Answer each of the following questions and put "X" on the correct choice on front page:

General

1. Which of the following statements is correct:

   a) When smelling a substance you can hold your face directly over the bottle.
   b) A 10 ml graduated cylinder delivers more accurate volumes than a 10 ml pipet.
   c) Your laboratory has a poster about hazardous chemicals.
   d) If you spell concentrated sulfuric acid on your clothes, you can wash it with concentrated sodium hydroxide solution.
   e) Clean pipets and droppers can be inserted into any reagent bottle.

Stoichiometry

2. Given the following set of data:
   Mass of hydrated salt = 1.26 g.
   Mass of water = 0.52 g
   Molar mass of anhydrous salt = 258 g/mol
   Molar mass of water = 18 g/mol
   Calculate water of crystallization x.

   a) 10 b) 12 c) 14 d) 18 e) 8

Volumetric Analysis

3. Given the following set of data:
   Volume of 0.15 M HCl used to dissolve antacid tablet = 50.0 mL
   Volume of 0.16 M NaOH used to titrate the excess acid = 20.0 mL
   Mass of antacid tablet = 0.50 g
   Calculate the neutralization capacity of the tablet (mol HCl/ g tablet).

   a) 2.0×10^{-2} b) 8.6×10^{-3} c) 3.8×10^{-2} d) 1.5×10^{-2} e) 6.0×10^{-2}

4. 15.0 ml of sulfuric acid (H_2SO_4) solution was titrated with 25.0 ml of 0.10 M NaOH solution to produce Na_2SO_4. Calculate the concentration of sulfuric acid in g/ L of solution. (Molar mass of H_2SO_4 = 98.0 g/mol)

a) 5.4 b) 6.5 c) 7.4 d) 9.2 e) 8.2

$2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$

Oxidation-Reduction Titration

5. A 10.0 ml sample of a bleach solution was diluted to 250. ml with distilled water. 20.0 ml of the dilute solution was treated with excess KI and HCl; the iodine liberated was titrated with 7.55 ml of 0.20 M $Na_2S_2O_3$ solution. If the density of the original bleach solution was 1.1 g/ml, calculate the mass percent of NaClO (molar mass = 74.5 g/mol) in the original bleach solution.

a) 9.3 b) 7.3 c) 8.4 d) 6.4 e) 4.5

Avogadro's Number

6. Given the following set of data:
   Mass of stearic acid used = 5.0×10^{-5} g (molar mass =284 g/mol)
   Area of monomolecular layer = 75.0 cm^2
   Avogadro's number = 6.0×10^{23} molecule/mol.
   Calculate the area occupied by one molecule (cm^2).

a) 7.1×10^{-16} b) 8.6×10^{-16} c) 6.4×10^{-16}
d) 5.5×10^{-16} e) 4.7×10^{-16}

Molecular Weight of Volatile Liquid

7. Given the following set of data:
   Mass of volatile liquid = 1.15 g
   Volume of the flask = 200 mL
   Atmospheric pressure = 737 mmHg
   The temperature of boiling water = 97 °C
   Calculate the molar mass (g/mol) of the liquid.

   a) 192 b) 180 c)185 d) 176 e) 160

8. Which of the following cases **increases** the calculated value of molar mass of a volatile liquid:

   a) Recording the pressure of one atmosphere instead of the actual external pressure in your laboratory.
   b) Recording the mass of empty flask higher than the actual value.
   c) When the mass of the flask and condensed vapor is measured the flask was not completely dry.
   d) Using a 50 mL flask instead of 150 mL in the experiment.
   e) The reported temperature is 5 °C lower than actual one.

Thermochemistry

9. A sample of 0.552 g of metal x (molar mass = 113 g/mol) was reacted with 150 mL of 1.0 M HCl in a styrofoam cup (heat capacity = 0). The temperature of solution increased by 7.92 °C. Calculate ΔH for the reaction. (Assume the specific heat of the solution = 4.18 J. $g^{-1}.°C^{-1}$, density of solution = 1.00 g/mL)

   a) - 860 kJ/mol x b)- 914 kJ/mol x c) -941 kJ/mol x
   d) -1020 kJ/mol x e) -1086 kJ/mol x

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10. Given that:

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$ $\Delta H = -215$ kJ/mol

$MgO_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_2O_{(l)}$ $\Delta H = -155$ kJ/mol

$H_2O_{(l)} \rightarrow H_{2(g)} + \frac{1}{2} O_{2(g)}$ $\Delta H = 286$ kJ/mol

Calculate ΔH_f for MgO in kJ/mol.

a) -505 b) -376 c) -321 d) -401 e) -345

11. When a 1.0 g of material X (molar mass = 40 g/mol) was dissolved in beaker containing 50.0 g of 1.0 M HCl, the rise in temperature was 7.0 °C. If the ΔH for this reaction is -74.8 kJ/mol of material X, and the specific heat of the solution = 4.10 J/g.°C, calculate the heat capacity of the beaker (J/ °C).

a) 66 b) 58 c) 74 d) 47 e) 40

Collegative properties

12. Which of the following statements is **correct**:

a) If the reported mass of cyclohexane is greater than the actual value.
b) K_f is dependent on the solute only.
c) If the solute used was not dissolved completely, the freezing point depression will be larger than actual.
d) If the thermometer used reads 1.0 °C lower than actual, then the calculated molar mass would be lower than actual.
e) The greater the mole fraction of the solute, the lower the freezing point of the solution.

