The University of Southern Mississippi
Department of Chemistry and Biochemistry

CHE 311 Analytical Chemistry

Chapter Quizzes

This set of quizzes of CHE 311-Analytical Chemistry are collected from the website associated with "*Quantitative Chemical Analysis*", 8th Ed, Daniel C. Harris/W.H. Freeman. Each chapter comes with a number of multiple choice-type questions. Understanding each of these questions is crucial for this course, particularly for preparing the ACS standardized exams. You are strongly encouraged to work on ALL of them and use them to test your knowledge or guide you on reviewing specific chapters. A few of the same or similar questions might be chosen for the course examinations.

Department of Chemistry and Biochemistry
University of Southern Mississippi
CHE 311 Class Practice

Overall 2

Chapter 00 -Analytical Process and Sampling

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1 of 15

A chemical firm was hired to monitor a nearby lake for possible mercury contamination. Several samples were taken at different locations around the lake, including water samples, lake bottom samples, and plant samples. When the chemist returned to the laboratory, the water samples were the first to be analyzed. The analysis began by removing a number of aliquots. An aliquot is

○ (a) a measure of the contamination of the lake water.

○ (b) a combined measure of the contamination in the lake.

○ (c) a precise liquid sample taken for analysis.

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2 of 15

The sampling technique is very important when analyzing a large area or vast amounts of material because you cannot analyze everything. When preparing a composite sample, a chemist would

○ (a) take several samples at random from pre-planned locations in the bulk sample and analyze each.

○ (b) take representative samples from various areas of the bulk samples and combine them for analysis.

○ (c) analyze as much of the bulk sample as possible.

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3 of 15

The steps in a chemical analysis are

○ (a) 1. Formulate the question.
2. Select the analytical procedure.
3. Sample.
4. Prepare the sample.
5. Make replicate measurements of the sample.

○ (b) 1. Select the analytical procedure.
2. Sample.
3. Prepare the sample.
4. Make replicate measurements of the sample.
5. Make a clear and complete written report of your findings.

○ (c) 1. Formulate the question.
2. Select the analytical procedure.

3. Sample.
4. Prepare the sample.
5. Make replicate measurements of the sample.
6. Make a clear and complete written report of your findings.

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4 of 15

A chemist following a procedure carefully was asked to decant a solution. This means

○ (a) stir the solution thoroughly to suspend the solids and pour the mixture into a filtering apparatus.

○ (b) allow any solid material to settle to the bottom of the flask, and then pours off the liquid above the solution.

○ (c) pour the solution from one flask to another.

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5 of 15

A sample is said to be homogeneous if

○ (a) the sample is the same throughout.

○ (b) the sample has a different composition in different parts of the sample.

○ (c) the sample can be separated into the individual components by filtering the sample.

---

6 of 15

When performing an analysis a chemist often uses a standard solution. What is a standard solution?

○ (a) A solution that complies with standards established by the Environmental Protection Agency.

○ (b) A solution that has a concentration of a chemical that is known to a high degree of certainty.

○ (c) A solution that is prepared from a chemical that has been designated as a primary standard.

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7 of 15

In discussing quantitative and qualitative analysis one could say

○ (a) the two terms are commonly used interchangeably.
○ (b) quantitative analysis deals with determining what materials may be present in a sample.
○ (c) quantitative analysis deals with the quantity of a material present in a sample.

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8 of 15

The term masking generally refers to

○ (a) removing any material that may interfere with an analysis.
○ (b) the transformation of an interfering species into a form that is not detected.
○ (c) selecting samples from which the identity has been masked. This procedure prevents the analyst from prejudging the outcome of the analysis.

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9 of 15

Interference occurs

○ (a) when a species other than the analyte causes an analysis to be inaccurate.
○ (b) when the analyte is precipitated from a non-homogeneous solution.
○ (c) when two or more methods used for separating species interfere with each other.

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10 of 15

Which of the following statements is incorrect?

○ (a) A bulk sample is taken from a lot.
○ (b) A bulk sample is taken from a laboratory sample.
○ (c) A bulk sample is also called a gross sample.

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11 of 15

A quantitative transfer is

○ (a) a complete transfer of material.
○ (b) a liquid transfer using a pipette.

○ (c) a powder transfer using a spatula.

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12 of 15

A detector response may be different for analytes with equal concentrations; therefore,

○ (a) quantitative analysis is impossible.
○ (b) a calibration curve must be constructed.
○ (c) more samples must be analyzed.

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13 of 15

The uncertainty in the measurement is as important as the

○ (a) samples selected.
○ (b) as the samples procured.
○ (c) measurement itself.

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14 of 15

Analysis of an unknown sample is meaningless unless you have

○ (a) collected the sample properly.
○ (b) collected the sample properly, taken measures to ensure the reliability of the analytical method, and communicated your results clearly and completely.
○ (c) collected the sample properly and taken measures to ensure the reliability of the analytical method.

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15 of 15

In a random heterogeneous material,

○ (a) differences in composition occur randomly and on a fine scale.
○ (b) large regions have obviously different compositions.
○ (c) samples are collected by taking portions from the desired number of segments chosen at random.

Keys:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	c	b	c	b	a	b	c	b	a	b	a	b	c	b	b

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CHE 311 Class Practice

Answer Sheet:

Name____________________________

USM ID__________________________

Date_____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				

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Chapter 01-Chemical Measurements

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1 of 17

A chemist is beginning to prepare 100.0 mL of a solution to be labeled "0.900% (wt/vol) sodium chloride." To prepare this solution, the chemist would

○ (a) weigh 0.900 grams of sodium chloride into a container and add 100.0 mL of water to dissolve the sodium chloride.

○ (b) weigh 0.900 grams of sodium chloride into a container, add water to dissolve the sodium chloride, and then add water to produce 100.0 mL of solution.

○ (c) weigh 9.00 grams of sodium chloride into a container, dissolve the sodium chloride in water, and then add water to produce 100.0 mL of solution.

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2 of 17

A solution is prepared by dissolving 25.8 grams of magnesium chloride ($MgCl_2$) in water to produce 250.0 mL of solution. Calculate the molarity of the chloride ion in the solution.

○ (a) 0.271 molar

○ (b) 1.08 molar

○ (c) 2.17 molar

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3 of 17

The Great Salt Lake, located in the state of Utah, is approximately eight times saltier than the ocean. The salinity of the lake is said to occasionally be as high as 27 parts per thousand (ppt) sodium chloride. Calculate the molarity of the sodium ion in the Great Salt Lake.

○ (a) 4.6×10^{-4} molar

○ (b) 0.46 molar

○ (c) 1.2 molar

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4 of 17

The ethyl alcohol content of many beers produced in the United States is 4.05% (vol/vol). If the density of ethyl alcohol at room temperature is 0.7893 grams/mL, what is the percent of ethyl alcohol in beer expressed as percent (wt/vol)?

○ (a) 3.20% ethyl alcohol (wt/vol)

○ (b) 5.13% ethyl alcohol (wt/vol)
○ (c) 7.80% ethyl alcohol (wt/vol)

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5 of 17

An analytical procedure required the preparation of a solution containing 100.0 ppm chromium. How many grams of potassium dichromate ($K_2Cr_2O_7$) would be required to prepare 1.000 liter of this solution?

○ (a) 0.2829 grams
○ (b) 0.1000 grams
○ (c) 0.5658 grams

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6 of 17

Calculate the formal concentration of a sodium acetate solution prepared by diluting 45.0 mL of a solution containing 25.0 ppm sodium acetate ($NaC_2H_3O_2$) to a total of 0.500 liters of solution.

○ (a) 6.10×10^{-4} molar
○ (b) 1.37×10^{-6} molar
○ (c) 2.75×10^{-5} molar

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7 of 17

Certain chemical compounds are given the label strong electrolyte. This means

○ (a) that the compound consists of atoms bonded together by bonds that are considered primarily covalent.

○ (b) that the compounds, when dissolved in water, dissociate into ions that will strongly inhibit the conduction of electricity.

○ (c) that the compounds dissociate into ions when dissolved in water and facilitate the conduction of electricity through the water.

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8 of 17

When concentrated sulfuric acid is sold to the chemist, the label contains no mention of the molarity of the acid. Instead, the label normally lists the concentration of sulfuric acid as a wt/wt percent and the density of the sulfuric acid solution. If the solution is 98.0 (wt/wt %) sulfuric acid and has a density of 1.80 g/mL, calculate the molarity of concentrated sulfuric acid.

○ (a) 18.0 molar
○ (b) 18.4 molar
○ (c) 10.0 molar

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9 of 17

The concentration term parts per million is defined as

○ (a) (the weight of the solute/the volume of the solution) x 10^6.
○ (b) (the weight of the solute/the weight of the solution) x 10^6.
○ (c) (grams of the solute/liters of solution).

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10 of 17

A solution was prepared by diluting 10.0 mL of a 1.00 x 10^{-3} molar solution of potassium dichromate to 100.0 mL. What is the concentration of chromium in the new solution in parts per million?

○ (a) 10.4 ppm
○ (b) 104 ppm
○ (c) 5.20 ppm

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11 of 17

During the late 1800's, hard rock miners replaced candles with carbide lamps for work in mine shafts. The lamps worked by dripping water onto calcium carbide that generated acetylene gas (H_2C_2) that was burned. If the reaction is $CaC_2 + 2H_2O \rightarrow H_2C_2 + Ca(OH)_2$, how many liters of acetylene gas at 1.00 atm pressure and 0.00 °C are produced from 75.0 grams of calcium carbide (CaC_2)?

○ (a) 13.1 L
○ (b) 26.2 L
○ (c) 52.4 L

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12 of 17

In the analysis of iron in a local water well, 500.0 mL of the water sample was poured through a Jones reductor to convert the iron present to the Fe^{2+} oxidation state. The resulting sample required 1.05 mL of 0.0110 molar $KMnO_4$ to react with the iron present. What is the wt/vol % of iron in the well water? The reaction is
$5Fe^{2+}_{(aq)} + MnO_4^-{}_{(aq)} + 8\ H^+_{(aq)} \rightarrow 5\ Fe^{3+}_{(aq)} + Mn^{2+}_{(aq)} + 4\ H_2O$.

○ (a) 1.29×10^{-4} %
○ (b) 6.45 %
○ (c) 6.46×10^{-4} %

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13 of 17

In a 0.001 M aqueous solution of NaCl, the solvent is

○ (a) NaCl.
○ (b) H_2O
○ (c) Not able to be determined from the information given.

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14 of 17

A 250.0 mL sample is concentrated for analysis to 25.0 mL. What is the correct expression for the new concentration?

○ (a) [sample] x (25.0 mL/250.0 mL)
○ (b) [sample] x 100
○ (c) [sample] x (250.0mL/25.0 mL)

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15 of 17

Anhydrous, primary standard sodium thiosulfate can be prepared from the pentahydrate, $Na_2S_2O_3 \bullet 5H_2O$. How many grams of primary standard should be dissolved in 500.0 mL of water to make a 0.040 M solution?

○ (a) 5.0 grams
○ (b) 3.2 grams
○ (c) 20 grams

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16 of 17

Given the reaction below, how many grams of KI are needed to produce 1.0 g of the yellow solid PbI_2

$2KI + Pb(NO_3)_2 \rightarrow PbI_2(s) + 2KNO_3$

○ (a) 5.5 grams

○ (b) 0.36 grams

○ (c) 0.72 grams

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17 of 17

The Environmental Protection Agency (EPA) allowable amount of arsenic in US drinking water is 10 ppb. Express the ppb concentration in molarity.

○ (a) 1.3×10^{-4} molar

○ (b) 1.3×10^{-7} molar

○ (c) 1.3×10^{-8} molar

Keys for Chapter 01

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
b	c	b	a	a	c	c	a	b	a	b	c	a	c	a	c	b			

Chapter 02

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M1

Answer Sheet:

Name____________________________

USM ID__________________________

Date_____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	C	B	A	A	C	A	C	B	C	C	A	B	C	A						

c

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Chapter 02-Tool of the Tread

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1 of 14

What are the three essential attributes of a laboratory notebook?

○ (a)
1. Record what you did.
2. Write in complete sentences.
3. The notebook should be understandable by a stranger.

○ (b)
1. Record what you did.
2. Record what you observed.
3. Always write balanced equations.

