Neap
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Trial Examination 2006

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

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Question 1 **B**

An empirical formula shows the simplest whole number ratio of the types of elements present in a compound. A shows a semi-structural formula which is not the empirical formula (CH_2O), C shows a molecular formula which is not the empirical formula (NO_2) and D shows a symbol for a metallic element.

Question 2 **A**

The molar mass of both C_2H_4 and N_2 is 28 g mol^{-1}. Therefore 1.0 mol of each will contain 6.02×10^{23} molecules and have a mass of 28 g. At constant temperature and pressure the volume of both gases will be the same ($V \propto n$). With the same mass and volume, the density of both will be the same.
1.0 mol of C_2H_4 contains 6.0 mol of atoms, while 1.0 mol of N_2 contains 2.0 mol of atoms. Therefore statement A is incorrect and so is the required response.

Question 3 **C**

Let the abundance of the lighter isotope be x.

RAM = Σ(RIM $\times$ abundance fraction)

$\therefore 6.94 = 6.02x + 7.02(1 - x)$

$\therefore x = 0.08$

$\therefore$ ratio of abundances = 0.08 to 0.92 or 1 to 12

Question 4 **A**

An acid is a proton donor. The equations in B and C represent redox reactions, not acid-base reactions. In D, the HCO_3^- ion gains a proton to form H_2CO_3, thereby acting as a base.

Question 5 **A**

Anaerobic respiration in yeast (fermentation) releases carbon dioxide, hence the statement in A is incorrect.

Question 6 **B**

Zn is the strongest reductant present. It will undergo oxidation at the anode to release electrons. This release of electrons generates the negative charge on the anode.

Question 7 **D**

The chemical in the salt bridge must not react with any of the other chemicals present. The hydroxide ion will precipitate both the zinc and nickel ions from the solutions and so is unsuitable for use in the salt bridge.

Question 8 **C**

Bases feel slippery, not acids, $\therefore$ not A. Acids ionise in water to produce conducting solutions, $\therefore$ not B. Acids react with alkalis to form a salt and water, $\therefore$ not D.

Question 9 **C**

HNO_3 is a strong monoprotic acid.

$\therefore [H_3O^+] = [HNO_3] = 0.015$ M

$pH = -\log[H_3O^+] = -\log 0.015 = 1.8$

Question 10 **D**

Increasing the temperature increases the average kinetic energy of the molecules and the spread of kinetic energies (speeds). With increased energy the molecules strike the walls of the vessels more often and harder, hence pressure increases. The area under the graph represents the number of molecules in the sample. This does not alter.

Question 11 **B**

A. $n(N) = 2 \times n(N_2) = 2 \times \frac{m}{M} = 2 \times \frac{26}{28} = 1.9$ mol

B. $n(N) = \frac{N}{N_A} = \frac{9.0 \times 10^{24}}{6.0 \times 10^{23}} = 15$ mol

C. $n(N) = n(NH_3) = \frac{V}{V_M} = \frac{490 \times 10^{-3}}{22.4} = 0.022$ mol

D. $n(N) = n(NO_2) = 0.25$ mol

Question 12 **B**

By the law of conservation of mass, the mass of products formed is equal to the mass of reactants used. Therefore, 6.2 g of reactants were used, so 5.5 g (6.2 – 0.7) of oxygen was used. This leaves 1.0 g (6.5 – 5.5) of oxygen.

Alternative answer:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

$n(H_2O) = \frac{m}{M} = \frac{6.2}{18.0}$

$n(O_2)$ used $= \frac{1}{2} \times n(H_2O) = \frac{1}{2} \times \frac{6.2}{18.0} = 0.172$

$m(O_2)$ used $= n \times M = 0.172 \times 32.0 = 5.5$ g

$\therefore m(O_2)$ remaining $= 6.5 - 5.5 = 1.0$

Question 13 **C**

Oxygen causes a lighted splint to flare.

Question 14 **A**

W reacts with X^{2+} and Y^{2+}. W is therefore a stronger reductant than X and Y. Y reacts with X^{2+}. Y is therefore a stronger reductant than X. Z reacts with W^{2+}, X^{2+} and Y^{2+}. Z is therefore a stronger reductant than W, X and Y. The order of reductant strength is therefore Z > W > Y > X.

Question 15 **D**

Z is the strongest reductant. Z^{2+} is the weakest oxidant, so it will be unable to react with any of the metals in order to be reduced to Z.

Question 16 **C**

Magnesium oxide reacts with acids to form a salt and water, ∴ A, C or D. A shows a full, formula equation, not an ionic equation. In D, the magnesium oxide is shown as separated ions. Since the magnesium oxide is an insoluble solid this is not correct.

Question 17 **D**

The iron(II) ion, Fe^{2+}, will react with any metal that is a stronger reductant than iron. Therefore it will react with aluminium, so this would be the unsuitable container.