13. A solution made by dissolving 10.25 g naphthalene ($C_{10}H_8$, non-electrolyte, molar mass = 128.0 g/mol) into 200.0 g benzene (molar mass = 78.0 g/mol, freezing point of benzene = 5.5 °C, K_f = 65.6 °C). What is the freezing point of this solution (in °C)?

a) 3.5 b) 4.0 c) 2.9 d) 2.6 e) 5.0

14. For which of the following aqueous solutions would one expect to have the largest Van't Hoff, i, factor?

a) 0.100 M NaCl
b) 0.100 M $Al(NO_3)_3$
c) 0.100 M $Al_2(SO_4)_3$
d) 0.100 M K_2SO_4
e) 0.100 M CH_3COOH

15. A solution of 1.22 g of benzoic acid (molar mass = 122.0 g/mol) in 78 g of benzene (molar mass = 78.0 g/mol) shows a freezing point depression of 0.45 °C. If the K_f of benzene = 65.6 °C, calculate the Van't Hoff factor (i) for benzoic acid in benzene.

a) 0.62 b) 0.49 c) 0.59 d) 0.69 e) 0.77

Equilibrium and K_{sp}

16. 17.0 mL of a saturated solution of CH_3COOAg was titrated with 15.3 mL of 0.040 M KSCN in acidic solution and in presence of Fe^{3+} as indicator. Calculate K_{sp} for CH_3COOAg.

a) 1.5×10^{-3} b) 1.3×10^{-3} c) 2.8×10^{-3}
d) 2.2×10^{-3} e) 1.8×10^{-3}

17. A 15.0 mL of 0.0320 M KSCN solution was needed to titrate a certain volume of saturated CH_3COOAg. Calculate the volume of silver acetate (mL) that was titrated. (K_{sp} for $CH_3COOAg = 2.30 \times 10^{-3}$)

a) 15.0 b) 20.0 c) 10.0 d) 12.1 e) 17.1

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Chemistry Department Chem 109 First Exam

60 min. 11/12/2004

Name(in Arabic):_ _____ ___ Registration Number :_____

Section: Instructor and time: _____ ___ ___ ___

Answer sheet

1-	a	b	c	d	**e**
2-	a	b	**c**	d	e
3-	**a**	b	c	d	e
4-	a	**b**	c	d	e
5-	a	b	c	**d**	e
6-	a	**b**	c	d	e
7-	a	b	c	d	**e**
8-	a	b	**c**	d	e
9-	**a**	b	c	d	e
10-	a	b	c	**d**	e

Answer each of the following questions and put "x" on the correct choice on front page:

General

1. Which of the following statements is **true**:

a) The uncertainty in the measurement 3.64 is ± 0.2.

b) It is acceptable to insert your dropper into the reagent bottle.

c) Throwing excess organic solvent down the sink is acceptable.

d) It is acceptable to return unused chemicals to the reagent bottle.

(e) Heating flammable materials with a direct flame is not acceptable.

Stoichiometry

2. A sample of 2.96 g of $KAl(SO_4)_2.12H_2O$ (Molar mass =474 g/mol) was heated to evaporate all of the water (Molar mass=18 g/mol). The mass of the anhydrous salt is:

a) 0.99 g b) 1.73 g (c) 1.61 g d) 2.28 g e) 1.19 g

3. A 100.0 g sample of a certain solvated salt ($Salt.xC_2H_5OH$) where the solvent is ethanol (C_2H_5OH). Upon heating all of the ethanol was driven off and the mass is reduced by 42%, what is the value of x?(Molar mass of dry salt =322 g/mol;molar mass of ethanol =46 g/mol)

(a) 5 b) 2 c) 6 d) 3 e) 7

$V_{NaOH} = 30 \times 10^{-3}$ L (0.15 M)

Volumetric Analysis

4. Given the following set of data:

Volume of vinegar solution = 15.0 mL.
The volume of 0.15 M NaOH needed for the titration of vinegar solution = 30. mL. Calculate the mass of acetic acid (in gram) in 1.0 L vinegar solution (Molar mass of of acetic acid =60.0 g/mol):

a) 15 g (b) 18.0 g c) 12.0 g d) 21.0 g e) 24 g

$n_{vinegar} = M \times V$

$= 0.15 \times 30 \times 10^{-3} = 4.5 \times 10^{-3}$ mol

$M = \frac{n}{V}$

$M_{vinegar} = \frac{4.5 \times 10^{-3}}{15 \times 10^{-3}} = 0.3$ M

mass = 0.3 mol acetic acid / 1 L vinegar × 1 L vinegar / 1 mol acetic acid × 60

5. Calculate the mass of sodium bicarbonate ($NaHCO_3$, molar mass = 84.0 g/mol) that can neutralize 25.0 mL of 0.30 M of HCl solution.

a) 0.525 g b) 0.325 g c) 0.420 g (d) 0.630 g e) 0.735 g

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

$m_{NaHCO_3} = 25 \times 10^{-3}$ L HCl × 0.30 mol HCl / L HCl × 1 mol $NaHCO_3$ / 1 mol HCl × 84 g / 1 mol = 0.630 g

6. Given the following set of data:
Mass of antacid = 0.80 g.
Volume of 0.15 M of HCl added = 50.0 mL.
Volume of 0.15 M NaOH needed for back titration of excess acid =15.0 mL.
Calculate the number of moles of HCl neutralized by 1.00 g antacid.

a) 7.5×10^{-3} (b) 6.5×10^{-3} c) 4.25×10^{-3} d) 8.75×10^{-3} e) 5.83×10^{-3}

$n_{total} = M_{HCl} V = 0.15 \text{ M} \times 50.0 \times 10^{-3} = 7.5 \times 10^{-3}$ mol

$n_{excess\ HCl} = M_{NaOH} V = 0.15 \text{ M} \times 15 \times 10^{-3} = 2.25 \times 10^{-3}$ mol

$n_{neutralized} = 5.25 \times 10^{-3}$ mol

n / g = 6.5625×10^{-3}

$3HCl + Al(OH)_3 \rightarrow 3H_2O + AlCl_3$

7. Calculate the mass of stomach acid (0.10 M HCl, density = 1.10 g/mL) that can be neutralized by 0.600 g $Al(OH)_3$ (Molar mass = 78.0 g/mol).