☒ (c)
1. Record what you did.
2. Record what you observed.
3. The notebook should be understandable by a stranger.

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2 of 14

The proper use of a buret involves

○ (a) reading the bottom of the meniscus in a manner that avoids a parallax error and making sure that you understand that the buret reads from 50.00 mL at the top to 0.00 mL at the bottom.

☒ (b) reading the bottom of the meniscus in a manner that avoids a parallax error and making sure that you understand that the buret reads from 0.00 mL at the top to 50.00 mL at the bottom.

○ (c) reading the top of the meniscus closest to the volume mark on the buret with your eye at the same height as the top of the liquid.

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3 of 14

A chemist is planning to use a transfer pipet to transfer 10.0 mL of a liquid from one flask to another. The pipet is labeled TD. Which of the following would be the correct procedure?

☒ (a)
1. Use a pipet bulb to raise the liquid above the 10.0 mL mark on the pipet.
2. Rapidly place your thumb or finger over the top of the pipet to contain the liquid.
3. Allow the liquid level to drain to the mark.
4. Allow the liquid to drain into the receiving flask.
5. Use the pipet bulb to blow any liquid remaining in the pipet into the receiving flask.

○ (b)

1. Use a pipet bulb to raise the liquid above the 10.0 mL mark on the pipet.
2. Rapidly place your thumb or finger over the top of the pipet to contain the liquid.
3. Release the pressure to allow the liquid level to drain to the mark.
4. Allow the liquid to drain into the receiving flask.

○ (c)

1. Use a pipet bulb to raise the liquid above the 10.0 mL mark on the pipet.
2. Rapidly place your thumb or finger over the top of the pipet to contain the liquid.
3. Release the pressure to allow the liquid level to drain to the mark.
4. Allow the liquid to drain into the receiving flask.
5. Stop the flow of liquid at the 10.0 mL line by applying pressure over the top with your thumb or forefinger.

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4 of 14

For very precise work, a chemist may want to calibrate the pipets used for an analysis. This can be done by pipeting water from a 20-mL pipet into a weighing bottle. If the weighing bottle was determined to contain 20.0012 grams of water at 22°C what is the actual volume of the pipet? The following data is available from Table 2-7 in your text. At 22°C the correction factor based on the density of water and buoyancy is 1.0033 mL/g.

$$\frac{20.0012\ \text{g} \times (1.0033\ \text{mL}/\text{g})}{1.0033\ \text{mL}/\cancel{\text{g}}}$$

☒ (a) 20.067 mL
○ (b) 19.935 mL
○ (c) 20.0672 mL

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5 of 14

Safety is a major issue in the laboratory. Laboratory workers must wear protective glasses at all times. Food and chemicals do not mix. Protect your body with long pants and a lab coat if possible. Never wear sandals to lab. Protect your feet from spills with real shoes. If you happen to have an accident, such as spilling a chemical on your body,

○ (a) do not panic, get help immediately, and notify your laboratory instructor.
○ (b) do not panic, get help immediately, notify your laboratory instructor, and wash the area with a mild detergent and water.
☒ (c) do not panic, get help immediately, notify your laboratory instructor, wash the area with a mild detergent and water, remove contaminated clothing, and get medical attention.

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6 of 14

1.225 kg/m3

$10^3 g/(100 cm)^3$ $\frac{10^3}{1000000}$ Air density 1.225 ~~kg~~ g/cm^3

Although not often an issue, you should be aware that the buoyancy of air will cause an object to appear lighter than its actual mass. This loss in weight will be equal to the mass of air the object displaces. This is exactly analogous to placing an object under water. A diver can lift masses much heavier than would be possible on land. An organic liquid with a density of 0.935 g/cm^3 weighed 2.7856 g. The balance was equipped with stainless steel weights, which have a density of 8.00 g/cm^3. What is the correct mass of the sample?

☒ (a) 2.7888 grams
○ (b) 1.0011 grams
○ (c) 2.7834 grams

$\frac{2.7856}{0.935}$ vs $\frac{2.7856}{8.00}$

2.7856 + 0.00322 (2.9793 − 0.34945) = 2.6299 cm^3

=

× 1.225 × 10^{-3} g/ml

0.00322 g

7 of 14

A chemist needs to accurately transfer 0.100 mL of liquid from one container to another. Which of the following devices should be used?

○ (a) a transfer pipet
○ (b) a measuring pipet
☒ (c) a micropipet

---

8 of 14

Which of the following statements is not correct?

○ (a) The precipitate is a solid that forms in the mother liquor.
☒ (b) When a precipitate is formed, the mother liquor passes through the filter and becomes the filtrate.
XX (c) The filtrate contains the precipitate, which can be dried and weighed. (C) NOT CORRECT

---

9 of 14

Which of the following pairs do not belong together?

○ (a) mortar and pestle
○ (b) hygroscopic and water
☒ (c) meniscus and tare

---

10 of 14

What is the tolerance of a 25 mL Class A volumetric flask?

○ (a) ±0.12

○ (b) ±0.02

☒ (c) ±0.03

11 of 14

In the laboratory, you calibrate a 25 mL pipet to use throughout the semester. You accidentally break the pipet during the fourth of ten experiments. What <u>should</u> you do?

☒ (a) Obtain a new pipet and calibrate it.

○ (b) Obtain a new pipet and use the reported tolerance.

○ (c) Borrow a friend's calibrated pipet.

12 of 14

You need to transfer 20 mL of your sample to a flask. What scenario is most appropriate?

○ (a) using a 10 mL transfer pipet twice

☒ (b) using a 20 mL transfer pipet

○ (c) using a 25 mL graduated measuring pipet

13 of 14

Errors made in the laboratory notebook

○ (a) should be removed by using white-out over the entry.

○ (b) should be scribbled out with an ink pen.

☒ (c) should have a single line drawn through the entry.

14 of 14

You need to make a 250 mL aqueous solution of NaCl. Which scenario is correct?

☒ (a) Weigh the NaCl, add the NaCl to the flask, add ~200 mL of water, dissolve the solid completely, and dilute to volume.

○ (b) Weigh the NaCl, add the NaCl to the flask, and dilute to volume.

○ (c) Weigh the NaCl, add the NaCl to the flask, add ~249 mL of water, dissolve the solid completely, and dilute to volume.

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Answer Sheet: Chapter 03

Name

USM ID

Date

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	A	B	A	C	B	B	C	A	B	A	A	A	B						

Chapter 03-Experimental Errors

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1 of 14

Values periodical table

Express the molecular weight of $K_2Cr_2O_7$ with the correct number of significant figures and find its uncertainty.

☒ (a) 294.185(±0.004)

○ (b) 294.185(± 0.001)

○ (c) 294.184600(±0.000008)

2K 2 x 0.0001

2Cr 2 x 0,0006

7O 7 x 0,0003 / 0.0035

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2 of 14

How many significant figures are in the number 6.230 X 10^{23}?

☒ (a) 4

○ (b) 3

○ (c) 23

---

3 of 14

How many significant figures are in the number 0.000120?

○ (a) 7

☒ (b) 3

○ (c) 2

---

4 of 14

Write the answer to the following calculation to the proper number of significant figures.
3.86 + 9.1 −0.231 = 12.7290

☒ (a) 12.7

○ (b) 12.73

○ (c) 12

---

5 of 14

Define the term precision.

- ○ (a) Precision refers to how close a measured value is to the "true" value.
- ○ (b) Precision refers to how accurately a given measurement is made.
- ☒ (c) Precision is a measure of the reproducibility of a result.

---

6 of 14

$e_x = \sqrt{e_{x_1}^2 + e_{x_2}^2}$

Find the absolute uncertainty of the following calculation, and express the answer to the proper number of significant figures. 12.40(±0.04) + 178.1(±0.2) - 18.493(±0.002) = 172.007

- ○ (a) 172.01(± 0.2)
- ☒ (b) 172.0(±0.2)
- ○ (c) 172.007(±0.242)

$\sqrt{0.04^2 + 0.2^2} = \sqrt{0.0416}$

$= 0.204$

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7 of 14

Find the absolute uncertainty of the following calculation and round the answer to the proper number of significant figures: 3.78(±0.04) x 6.23(±0.03) x 10^{23} = 2.3549 x 10^{24}.

- ○ (a) 2.3(±0.1) x 10^{24}
- ☒ (b) 2.35(±0.01) x 10^{24}
- ○ (c) 2.35(±0.03) x 10^{24}

$\sum e_x = \sqrt{\left(\frac{0.04}{3.78}\right)^2 + \left(\frac{0.03}{6.23}\right)^2}$

0.013

$e_x = \frac{\cancel{1.015}\ 0.013}{2.3570} = 0.045$

$\sqrt{(0.11197 + 2.3188)\times 10^{-5}} = \cancel{1.058}$

0.0056

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8 of 14

Write the antilog of 4.278 showing the proper number of significant figures.

- ○ (a) 0.6310
- ○ (b) 1.897 x 10^4
- ☒ (c) 1.90 x 10^4

$Y = \log X = 4.278$

$X = 10^{4.278} = 10^4 \cdot 10^{0.278}$

$= 1.8967 \times 10^4$

$= \underline{1.90}$

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9 of 14

A systematic error

- ☒ (a) can be discovered and corrected.
- ○ (b) arises from the limitations on the ability to make a physical measurement.

○ (c) is also known as an indeterminate error.

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10 of 14

Showing the proper number of significant figures, write the [H⁺] that corresponds to physiological pH, which is 7.4.

○ (a) 3.98×10^{-8} molar
☒ (b) 4×10^{-8} molar
○ (c) 4.0×10^{-8} molar

---

11 of 14

You need to transfer 20 mL of your sample to a flask and only have a Class A 10 mL transfer pipet with a reported tolerance of ±0.02. What is the uncertainty in the volume?

☒ (a) ±0.04 mL
○ (b) ±0.03 mL
○ (c) ±0.02 mL

---

12 of 14

What would 4.6105 be rounded to, if we can only have four significant figures in your final answer?

☒ (a) 4.611
○ (b) 4.61
○ (c) 4.610

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13 of 14

76.3 − 7.6 = 68.7

Write the answer to the following calculation with the proper number of significant figures: (582/7.63)-(6.345*1.2)= 68.663851

3 - 2

☒ (a) 68.7
○ (b) 68.66
○ (c) 69

---

14 of 14

You perform an acid-base titration, and the endpoint is 24.95 mL with an error of ±0.1 mL. What is the relative uncertainty in the endpoint volume?

○ (a) 249.5

[✓ (b) 0.004]

○ (c) 0.004 mL

$\frac{0.1}{24.55}$ [illegible]

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CHE 311 Class Practice

Answer Sheet: Chapter____04___________

Name___________________________

USM ID_________________________

Date____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				

Chapter 04-Statistics

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1 of 17

When an analytical chemist uses the word precision when referring to the data obtained from an analysis, the chemist is talking about

○ (a) how close the mean obtained from a set of data is to the true value of the composition of the sample analyzed.

○ (b) relative error calculated from the mean of a set of data.

○ (c) how close the individual data points obtained from a set of data are to each other.

---

2 of 17

A government chemist has performed a gravimetric analysis for chloride ion on a sample submitted to the laboratory. The following results were obtained:

Sample	**Percent Chloride Ion**
1	27.46
2	27.52
3	27.48
4	27.10

When reporting the standard deviation, the analyst said that

○ (a) approximately 68.3% of the data points lie between 27.19 and 27.59 percent chloride.

○ (b) approximately 75% of the data points lie between 27.46 and 27.52 percent chloride.

○ (c) approximately 68.3% of the data points lie between 27.29 and 27.49 percent chloride.

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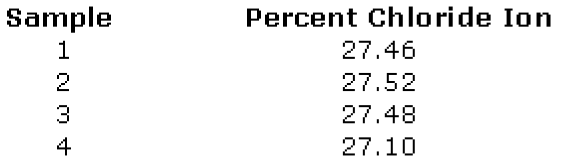
3 of 17

A government chemist has performed a gravimetric analysis for chloride ion on a sample submitted to the laboratory. The following results were obtained:



Sample	Percent Chloride Ion
1	27.46
2	27.52
3	27.48
4	27.10

Given the following data:

Degrees of Freedom	98% Confidence Level
1	31.821
2	6.965
3	4.541
4	3.747
5	3.365

What is the 98% confidence interval for this set of data?

