

Name: _____ Department: _____ Student ID: _____

Note:

- ✧ **Time: 12:20~13:10**
- ✧ **Write down the answers on the test sheet.**
- ✧ **There are 20 questions in the test, 4 points for each and the total score is 80.**
- ✧ **The questions marked with * has only one answer.**
- ✧ **Atomic mass (amu): O = 16.0, Cu = 63.6, S = 32.1, R = 0.082 L atm/mol K**

Experiment 1 Molar volume of nitrogen gas

1. According to the experiment, which statement is correct?
 $\text{NaNO}_{2(\text{aq})} + \text{H}_2\text{NSO}_3\text{H}_{(\text{s})} \rightarrow \text{NaHSO}_{4(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} + \text{N}_{2(\text{g})}$
 (A) Sulfamic acid ($\text{H}_2\text{NSO}_3\text{H}$) is the limiting reagent.
 (B) This is an exothermic reaction.
 (C) The by-product nitrogen dioxide (NO_2) is a reddish-brown gas with a pungent odour.
 (D) STP stands for standard temperature (0°C) and pressure (1 atm).
2. Which of the following conversion is correct?
 (A) $27^\circ\text{C} = 300\text{ K}$ (B) $26\text{ torr} = 26\text{ mmHg}$ (C) $314\text{ mL} = 3.14\text{ L}$ (D) $76\text{ mmHg} = 1\text{ atm}$

Experiment 3 Determination of the chemical formula of a compound

3. According to the experiment, which statement is correct?
 (A) Copper oxide reacts with hydrogen gas is a redox reaction.
 (B) Hydrogen gas is the reducing agent in the above reaction.
 (C) Zinc metal reacts with hydrochloric acid is an acid-base neutralization reaction.
 (D) Calcium chloride is used as an oxidizing agent in the experiment.

Experiment 6 The enthalpies of reactions

- 4*. According to the following data, calculate the heat capacity of calorimeter in unit $\text{cal}/^\circ\text{C}$.

Temp. of 50.0 mL hot water	40.5°C	$\text{MgO}_{(\text{s})}$	0.017 mol
Temp. of 50.0 mL cold water and calorimeter	26.0°C	Temp. of 100.0 mL of 1.0 M HCl and calorimeter	26.0°C
Equilibrium temp. after mixing	32.8°C	Equilibrium temp. after reaction	33.3°C

- (A) 6.62 (B) 45 (C) 6.6 (D) 4.5 $\text{cal}/^\circ\text{C}$
- 5*. We use this calorimeter to measure the molar heat of reaction of $\text{MgO}_{(\text{s})}$ and $\text{HCl}_{(\text{aq})}$ according to the above data. Assume the density and specific heat of the solution is same as that of water
 (A) -45.8 (B) -46 (C) -42.9 (D) -43 kcal/mol

Experiment 8 Acid-base indicators and pH determination

6. Which of the following 0.10 M solution is neutral ($\text{pH} = 7$)?
 (A) KCl (B) FeCl_3 (C) NaNO_3 (D) NH_4Cl

Experiment 9 Solubility Rules

- 7*. Which one of the following substances shows the highest solubility in water?
 (A) $\text{Pb}(\text{NO}_3)_2$ (B) PbCl_2 (C) PbSO_4 (D) PbO_2
8. Which of the following 1.0 M solution shows color?
 (A) $\text{Cu}(\text{NO}_3)_2$ (B) $\text{Co}(\text{NO}_3)_2$ (C) $\text{Mg}(\text{NO}_3)_2$ (D) $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
9. According to the solubility rule, which of the following reagent can be used to separate the Ag^+ and Cu^{2+} cations?
 (A) $\text{NaCl}_{(\text{aq})}$ (B) $\text{NaOH}_{(\text{aq})}$ (C) $\text{Na}_2\text{SO}_{4(\text{aq})}$ (D) $\text{NaNO}_{3(\text{aq})}$

Experiment 10 Qualitative Analysis of Cation Group 1

10. Which one of the following cations is able to form white precipitate with 6 M HCl_(aq), that is insoluble in hot water but soluble in conc. NH₃(aq)?
(A) Ag⁺_(aq) (B) Hg₂²⁺_(aq) (C) Pb²⁺_(aq) (D) Hg²⁺_(aq)

Experiment 12 Quantitative analysis of vitamin C

- 11*. In the experiment, a solution containing vitamin C is titrated with 0.0500 M KIO₃. The initial and final reading of buret is 12.00 mL and 36.00 mL, respectively. Calculate the contents of vitamin C in the solution in mmol? (The molar mass of vitamin C is 176 g/mol)
 $\text{IO}_3^- + 5\text{I}^- + 6\text{H}^+ \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$ $\text{C}_6\text{H}_8\text{O}_6 + \text{I}_2 \rightarrow \text{C}_6\text{H}_6\text{O}_6 + 2\text{I}^- + 2\text{H}^+$
(A) 1.20 (B) 2.40 (C) 3.60 (D) 5.40 mmol
12. According to the experiment, which of the following statement is correct?
(A) Vitamin C is an organic compound.
(B) Vitamin C is water soluble for it can form hydrogen bonds with water.
(C) We use KIO_{3(aq)} as the titrant in the experiment.
(D) At the end point triiodide ions (I₃⁻) react with starch to produce a blue-black complex.