a) 169 g b) 338 g c) 212 g d) 190 g (e) 253 g

$3HCl + Al(OH)_3 \rightarrow AlCl_3 + 3H_2O$

$V_{(HCl)} =$ 0.600 g $Al(OH)_3$ / 78.0 g × 1 mol $Al(OH)_3$ / 3 mol HCl × 1 L HCl / 0.10 mol HCl × 1.10 g HCl / 1×10^{-3} L HCl

$= 253.8$ g

Oxidation-reduction Titration:

8. Choose the correct statement (for the experiment performed in the laboratory):

   a- Laundry bleach contains a reducing agent.
   b- ClO^- forms a blue complex with starch.
   c- Iodine acted as an oxidizing agent.
   d- Sodium hypochlorite was delivered from the buret.
   e- Iodide acted as an oxidizing agent

9. A 9.00 ml of a sodium hypochlorite (NaClO) solution required 6.4 ml of 0.310 M $Na_2S_2O_3$ to complete the reaction according to the following **unbalanced equation:**

$$ClO^- + S_2O_3^{-2} \longrightarrow Cl^- + S_4O_6^{-2}$$

Calculate the concentration of sodium hypochlorite (NaClO) solution.

a) 0.110 b) 0.117 M c) 0.251 M d) 0.588 M e) 0.081 M

Avogadro's Number:

10. Given the following set of data:
Mass of stearic acid = 9.8×10^{-6} gm.
Molar mass of stearic acid= 284 g/mol.
Density of solid stearic acid acid = 0.850 gm/mL.
Area of the monomolecular layer formed by stearic acid = 100.0 cm^2,(t = 5.44 a).
Calculate Avogadro's number (molecules/mol).

a) 4.6×10^{24} b) 1.5×10^{24} c) 9.2×10^{24} d) 6.4×10^{24} e) 2.9×10^{24}

$V_{(NaClO)} = 9.00 \times 10^{-3}$ L

$V_{(Na_2S_2O_3)} = 6.4 \times 10^{-3}$ L (0.310 M)

$n_{NaClO} = \frac{1}{2} n_{S_2O_3}$

$M \times V = \frac{1}{2} \times M \times V$

$M = \frac{0.310 \times 6.4 \times 10^{-3}}{9.00 \times 10^{-3}}$

mass (stearic acid) = 9.8×10^{-6} g

M_w (stearic acid) = 284 g/mol

$d_{solid\ stearic\ acid}$ = 0.850 g/mL

Area layer = 100.0 cm^2

t = 5.44 a

solution

$n_{(stearic\ acid)} = \frac{9.8 \times 10^{-6}}{284} = 3.5 \times 10^{-8}$ mol

$V_{stearic\ acid} = \frac{m}{d} = \frac{9.8 \times 10^{-6}\ g}{0.850\ g/mL} = 1.1529 \times 10^{-5}$ mL

$t = \frac{V}{area} = \frac{1.1529 \times 10^{-5}\ cm^3}{100.0\ cm^2} = 1.15 \times 10^{-7}$ cm

$a = \frac{t}{n} = 2.1 \times 10^{-8}$ cm

Important Note:

The exams which we solve, are solved by the students, so, please, ignore any solution except for the suggested detailed answer in this copy.

عزيزي الطالب : الاسئلة المصورة ، هي نسخ بعض الطلبة ، فليس بالضرورة ان تكون ذات حل صحيح ، والرجاء حصر تركيزك فيما يُحل كأجابة تفصيلية على هذه الأوراق .

GENERAL:

Question No. 1:

- Statement a is incorrect, because the uncertainty should involve the final decimal place.
- Statement b is uncorrect, because you are not allowed to insert your dropper into the reagent bottle.
- Statement c is incorrect, because you are not allowed to through excess organic solvent down the sink due to the insolubility in water.
- Statement d is incorrect, because It's not allowed to return unused chemicals to the reagent bottle due to contamination of the stock bottle.
- Statement e is correct, because it is not acceptable to heat flammable material with direct flame.

Choice [e].

Stoichiometry:

Question No. [2]:

We're given: weight of alum / Hydrous salt = 2.96 g , weight of anhydrous salt = ??

$$KAl(SO_4)_2 \cdot 12H_2O \xrightarrow{\Delta} KAl(SO_4)_2 + 12H_2O$$

Strategy:

mass of alum ⟶ mole of alum ⟶ mole of anhydrous salt ⟶ mass of anhydrous salt.

$$= 2.96\ g\ alum \times \frac{1\ mol\ alum}{474\ g\ alum} \times \frac{1\ mol\ anhydrous\ salt}{1\ mol\ alum} \times \frac{[474-(12\times18)]\ g\ anhydrous\ salt}{1\ mol\ anhydrous\ salt}$$

= 1.61 g of anhydrous salt ⟹ choice [c]

Question No. 3 :

$$\text{Salt}.x C_2H_5OH \xrightarrow{\Delta} \text{Salt} + x\, C_2H_5OH$$

100g → the mass is reduced by 42%

⇒ we can conculde that the mass of salt became = 100.0 − 42.0 = 58.0 g.

⇒ no. of moles of non-solvated salt (Salt.) = mass / molar mass of dry salt

= 58.0g / 322 g mol^{-1} = 0.180 mol dry salt.