○ (a) 27.39±0.37

○ (b) 27.39±0.52

○ (c) 27.39±0.45

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4 of 17

The following data were collected when performing a spectrophotometric analysis for chromium:

Analysis #	mg Cr/Liter	Absorbance
1	5.23	0.095
2	10.52	0.198
3	15.41	0.295
	?	0.265

Using the least squares method of linear regression, the following equation was determined to define the line generated by plotting concentration *vs.* absorbance:

$$y = 0.0196x - 0.008$$

Which of the following statements is correct?

○ (a) This equation represents the statistical best fit of a line drawn through the data points.

○ (b) The amount of unknown in the sample may be determined by substituting the absorbance value of the unknown for x in the equation and solving for the y value.

○ (c) The value 0.0196 represents the value on the y axis where the line crosses this axis.

---

5 of 17

The following data were collected when performing a spectrophotometric analysis for chromium:

Analysis #	mg Cr/Liter	Absorbance

1	5.23	0.095
2	10.52	0.198
3	15.41	0.295
Unknown	?	0.265

Using the least squares method of linear regression, the following equation was determined to define the line generated by plotting concentration vs. absorbance:

$$y = 0.0196x - 0.008.$$

The concentration of chromium in the sample was found to be

○ (a) 13.11 mg Cr/L.

○ (b) 2.81 mg Cr/L.

○ (c) 13.93 mg Cr/L.

6 of 17

If one has a Gaussian distribution of data points,

○ (a) approximately two thirds of the data points lie above the mean, and one third of the data points lie below the mean accounting for all of the data points.

○ (b) approximately 2/3 of the data points lie within plus or minus two standard deviations of the mean.

○ (c) Approximately 2/3 of the data points lie within plus or minus one standard deviation of the mean.

7 of 17

A Gaussian distribution of data is symmetric if

○ (a) 4.5% of measurements lie outside the range defined by 2 standard deviations above the mean, and two standard deviations below the mean.

○ (b) 4.5% of measurements lie outside the range defined by 2 standard deviations above the mean, and two standard deviations below the mean with 2.25% of the values above 2 standard deviations from the mean and 2.25% of the values below 2 standard deviations from the mean.

○ (c) 68.3% of the measurements lie within plus or minus one standard deviation from the mean.

8 of 17

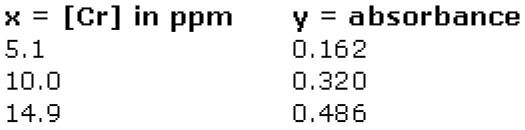
The degrees of freedom used to calculate the confidence interval are

○ (a) the number of data points which are being evaluated.
○ (b) the number of data points - 1.
○ (c) the value associated with the number of data points used to determine the value of *t*.

---

9 of 17

A spectrometer was used to measure the light absorbed by three standard solutions containing different concentrations of $K_2Cr_2O_7$. The following data were obtained:



x = [Cr] in ppm	**y = absorbance**
5.1	0.162
10.0	0.320
14.9	0.486

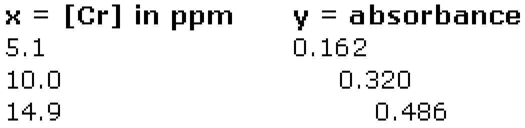
The equation of the straight line generated using the method of least squares is

○ (a) y = 0.0331x - 0.0079
○ (b) y = 30.24x + 0.242
○ (c) y = -0.0079x + 0.0331

---

10 of 17

A spectrometer was used to measure the light absorbed by three standard solutions containing different concentrations of $K_2Cr_2O_7$. The following data was obtained:



x = [Cr] in ppm	**y = absorbance**
5.1	0.162
10.0	0.320
14.9	0.486

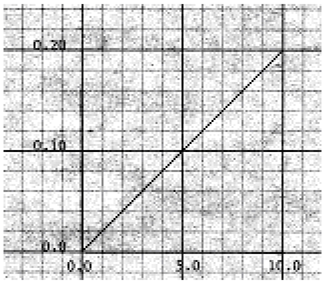
The equation of the straight line generated using the method of least squares is y = 0.0331x - 0.0086. Use this information to find the standard deviation of the slope of the line expressed to the proper number of significant figures.

○ (a) m = 0.033(± 0.0004)
○ (b) m = 0.0331(± 0.0045)
○ (c) m = 0.0331(± 0.0001)

---

11 of 17

The following standardization curve was prepared by plotting light absorbed on the y axis and ppm Cr on the x axis.



You have 100 mL of an unknown sample of solution containing $K_2Cr_2O_7$. You remove 2.00 mL and dilute it to 100 mL with 0.5 M H_2SO_4. You further dilute this mixture, 10 to 100 mL with the same H_2SO_4 solution. The resulting solution had an absorbance of 0.20. How many milligrams of chromium were in your original unknown sample?

○ (a) 100 ppm Cr
○ (b) 5000 mg Cr
○ (c) 500 mg Cr

---

12 of 17

When analyzing the iron content of a well drilled for use in a new housing development, water from the well was analyzed on three different days. The following data were obtained:

Sample	**Number of measurements on the sample**	**Fe content mg/L**
1	3	1.56, 1.45, 1.51
2	3	1.42, 1.39, 1.46
3	3	1.52, 1.29, 1.41

The pooled estimate of the standard deviation of the analysis is

○ (a) 0.14 mg Fe/L.
○ (b) 0.072 mg Fe/L.
○ (c) 0.076 mg Fe/L.

---

13 of 17

Given the following titration data, correctly report the average and standard deviation for the volume of NaOH: (Trial 1) 25.60 mL, (Trial 2) 25.75 mL, and (Trial 3) 25.85 mL.

○ (a) 25.73 ± 0.1 mL
○ (b) 25.7 ± 0.13 mL
○ (c) 25.7 ± 0.1 mL

---

14 of 17

Police have a hit-and-run case and need to identify the brand of red auto paint. What statistical test might they perform?

○ (a) *Q* test
○ (b) *t* test
○ (c) *F* test

---

15 of 17

Police have a hit-and-run case and need to identify the brand of red auto paint. The percentage of iron oxide, which gives paint its red color, found during analysis is as follows: 43.15, 43.81, 45.71, 43.23, 42.99, and 43.56%. What is the average percentage of the iron oxide in the paint sample? (Hint: use a 90% confidence level)

○ (a) 43.35%
○ (b) 43.74%
○ (c) 43.90%

---

16 of 17

Police have a hit-and-run case and need to identify the brand of red auto paint. The percentage of iron oxide, which gives paint its red color, was determined to be $43.3_5 \pm 0.3_3\%$ by one method of analysis using five measurements. The color reference provided by the automotive manufacturer is $44.2_1\%$. What can you conclude about whether the sample matches the reference at a 95% confidence level?

○ (a) The sample matches the reference.
○ (b) The sample does not match the reference.
○ (c) There are an insufficient number of trials to determine if the sample is a match.

---

17 of 17

Police have a hit-and-run case and need to identify the brand of red auto paint. The percentage of iron oxide, which gives paint its red color, was analyzed by two different methods. The results were 43.3 ± 0.3_3% and 43.6 ± 0.1_4% with five measurements each. Are the standard deviations "significantly" different from each other a 95% confidence level?

○ (a) Yes

○ (b) No

○ (c) Possibly

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CHE 311 Class Practice

Answer Sheet: Chapter______05_________

Name____________________________

USM ID__________________________

Date_____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				

Chapter 05-Quality Assurance and Calibration Methods

---

1 of 19

Often the analyst will compare known quantities of analyte to unknown quantities of the material to be analyzed. This may be done in one of three ways: use calibration curves; use standard additions; or use internal standards. The method of standard additions would be used when

○ (a) the standard solutions and the unknown solution all have similar characteristics and are unaffected by the other material in the sample.

○ (b) the quantity of sample analyzed or the instrument response varies from run to run.

○ (c) the sample composition is unknown or complex and affects the analytical signal.

---

2 of 19

Which of the following is true regarding the matrix effect?

○ (a) The matrix effect is normally minimized when a careful calibration curve is prepared.

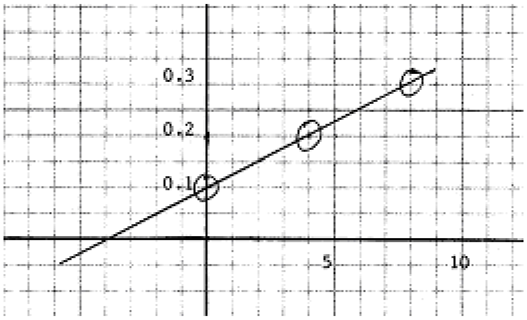
○ (b) The matrix effect is defined as the change in the analytical signal caused by the sample and the analyte.

○ (c) The matrix effect may be minimized by using the method of standard additions.

---

3 of 19

An analysis for iron was done using an atomic absorption spectrophotometer and the method of standard additions. When the concentration of added iron (in ppm) was plotted on the x axis and the light absorbed was plotted on the y axis, the following graph was obtained:



The concentration of iron in the unknown is

○ (a) -4.00 ppm iron

○ (b) 0.100 ppm iron

○ (c) 4.00 ppm iron

---

4 of 19

The content of manganese in steel was found using atomic absorption and the method of standard additions. A standard solution of manganese containing 95.5 ppm Mn was prepared for the analysis. The steel sample was dissolved in dilute nitric acid, placed in a volumetric flask, and diluted to 100.0 mL. When this sample was introduced into the spectrophotometer, the light absorbed was indicated by an absorbance of 0.185. A second sample for analysis was prepared by pipeting 5.00 mL of the standard Mn solution and 50.0 mL of the steel sample into a 100.0 mL volumetric flask and diluting to 100.0 mL. The light absorbed by this sample was indicated by an absorbance of 0.248. Calculate the concentration of manganese in the original 100.0 mL of the dissolved steel.

○ (a) 5.68 ppm Mn
○ (b) 9.55 ppm Mn
○ (c) 140 ppm Mn

---

5 of 19

A solution was prepared by mixing 5.00 mL of an unknown solution containing Fe^{3+} with 5.00 mL of standard $K_2Cr_2O_7$ containing 9.50 ppm Cr and diluting to 50.0 mL. When the absorption by the Cr and Fe present were measured with an atomic absorption instrument, the light absorbed by the Fe was recorded as 1.15 and the Cr was recorded as 0.93. Because the iron was being analyzed by adding an internal standard, a second experiment was required where known quantities of Fe and Cr were analyzed. In this experiment it was found that the ratio of Fe light absorbed to Cr light absorbed was 0.86. The ratio of the Fe concentration to Cr concentration was 1.34. Find the concentration of Fe in the unknown.

○ (a) 18.3 ppm Fe
○ (b) 1.43 ppm Fe
○ (c) 36.6 ppm Fe

---

6 of 19

A solution containing 1-pentanol was sent to the laboratory to be analyzed utilizing a high performance liquid chromatograph. The analyst decided to use the method of internal standards for the analysis, with 1-hexanol as the internal standard. The first solution contained a ratio of 2.54:1 pentanol to hexanol. When the chromatogram was run, the peak area of the pentanol was found to be 4,320, and the peak area of the hexanol was found to be 4,156. When the unknown was run, a solution containing 1.00 mL of the unknown pentanol was mixed with 5.00 mL of 1.42 mM hexanol, and the resulting solution was diluted to 10.0 mL. The area of the pentanol peak was found to be 2,250 and the hexanol 5,450. Calculate the concentration of pentanol in the unknown.

○ (a) 7.16 mM pentanol
○ (b) 1.43 mM pentanol
○ (c) 0.120 mM hexanol

---

7 of 19

Which of the following in untrue regarding a blank solution?

○ (a) Solutions containing known concentrations of analyte are called blank solutions.

○ (b) A solution containing all of the reagents and solvents used in the analysis and not deliberately added analyte is called a blank solution.

○ (c) A blank solution measures the response of the analytical procedure to impurities or interfering species in the reagents.

---

8 of 19

Fractional factorial experimental design and simplex optimization are complex techniques enabling the chemist involved in methods development to

○ (a) statistically determine which method of analysis to select among several approved methods when a specific goal has been specified.

