_3, if p, V and T are all equal, then the two gases must contain the same number of mole, n. If $n(SO_2) = n(SO_3)$, then the number of molecules must be the same. Masses and percentage mass of sulfur will differ due to differing molar masses. Number of oxygen atoms will differ due to different S : O ratios.

Question 15 **A**

At 80°C, solubility is 170 g per 100 g.
At 40°C, solubility is 60 g per 100 g.
$\therefore$ 170 – 60 = 110 g per 100 g will crystallise
$\therefore$ 55 g per 50 g (50 mL) will crystallise.

Question 16 **C**

At 60°C, solubility is 160 g per 100 g of water.

$\therefore \left(\frac{40}{100} \times 160\right)$ g per 40 g of water

$\therefore$ 64 g per 40 g of water.
We have 10 g in 40 g of water.
We need to add 54 g to saturate the solution.

Question 17 **C**

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$\frac{700 \times 58}{(273 + 13)} = \frac{p_2 \times 33}{(273 + 100)}$$

$p_2 = 1604$ mmHg = 214 kPa

Question 18 **B**

The stronger acid in each pair will be the better conductor because it will be more extensively ionised. HCl, HNO_3 and H_2SO_4 are all strong acids. HOOH is a weak acid. H_2O is a very weak acid.

Question 19 **B**

The speed of the molecules relates to their kinetic energy, which in turn is related to the gas temperature. At constant temperature, the curves for the same gas will be the same, irrespective of the volume or pressure (**A** and **C** are incorrect). Differing amounts of the same gas at the same temperature will produce the same shaped curves, but with different areas under the curve (**D** is incorrect).

Question 20 **D**

Process W would represent atmospheric fixation of nitrogen (**A** is correct). Process X represents denitrification (**B** is correct). Process Y could occur through fertiliser production (**C** is correct). Process Z is the action of nitrifying bacteria. Nitrogen fixing bacteria convert atmospheric N_2 to soil NO_3^-; therefore **D** is incorrect and is the required response.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

a. i. $2C_8H_{18}(l) + 17O_2(g) \rightarrow 16CO(g) + 18H_2O(g)$ 1 mark

ii. Conduct the combustion in a plentiful supply of oxygen. 1 mark

b. i. *For example:*

- CO_2 is the greenhouse gas present in the highest concentration.
- CO_2 concentrations have shown large increases due to human activities (fossil fuel burning).

1 mark

ii. *For example:*

- CH_4 is a more efficient infrared absorber than CO_2.
- CH_4 is produced naturally by animals (cows etc.). Agricultural practices may lead to changes in CH_4 concentrations.

1 mark

iii. $6CO_2(g) + 6H_2O(l) \xrightarrow[UV]{\text{chlorophyll}} C_6H_{12}O_6(aq) + 6O_2(g)$ 1 mark

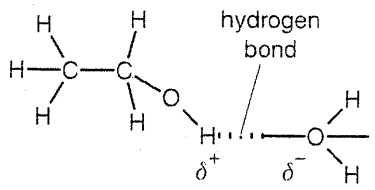
c. i. Cool the gas mixture to below 100°C and the water will condense to form a liquid.
OR
Bubble the gas mixture through a desiccant such as $CaCl_2$. 1 mark

ii. Bubble the gas mixture through NaOH solution. The CO_2 will react and be separated from the nitrogen. 1 mark

Total 7 marks

Question 2

a.



2 marks

b. i. 4.50% v/v means 4.50 mL of ethanol in 100 mL of beer.

$\therefore 4.50 \times \frac{375}{100}$ of ethanol in 375 mL of beer

$\therefore$ 16.9 mL 1 mark

ii. 4.50 mL in 100 mL of beer

$\therefore$ 45.0 mL in 1000 mL of beer

$\therefore$ (45.0 × 0.785) g per 1000 mL of beer (mass = density × volume) 1 mark

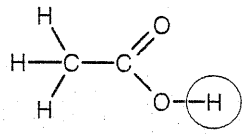
$\therefore \frac{45.0 \times 0.785}{46.0}$ mol per 1000 mL of beer 1 mark

$\therefore$ 0.768 M 1 mark

c. **i.** One of the following points:

- Oxygen is added to the compound.
- Hydrogen is removed from the compound.
- The oxidation number of carbon increases from –2 to 0. 1 mark

ii.