⇒ no. of moles of C_2H_5OH = mass / molar mass of C_2H_5OH

= 42g / 46 g mol^{-1} = 0.88 mol C_2H_5OH.

x = moles of C_2H_5OH / moles of dry salt = 0.88 mol / 0.18 mol ≃ 5

Choice [a]

VOLUMETRIC ANALYSIS:

Question No. 4 : We know that the acetic acid (component of vinegar) reacts with Sodium Hydroxide according to the following equation:

$$CH_3COOH_{(aq)} + NaOH_{(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$$

⇒ No. of moles of NaOH = Molarity(NaOH) × Volume(NaOH)

$$= 0.15 \frac{mol}{L} \times 30.\cancel{mL} \times \frac{1L}{1000\cancel{mL}} = 4.5 \times 10^{-3} \text{ mol NaOH.}$$

From the balanced chemical equation, we see:

No. of moles of NaOH = No. of moles CH_3COOH

⇒ No. of moles of CH_3COOH = Molarity(CH_3COOH) × Volume(CH_3COOH)

$$4.5 \times 10^{-3} \text{ mol} = \text{Molarity}(CH_3COOH) \times 15.0\cancel{mL} \times \frac{1L}{1000\cancel{mL}}$$

$$\text{Molarity}(CH_3COOH) = 4.5 \times 10^{-3} \text{ mol} / 15.0 \times 10^{-3} L$$

$$= 0.30 \text{ mol/L}.$$

$$\text{g} = \frac{0.30 \text{ mol}}{1 L} \times \frac{60 \text{g } CH_3COOH}{1 \text{mol } CH_3COOH} = 18 \text{ g/L}$$

(Molar mass)

Choice [b]

0.3 × 60 / 10

Question No. 5 :

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2CO_3$$
$$\hookrightarrow H_2O + CO_2$$

We can see that according to the balanced eqn.:

No. of moles of $NaHCO_3$ = No. of moles of HCl

$$\frac{\text{mass of } NaHCO_3}{\text{molar mass}} = \text{Molarity (HCl)} \times \text{Volume (HCl)}$$

$$\frac{\text{mass } (NaHCO_3)}{84.0\ g/mol} = 0.30\ \frac{mol\ HCl}{L} \times 25.0\ mL \times \frac{L}{1000\ mL}$$

$$\Rightarrow \text{mass } (NaHCO_3) = 0.63\ g.$$ Choice d.

Question No. 6 :

Total No. of moles of HCl added = moles of HCl reacted with antacid (given mass) + moles of HCl titrated Versus NaOH in back titration.

$$\Rightarrow (M_{HCl} \times V_{HCl}) = \text{moles of HCl reacted with specific mass of antacid.} + (M_{NaOH} \times V_{NaOH})$$

↳ since ↴

$$NaOH + HCl \rightarrow NaCl + H_2O$$
1 mol. 1 mol.

$$\Rightarrow \left[\frac{0.15\ mol\ HCl}{L} \times 50.0\ mL \times \frac{L}{1000\ mL}\right] = \text{moles of HCl reacted with specific mass of antacid.} + \left[\frac{0.15\ mol\ NaOH}{L} \times 15.0\ mL \times \frac{L}{10^3\ mL}\right]$$

(NaOH or HCl.)

$$\Rightarrow 7.5 \times 10^{-3}\ mol\ HCl = \text{moles of HCl reacted with specific mass of antacid} + 2.25 \times 10^{-3}\ mol\ HCl$$

$$\Rightarrow \text{moles of HCl reacted with } 0.8\ g \text{ antacid} = 7.5 \times 10^{-3}\ mol - 2.25 \times 10^{-3}\ mol$$
$$= 5.25 \times 10^{-3}\ mol$$

$$0.8\ g \longrightarrow 5.25 \times 10^{-3}\ mol$$
$$1.0\ g \longrightarrow X$$

$$\Rightarrow X = 6.5 \times 10^{-3}\ mol\ HCl$$ neutralized by 1.00 g antacid ⇒ choice b

Question No. [7] : We must write the balanced chemical equation:

$$3HCl + Al(OH)_3 \longrightarrow AlCl_3 + 3H_2O$$

No. of moles of $Al(OH)_3$ = mass of $Al(OH)_3$ / molar mass of $Al(OH)_3$

$= 0.600\,g\ Al(OH)_3 / 78.0\,g\,mol^{-1}$

$= 7.69 \times 10^{-3}\ mol\ Al(OH)_3$:

$$7.69 \times 10^{-3}\ mol\ Al(OH)_3 \times \frac{3\ mol\ HCl}{1\ mol\ Al(OH)_3} = 0.0231\ mol\ HCl.$$

$\Rightarrow$ mole HCl = Molarity (HCl) x Volume (HCl)

$0.0231\ mol = 0.10\ \frac{mol}{L} \times$ Volume (HCl) $\Rightarrow$ Volume $= 0.231\ L$

using the density, we can find:

$$0.231\ \cancel{L} \times \frac{1000\ \cancel{mL}}{1\ \cancel{L}} \times \frac{1.10\ g}{1\ \cancel{mL}} = 253\ g \Rightarrow \text{choice [e]}$$

Oxidation - Reduction Titration:

Question No. [8] :

- Statement [a] is incorrect, because laundry bleach contains an oxidizing agent.
- Statement [b] is incorrect, because I_2 and I_3^- form a blue complex with starch.
- Statement [c] is correct, because I_2 acted as an oxidizing agent.
- Statement [d] is incorrect, because $S_2O_3^{-2}$ was delivered from the buret.
- Statement [e] is incorrect, because I^- acted as a reducing agent.

So, the answer is choice [c].

Question No. [9] :

First of all we have to balance the equation according to the oxidation reduction reaction:

$ClO^- \longrightarrow Cl^-$

$ClO^- \longrightarrow Cl^- + H_2O$: O atom

$2H^+ + ClO^- \longrightarrow Cl^- + H_2O$: H atom

$2H^+ + ClO^- + 2\bar{e} \longrightarrow Cl^- + H_2O$: $\bar{e}$

$2S_2O_3^{-2} \longrightarrow S_4O_6^{-2}$: atoms except O, H

$2S_2O_3^{-2} \longrightarrow S_4O_6^{-2}$: O atom

$2S_2O_3^{-2} \longrightarrow S_4O_6^{-2}$

$2S_2O_3^{-2} \longrightarrow S_4O_6^{-2} + 2\bar{e}$: $\bar{e}$

Add two Half - Reactions to each other :

$$2H^+ + ClO^- + 2S_2O_3^{-2} \longrightarrow Cl^- + H_2O + S_4O_6^{-2}$$

Now, we can continue our solution:

Moles of $S_2O_3^{-2}$ = Molarity $(S_2O_3^{-2})$ x Volume $(S_2O_3^{-2})$

Moles of $S_2O_3^{2-}$ = $0.310 \frac{mol}{L} \times 6.4\ mL \times \frac{1\ L}{1000\ mL}$

$= 2.0 \times 10^{-3}$ mol

2.0×10^{-3} mol $S_2O_3^{-2} \times \frac{1\ mol\ ClO^-}{2\ mol\ S_2O_3^{-2}} = 1.0 \times 10^{-3}$ mol ClO^-

Moles of ClO^- = Molarity (ClO^-) x Volume (ClO^-)

1.0×10^{-3} mol = Molarity x 9.00 mL $\times \frac{1\ L}{1000\ mL}$

$\Rightarrow$ Molarity = 0.110 mol/L $\Rightarrow$ Choice [a].