○ (b) optimize the parameters of a method by varying one parameter at a time while keeping everything else constant.

○ (c) efficiently optimize a method by varying more than one parameter at a time.

---

9 of 19

Which of the following is not included in a method validation?

○ (a) linearity
○ (b) chain of custody
○ (c) robustness

---

10 of 19

When method validation is considered, linearity measures how well a graph of analytical response versus concentration of analyte follows a straight line. Which of the following is not a measure of linearity?

○ (a) the square of the correlation coefficient

○ (b) the correlation coefficient

○ (c) The vertical deviations of the data points from the least-squares line

---

11 of 19

Which of the following responses best illustrates ways to demonstrate the accuracy of a method?

○ (a) Analyze a standard reference material, compare results from two or more different analytical methods, analyze a spiked sample, or add standard additions of analyte to an unknown.

○ (b) Analyze a standard reference material or compare results from two or more different analytical methods.

○ (c) Analyze a standard reference material, compare results from two or more different analytical methods, or analyze a spiked sample.

---

12 of 19

The minimum detectable concentration may be found by

○ (a) multiplying the student t value for at least 6 degrees of freedom times the standard deviation of at least 7 measurements of a sample whose concentration is 1 to 5 times the detection limit, and dividing by the mean value of the measurement of the sample minus the mean value of the measurement of the blank.

○ (b) adding the mean value of the measurement of the blank to the product of the student t value with at least 6 degrees of freedom and the standard deviation of the measurements of the sample.

○ (c) multiplying the student t value for at least 6 degrees of freedom times the standard deviation of at least 7 measurements of a sample whose concentration is 1 to 5 times the detection limit.

---

13 of 19

The term robustness refers to

○ (a) the ability of an analytical method to be unaffected by small, deliberate changes in operating parameters.

○ (b) the changes in the instrument detection limit as the operating parameters of the instrument are adjusted to optimize the sensitivity of the measurements.

○ (c) linearity of the data obtained from a series of measurements taken by an instrument when multiple samples are analyzed.

---

14 of 19

A chemist is involved in checking the results that were obtained in a routine analysis of magnesium. The chemist decided to purchase a certified standard. This standard would be purchased from the

○ (a) EPA, the Environmental Protection Agency.

○ (b) NIST, the National Institute of Standards and Technology.

○ (c) NBS, the National Bureau of Standards.

---

15 of 19

Which of the following is true regarding a blank used in an analytical analysis?

○ (a) A method blank is a sample containing all components except the analyte and is taken through all steps of the analytical procedure.

○ (b) A field blank is a sample containing all components except the analyte and is taken through all steps of the analytical procedure.

○ (c) A reagent blank is the same as a method blank; that is, it has been taken through all of the steps of the analytical procedure.

---

16 of 19

You have taken several sediment samples from the bottom of the Great Lakes and wish to analyze the material for the presence of polycyclic aromatic hydrocarbons, a class of compounds with many Environmental Protection Agency (EPA) priority pollutants. Which calibration method is most appropriate for the analysis?

○ (a) method of standard addition

○ (b) method of calibration curve

○ (c) method of internal standard

---

17 of 19

A solution containing 0.0837 M of X and 0.0660 M of S (standard) gave peak areas of 423 and 347, respectively. To analyze the unknown, 10.00 mL of 0.146 M S were added to 10.00 mL X, and the mixture was diluted to 25.00 mL. This mixture gave a chromatogram with peak areas of A_X = 553 and A_S = 582. What is the concentration of X in the unknown?

○ (a) 0.144 molar

○ (b) 0.0578 molar

○ (c) 0.0584 molar

18 of 19

Which statement is correct?

○ (a) An internal standard is the same substance as the analyte.

○ (b) An internal standard is the same substance as the analyte matrix.

○ (c) An internal standard is a different substance from the analyte.

19 of 19

Performance test samples (also called quality control samples or blind samples) are

○ (a) samples of known composition that are provided to the analyst as unknowns. Results are then compared with the known values, usually by a quality assurance manager.

○ (b) samples of unknown composition that are provided to the analyst as knowns. Results are then compared with the known values, usually by a quality assurance manager.

○ (c) samples of known composition that are provided to the analyst as unknowns. Results are then compared with the known values, usually by the analyst.

Department of Chemistry and Biochemistry

CHE 311/311L Analytical Chemistry

Class Practice –Chapters 8

Key:

Question #	Key	
1	c	Q4: $A = kC$, $0.185 = kC$; $0.248 = k[(5.00\text{x}95.5+50.0C)/100]$ $C = 5.68$ ppm. Q5: $1.15 = k1(5.00x/50)$; $0.93 = k2(5.00\bullet 9.50/50)$; $0.86 = k1/k2\bullet 1.34$; $x = 18.3$ ppm Q6: peak area = k[C] Q12: $y_{dl} = y_{blank} + 3s$, *s calculated from n>=7*
2	c	
3	c	
4	a	
5	a	
6	a	
7	a	
8	a	
9	b	
10	c	
11	a	
12	b	
13	a	
14	b	
15	c	
16	a	
17	a	
18	a	
19	a	

Department of Chemistry and Biochemistry
University of Southern Mississippi
CHE 311 Class Practice

Answer Sheet: Chapter_____06__________

Name____________________________

USM ID__________________________

Date_____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				

Chapter 06-Chemical Equilibrium

---

1 of 18

The mathematical equation which represents the solubility product when the insoluble compound Mn_2S_3 is dissolved in water is

○ (a) $[Mn^{3+}][S^{2-}] = K_{sp}$.

○ (b) $[Mn^{3+}]^3[S^{2-}]^2 = K_{sp}$.

○ (c) $[Mn^{3+}]^2[S^{2-}]^3 = K_{sp}$.

---

2 of 18

Given that the solubility product for $La(IO_3)_3$ is 1.0×10^{-11}, what is the concentration of La^{3+} in a saturated solution of lanthanum iodate?

○ (a) 7.8×10^{-4} molar

○ (b) 0.44×10^{-3} molar

○ (c) 7.2×10^{-5} molar

---

3 of 18

If a 0.100 M solution of NaOH is added to a solution containing 0.200 M Ni^{2+}, 0.200 M Ce^{3+}, and 0.200 M Cu^{2+}, which metal hydroxide will precipitate first? K_{sp} for $Ni(OH)_2 = 6.0 \text{ X } 10^{-16}$, K_{sp} for $Ce(OH)_3 = 6.0 \text{ X } 10^{-22}$, and K_{sp} for $Cu(OH)_2 = 4.8 \times 10^{-20}$.

○ (a) $Ni(OH)_2$

○ (b) $Ce(OH)_3$

○ (c) $Cu(OH)_2$

---

4 of 18

What is the lead concentration of a saturated solution of lead(II) sulfate containing 0.020 molar Na_2SO_4? K_{sp} for $PbSO_4 = 6.3 \times 10^{-7}$.

○ (a) 7.9×10^{-4} molar

○ (b) 5.6×10^{-3} molar

○ (c) 3.2×10^{-5} molar

---

5 of 18

A beaker contains 250.0 mL of 0.150 molar silver ion (Ag^+). To this beaker is added 250.0 mL of 0.300 M bromide ion (Br^-). What is the concentration of Ag^+ in the final solution? K_{sp} for AgBr = 5.0×10^{-13}.

○ (a) 7.1×10^{-7} molar
○ (b) 6.7×10^{-12} molar
○ (c) 3.3×10^{-12} molar

---

6 of 18

In the following reaction, identify the conjugate acid-base pair:$NO_2^- + H_2O \rightleftharpoons HNO_2 + OH^-$.

○ (a) NO_2^-, OH^-
○ (b) NO_2^-, H_2O
○ (c) NO_2^-, HNO_2

---

7 of 18

A solution was found to contain 8.26×10^{-4} M NaOH. Calculate the pH of the solution.

○ (a) 3.08
○ (b) 10.9
○ (c) 1.00

---

8 of 18

Calculate the hydrogen ion concentration of a 0.100 molar solution of chloroacetic acid ($ClCH_2CO_2H$). K_a for chloroacetic acid = 1.36×10^{-3}.

○ (a) 0.0117 molar
○ (b) 0.0369 molar
○ (c) 7.39×10^{-12} molar

---

9 of 18

Calculate the hydrogen ion concentration of a 0.100 M solution of methyl amine (CH_3NH_2). K_a for methyl amine hydrochloride = 2.3×10^{-11}.

○ (a) 1.5×10^{-6} molar

○ (b) 6.6×10^{-3} molar

○ (c) 1.5×10^{-12} molar

---

10 of 18

Calculate the pH of a 0.100 molar solution of sodium chloroacetate. K_a for chloroacetic acid ($ClCH_2CO_2H$) = 1.4×10^{-3}.

○ (a) 1.17×10^{-8}

○ (b) 7.93

○ (c) 1.93

---

11 of 18

Calculate the pH of a 0.050 M solution of iodic acid. K_a for iodic acid = 0.17.

○ (a) 1.39

○ (b) 1.03

○ (c) 1.30

---

12 of 18

A 0.100 M solution of nitrous acid (HNO_2) had a pH of 2.07. What is the K_a value for nitrous acid?

○ (a) 7.2×10^{-4}

○ (b) 7.2×10^{-5}

○ (c) 8.5×10^{-2}

---

13 of 18

Find the concentration of phenol and phenolate ion in a 0.0100 M solution of phenol. K_a for phenol = 1.05×10^{-10}.

○ (a) 1.02×10^{-6} molar phenol and 1.02×10^{-6} molar phenolate ion

○ (b) 1.02×10^{-6} molar phenol and 1.00×10^{-2} molar phenolate ion

○ (c) 1.00×10^{-2} molar phenol and 1.02×10^{-6} M phenolate ion

---

14 of 18

Which is the strongest base?

○ (a) HCl

○ (b) CH_3NH_2

○ (c) RbOH

---

15 of 18

Which of these statements concerning the solubility is correct?

○ (a) A salt is less soluble if one of its ions is already present in solution.

○ (b) A salt is no more soluble if one of its ions is already present in solution.

○ (c) A salt is more soluble if one of its ions is already present in solution.

---

16 of 18

What is the solubility of the mineral hydroxyapatite found in tooth enamel, if the ionic composition is $Ca_5(PO_4)_3OH$ ($K_{sp} = 2.34 \times 10^{-59}$)?

○ (a) 3.06×10^{-7} molar

○ (b) 8.67×10^{-8} molar

○ (c) 4.34×10^{-7} molar

---

17 of 18

What is the calcium concentration in the mineral hydroxyapatite found in tooth enamel if the ionic composition is $Ca_5(PO_4)_3OH$ ($K_{sp} = 2.34 \times 10^{-59}$)?

○ (a) 1.53×10^{-6} molar

○ (b) 8.67×10^{-8} molar

○ (c) 4.34 x 10^{-7} molar

---

18 of 18

What concentration of carbonate must be added to 0.10 M Ag^+ to precipitate 99.99% of the Ag^+ (K_{sp} Ag_2CO_3 = 8.1 x 10^{-12})?

○ (a) 8.1 x 10^{-2} M

○ (b) 8.1 x 10^{-7} M

○ (c) 8.1 x 10^{-10}M

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University of Southern Mississippi
CHE 311 Class Practice

Answer Sheet: Chapter_______07________

Name____________________________

USM ID__________________________

Date_____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 07-Activity and the Systematic Treatment Of Equilibrium

---

1 of 23

Chloride concentration in aqueous samples can be determined by adding silver nitrate to the solution to precipitate AgCl as a colloid. Nitric acid is added to the solution to encourage coagulation of the colloid for filtration. If too much nitric acid is added to the solution, the solubility of the AgCl begins to increase. How can this be explained?

○ (a) Hydrogen and nitrate ions enter the counter ion layer surrounding the colloid causing the counter ion layer to shrink, and the colloidal particles to coagulate. As the colloid coagulates, more AgCl dissolves.

○ (b) The greater the ionic strength of a solution, the higher the charge in the ionic atmosphere. Each ion-plus-atmosphere contains less net charge, so there is more attraction between any particular cation and anion.

○ (c) An ionic atmosphere surrounds ions in solution. The charge of the atmosphere is less than the charge of the central ion. The greater the ionic strength of the solution the greater the charge in the ionic atmospheres and the less attraction the ions have for one another.