Experiment 13 Determination of solubility product constant of silver acetate

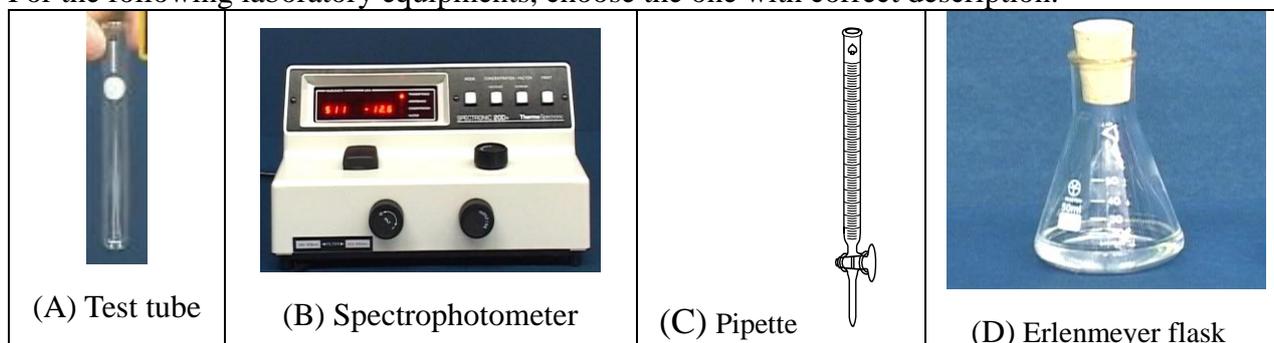
13. Which of the following would affect the K_{sp} of silver acetate (CH₃COOAg)?
(A) Temperature (B) pH value of solution (C) Common ions (D) Pressure

Experiment 15 Potentiometric titration of acid-base

- 14*. According to the experiment, we use 0.20 M NaOH(aq) to titrate 4.00 mL acetic acid solution. If the volume of the **half-equivalence point** is 20.00 mL, what is the concentration of acetic acid in weight %? The density of the solution is 1.0 g/cm³ and molar mass of CH₃COOH is 60.05 g/mol.
(A) 0.6 % (B) 1.2 % (C) 6.0 % (D) 12 %
15. Indicate the suitable indicator for the above titration.
(A) Methyl red (B) Methyl orange (C) Bromthymol blue (D) Phenolphthalein

Experiment 17 Quantitative analysis of cobalt(II) ions

- 16*. The calibration curve of absorbance vs. Co(II) concentration (mg/mL) is $y = 33.92x + 0.0048$. We take 0.50 mL of unknown Co(II) solution, add reagents, and dilute to 10.0 mL according to the experiment. It shows an absorbance of 0.273. What's the concentration of Co(II) ion in the unknown solution?
(A) 7.9×10^{-3} mg/mL (B) 9.3 mg/mL (C) 186 mg/mL (D) 0.16 mg/mL
17. For the following laboratory equipments, choose the one with correct description.



Experiment 20. The preparation of alum

18. According to the experiment, which statement is true?
(A) The Al foils react with KOH(aq) and oxygen gas evolves.
(B) Al(OH)₃ is an amphoteric substance.
(C) The crystal of KAl(SO₄)₂·12H₂O is water soluble.
(D) The shape of Cr-Al alum crystal is octahedral.

19*. Base on the experiment, calculate the percent yield of alum according to the given data: Al: 0.51 g and alum 7.10 g. Molar mass of Al: 27 g mol^{-1} ; $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$: 474 g mol^{-1}

(A) 1.9% (B) 5.7% (C) 14% (D) 79%

Experiment 19. Determination of rate law

20. According to the experiment, the rate law for the reaction $\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \rightarrow 2\text{SO}_4^{2-} + \text{I}_2$ is determined as: $\text{rate} = k[\text{S}_2\text{O}_8^{2-}]^{0.83}[\text{I}^-]^{1.1}$. Which of the following trials will turn the color of solution to blue within 53 second, i.e. Δt is less than 53 s?

Trial	0.20 M NaI (mL)	0.20 M NaCl (mL)	0.0050 M $\text{Na}_2\text{S}_2\text{O}_3$ (mL)	2% Starch (mL)	0.10 M K_2SO_4 (mL)	0.10 M $\text{K}_2\text{S}_2\text{O}_8$ (mL)	Reaction time (Δt) (s)
1	2.0	2.0	1.0	1.0	2.0	2.0	53
(A)	3.0	1.0	1.0	1.0	2.0	2.0	Δt_A
(B)	2.0	2.0	1.0	1.0	3.0	1.0	Δt_B
(C)	2.0	2.0	1.0	1.0	1.0	3.0	Δt_C
(D)	3.0	1.0	1.0	1.0	1.0	3.0	Δt_D

ANSWER

1	ABCD	2	AB	3	AB	4*	C	5*	B
6	AC	7*	A	8	AB	9	AC	10	A
11*	C	12	ABCD	13	A	14*	D	15	D
16*	D	17	BD	18	BCD	19*	D	20	ACD

Have a wonderful summer vacation!