Avogadro's Number:

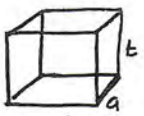
Remember the procedure of the experiment.

- The volume which the solid stearic acid occupies = mass of stearic acid / density of solid stearic acid.

$= 9.8 \times 10^{-6}$ g / 0.850 g/mL

$= 1.2 \times 10^{-5}$ mL (cm^3)

$t = 5.44a$



- The thickness (t) of monomolecular layer = Volume / area of monomolecular layer

$t = 1.2 \times 10^{-5}\ cm^3 / 100.0\ cm^2 = 1.2 \times 10^{-7}$ cm.

- $a = \frac{t}{5.44} \Rightarrow a = \frac{1.2 \times 10^{-7}\ cm}{5.44} = 2.2 \times 10^{-8}$ cm

- the area of one molecule $= a^2 = (2.2 \times 10^{-8}\ cm)^2 = 4.8 \times 10^{-16}\ cm^2$

- No. of molecules present = total area of monomolecular layer / area of one molecule

$= 100.0\ cm^2 / 4.8 \times 10^{-16}\ cm^2 = 2.1 \times 10^{17}$ molecule.

- No. of moles present = mass of stearic acid / molar mass of stearic acid

$= 9.8 \times 10^{-6}\ g / 284\ g\,mol^{-1} = 3.5 \times 10^{-8}$

- Avogadro's No. = No. of molecules / No. of moles $= 2.1 \times 10^{+17} / 3.5 \times 10^{-8} \cong 6.4 \times 10^{24}$ choice [d]

Volumetric Analysis:

Question No. 3:

total no. of moles of HCl added to dissolve the tablet = moles of HCl reacted actually with antacid + moles of HCl reacted with NaOH solution.

Remember that Molarity = moles / Volume (L)

$M_{HCl} \times V_{HCl}$ = moles of HCl reacted actually with antacid + $M_{NaOH} \times V_{NaOH}$

since $NaOH + HCl \rightarrow NaCl + H_2O$, 1 mol : 1 mol.

$\Rightarrow$ moles of HCl reacted actually with antacid $= M_{HCl} \times V_{HCl} - (M_{NaOH} \times V_{NaOH})$

$= 0.15 \frac{mol}{L} \times 50.0 mL \times \frac{1 L}{1000 mL} - 0.16 \frac{mol}{L} \times 20 mL \times \frac{1 L}{1000 mL}$

$= 4.3 \times 10^{-3}$ mol HCl per 0.50 g tablet.

$= 8.6 \times 10^{-3}$ mol HCl per 1 g tablet $\Rightarrow$ choice [b].

Question No. 4: We must write balanced chemical equation represents the reaction of $H_2SO_4(aq)$ and $NaOH(aq)$ as the following:

$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + H_2O(\ell)$$

$V_{H_2SO_4} = 15.0 mL$, $V_{NaOH} = 25.0 mL$, $M_{NaOH} = 0.10 M$.

$$25.0 \cancel{mL}\ NaOH \times \frac{1 \cancel{L}\ NaOH}{1000 \cancel{mL}\ NaOH} \times \frac{0.10\ \cancel{mol\ NaOH}}{\cancel{L}} \times \frac{1\ mol\ H_2SO_4}{2\ \cancel{mol\ NaOH}} = 1.25 \times 10^{-3}\ mol\ H_2SO_4$$

$M_{H_2SO_4}$ = moles H_2SO_4 / Liters of Solution $= 1.25 \times 10^{-3}$ mol $H_2SO_4 / (15.0 mL \times \frac{1 L}{1000 mL})$

$= 0.083 \frac{mol\ H_2SO_4}{L}$

$$0.083 \frac{\cancel{mol\ H_2SO_4}}{L} \times \frac{98.0\ g\ H_2SO_4}{1\ \cancel{mol\ H_2SO_4}} = 8.2\ g/L$$ Choice [e]

Detailed Answers For The (Final Exam) Of
(Experimental General Chemistry) {106-107-108-109}.

Date of Exam: 15 / 1 / 2005.

General:

Question No. 1:

Statement a is incorrect, because it is not allowed to hold your face directly orer the bottle when smelling a substance. (Look your manual.)

Statement b is incorrect, it's known that volumetric flasks, burets and pipets are the most accurate glassware used in Laboratory.

Statement c is correct, because any Lab. must contain posters about Hazarodous Chemicals and some chemicals used in Lab. in general.

Statement d is incorrect, because if you spell concentrated sulfuric acid on your clothes, you must washit with water, then neutralize it with DILUTE (Weak) base NOT CONCENTRATED ONE. Sodium hydroxide solution is strong base also.

Statement e is incorrect, because you are not allowed to insert clean pipets or dropper into any reagent bottle due to contamination of stock reagent bottle.