---

2 of 23

An activity coefficient

○ (a) measures the deviation of behavior of ions from ideality.

○ (b) is obtained by multiplying the concentration of a solution times the ionic strength.

○ (c) replaces the concentration term in chemical calculations. It corrects for the ionic strength of the solution.

---

3 of 23

The Debye-Hückel equation is $\log \gamma = (-0.51z^2\sqrt{\mu})/[1 + (\alpha\sqrt{\mu}/305)]$. Which of the following statements is true?

○ (a) As the ionic strength increases, the activity coefficient increases.

○ (b) As the charge of the ion increases, the departure of its activity coefficient from unity decreases.

○ (c) The smaller the hydrated radius of the ion, the more important activity effects become.

---

4 of 23

A solution contains 0.100 M sodium nitrate ($NaNO_3$) and 0.200 M $MgCl_2$. Find the ionic strength of the solution.

○ (a) μ = 0.700 molar
○ (b) μ = 0.600 molar
○ (c) μ = 0.500 molar

---

5 of 23

Using Equation 7-7 and Table 7-1 in your text, calculate the activity coefficient for Ca in a 0.01 M solution of $Ca(ClO_4)_2$.

○ (a) 0.580
○ (b) 0.675
○ (c) 0.485

---

6 of 23

Calculate the solubility of silver bromate ($AgBrO_3$), using activities, in a saturated solution of silver bromate. K_{sp} for $Ag(BrO_3) = 5.5 \times 10^{-5}$.

○ (a) 7.4×10^{-3} molar
○ (b) 8.1×10^{-3} molar
○ (c) 7.8×10^{-3} molar

---

7 of 23

What is the pH of water containing 0.0333 M $Ca(NO_3)_2$.

○ (a) 7.00
○ (b) 6.98
○ (c) 7.02

---

8 of 23

At very low concentrations the activity coefficients approach 1. Ignoring activity coefficients, calculate the solubility of $Co(OH)_3$ in a saturated solution of $Co(OH)_3$. K_{sp} for cobalt(III) hydroxide = 3×10^{-45}.

○ (a) 3×10^{-12} molar

○ (b) 3 x 10^{-38}molar
○ (c) 3 x 10^{-24} molar

---

9 of 23

Magnesium carbonate is slightly soluble in water. The K_{sp} for $MgCO_3$ is 3.5 X 10^{-8}. The carbonate ion being a conjugate base may form the bicarbonate ion (HCO_3^-) and carbonic acid (H_2CO_3) in solution. Which of the following represents the correct mass balance equation at a pH of 7.5 for this system?

○ (a) $2[Mg^{2+}] = 2[CO_3^{2-}] + [HCO_3^-] + [H_2CO_3]$
○ (b) $[Mg^{2+}] = [CO_3^{2-}] + [HCO_3^-] + [H_2CO_3]$
○ (c) $[Mg^{2+}] = [CO_3^{2-}] + [HCO_3^-]$

---

10 of 23

If one were to calculate the solubility of AgCN in an aqueous solution, one would take into account the solubility product equation for AgCN ($K_{sp} = 2.2 \times 10^{-16} = [Ag^+][CN^-]$) and the acid dissociation constant for hydrocyanic acid ($K_a = [H^+][CN^-]/[HCN] = 6.2 \times 10^{-10}$), as well as the mass balance equation ($[Ag^+] = [CN^-] + [HCN]$). If the solution were held at a pH of 5.0 the solubility of AgCN would be

○ (a) 3.55 x 10^{-12} molar.
○ (b) 1.48 x 10^{-8} molar.
○ (c) 1.88 x 10^{-6} molar.

---

11 of 23

Given the chemical equilibrium $HC_2H_3O_2 + H_2O \rightleftharpoons C_2H_3O_2^- + H_3O^+$, which of the following best represents the mathematical expression of this equilibrium.

○ (a) $[H_3O^+][C_2H_3O_2^-]/HC_2H_3O_2 = K_a$
○ (b) $[H_3O^+]\ \gamma H_3O^+\ [C_2H_3O_2^-]\ \gamma C_2H_3O_2^-/HC_2H_3O_2\ \gamma HC_2H_3O_2 = K_a$
○ (c) $[H_3O^+][C_2H_3O_2^-]/HC_2H_3O_2 = K_a\ \gamma_a$

---

12 of 23

Silver arsenate (Ag_3AsO_4) is only slightly soluble in water. The compound arsenic acid (H_3AsO_4) behaves in much the same manner as phosphoric acid. Which of the following represent a mass balance equation for the solution at pH 8.0?

○ (a) $[Ag^+]/3 = [AsO_4^{3-}] + [HAsO_4^{2-}] + [H_2AsO_4^-] + [H_3AsO_4]$

○ (b) $[Ag^+] = [AsO_4^{3-}] + [HAsO_4^{2-}] + [H_2AsO_4^-] + [H_3AsO_4]$

○ (c) $[Ag^+] + [H^+] = 3[AsO_4^{3-}] + 2[HAsO_4^{2-}] + [H_2AsO_4^-] + [H_3AsO_4] + [OH^-]$

---

13 of 23

A solution contains a 0.100 M $Al(NO_3)_3$ and 0.100 M $MgCl_2$. Which of the following represents the correct charge balance equation for this system?

○ (a) $3[Al^{3+}] + 2[Mg^{2+}] = [NO_3^-] + [Cl^-]$

○ (b) $[Al^{3+}] + [Mg^{2+}] + [H^+] = 3[NO_3^-] + 2[Cl^-] + [OH^-]$

○ (c) $3[Al^{3+}] + 2[Mg^{2+}] + [H^+] = [NO_3^-] + [Cl^-] + [OH^-]$

---

14 of 23

Which of the following equations represents a charge balance equation for a saturated solution of Ag_3AsO_4?

○ (a) $[Ag^+] + [H^+] = 3[AsO_4^{3-}] + 2[HAsO_4^{2-}] + [H_2AsO_4^-] + [OH^-]$

○ (b) $[Ag^+] + [H^+] = 3[AsO_4^{3-}] + 2[HAsO_4^{2-}] + [H_2AsO_4^-] + [H_3AsO_4] + [OH^-]$

○ (c) $[Ag^+]/3 = [AsO_4^{3-}] + [HAsO_4^{2-}] + [H_2AsO_4^-] + [H_3AsO_4]$

---

15 of 23

One of the most popular questions ever created for chemistry exams involved calculating the pH of a 1.0×10^{-8} M solution of hydrochloric acid. So here it is for you. What is the correct answer?

○ (a) 8.00

○ (b) 6.00

○ (c) 6.99

---

16 of 23

Magnesium carbonate is slightly soluble in water. The K_{sp} for $MgCO_3$ is 3.5 x 10^{-8}. The carbonate ion being a conjugate base may form the bicarbonate ion (HCO_3^-) and carbonic acid (H_2CO_3) in solution. K_{a1} and K_{a2} for carbonic acid are 4.46 x 10^{-7} and 4.69 x 10^{-11}, respectively. What is the solubility of $MgCO_3$ in a solution that has at least a pH of 7.5?

○ (a) 2.53 x 10^{-5} molar
○ (b) 5.03 x 10^{-3} molar
○ (c) 1.87 x 10^{-4} molar

17 of 23

Hydrosulfuric acid $H_2S_{(aq)}$ was used for years in chemistry laboratories to precipitate metal sulfides from solution. The H_2S dissociates in two steps to form the S^{2-} ion that then reacts with the metal ion in solution. By controlling the hydrogen ion concentration, the amount of sulfide in the solution can be controlled, and thus, very insoluble metal sulfides may be precipitated while other metals remain in solution. Given that for H_2S_{aq} K_{a1} = 9.5 x 10^{-8}, K_{a2} = 1.3 x 10^{-14}, K_{sp} for MnS = 3.0 x 10^{-11}, and that a saturated solution of H_2S is approximately 0.100 M, calculate the hydrogen ion concentration required to prevent the precipitation of MnS.

○ (a) 4.75 x 10^{-9} molar
○ (b) 2.36 x 10^{-9} molar
○ (c) 2.11 x 10^{-6} molar

18 of 23

Aqueous H_2S dissociates in two steps to form hydrogen ion (H^+) and sulfide ion (S^{2-}). Given that a saturated solution of H_2S is approximately 0.100 M and K_{a1} and K_{a2} for H_2S are 9.5 x 10^{-8} and 1.3 x 10^{-14}, respectively, calculate the hydrogen ion concentration of a saturated solution of H_2S.

○ (a) 3.14 x 10^{-8} molar hydrogen ion
○ (b) 9.75 x 10^{-5} molar hydrogen ion
○ (c) 4.99 x 10^{-8} molar hydrogen ion

19 of 23

Using equation 7-6 and Table 7-1 in your text, calculate the activity coefficient for Ca in a 0.01 M solution of $Ca(ClO_4)_2$.

○ (a) 0.545
○ (b) 0.675

○ (c) 0.485

---

20 of 23

Neglecting activity coefficients and assuming complete dissociation, calculate the pH of a 4.0×10^{-8} M $Ca(OH)_2$ solution.

○ (a) 6.60
○ (b) 7.40
○ (c) 7.17

---

21 of 23

Using the equilibria below, what is the $[H_3AsO_4]$ equal to in terms of $[AsO_4^{3-}]$?

$Ag_3AsO_4\ (s) \rightleftharpoons 3Ag^+ + AsO_4{}^{3-}$ $K_{sp} = 1.03 \times 10^{-22}$
$H_3AsO_4 \rightleftharpoons H^+ + H_2AsO_4-$ $K_{a1} = 5.8 \times 10^{-3}$
$H_2AsO_4^- \rightleftharpoons H^+ + HAsO_4^{2-}$ $K_{a2} = 1.10 \times 10^{-7}$
$HAsO_4^{2-} \rightleftharpoons\ ;\ H^+ + AsO_4^{3-}$ $K_{a3} = 3.2 \times 10^{-12}$

○ (a) $[H_3AsO_4] = ([H_2AsO_4^-][H^+])/K_{a1}$
○ (b) $[H_3AsO_4] = ([AsO_4^{3-}][H^+]^3)/K_{a3}\ K_{a2}\ K_{a1}$
○ (c) $[H_3AsO_4] = K_{a3}\ K_{a2}\ K_{a1}/([AsO_4^{3-}][H^+]^3)$

---

22 of 23

Assuming compete dissociation of the salts, what is the ionic strength of 2×10^{-4} M $MgCl_2$ and 3×10^{-4} M $AlCl_3$?

○ (a) 1.3×10^{-3}
○ (b) $4.0 \text{ X } 10^{-3}$
○ (c) 2.4×10^{-3}

---

23 of 23

Using the equilibria below, calculate the solubility of PbS in a solution with a pH = 3.00?

$PbS\ (s) \rightleftharpoons Pb^{2+} + S^{2-}$ $K_{sp} = 3.0 \times 10^{-28}$

$H_2S \rightleftharpoons H^+ + HS^-$ $K_{a1} = 9.5 \times 10^{-8}$

$HS^- \rightleftharpoons H^+ + S^{2-}$ $K_{a2} = 1.3 \text{ X } 10^{-14}$

○ (a) 4.9×10^{-7} molar
○ (b) 1.7×10^{-14} molar
○ (c) 5.7×10^{-10} molar

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CHE 311 Class Practice

Answer Sheet: Chapter_____08__________

Name___________________________

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Date____________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 08-Monoprotic Acid-Base Equalibria

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1 of 16

Which of the following pairs of compounds and ions could be used to form a buffer solution?

○ (a) 0.10 M HCl and 0.10 M NaCl
○ (b) 0.10 M NH_4Cl and 0.10 M NH_3
○ (c) 0.10 M HNO_2 and 1.0 x 10^{-4} M $NaNO_2$

---

2 of 16

Which of the combination of ions and molecules may produce a buffer solution in an aqueous environment?

○ (a) 50.00 mL of 0.100 M NaOH and 50.00 mL of 0.100 M CH_3COOH
○ (b) 50.00 mL of 0.100 M HNO_3 and 50.00 mL of 0.100 M CH_3COOH
○ (c) 50.0 mL of 0.050 M HNO_3 and 50.0 mL of 0.100 M CH_3COONa

---

3 of 16

Calculate the ratio of ethyl amine ($CH_3CH_2NH_2$) to the ethyl ammonium ion ($CH_3CH_2NH_3^+$) in a solution with a pH of 11.0. pK_a for $CH_3CH_2NH_3^+$ = 10.636.