1 mark

d. **i.** 7.0
No ionisation has occurred and the solution remains neutral. 1 mark

ii. The globe glows less brightly than for solution A.
C has a weaker acid, and hence a lower conductivity is expected. 1 mark

iii. ethanol (*non-acidic*) 1 mark

iv. methanoic acid (*A is a stronger acid than C as the pH is lower*) 1 mark

Total 12 marks

Question 3

a. **i.** $2HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2H_2O(l)$ 1 mark

ii. $HCl(aq) + NaHCO_3(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$ 1 mark

b. $n(Mg(OH)_2) = \frac{m}{M} = \frac{0.50}{58.3}$ mol 1 mark

$n(HCl) = 2 \times n(Mg(OH)_2) = \frac{2 \times 0.50}{58.3} = 0.017$ mol 1 mark

$n(NaHCO_3) = \frac{m}{M} = \frac{0.50}{84.0}$ mol

$n(HCl) = n(NaHCO_3) = \frac{0.50}{84.0} = 0.0060$ mol 1 mark

$\therefore$ $Mg(OH)_2$ neutralises the greater amount of HCl. 1 mark

c. $n(NaHCO_3) = \frac{m}{M} = \frac{0.50}{84.0}$ mol

$n(CO_2) = n(NaHCO_3)$ 1 mark

$V(CO_2) = \frac{nRT}{p} = \frac{0.50 \times 8.31 \times 310}{84.0 \times 1.0 \times 101.3} = 0.15$ L 1 mark

Total 8 marks

Question 4

a. **i.** $Sn(s) + Cu^{2+}(aq) \rightarrow Sn^{2+}(aq) + Cu(s)$
Sn is the stronger reductant present. It will be oxidised at the anode. 1 mark

ii. Cu (*reduction occurs at the cathode*) 1 mark

iii. Cu (*electrons flow towards the Cu electrode*) 1 mark

iv. towards the Sn
The anions balance the positive charge formed in the Sn half cell due to the production of Sn^{2+} ions. 1 mark

b. NaOH would react with both the Cu^{2+} and Sn^{2+} ions, disrupting cell function. 1 mark

Total 5 marks

Question 5

a. i. Water has a different boiling point than the other components of the aqueous solution. 1 mark

ii. Cost. The energy needed to heat the water is expensive. 1 mark

iii. At reduced pressures, the boiling point of water is lowered. 1 mark
Less energy is needed to heat the water, making the process more economical. 1 mark

b. i. $Al^{3+}(aq) + 3OH^{-}(aq) \rightarrow Al(OH)_3(s)$ 1 mark

ii. sand and gravel filters 1 mark

iii. addition of Cl_2 1 mark

Total 7 marks

Question 6

a. i. $2e^{-} + I_2(aq) \rightarrow 2I^{-}(aq)$ 1 mark

ii. reductant 1 mark
The I_2 is being reduced. The ascorbic acid is therefore behaving as a reductant. 1 mark

b. i. $n(C_6H_8O_6) = \frac{m}{M} = \frac{500 \times 10^{-3}}{176} = 2.84 \times 10^{-3}$ mol 1 mark

ii. $n(C_6H_8O_6) = 2.84 \times 10^{-3}$ mol

$n(I_2) = n(C_6H_8O_6)$ 1 mark

$c(I_2) = \frac{n}{V} = \frac{2.84 \times 10^{-3}}{24.55 \times 10^{-3}} = 0.116$ M 1 mark

Total 6 marks

Question 7

a. i. 24.5 L *(conditions are SLC)*
or

$V = \frac{nRT}{p} = \frac{1.00 \times 8.31 \times 298}{101.325} = 24.5$ L 1 mark

ii. 1.22 g in 1 L
$\therefore$ M g in 24.5 L
$\therefore$ M = 29.9 g mol^{-1} 1 mark

iii. ethane
For an alkane C_nH_{2n+2}, $M(C_nH_{2n+2}) = 12n + 2n + 2 = 14n + 2$,
$14n + 2 = 30$ $\therefore$ n = 2, $\therefore$ C_2H_6 1 mark

b. i. unchanged *(mass and volume are constant, hence density is constant)* 1 mark

ii. decreases
For constant pressure the volume must increase when the gas is heated.
Increased volume will mean a decreased density. 1 mark

Total 5 marks