Stiochiometery:

Question No. 2:

mass of hydrated salt = 1.26 g , mass of water = 0.52 g ,

Molar mass of anhydrous salt = 258 g mol^{-1}, molar mass of water = 18 g mol^{-1}.

water of crystalization (x) = moles of water / moles of anhydrous salt

mass of anhydrous salt = mass of hydrated salt − mass of water = 1.26g − 0.52g = 0.74g

$$0.74\text{ g anhydrous} \times \frac{1\text{ mol anhydrous}}{258\text{ g anhydrous}} = 2.9 \times 10^{-3}\text{ mol anhydrous}$$

$$0.52\text{g water} \times \frac{1\text{mol water}}{18\text{ g water}} = 0.029\text{ mol Water} \Rightarrow X = 0.029/2.9\times10^{-3} \simeq 10$$ Choice (a)

Oxidation - Reduction Titration:

Question No. 5:

10.0 mL Sample of bleach was diluted to 250. mL.

Let's revise the full reactions

$$2I^- \longrightarrow I_2 + 2\bar{e}$$
$$2\bar{e} + 2H^+ + ClO^- \longrightarrow Cl^- + H_2O$$
$$2H^+ + 2I^- + ClO^- \longrightarrow I_2 + Cl^- + H_2O \quad \cdots (1)$$

$$2\bar{e} + I_2 \longrightarrow 2I^-$$
$$2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2\bar{e}$$
$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-} \quad \cdots (2)$$

combination of (1) and (2) $\Longrightarrow 2H^+ + ClO^- + 2S_2O_3^{2-} \longrightarrow Cl^- + S_4O_6^{2-} + H_2O$.

$V_{Diluted\ solution} = 20.0\ mL$, $V_{S_2O_3^{2-}} = 7.55\ mL$, $M_{S_2O_3^{2-}} = 0.20\ M$.

$$moles\ (S_2O_3^{2-}) = M_{S_2O_3^{2-}} \times V_{S_2O_3^{2-}} = 0.20\ M \times 7.55\ \cancel{mL} \times \frac{1\ L}{1000\ \cancel{mL}} = 1.5 \times 10^{-3}\ mol\ S_2O_3^{2-}$$

$$1.5 \times 10^{-3}\ mol\ S_2O_3^{2-} \times \frac{1\ mol\ ClO^-}{2\ mol\ S_2O_3^{2-}} = 7.5 \times 10^{-4}\ mol\ ClO^-.$$

$$\Rightarrow Molarity\ ClO^- = mol\ ClO^- / volume\ (L) = 7.5 \times 10^{-4}\ \cancel{mol} / 20.0\ \cancel{mL} \times \frac{1\ L}{1000\ \cancel{mL}} = 0.0375\ M.$$

$M_{Diluted}$.

$M_{conc.} \times V_{conc.} = M_{Diluted} \times V_{Diluted} \Rightarrow M_{conc.} \times 10\ mL = 0.0375\ M \times 250\ mL$

$M_{conc.} = 0.9375\ mol/L$.

$$\% = \frac{M \times M.wt \times 100}{1000 \times Density}\ \% \Rightarrow \frac{0.9375\ mol \times 74.5\ g\ mol^{-1} \times 100}{1000\ mL \times 1.1\ g/mL}\ \% = 6.4\ \%$$

Choice [d]

Avogadro's Number:

Question No. 6:

Avogadro's number = no. of molecule / no. of moles

no. of moles = mass / molar mass $\Longrightarrow$ moles $= 5.0 \times 10^{-5}\ g / 284\ g\ mol^{-1}$

$\Rightarrow$ moles $= 1.8 \times 10^{-7}$ moles.

$$\text{no. of molecule} = \text{Avogadro's no.} \times \text{no. of moles} = 6.0 \times 10^{23}\ \frac{molecule}{\cancel{mole}} \times 1.8 \times 10^{-7}\ \cancel{mol}$$

$$= 1.08 \times 10^{17}\ molecules.$$

$$\text{No. of molecules} = \frac{\text{area of total layer of monomolecular}}{\text{area of one molecule}}$$

$\Longrightarrow$ area of one molecule $= 75.0 / 1.08 \times 10^{17} = 7 \times 10^{-16}$ Choice [a]

Molecular Weight Of Volatile Liquid:

Question No. 7:

$$PV = \frac{\text{mass } R.T}{\text{molar mass}} \Rightarrow \text{molar mass} = \frac{\text{mass} \cdot R \cdot T}{PV} = \frac{1.15\,g \times 0.08206\,\frac{L \cdot atm}{mol \cdot K} \cdot 370\,K}{\frac{737\,mmHg}{760\,mmHg/atm} \times \frac{200\,mL}{1000\,mL} \times K}$$

$\Rightarrow$ molar mass = 180 g mol^{-1} Choice [b]

Question No. 8:

Remember molar mass = mass. R.T / PV

Statement a is NOT SUITABLE, the pressure of one atmosphere is higher than external pressure, so the denominator increases, the molar mass will decrease.

Statement b is NOT SUITABLE, there is no effect because if the mass of empty is higher also the mass of actual value will be higher as the same amount for empty one.

Statement c is SUITABLE, because the mass in general is higher, the molar mass will increase.

Statement d is NOT SUITABLE, because the difference in volume will affect the mass.

Statemend e is NOT SUITABLE, because when T is low, molar mass will decrease.

Thermochemistry:

mass of X metal = 0.552 g. molar mass = 113 g mol^{-1}

Volume of HCl = 150 mL Molarity HCl = 0.1 M. ΔT = 7.92 °C

Specific heat = 4.18 J.g^{-1}C^{-1}, density = 1.0 g mL^{-1}.

