Neap:

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

N_2 is not an infrared absorbing gas and so does not contribute to the greenhouse effect. CO_2, CH_4 and H_2O are all greenhouse gases.

Question 2   B

$$n(H_2) = \frac{m}{M} = \frac{0.10}{2.0} = 0.050$$

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

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, N_2, to a soluble form that plants can absorb, such as NO_3^- and NH_4^+. Interconversion of NH_4^+ and NO_3^- is the action of nitrifying bacteria (so **A** is not the correct answer). Return to N_2 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

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

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

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

Question 5   **A**

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

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

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

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

Question 6   **A**

For an actively growing plant, the overall rate of CO_2 uptake for photosynthesis will be greater than the overall rate of CO_2 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 mmHg = 1 atm

$\therefore 855 \text{ mmHg} = \dfrac{855}{760} = 1.125$ 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
$CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$
$H_2CO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HCO_3^-(aq)$ 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
($p \, \alpha \, T$ at fixed V and n)

ii. remains unchanged   1 mark
(This area represents the fixed number of particles.)

iii. increases   1 mark
(Average kinetic energy is proportional to temperature.)

b. **i.** X   1 mark
($V \, \alpha \, T$)

ii. Y   1 mark
$\left(V \, \alpha \, n, \text{ not } V \, \alpha \, \dfrac{1}{n} \right)$

c. **i.** incomplete combustion of coal (carbon)   1 mark
($2C(s) + O_2(g) \rightarrow 2CO(g)$)

ii. combustion of methane
OR
aerobic respiration
OR
incomplete combustion of coal (carbon)   1 mark
(all have oxygen as a reactant)

iii. addition of magnesium to dilute acid   1 mark
($Mg(s) + 2HA(aq) \rightarrow MgA_2(aq) + H_2(g)$)

Total 8 marks

Question 3

a. $V \alpha n$ for gases at the same temperature and pressure.

20 mL of NO reacts with 10 mL of O_2 to produce 20 mL of NO_2 (ratio is 2 : 1 : 2). 1 mark

Therefore the remaining volume is 30 mL (10 mL of O_2 and 20 mL of NO_2) 1 mark

b. Contributes to acid rain.

$2NO_2(g) + H_2O(l) \rightarrow HNO_2(aq) + HNO_3(aq)$

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. $CuCO_3(s) \xrightarrow{\Delta} CuO(s) + CO_2(g)$ 1 mark

b. **i.** $p_{gas} = p_{total} - p_{water} = 762 - 21 = 741$ mmHg 1 mark

ii. $n = \dfrac{pV}{RT} = \dfrac{741 \times 101.3 \times 0.621}{760 \times 8.31 \times 295} = 0.0250$ mol 2 marks

iii. $n(CuCO_3) = n(CO_2)$ 1 mark

$m(CuCO_3) = n \times M = 0.0250 \times 123.5 = 3.09$ 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