○ (a) 2.31
○ (b) 10.81
○ (c) 0.432

---

4 of 16

A buffer solution was prepared by mixing 50.0 mL of a 0.100 M solution of CH_3COOH with 0.500 grams of $NaCH_3COO$. The resulting mixture is diluted to 100.0 mL. What is the pH of the solution? K_a for acetic acid is 1.8 x 10^{-5}.

○ (a) 4.53
○ (b) 7.6
○ (c) 5.83

---

5 of 16

How many grams of $NaCH_3COO$ must be added to 150.0 mL of a 0.150 M solution of CH_3COOH to produce a buffer of pH 4.75? Assume that the volume will remain constant, pK_a for CH_3COOH = 4.757

○ (a) 0.147 molar

○ (b) 12.1 grams

○ (c) 1.81 grams

---

6 of 16

A buffer solution was prepared by dissolving 5.00 grams of sodium propanate ($NaCH_3CH_2CO_2$) in a solution containing 0.100 moles of propanoic acid ($CH_3CH_2CO_2H$) and diluting the mixture to 500.0 mL. To this solution was added 5.00 mL of 1.00 M HCl. Calculate the pH of the resulting solution. pK_a for propanoic acid is 4.874.

○ (a) 4.65

○ (b) 4.62

○ (c) 4.52

---

7 of 16

A beaker containing 500.0 mL was determined to contain 0.150 M ammonia (NH_3) and 0.150 M ammonium chloride NH_4Cl. To this solution was added 50.0 mL of 0.150 M HCl. What was the change in pH of the ammonia-ammonium ion solution? pK_a for NH_4^+ = 9.244.

○ (a) The pH of the solution will go down 0.087 pH units.

○ (b) The pH of the solution will go up 0.13 pH units.

○ (c) The pH of the solution will go up 0.087 pH units.

---

8 of 16

How many mL of 0.100 M HCl should be added to 500.0 mL of 0.150 M sodium acetate ($NaCH_3CO_2$) to produce a buffer pH 5.000? pK_a acetic acid = 4.757.

○ (a) 273 mL

○ (b) 1000 mL

○ (c) 476 mL

9 of 16

Using the acid dissociation constant table in your textbook, which buffer system will give the greatest buffer capacity at pH 5.0?

○ (a) chlorous acid/chlorite ion

○ (b) hydrogen cyanide/cyanide ion

○ (c) propanoic acid/propanate ion

---

10 of 16

An indicator may be selected for an acid-base application based on the pH range where the indicator changes color. A chemist wanted an indicator to change color between pH 5.8 and 6.1. The following compounds were available for selection: In_a $K_a = 1.5 \text{ X } 10^{-3}$, In_b $K_a = 1.3 \text{ X } 10^{-6}$, and In_c $K_a = 1.8 \text{ X } 10^{-8}$. Which would be the proper indicator to select?

○ (a) In_a

○ (b) In_b

○ (c) In_c

---

11 of 16

How many grams of NaOH must be added to 1.50 L of a 0.400 M solution of oxoacetic acid ($HCOCO_2H$) to produce a buffer pH 4.00? pK_a for oxoacetic acid = 3.46.

○ (a) 18.7 grams

○ (b) 0.470 grams

○ (c) 5.33 grams

---

12 of 16

What is the K_a of 0.0450 M HA, if the measured pH is 5.78?

○ (a) 6.1×10^{-11}molar

○ (b) 1.7×10^{-6} molar

○ (c) 3.7×10^{-5} molar

---

13 of 16

If one measures the equilibrium constant for each of the following solutions, which relationship is correct?

A - mix $CH_2CH_2CH_2CH_2COOH$ with $CH_2CH_2CH_2NH_2$
B - mix HNO_3 with CsOH
C - mix KOH with HCOOH

○ (a) *K* for A > *K* for B > *K* for C
○ (b) *K* for C > *K* for A > *K* for B
○ (c) *K* for B > *K* for C > *K* for A

---

14 of 16

Calculate the pH of a solution prepared by dissolving 0.0775 mol acetic acid (HCOOH) and 0.0460 mol sodium acetate (HCOONa) in 1 L of water. The K_a of acetic acid is 1.77×10^{-4}.

○ (a) 3.107
○ (b) 3.525
○ (c) 3.752

---

15 of 16

A solution prepared by dissolving 0.0775 mol acetic acid (HCOOH) and 0.0460 mol sodium acetate (HCOONa) in 1 L of water. What is the pH if 0.0100 mol of KOH is added to the solution. The K_a of acetic acid is 1.77×10^{-4}.

○ (a) 3.107
○ (b) 3.525
○ (c) 3.671

---

16 of 16

What weight of sodium lactate ($CH_3CHOHCOONa$; MW = 112.05) must be added to 500 mL of 0.200 M lactic acid ($CH_3CHOHCOOH$, MW= 90.07; $K_a = 1.4 \times 10^{-4}$) in order to produce a buffered solution with a pH = 4.50?

○ (a) 4.03 grams
○ (b) 50.09 grams
○ (c) 0.893 grams

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Answer Sheet: Chapter_______09________

Name____________________________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 09-Polyprotic Acid-Base Equalibria

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1 of 15

Using the symbol H_2M to represent maleic acid, what is the pH and M^{2-} concentration of a solution containing 0.100 M H_2M? For maleic acid pK_1 = 1.91 and pK_2 = 6.33.

○ (a) pH = 1.54 and $[M^{2-}] = 3.51 \times 10^{-2}$ molar

○ (b) pH = 1.54 and $[M^{2-}] = 4.68 \times 10^{-7}$ molar

○ (c) pH = 3.89 and $[M^{2-}] = 1.29 \times 10^{-4}$ molar

---

2 of 15

The amino acid glycine (H_2NCH_2COOH) has two equilibrium constants, one for the –COOH group, and one for the $–NH_3$ group. pK_a for –COOH = 2.350 and pK_a for $–NH_3$ = 9.778. At pH 6.06, which compounds or ions predominate in solution?

○ (a) A mixture of H_3NCH_2COOH and $H_3NCH_2COO^-$

○ (b) A mixture of $H_3NCH_2COO^-$ and $H_2NCH_2COO^{2-}$

○ (c) $H_3NCH_2COO^-$ only

---

3 of 15

A 0.200 M solution of HCl is added to a solution containing 0.150 moles of sodium phosphate (Na_3PO_4). The resulting solution is then diluted to exactly 1.00 L, at which time the pH was found to be pH 8.00. What is the concentration of $H_2PO_4^-$ in the solution? For phosphoric acid, $K_{a1} = 7.11 \times 10^{-3}$, $K_{a2} = 6.32 \times 10^{-8}$, and $K_{a3} = 7.1 \text{ X } 10^{-13}$.

○ (a) 0.0205 molar

○ (b) 0.150 molar

○ (c) 0.0750 molar

---

4 of 15

Sulfurous acid (H_2SO_3) has pK_{a1} = 1.91 and pK_{a2} = 7.18. At what pH does $[HSO_3^-] = [SO_3^{2-}]$?

○ (a) 1.91

○ (b) 4.54

○ (c) 7.18

---

5 of 15

Find the fraction of association of a 0.100 molar solution of hydrazoic acid. K_a for hydrazoic acid = 2.20 x 10^{-5}.

○ (a) 98.6%

○ (b) 1.45%

○ (c) 0.40%

---

6 of 15

Which of the following statements is true regarding the isoionic point and the isoelectric point?

○ (a) The isoionic point and the isoelectric point are the same thing.

○ (b) At the isoelectric point only the ions H_2A^+, A^-, H^+, and OH^- are present and the concentrations of H_2A^+ and A^- are not equal to each other.

○ (c) At the isoelectric point, the average charge of the polyprotic acid is 0, and the concentration of H_2A^+ is equal to the concentration of A^-.

---

7 of 15

How many grams of NaH_2PO_4 would be added to 5.60 grams of Na_3PO_4 to produce 500.0 mL of a buffer at pH = 7.3? For H_3PO_4 pK_{a1} = 2.148, pK_{a2} = 7.199, and pK_{a3} = 12.15.

○ (a) 7.36 g NaH_2PO_4.

○ (b) 1.63 g NaH_2PO_4.

○ (c) 5.73 g NaH_2PO_4.

---

8 of 15

How many mL of 12.0 M HCl would be added to 500.0 mL of 0.100 M Na_2SO_3 to produce a buffer with a pH of 7.50? Assume no volume change. For H_2SO_3 K_{a1} = 1.23 x 10^{-2} and K_{a2} = 6.6 x 10^{-8}.

○ (a) 1.36 mL HCl

○ (b) 2.81 mL HCl

○ (c) 4.17 mL HCl

---

9 of 15

What is the pH of a 0.100 M solution of potassium hydrogen phthalate, $KHC_8H_4O_2$? For phthalic acid, $pK_{a1} = 2.950$ and $pK_{a2} = 5.408$.

○ (a) 1.98

○ (b) 3.20

○ (c) 4.18

---

10 of 15

Given a 0.100 M solution of the hypothetical diprotic acid H_2M, calculate the fraction of species in the form H_2M (α_{H2M}). For H_2M, $K_{a1} = 1.0 \times 10^{-4}$ and $K_{a2} = 1.0 \times 10^{-7}$.

○ (a) 3.12%

○ (b) 96.88%

○ (c) 0.00%

---

11 of 15

How many mL of 12.0 M HCl should be added to 500.0 mL of 0.100 M Na_2SO_3 ($K_{b2} = 8.13 \times 10^{-13}$ and $K_{b1} = 1.5 \times 10^{-7}$) to produce a buffer at pH of 7.00? Assume no volume change.

○ (a) 2.51 mL

○ (b) 3.39×10^{-5} mL

○ (c) 8.11 mL

---

12 of 15

Given the hypothetical acid H_4A^{2+}, what species determines the isoionic pH?

○ (a) H_4A^{2+}

○ (b) A^{2-}

○ (c) H_2A

---

13 of 15

Given the hypothetical acid H_4A^{2+} (pK_{a1} = 1.4, pK_{a2} = 3.44, pK_{a3} = 6.01, and pK_{a4} = 8.45), what is the principle species in solution at pH = 9.00?

○ (a) H_3A^+
○ (b) A^{2-}
○ (c) H_2A

---

14 of 15

Given the hypothetical acid H_4A^{2+}, the concentration of which species are equal at the isoelectric pH?

○ (a) $[H_4A^{2+}] = [H_3A^+]$
○ (b) $[H_3A^+] = [HA^-]$
○ (c) $[H_2A] = [HA^-]$

---

15 of 15

Calculate the pH for 0.200 M KHA (K_{a1} = 1.00 x 10^{-5} and K_{a2} = 1.00 x 10^{-9}).

○ (a) 2.849
○ (b) 11.151
○ (c) 7.000

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Answer Sheet: Chapter______10__________

Name_____________________________

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A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 10-Acid-Base Titrations

---

1 of 21

A solution containing 75.0 mL of 0.150 M HCl is titrated with 75.0 mL of 0.300 M NaOH. What is the pH of the resulting solution?

○ (a) 7.00

○ (b) 13.20

○ (c) 12.90

---

2 of 21

Consider the titration of 25.0 mL of 0.150 M HBr with 0.0750 M NaOH. What is the volume of NaOH required to reach the equivalence point?

○ (a) 25.0 mL

○ (b) 50.0 mL

○ (c) 12.5 mL

---

3 of 21

A solution containing 50.0 mL of 0.1500 M C_2H_3COOH is titrated with 0.1500 M NaOH. What is the pH of the solution after the addition of 25.0 mL of NaOH? pK_a for C_2H_3COOH is 4.76.

○ (a) 4.76

○ (b) 9.24

○ (c) 1.30

---

4 of 21

When an ant bites you, the reason it stings is because of an injection of formic acid. What is the pH when 50.0 mL of 0.1480 M formic acid (HCOOH) is titrated with 40.2 mL of 0.1841 M NaOH? pK_a formic acid = 3.745.