Heat = q_p = mass of solution x specific heat x ΔT.

$$150\,mL\ HCl \times \frac{1.00\,g\ HCl\ Solution}{1.00\,mL} = 150\,g\ Solution\ HCl.$$

total mass = 0.552 g + 150 g = 150.552 g

Continued →

Continue :

Now substituting in main rule ;

$$(\text{Energy/Heat}) = 150.552\,g \times 4.18 \frac{J}{g^{-1}C^{o-1}} \times 7.92\,^{o}C = 4.98\ KJ$$

$$\Rightarrow 0.552\ g\ of\ x \times \frac{1\ mol\ x}{113\ g\ x} = 4.15 \times 10^{-3}\ mol\ x.$$

$$\Delta H = \frac{4.98\ KJ}{4.15 \times 10^{-3}\ mol\ x} = -1020\ KJ/mol\ x.$$

because the temperature is increased by 7.92 $\Rightarrow$ evolution of Heat (+ve) $\Rightarrow$ Exothermic

Choice [d]

Furthermore you should not round any no. untill you reach the final answer But I wrote the answers only to show the correct no. of significant figures, so, do all calculations together and DO NOT ROUND UNTILL THE FINAL ANSWER.

Question No. [10] :

(1) ... $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2\,(aq)} + H_{2\,(g)}$ $\Delta H = -215\ KJ/mol$

(2) ... $MgO_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2\,(aq)} + H_2O_{(l)}$ $\Delta H = -155\ KJ/mol.$

(3) ... $H_2O_{(l)} \longrightarrow H_{2\,(g)} + \frac{1}{2} O_{2\,(g)}$ $\Delta H = 286\ KJ/mol.$

ΔH_f MgO = ??

Rearrangement of above equations leads to:

Equation (1) remains the same: $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2\,(aq)} + H_{2\,(g)}$, $\Delta H_1 = -215\ KJmol^{-1}$

Equation (2) is reversed : $MgCl_{2\,(aq)} + H_2O_{(l)} \longrightarrow MgO_{(s)} + 2HCl_{(aq)}$, $\Delta H_2 = 155\ KJmol^{-1}$

Equation (3) is reversed : $H_{2\,(g)} + \frac{1}{2} O_{2\,(g)} \longrightarrow H_2O_{(l)}$, $\Delta H_3 = -286\ KJmol^{-1}$

the Sum of eqn.s (1), (2) & (3): $Mg_{(s)} + \frac{1}{2} O_{2\,(g)} \longrightarrow MgO_{(s)}$

$\Delta H_{rxn} = \Delta H_1 + \Delta H_2 + \Delta H_3$

$= -215\ KJmol^{-1} + 155\ KJmol^{-1} + -286\ KJmol^{-1}$

$= -346\ KJmol^{-1}$

$\cong 345\ KJmol^{-1}$

Choice [e]

Continue :

$\Delta T_f = K_f \times X_{Napthalene} \Rightarrow \Delta T_f = ??$ $\quad n$ = mass / molar mass

$X_{Naphthalene} = n_{Naphthalene} / n_{Naphthalene} + n_{Benzene}$

$= (10.25g / 128.0 g mol^{-1}) / [(10.25g / 128.0 g mol^{-1}) + (200.0g / 78.0 g mol^{-1})]$

$= 0.03028.$

$\Delta T_f = K_f \times X_{Naph.} \Rightarrow \Delta T = 65.6\,^{\circ}C \times 0.03028 = 1.99\,^{\circ}C.$

$T_{f\,(benzene)} - T_{f\,(soln.)} = 1.99\,^{\circ}C \Rightarrow 5.5\,^{\circ}C - T_{soln.} = 1.99\,^{\circ}C \Rightarrow T_{soln.} = 3.5\,^{\circ}C$ choice [a]

Question No. 14 :

Since all solutions given are equal. The soln. which gives higher no. of species will have the largest Van't Hoff factor, i ?

a) Na^+, Cl^- (2) b) $Al^{+3}, 3NO_3^-$ (4) c) $2Al^{3+}, 3SO_4^{-2}$ (5) d) $2K^+, SO_4^{2-}$ (3) e) weak electrolyte

Choice [c]

Question No. 15 :

$1/i = X_{calc.} / X_{meas.} \Rightarrow i = X_{measured} / X_{calculated}$

$X_{calculated}$ = moles benzoic acid / (moles benzoic acid + moles of benzene)

$= 1.22\,g / 122.0 g mol^{-1} / [(1.22g / 122.0 g mol^{-1}) + (78\,g / 78 g mol^{-1})]$

$= 9.90 \times 10^{-3}$

$X_{measured} = \Delta T / K_f = 0.45\,^{\circ}C / 65.6\,^{\circ}C = 6.9 \times 10^{-3}.$

$i = 6.9 \times 10^{-3} / 9.90 \times 10^{-3} = 0.69$ choice [d].

Equilibrium and Ksp :

Question No. 16:

$CH_3COOAg \rightleftharpoons CH_3COO^- + Ag^+$

$Ag^+ + SCN^- \longrightarrow AgSCN$ white ppt.

moles of KSCN = molarity (KSCN) × Volume (KSCN) $= 0.040 \frac{mol}{L} \times 15.3\,\cancel{mL} \times \frac{1\,\cancel{L}}{1000\,\cancel{mL}}$

$= 6.12 \times 10^{-4}$ mol.

Question No. 11:

mass of X material = 1.0 g , molar mass = 40 g mol^{-1}
mass of HCl = 50.0 g , rise in temperature = 7.0 °C
ΔH = −74.8 KJ / mol X , Specific heat of solution = 4.10 J/g.°C
Heat Capacity = ??
moles of X = mass of X / molar mass of X = 1.0 g / 40 g mol^{-1} = 0.025 mol X

It is known that

74.8 KJ is evolved ⟶ 1 mol X

?? ⟵ 0.025 mol X

amount of heat evolved for $\underbrace{1\text{g of X}}_{0.025\text{ mol}}$ = 1.870 KJ. = 1870 KJ

Heat = (mass (soln.) x specific heat (soln.) x ΔT) + (heat capacity x ΔT)

1870 J = (1.0 g + 50.0 g) x 4.10 g/g.°C x 7.0 °C) + C x 7.0 °C

1870 J = 1463.7 J + 7.0 C

406.3 J = 7 C

C = 58 J/°C. Choice [b]

Colligative Properties:

Question No. 12:

Statements a, b, c, d are all incorrect

Statement e is correct; the greater the mole fraction, the greater ΔT_f value, and because T_f for pure solvent is constant, so T_f for solution will be lower.