Question 18 **D**

$$n(\text{MgO}) = \frac{m}{M} = \frac{78.0}{40.3} \text{ mol}$$

$$n(\text{MgCO}_3) = n(\text{MgO}) \text{ mol}$$

$$m(\text{MgCO}_3) = n \times M = \frac{78.0}{40.3} \times 84.3 = 163 \text{ g}$$

Question 19 **B**

$$n(\text{H}_3\text{O}^+)_1 = c \times V = 10^{-\text{pH}} \times V = 10^{-3.0} \times 20.0 \times 10^{-3} \text{ mol}$$

$$n(\text{H}_3\text{O}^+)_2 = c \times V = 10^{-4.0} \times 20.0 \times 10^{-3} \text{ mol}$$

$$n(\text{H}_3\text{O}^+)_\text{T} = n(\text{H}_3\text{O}^+)_1 + n(\text{H}_3\text{O}^+)_2 = 2.20 \times 10^{-5} \text{ mol}$$

$$[\text{H}_3\text{O}^+] = \frac{n_T}{V_T} = \frac{2.20 \times 10^{-5}}{40.0 \times 10^{-3}} = 0.00055 \text{ M}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] = -\log(0.00055) = 3.3$$

Question 20 **A**

Reduction occurs at the cathode, ∴ A or D. During corrosion, iron reacts with water and oxygen, ∴ A.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

a. HPO_4^{2-}/PO_4^{3-} 1 mark

b. H_2S or NO_2 or SO_2 1 mark

c. NO_3^- 1 mark

d. HSO_4^- 1 mark

e. HPO_4^{2-} or HSO_4^- 1 mark

f. N_2 1 mark

Total 6 marks

Question 2

a. i. $V(H_2) = 4800\ m^3 = 4800 \times 10^3\ L$

$T(H_2) = 15°C = 288\ K$

$p(H_2) = 1.0\ atm = 101.3\ kPa$ 1 mark

$n(H_2) = \frac{pV}{RT} = \frac{101.3 \times 4800 \times 10^3}{8.31 \times 288} = 2.0 \times 10^5\ mol$ 1 mark

ii. $n(Fe) = n(H_2)$ 1 mark

$m(Fe) = n \times M = 2.0 \times 10^5 \times 55.8 = 1.1 \times 10^7\ g = 1.1 \times 10^4\ kg$ 1 mark

b. i. As the temperature decreases the average kinetic energy of the molecules decreases.

The molecules therefore strike the walls of the balloon less often and with less force. 1 mark

In order to maintain the pressure at a constant value, the balloon will decrease in size. 1 mark

ii. The middle graph is correct (*Boyle's law – pressure is inversely related to volume*). 1 mark

c. i. $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$ $\therefore$ oxidation

$2H^+(aq) + 2e^- \rightarrow H_2(g)$ $\therefore$ reduction 2 marks

ii. Sulfuric acid (H_2SO_4) or the hydrogen ion (H^+). 1 mark

Total 10 marks

Question 3

a. i. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ 1 mark

ii. $2H_2O_2(aq) \xrightarrow{MnO_2} 2H_2O(l) + O_2(g)$ 1 mark

b. To increase the surface area and hence increase the rate of reaction. 1 mark

c. i. Calcium carbonate has been completely reacted, as the sulfuric acid is in excess. 1 mark

ii. Manganese dioxide is a catalyst for this reaction. The catalyst is not consumed in the reaction. 1 mark

d. $n(CO_2) = n(CaCO_3) = \frac{m}{M} = \frac{2.40}{100.1} = 0.0240$ mol — 1 mark

$n(H_2O_2) = c \times V = 0.500 \times 100.0 \times 10^{-3} = 0.0500$ mol — $\frac{1}{2}$ mark

$n(O_2) = \frac{1}{2} \times n(H_2O_2) = \frac{1}{2} \times 0.0500 = 0.0250$ mol — $\frac{1}{2}$ mark

The largest volume will be the gas produced in the greatest amount (in mol), ∴ flask 2. — 1 mark

e. $V(CO_2) = n \times V_M = 0.0240 \times 24.5 = 0.588$ L $= 588$ mL — 1 mark

Total 9 marks

Question 4

a. $[OH^-] = 2 \times [Ba(OH)_2] = 2 \times 0.100 = 0.200$ M — $\frac{1}{2}$ mark

$[H_3O^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{0.200} = 5.00 \times 10^{-14}$ M — $\frac{1}{2}$ mark

$pH = -\log[H_3O^+] = -\log(5.00 \times 10^{-14}) = 13.3$ — 1 mark

b. $Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$ — 1 mark

c. As the H^+ and SO_4^{2-} ions are added, they react to remove the OH^- and Ba^{2+} ions respectively from the solution. With fewer ions in solution, the conductivity decreases. — 1 mark

d. 7 (the solution will be neutral at point X) — 1 mark

e. At X, $V(H_2SO_4) = 15.0$ mL

$n(Ba(OH)_2) = c \times V = 0.100 \times 25.0 \times 10^{-3}$ mol — $\frac{1}{2}$ mark

$n(H_2SO_4) = n(Ba(OH)_2)$ — $\frac{1}{2}$ mark

$c(H_2SO_4) = \frac{n}{V} = \frac{2.50 \times 10^{-3}}{15.0 \times 10^{-3}} = 0.167$ M — 1 mark

Total 7 marks

Question 5

a. With more sunlight in spring and summer, the rate of photosynthesis, and hence the rate of use of carbon dioxide, increases. This decreases the atmospheric carbon dioxide level. — 1 mark

b. Increased burning of fossil fuels **or** deforestation. — 1 mark

c. Global warming, with consequent changes in sea levels and weather patterns. — 1 mark

Total 3 marks

Question 6

a. $2Fe(s) + O_2(g) + 2H_2O(l) \rightarrow 2Fe(OH)_2(s)$ 1 mark

b. Tube II $\frac{1}{2}$ mark

The presence of an electrolyte such as NaCl increases the rate of corrosion. 1 mark

Glucose solution does not contain ions. $\frac{1}{2}$ mark

c. Tube V $\frac{1}{2}$ mark

Manganese is a stronger reductant than iron. It will be oxidised in preference to the iron, thereby slowing the rate of corrosion of the iron. 1 mark

Tin is a less reactive metal than iron. It will not protect the iron. $\frac{1}{2}$ mark

Total 5 marks