

8:00  
7:40  
20 min

# CHEMISTRY 121 MIDTERM 1

Sept. 30, 2005

Show all your reasoning/work for full marks

(2 marks)

1) A man has 7.3 cubic meters of dirt. Convert this to cubic feet. 1.08 yd = m, 3 ft = 1 yd.

$$7.3 \text{ m}^3 \times \frac{(1.08 \text{ yd})^3}{(1 \text{ m})^3} \times \frac{(3 \text{ ft})^3}{(1 \text{ yd})^3} \quad \textcircled{1} \text{ set up eq}^n$$

$$= 2.5 \times 10^2 \text{ ft}^3 \quad \textcircled{1} \text{ correct answer}$$

$\textcircled{-1}$  Sig. fig error

(2 marks)

2) The anion of an unknown element has 40 neutrons and an atomic mass of 74 amu. What is the name of the element?

↓

∴ 34 protons  $\textcircled{1}$   
 ∴ Selenium  $\textcircled{1}$  (either right/wrong)

if > 2 answered  
mark left hand  
column only

(2 marks)

3) Write ONE correct name and ONE correct formula only. Your choice.

obvious  
-1/2 error

Se(OH)<sub>2</sub> Selenium hydroxide

HNO<sub>2</sub> (aq) Hydronitrous acid

Cobalt(II)dichromate CoCr<sub>2</sub>O<sub>7</sub>

Dichlorine heptoxide Cl<sub>2</sub>O<sub>7</sub>

(3 marks)

4) You are given 3 M HNO<sub>3</sub>. How would you make 245 mL of 0.12 M HNO<sub>3</sub>?

$$V_1 M_1 = V_2 M_2$$

$$V_1 (3M) = 245 \text{ mL} (.12M) \quad \text{Setup thinking } \textcircled{1}$$

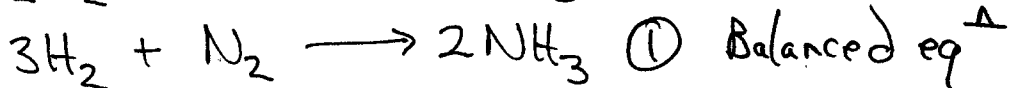
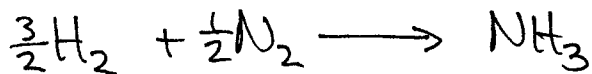
$$V_1 = 9.8 \text{ mL } \textcircled{1}$$

$\textcircled{-1}$   
Sig. figs.  
error

Put in flask & add enuff H<sub>2</sub>O to  
make up to 245 mL total.  $\textcircled{1}$

(3 marks)

5) Hydrogen gas (MW = 2 g/mol) and nitrogen gas (MW = 28 g/mol) are reacted together to form ammonia (MW = 17 g/mol). How many grams of hydrogen gas could react with 42.0 grams of nitrogen gas.



$$\frac{42.0g}{28g/mol}$$

$$\textcircled{1} \quad 4.5 \text{ mol } H_2 \xleftarrow{\times 3} 1.5 \text{ mol } N_2$$

$$\downarrow \times 2g/mol$$

$$\boxed{9.0g H_2}$$

$\textcircled{1}$  Correct answer

$\textcircled{-1}$  Sig. fig. error

(4 marks)

6) An unknown mass of pyridine,  $C_5H_5N$ , (MW = 79.1 g/mol) contains many H atoms (295,700,000,000,000,000,000). Calculate the mass of the pyridine sample.

$$2.957 \times 10^{23} \text{ H atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{\text{pyridine}}{5 \text{ H atoms}} \times \frac{79.1 \text{ g}}{\text{mol}}$$

$\textcircled{1}$  calc. mol H atoms

$\textcircled{1}$  correct use of FW

$\textcircled{1}$  converting mol H to mol pyr.

$$\boxed{= 7.77 \text{ g}}$$

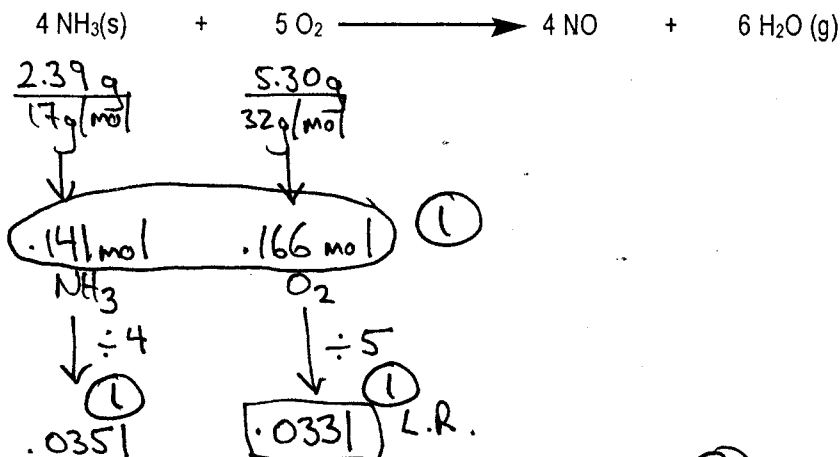
$\textcircled{1}$  Correct answer

$\textcircled{-1}$  Sig. fig. error

- 7) Ammonia,  $\text{NH}_3$ , (2.39 g, MW = 17 g/mol) is reacted with oxygen gas (5.30 g, MW = 32 g/mol) according to the balanced equation below. Exactly 3.2 g of dihydrogen monoxide (MW = 18 g/mol) is isolated.