Choice [e]

Question No. 13:

mass of $C_{10}H_8$: 10.25 g as a solute () Naphthalene. molar mass = 128.0 g mol^{-1}.
mass of C_6H_6 : 200.0 as a solvent () Benzene . molar mass = 78.0 g mol^{-1}
T_f of pure benzene = 5.5 °C , K_f = 65.6 °C for benzene, T_f soln. = ??

Continued ⟶

Detailed Answers For The (Final Exam) Of
(Experimental General Chemistry) {106-107-108-109}.

Date of Exam: 15 / 1 / 2005.

Chemical Equilibrium:

Question No. 19:

Statement a is incorrect, because the formation of Turnball blue is an indication for the presense of Fe^{2+}. $K_3Fe(CN)_6 + Fe^{2+} \longrightarrow K^{+}[Fe^{+2}Fe^{+3}(CN)_6]^{-}$

Statement b is incorrect, because the white precipitate which was formed when the equilibrium solution of Ag^+ and Fe^{2+} when treated with KSCN (aquous) is AgSCN.

Statement c is incorrect, Turnbull blue contains both Fe^{2+} and Fe^{3+}.

Statement d is correct. $AgNO_{3(aq)} + Fe(NH_4)_2(SO_4)_{2(aq)} \longrightarrow Fe^{3+}_{(aq)} + Ag_{(s)}$.

Statement e is incorrect, because that turnball blue is not clear blue solution, it goes to white color with time.

Question No. 20:

Statement a is correct, the solubility of AgCl increases when NH_3 solution is added.

$$AgCl_{(s)} \rightleftharpoons Ag^+ + Cl^-$$

$$Ag^+ + (NH_3) \xrightarrow{OH^-} [Ag(NH_3)_2]OH$$

Statement b is incorrect, the solubility of $AgI_{(s)}$ in $KI_{(aq)}$ solution is more than $AgCl_{(s)}$ in $KCl_{(aq)}$ solution due to the formation of stable soluble AgI_2^- complex which does not form in $AgCl_{(s)}$ case.

Statement c is incorrect, The solubility of $AgCl_{(s)}$ in $NH_{3(aq)}$ solution is more than $AgI_{(s)}$ in $NH_{3(aq)}$ solution. because $[Cl^-]$ and $[Ag^+]$ are much available than the correspondings in AgI, so the probability of rxn to happen is increased, so the rxn will shift to left $AgCl \rightleftharpoons Ag^+ + Cl^-$ in order to compensate for the decrease of $[Ag^+]$ in solution.

Statement d is incorrect, AgCl does NOT react with excess $Cl^-_{(aq)}$ to form stable anion $AgCl_2^-$
AgI does REACT " " $I^-_{(aq)}$ " " " " AgI_2^-.

Statement e is incorrect, because the solubility of $AgCl_{(s)}$ in water in more than of $AgI_{(s)}$ look to Ksp values.

Good Luck.

Continue →

moles KSCN = 6.12×10^{-4} mol = mole Ag^+ (according the chemical eqn.).

and moles/volume = molarity.

$M_{Ag^+} = 6.12 \times 10^{-4}$ mol / 17.0×10^{-3} L = 0.036 M Ag^+.

Since moles Ag^+ = moles CH_3COO^- , so $M_{Ag^+} = M_{CH_3COO^-}$

$K_{sp} = [Ag^+][CH_3COO^-] = 0.036\ M \times 0.036\ M \cong 1.3 \times 10^{-3}$ Choice [b]

Question No. 17:

$K_{sp} = 2.30 \times 10^{-3} = [Ag^+][CH_3COO^-] = [Ag^+]^2 \Longrightarrow [Ag^+] = \sqrt{2.3 \times 10^{-3}} = 0.048\ M\ Ag^+$.

Since $KSCN + Ag^+ \longrightarrow AgSCN + K^+$

1 : 1 ratio , so we can say

$M_{SCN^-} \times$ Volume $SCN^- = M_{Ag^+} \times V_{Ag^+}$

$15.0\ mL \times 0.0320\ M = 0.048\ M \times V_{Ag^+} \Longrightarrow V_{Ag^+} = 10.0\ mL$ Choice [c]

Question No. 18:

Statement a is correct, because Ksp value depends on aqeeous species not on solid components.

Statement b is correct, because if we increase $[CH_3COO^-]$, the amount of CH_3COOAg increases according to Le Châtelir's equilib. principle, so the amount of solid precipitate increases and solubility decreases.

Statement c is correct, for the same reason mentioned in b but here we are talking about $[Ag^+]$.

Statement d is correct, because the addition of HNO_3 will lead to form the following rxn

$CH_3COO^- + H^+ \rightleftharpoons CH_3COOH$, which in turns, will shift rxn to left.

So, the amount of solid decreases and will be soluble.

Statement e is incorrect, ✓

moles $AgNO_3$ = molarity $AgNO_3 \times$ Volume $AgNO_3 = 5.0 \times 10^{-3}\ L \times 0.1 \frac{mol}{L} = 5.0 \times 10^{-4}$ mol.

moles CH_3COONa = molarity $CH_3COONa \times$ Volume $CH_3COONa = 15.0\ mL \times 0.015 \frac{mol}{L} = 2.25 \times 10^{-4}$ mol

total Volume is = 5.0 mL + 15.0 mL = 20.0 mL.

$[AgNO_3] = 5.0 \times 10^{-4} / 20 \times 10^{-3}\ L = 0.025$ $\quad [CH_3COONa] = 2.25 \times 10^{-4}\ mol / 20 \times 10^{-3} = 0.01125$

$[Ag^+][CH_3COO^-] = 0.025 \times 0.01125 = 2.81 \times 10^{-4} < K_{sp}$ ∴ No Precipitate is formed.