○ (a) 10.040

○ (b) 4.201

○ (c) 3.96

---

5 of 21

In a titration, 48.6 mL of 0.1280 M KOH is added to 45.0 mL of 0.1200 M hydroxyacetic ($HOCH_2CO_2H$) acid. Calculate the pH of the solution. pK_a for $HOCH_2CO_2H$ = 3.831.

○ (a) 2.06
○ (b) 2.38
○ (c) 11.94

---

6 of 21

In a titration, 25.0 mL of 0.154 M HNO_3 was added to 45.0 mL of 0.213 M ammonia (NH_3). What is the pH at this point? pK_a NH_4^+ = 9.245.

○ (a) 9.42
○ (b) 4.58
○ (c) 9.07

---

7 of 21

The weak base trimethyl amine, $(CH_3)_3N$, was titrated with HCl. If 25.30 mL of 0.150 M HCl was added to 35.15 mL of 0.108 M trimethyl amine, what is the pH of the solution? pK_a for $(CH_3)_3NH^+$ = 9.80.

○ (a) 6.30
○ (b) 2.70
○ (c) 8.50

---

8 of 21

A titration was performed by adding 35.85 mL of 0.1350 M HNO_3 to 55.80 mL of 0.08673 M KOH. What is the pH of the solution?

○ (a) 1.28
○ (b) 7.00
○ (c) 3.28

---

9 of 21

25.0 mL of 0.100 M triethyl amine, $(CH_3CH_2)_3N$, is titrated with 0.0500 M HCl. The following data was obtained:

mL	HCl added pH
0.0	11.86
25.0	10.71
50.0	6.79

What is the pK_a for the triethylammonium ion?

○ (a) 11.86
○ (b) 10.71
○ (c) 6.79

---

10 of 21

A flask containing 36.8 mL of 0.138 M sodium acetate ($NaC_2H_3O_2$) is titrated with 24.9 mL of 0.128 M HNO_3. Calculate the pH of the solution. pK_a for acetic acid = 4.76.

○ (a) 4.53
○ (b) 9.47
○ (c) 4.98

---

11 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 0.00 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 1.85
○ (b) 4.50
○ (c) 3.35

---

12 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 30.0 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 6.00
○ (b) 3.00
○ (c) 7.50

13 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 60.0 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 6.00
○ (b) 9.00
○ (c) 7.50

14 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 70.0 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 8.30
○ (b) 5.30
○ (c) 12.00

15 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 120 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 7.50
○ (b) 9.15
○ (c) 10.80

16 of 21

In the titration of 30.0 mL of a 0.200 M solution of a hypothetical compound NaH_2M, what is the pH of the solution after the addition of 180 mL of 0.100 M NaOH? For H_3M, $pK_{a1} = 3.00$, $pK_{a2} = 6.00$, and $pK_{a3} = 9.00$.

○ (a) 9.15
○ (b) 8.73
○ (c) 12.40

---

17 of 21

For the titration of 10.00 mL of a 0.100 M nicotine ($pK_{b1} = 6.15$ and $pK_{b2} = 10.85$) with 0.100 M HCl, calculate the initial pH.

○ (a) 10.42
○ (b) 13.00
○ (c) 3.58

---

18 of 21

For the titration of 10.00 mL of a 0.100 M nicotine ($pK_{b1} = 6.15$ and $pK_{b2} = 10.85$) with 0.100 M HCl, calculate the pH at $\frac{1}{2}V_{e1}$.

○ (a) 10.85
○ (b) 7.85
○ (c) 5.50

---

19 of 21

For the titration of 10.00 mL of a 0.100 M nicotine ($pK_{b1} = 6.15$ and $pK_{b2} = 10.85$) with 0.100 M HCl, calculate the pH at V_{e1}.

○ (a) 8.50
○ (b) 7.85
○ (c) 5.50

---

20 of 21

What two assumptions must be true for the pH of an intermediate of a diprotic acid to equal $(pK_{a1} + pK_{a2})/2$?

○ (a) $K_{a2}F >> K_w$ and $K_{a1}F << F$
○ (b) $K_{a2}F << K_w$ and $K_{a1}F << F$
○ (c) $K_{a1}F >> K_w$ and $K_{a2}F << F$

---

21 of 21

Given the transition ranges for the pH indicators below, which indicator is most appropriate for the titration of a weak acid with a strong base?

Cresol purple: pH transition = 1.2-2.8
Bromocresol purple: pH transition = 5.2-6.8
Cresol red: pH transition = 7.2-8.8

○ (a) Cresol purple
○ (b) Bromocresol purple
○ (c) Cresol red

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Answer Sheet: Chapter_______11________

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Q	21	22	23	24	25	26	27	28	29	30										
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Chapter 11-EDTA Titrations

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1 of 15

The reaction of EDTA with a divalent metal ion, such as Cu^{2+}, complexed with ammonia could be represented as

○ (a) $M(NH_3)_4^{2+} + Y^{4-} \rightleftharpoons MY^{2-} + 4NH_3$.

○ (b) $M(NH_3)^{2+} + Y^{4-} \rightleftharpoons MY^{2-} + NH_3$.

○ (c) $M(NH_4)_4^{6+} + Y^{4-} \rightleftharpoons MY^{2-} + 4NH_4^{4+}$.

---

2 of 15

The reaction of EDTA with a trivalent metal ion at a pH of 4.0 may be written as

○ (a) $M^{3+} + Y^{4-} \rightleftharpoons MY^{-}$.

○ (b) $M^{3+} + H_2Y^{2-} \rightleftharpoons MY^{-} + 2\,H^{+}$.

○ (c) $M^{3+} + H_4Y \rightleftharpoons MY^{-} + 4\,H^{+}$.

---

3 of 15

Calculate the conditional formation constant $K_{f'}$ for the formation of an EDTA complex with copper(II) at a pH of 5.00, if $\log K_f = 18.80$.

○ (a) 1.8×10^{12}

○ (b) 5.4×10^{-6}

○ (c) 4.6×10^{-26}

---

4 of 15

Fe^{3+} can be successfully titrated with EDTA in the presence of Ni^{2+} by

○ (a) masking Ni^{2+} with cyanide and titrating Fe^{3+} at pH 3.0.

○ (b) titrating at pH 2.0.

○ (c) masking Ni^{2+} with triethanolamine and titrating Fe^{3+} at pH 3.0.

---

5 of 15

Which of the following displacement titrations would be feasible?

○ (a) $Ag^{+} + MgY^{2-} \rightleftharpoons Mg^{2+} + AgY^{3-}$

○ (b) $Ba^{2+} + MgY^{2-} \rightleftharpoons Mg^{2+} + BaY^{2-}$

○ (c) $Cu^{2+} + MgY^{2-} \rightleftharpoons Mg^{2+} + CuY^{2-}$

---

6 of 15

Given that K_f of $CuY^{2-} = 6.3 \times 10^{18}$ and K_f of $MgY^{2-} = 6.2 \times 10^{8}$, calculate the equilibrium constant for the reaction $Cu^{2+} + MgY^{2-} \rightleftharpoons Mg^{2+} + CuY^{2-}$.

○ (a) 1.0×10^{10}

○ (b) 2.1

○ (c) 9.8×10^{-11}

---

7 of 15

Which of the following EDTA titrations would be most complete?

○ (a) Cu^{2+} at pH 10

○ (b) Al^{3+} at pH 4

○ (c) Fe^{3+} at pH 5

---

8 of 15

A beaker containing 50.0 mL of 0.300 M Ca^{2+} at pH 9 is titrated with 0.150 M EDTA. The pCa^{2+} at the equivalence point is

○ (a) 5.39.

○ (b) 5.12.

○ (c) 1.58.

---

9 of 15

A student wishes to use Eriochrome black-T as an indicator for an EDTA titration of Pb^{2+}, and therefore, must work at a pH of about 10. To adjust the pH, the student should use

○ (a) NaOH.
○ (b) NH_3.
○ (c) NH_3 buffer.

---

10 of 15

The equation for the conditional formation constant of an EDTA-metal complex ion is $K_{f'} = K_f \times \alpha y^{4-} = [MY^{n-4}]/[M^{n+}][Y^{4-}]$. The presence in the solution of an auxiliary complexing agent such as tartrate ion, at a given concentration of Y^{4-} would

○ (a) have no effect on $[MY^{n-4}]$.
○ (b) lower $[MY^{n-4}]$.
○ (c) increase $[MY^{n-4}]$.

---

11 of 15

When is a direct EDTA titration not useful?

○ (a) When the metal precipitates in the absence of EDTA.
○ (b) When the metal reacts too quickly with EDTA.
○ (c) When the metal does not block the indicator.

---

12 of 15

Calculate the pCo^{2+} after 12.00 mL of 0.03846 M EDTA in the titration of 25.00 mL of 0.020 M Co^{2+} ($K_f = 2.04 \times 10^{16}$) at pH = 6.00.

○ (a) 1.04×10^{-3} molar
○ (b) 4.415
○ (c) 2.983

---

13 of 15

Calculate the pCo^{2+} after 13.00 mL of 0.03846 M EDTA in the titration of 25.00 mL of 0.020 M Co^{2+} (K_f = 2.04 x 10^{16}) at pH = 6.00.

○ (a) 9.095

○ (b) 6.723

○ (c) 1.89 x 10^{-7} molar

---

14 of 15

Calculate the pCo^{2+} after 14.00 mL of 0.03846 M EDTA in the titration of 25.00 mL of 0.020 M Co^{2+} (K_f = 2.04 X 10^{16}) at pH = 6.00.

○ (a) 10.455

○ (b) 15.196

○ (c) 3.51 x 10^{-11} molar

---

15 of 15

Using your textbook, determine which single-element EDTA titration can be carried out as described.

○ (a) Analyze In^{3+} in the presence of Co^{2+} and Ni^{2+} at a pH = 2.50

○ (b) Analyze Fe^{3+} in the presence of Al^{3+} at a pH = 3.50

○ (c) Analyze Pb^{2+} in the presence of In^{3+} and Hg^{2+} at a pH = 8.00

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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 12-Advanced Topics in Equalibrium

---

1 of 5

A generalized approach to finding the pH for a complex acid-base mixture with multiple equilibria is to

○ (a) write a fractional composition equation for each acid or base that appears in the charge balance, substitute the fractional composition expressions into the charge balance, enter any known concentrations, and use a spreadsheet to solve for $[H^+]$.

○ (b) write a fractional composition equation for each acid or base that appears in the mass balance, substitute the fractional composition expressions into the mass balance, enter any known concentrations, and use a spreadsheet to solve for $[H^+]$.

○ (c) write a fractional composition equation for each acid or base that appears in the charge balance, substitute the fractional composition expressions into the mass balance, enter any known concentrations, and use a spreadsheet to solve for $[H^+]$.

---

2 of 5

Tools to compute the concentrations of species in systems with many simultaneous equilibria do not include

○ (a) spreadsheets.

○ (b) systematic treatment of equilibria.

○ (c) activity coefficients.

---

3 of 5

A difference plot is

○ (a) an excellent means to interpolate activity coefficients.

○ (b) an excellent means to solve simultaneous equilibria.

○ (c) an excellent means to extract metal-ligand formation constants or acid-dissociation constants from titration data obtained with electrodes.

---

4 of 5

Coupled equilibria are

○ (a) reversible reactions that share a species in common.

○ (b) irreversible reactions that share a species in common.
○ (c) reversible reactions that do not share a species in common.

---

5 of 5

When we considered solubility problems in which the cation and anion could each undergo one or more acid-base reactions and in which ion pairing could occur, the fractional composition expressions for all acid-base species are substituted into

○ (a) the charge balance.
○ (b) the mass balance.
○ (c) the difference plot.

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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 13-Fundamentals of Electrochemistry

1 of 15

In the reaction $MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_20$, the manganese in 3.95 grams of $KMnO_4$ is reduced to Mn^{2+}. How many coulombs of charge must have been transferred to the permanganate ion?

○ (a) 1.60×10^4 C

○ (b) 2.41×10^3 C

○ (c) 1.20×10^4 C

2 of 15

Calculate E^o for the reaction $MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 4H_2O + 5Fe^{3+}$.