(5 marks)

Calculate the % yield for the reaction and justify your choice of limiting reagent.



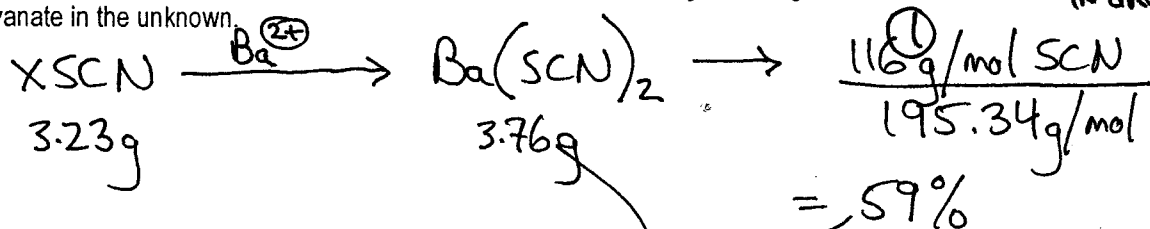
$$\therefore .166 \text{ mol O}_2 \times \frac{6 \text{ H}_2\text{O}}{5 \text{ O}_2} \times \frac{18 \text{ g}}{\text{mol}} = 3.58 \text{ g H}_2\text{O theoretical}$$

$$\% \text{ yield} = \frac{3.2 \text{ g}}{3.58 \text{ g}} \times 100 = 89\%$$

(-1) Sig. figs. error

(4 marks)

- 8) An unknown thiocyanate compound  $\text{XSCN}$  (3.23 g) is treated with  $\text{BaCl}_2(\text{aq})$  and the resulting precipitate of  $\text{Ba}(\text{SCN})_2$  (FW = 195.34 g/mol) is collected and dried to give 3.76 g. Calculate the % thiocyanate in the unknown.



2.23 g SCN in  $\text{Ba}(\text{SCN})_2$

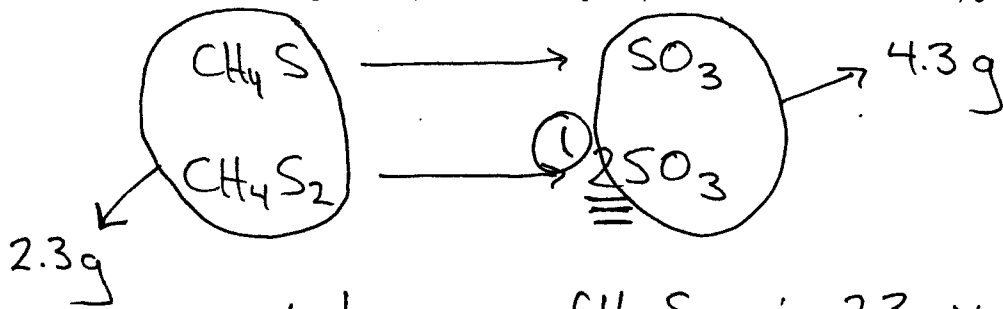
$$\therefore \frac{2.23}{3.23} \times 100$$

(1) = 69% SCN in unknown

(-1) Sig. fig. error

(5 marks)

- 9) A 2.3 g sample containing both methyl thiol ( $\text{CH}_4\text{S}$ ) and methyl dithiol ( $\text{CH}_4\text{S}_2$ ) are combusted to make sulfur trioxide (4.3 g) plus other products not isolated. Calculate the ratio (by wt.) of methyl thiol to methyl dithiol in the original sample. Atomic weights: (H = 1, C = 12, O = 16, S = 32) g/mol.



$$\text{Let } x = \text{g } \text{CH}_4\text{S} \quad \therefore 2.3 - x = \text{g } \text{CH}_4\text{S}_2$$

$$\frac{x \text{ g } \text{CH}_4\text{S}}{\text{MW}_{\text{CH}_4\text{S}}} = \text{moles } \text{CH}_4\text{S} = \text{moles of } \text{SO}_3 \text{ from } \text{CH}_4\text{S}$$

$$\textcircled{1} \frac{x \text{ moles } \text{SO}_3 \text{ from } \text{CH}_4\text{S}}{48} \times \text{MW}_{\text{SO}_3} = \text{g of } \text{SO}_3 \text{ from } \text{CH}_4\text{S}$$

$$= \left(\frac{x}{48}\right)(80 \text{ g/mol})$$

Same eq<sup>n</sup> for  $\text{CH}_4\text{S}_2$  but factor in  $\text{CH}_4\text{S}_2 \rightarrow 2\text{SO}_3$ !

Put it all together  $\textcircled{1}$

$$\frac{x}{48}(80 \text{ g/mol}) + \frac{2.3-x}{80}(2)(80 \text{ g/mol}) = 4.3 \text{ g} \quad \textcircled{1}$$

$$x + (2.3-x)(1.2) = 2.58$$

$$-.2x = -.18$$

$$\boxed{x = .9 \text{ g } \text{CH}_4\text{S} \text{ and } 1.4 \text{ g } \text{CH}_4\text{S}_2} \quad \textcircled{1}$$

$\textcircled{-1}$  sig. figs error

(1 mark)

Bonus question! Write down either Dr. Neeland's or Dr. Perry's office number in the science building.

208 ← either right/wrong → 207