
CHEMISTRY VCE UNITS 1&2 DIAGNOSTIC TOPIC TESTS 2007

TEST 8: GASES

SUGGESTED SOLUTIONS AND MARKING SCHEME

SECTION A: MULTIPLE-CHOICE QUESTIONS

Question 1 D

N₂ is not an infrared absorbing gas and so does not contribute to the greenhouse effect. CO₂, CH₄ and H₂O are all greenhouse gases.

Question 2 B

$$n(\text{H}_2) = \frac{m}{M} = \frac{0.10}{2.0} = 0.050$$

$$V_M = \frac{V}{n} = \frac{0.625}{0.050} = 12.5 \text{ L}$$

Note that 22.4 L and 24.5 L are the molar volumes of gases at STP and SLC respectively.

Question 3 B

Nitrogen fixation is the conversion of atmospheric nitrogen, N₂, to a soluble form that plants can absorb, such as NO₃⁻ and NH₄⁺. Interconversion of NH₄⁺ and NO₃⁻ is the action of nitrifying bacteria (so **A** is not the correct answer). Return to N₂ to the air is denitrification (so **C** is not the correct answer). Breakdown of wastes is decomposition (so **D** is not the answer).

Question 4 A

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$\therefore \frac{621 \times V_1}{293} = \frac{500 \times V_2}{288}$$

$$\therefore V_2 = 1.22 V_1. \text{ Volume has increased by } 0.22, \text{ or approximately } 25\%.$$

Question 5 A

$$V(\text{air}) = 4 \times 4 \times 2 = 32 \text{ m}^3$$

$$n(\text{air}) = \frac{V}{V_M} = \frac{32}{24.5 \times 10^{-3}} \text{ mol}$$

$$n(\text{N}_2) = \frac{80}{100} \times n(\text{air})$$

$$N(\text{N}_2) = n \times N_A = \frac{80}{100} \times \frac{32}{24.5 \times 10^{-3}} \times 6.02 \times 10^{23} = 6.29 \times 10^{26}$$

Question 6 A

For an actively growing plant, the overall rate of CO₂ uptake for photosynthesis will be greater than the overall rate of CO₂ release by respiration. Hence uptake of carbon dioxide (K) and release of oxygen (M).

Question 7 B

Fermentation is a form of anaerobic respiration, hence there is no oxygen uptake (therefore the correct answer is not **D**). Fermentation releases carbon dioxide, therefore answer **B**. (**A** is incorrect). No oxygen is released (**C** is incorrect).

Question 8 C

For the gas in A, when forced into B, $p_1 V_1 = p_2 V_2$

$$\therefore 1.5 \times 200 = p_2 \times 800$$

$$\therefore p_2 = 0.375$$

Total pressure will be 1.0 (the original gas exerts this) plus 0.375. Hence 1.4 atm.

Question 9 C

Kyoto dealt with greenhouse gas emissions. The Montreal Protocol dealt with CFCs and ozone depletion (hence the correct answer is not **D**).

Question 10 D

The gas is exerting a pressure greater than the atmospheric pressure by 95 mmHg. Hence pressure is 760 + 95 = 855 mmHg (answer **C** or **D**).

$$760 \text{ mmHg} = 1 \text{ atm}$$

$$\therefore 855 \text{ mmHg} = \frac{855}{760} = 1.125 \text{ atm (hence answer D)}.$$

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

- a. At high temperatures, gas particles are moving rapidly and collisions are likely to be elastic. Minimal forces will operate between the particles. At low pressures particles are widely spaced. 1 mark
- Under these conditions the gas particles act like those described in the kinetic molecular theory, and so the gas behaves more 'ideally'. 1 mark
- b. Atmospheric carbon dioxide dissolves in rainwater to form carbonic acid. 1 mark
- $\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{CO}_3(\text{aq})$
- $\text{H}_2\text{CO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$ 1 mark
- c. Ground level ozone is a respiratory irritant and is toxic to plants. 1 mark
- Ozone in the upper atmosphere absorbs harmful ultraviolet radiation. 1 mark
- Total 6 marks

Question 2

- a. i. increases 1 mark
- $(p \propto T \text{ at fixed } V \text{ and } n)$
- ii. remains unchanged 1 mark
- $(\text{This area represents the fixed number of particles.})$
- iii. increases 1 mark
- $(\text{Average kinetic energy is proportional to temperature.})$
- b. i. X 1 mark
- $(V \propto T)$
- ii. Y 1 mark
- $\left(V \propto n, \text{ not } V \propto \frac{1}{n}\right)$
- c. i. incomplete combustion of coal (carbon) 1 mark
- $(2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g}))$
- ii. combustion of methane
- OR**
- aerobic respiration
- OR**
- incomplete combustion of coal (carbon) 1 mark
- $(\text{all have oxygen as a reactant})$
- iii. addition of magnesium to dilute acid 1 mark
- $(\text{Mg}(\text{s}) + 2\text{HA}(\text{aq}) \rightarrow \text{MgA}_2(\text{aq}) + \text{H}_2(\text{g}))$

Total 8 marks

Question 3

- a. $V \propto n$ for gases at the same temperature and pressure.
20 mL of NO reacts with 10 mL of O₂ to produce 20 mL of NO₂ (ratio is 2 : 1 : 2). 1 mark
Therefore the remaining volume is 30 mL (10 mL of O₂ and 20 mL of NO₂) 1 mark
- b. Contributes to acid rain.
 $2\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HNO}_2(\text{aq}) + \text{HNO}_3(\text{aq})$
OR
Contributes to photochemical smog.
Oxides react with unburnt hydrocarbons and oxygen in the presence of sunlight to form secondary pollutants such as PAN. 2 marks
Total 4 marks

Question 4

- a. $\text{CuCO}_3(\text{s}) \xrightarrow{\Delta} \text{CuO}(\text{s}) + \text{CO}_2(\text{g})$ 1 mark
- b. i. $p_{\text{gas}} = p_{\text{total}} - p_{\text{water}} = 762 - 21 = 741 \text{ mmHg}$ 1 mark
- ii. $n = \frac{pV}{RT} = \frac{741 \times 101.3 \times 0.621}{760 \times 8.31 \times 295} = 0.0250 \text{ mol}$ 2 marks
- iii. $n(\text{CuCO}_3) = n(\text{CO}_2)$ 1 mark
 $m(\text{CuCO}_3) = n \times M = 0.0250 \times 123.5 = 3.09 \text{ g}$ 1 mark
- c. Carbon dioxide is partially soluble in water. The measured gas volume is smaller than it should be, resulting in a smaller calculated value for the mass of copper(II) carbonate. 1 mark
Total 7 marks