○ (a) +0.736 V

○ (b) –2.35 V

○ (c) -0.736 V

3 of 15

Write the balanced net equation for the following cell:
$Cd(s) \mid Cd^{2+}$ (1 M) || $H^+(aq$, 1 M), Mn^{2+} (l M), MnO_4^- (l M) | Pt

○ (a) $5Cd(s) + 2MnO_4^- + 16H^+ \rightleftharpoons 5Cd^{2+} + 2Mn^{2+} + 8H_20$

○ (b) $Cd(s) + MnO_4^- + 8H^+ \rightleftharpoons Cd^{2+} + Mn^{2+} + 4H_2O$

○ (c) $5Cd^{2+} + 2Mn^{2+} + 8H_2O \rightleftharpoons 2MnO_4^- + 16H^+ + 5Cd(s)$

4 of 15

Which of these salts could be used in a salt bridge?

○ (a) $NaNO_3$

○ (b) KNO_3

○ (c) $NaC_2H_3O_2$

---

5 of 15

In the cell Cd(*s*) | Cd^{2+} (1 M) || H^+ (*aq*, 1 M), Mn^{2+} (1 M), MnO_4^- (1 M) | Pt,

○ (a) the salt bridge plays no role.
○ (b) cations diffuse into the right half-cell, and anions diffuse into the left half-cell.
○ (c) anions diffuse into the right half-cell, and cations diffuse into the left half-cell.

---

6 of 15

Which of the following shows the correct order of increasing strength as an oxidizing agent?

○ (a) $Ag^+ < H^+ < O_3$(*g*)
○ (b) $K^+ < MnO_4^- < 0_3$(*g*)
○ (c) $K^+ < Li^+ < H^+$

---

7 of 15

Over time, the voltage of the cell S.C. E. || Ag^+ (1 M) | Ag(*s*) decreases and the concentration of Ag^+ decreases. Which of the following statements is true?

○ (a) The concentration of the Cl^- in the S.C.E. will increase.
○ (b) The concentration of the Cl^- in the S.C.E. will decrease.
○ (c) The concentration of the Cl^- in the S.C.E. will remain essentially constant.

---

8 of 15

A cathode can always be defined as

○ (a) the electrode at which oxidation occurs.
○ (b) the electrode at which reduction occurs.
○ (c) the negative electrode.

---

9 of 15

When $F_2(g)$ is 0.50 bar and $[F^-]$ is 0.10 M, the half-cell potential for the half reaction $F_2(g) + 2e^- \rightleftharpoons 2F^-$ is

○ (a) 2.931 V.
○ (b) 2.840 V.
○ (c) 2.940 V.

---

10 of 15

The equilibrium constant for the reaction $MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 4H_2O + 5Fe^{3+}$ is approximately

○ (a) 2×10^{62}.
○ (b) 3×10^{12}.
○ (c) 1×10^{-20}.

---

11 of 15

Given the information below, calculate the voltage the cell.
$Cu(s)$ | Cu^{2+} (0.50 M) || I^- (0.30 M) | I_3^- (0.15 M) | Pt

$I_3^- + 2e^- \longrightarrow 3I^-$ $E^o = 0.535$ V
$Cu^{2+} + 2e^- \longrightarrow Cu(s)$ $E^o = 0.339$ V

○ (a) –0.227 V
○ (b) 0.2 V
○ (c) 0.196 V

---

12 of 15

Using the standard reduction tables in the appendix of your textbook, identify the best oxidizing agent.

○ (a) $Li^+(s)$
○ (b) $F_2(g)$

○ (c) Cu^{2+}

---

13 of 15

Given the following reduction potential for potassium, which statement is correct?

$K^+ + e^- \rightleftharpoons K(s)$ $E^0 = 2.936$ V

○ (a) K is a good reducing agent.
○ (b) K^+ is a good oxidizing agent.
○ (c) K^+ is a good reducing agent.

---

14 of 15

Calculate E_{cell} for the electrochemical cell shown below. The E^o for $Fe^{3+}/Fe^{2+} = 0.771$ V and E^o for $MnO_4^-/Mn^{2+} = 1.51$ V.
Pt | Fe^{2+} (4.25×10^{-3} M), Fe^{3+} (1.50×10^{-3} M) || MnO_4^- (6.50×10^{-3} M), Mn^{2+} (2.00×10^{-2} M), H^+ (0.100 M) | Pt

○ (a) 0.739 V
○ (b) 0.667 V
○ (c) 1.48 V

---

15 of 15

Calculate the $[H^+]$, given the electrochemical cell shown below has an $E_{cell} = 1.018$ V. The E^o for $Fe^{3+}|Fe^{2+} = 0.771$ V and E^o for $UO_2^{2+}|U^{4+} = 0.273$ V.Pt | UO_2^{2+} (0.05 M), U^{4+} (0.05 M), HCO_2H (0.1 M), HCO_2Na (0.3 M) || Fe^{3+}(0.05 M), Fe^{2+} (0.025 M) | Pt

○ (a) 2.6 molar
○ (b) 9.4×10^{-18} molar
○ (c) 5.5×10^{-5} molar

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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 14-Electrodes and Potentiometry

---

1 of 15

A calcium ion-selective electrode is dipped into a solution whose [Ca^{2+}] is fifteen times less concentrated than the internal solution. The potential difference that would develop is

○ (a) 0.0348 V.

○ (b) 0.0444 V.

○ (c) 0.444 V.

---

2 of 15

A glass electrode with an internal pH of 7.00 is dipped into a solution whose pH is 10.40. If the factor β is 0.98, how much voltage is generated by the pH gradient?

○ (a) 0.197 V

○ (b) 0.603 V

○ (c) 0. 201 V

---

3 of 15

Which of the following operators would *not* lead to an incorrect pH reading using a glass electrode?

○ (a) Measuring the pH of a basic solution with a high concentration of Na^+.

○ (b) Using a brand new electrode directly out of the box.

○ (c) Calibrating and measuring pH at 50°C.

---

4 of 15

A fluoride ion-selective electrode is used in two solutions. Both solutions have [F^-] of 5.00×10^{-3} M, but one has a pH of 2.00 and the other a pH of 7.00. You would expect that

○ (a) the potential would be the same in both solutions.

○ (b) the potential would be lower in the pH 2.00 solution.

○ (c) the potential would be higher in the pH 2.00 solution.

---

5 of 15

The Zn^{2+} ion interferes with a Ca^{2+} ion-selective electrode more than the same concentration of Mg^{2+} does. This means that

○ (a) the selectivity coefficient is higher for Zn^{2+} than for Mg^{2+}.

○ (b) the selectivity coefficient is lower for Zn^{2+} than for Mg^{2+}.

○ (c) Zn^{2+} and Mg^{2+} have similar selectivity coefficients but their concentrations are raised to different powers.

6 of 15

An electrode specific for X^{2+} responds to Y^{+} with a selectivity coefficient of 0.30. Calculate the change in the potential of a 1.0 mM X^{2+} solution when 5.0 mM Y^{+} is added. In this case where an interfering ions has a different charge from the primary ion, ($k_{A,X}$ A_X) becomes [($k_{A,X}$)(A_X)^(n_X/n_Y)].

○ (a) –88.5 mV

○ (b) 11.7 mV

○ (c) 0.100 mV

7 of 15

A solution of K_2CrO_4 was titrated with $AgNO_3$, using a silver indicator electrode and a S.C.E. reference electrode. The product, Ag_2CrO_4, has a $K_{sp} = 1.1 \times 10^{-12}$. Then potential at the equivalence point would be

○ (a) 0.328 V.

○ (b) 0.310 V.

○ (c) 0.204 V.

8 of 15

The junction 0.10 M HCl/3.5 M KCl develops a liquid junction potential of +3.1 mV at 25°C because

○ (a) the concentration of KCl is higher than the concentration of HCl.

○ (b) the mobility of H^+ is very much less than the mobility of K^+.

○ (c) the mobility of H^+ is much higher than the mobility of K^+.

9 of 15

A double-junction reference electrode would be preferred over a S.C.E.

○ (a) always.

○ (b) for the measurement of pH with a glass electrode.

○ (c) for the measurement of Pb^{2+} with a Pb indicator electrode.

10 of 15

Over time, the voltage of the cell S.C. E. || Ag^+ (1 M) | Ag(*s*) decreases and the concentration of Ag^+ decreases. Which of the following statements is true?

○ (a) The concentration of the Cl^- in the S.C.E. will increase.

○ (b) The concentration of the Cl^- in the S.C.E. will decrease.

○ (c) The concentration of the Cl^- in the S.C.E. will remain essentially constant.

11 of 15

A chloride ion-selective electrode obeys the equation E = constant - 0.059log[Cl^-]. The potential was -0.430 V when the electrode was immersed in 0.100 M NaCl. What is [Cl^-] if E = -0.300 V?

○ (a) 1.13 Molar

○ (b) 6.26×10^{-2} molar

○ (c) 6.26×10^{-4} molar

12 of 15

Which common error that occurs in pH measurements is correctly described?

○ (a) "Buffer Error" associated with pH standards used to calibrate the electrode.

○ (b) Junction potential drift associated with electrode response to Na^+ ion.

○ (c) Temperature errors associated glass surface saturation.

13 of 15

If the E_{cell} = 0.222 V *versus*. S.C.E., what is the cell potential versus a S.H.E.?

○ (a) –0.019 V

○ (b) 0.463 V

○ (c) 0.019 V

---

14 of 15

If the E_{cell} = 0.0230 V *vs*. S.C.E., what is the cell potential *vs.* Ag|AgCl?

○ (a) 0.266 V

○ (b) -0.415 V

○ (c) –0.0210 V

---

15 of 15

Which of the following statements is correct?

○ (a) A S.H.E. is an indicator electrode, Pt can used as a metallic reference electrode, and sodium concentration cannot be determined with an ion-selective electrode.

○ (b) A S.H.E. is an ion-selective electrode, Pt can be used as a metallic-indicator electrode, and sodium concentration can be determined with a reference electrode.

○ (c) A S.H.E. is a reference electrode, Pt can used as a metallic indicator electrode, and sodium concentration can be determined with an ion-selective electrode.

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Chapter 15-Redox Titrations

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1 of 16

1. A standard I_2 solution can be made by reacting KIO_3 with excess KI in a strongly acidic solution: $IO_3^- + 8I^- + 6H^+ \rightleftharpoons 3I_2 + 3H_2O$. The species being reduced is

○ (a) IO_3^-
○ (b) I-
○ (c) H^+

---

2 of 16

2. $KMnO_4$ can be standardized by titration against primary standard sodium oxalate in a *strongly* acidic solution. The balanced equation for the titration reaction is

○ (a) $2MnO_4^- + 8H^+ + 3C_2O_4^{2-} \rightleftharpoons 2MnO_2 + 6CO_2 + 4H_2O$.
○ (b) $2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \rightleftharpoons 2Mn^{2+} + 5CO_2 + 8H_2O$.
○ (c) $2MnO_4^- +16H^+ + 5C_2O_4^{2-} \rightleftharpoons 2Mn^{2+} + 10CO_2 + 8H_2O$.

---

3 of 16

3. $KMnO_4$ is used as the titrant in a potentiometric titration of tin(II) to tin(IV), using a S.C.E. reference electrode. Before the equivalence point, you would calculate the cell voltage using the potentials of

○ (a) the $MnO_4^-|Mn^{2+}$ couple and the S.C.E.
○ (b) the $Sn^{4+}|Sn^{2+}$ couple and the S.C.E.
○ (c) the $MnO_4^-|Mn^{2+}$ couple and the Sn^{4+}/Sn^{2+} couple.

---

4 of 16

4. $KMnO_4$ is used as the titrant in a potentiometric titration of tin(II) to tin(IV), using a S.C.E. reference electrode. After the equivalence point, you would calculate the cell voltage using the potentials of

○ (a) the $MnO_4^-|Mn^{2+}$ couple and the S.C.E.
○ (b) the $Sn^{4+}|Sn^{2+}$ couple and the S.C.E.

○ (c) the $MnO_4^-|Mn^{2+}$ couple and the Sn^{4+}/Sn^{2+} couple:

---

5 of 16

5. $KMnO_4$ is used as the titrant in a potentiometric titration of tin(II) to tin(IV), using a S.C.E. reference electrode. The potential of the indicator electrode at the equivalence point would be calculated as

○ (a) $7E^+ = 5E^o(MnO_4^-|Mn^{2+}) + 2E^o(Sn^{4+}|Sn^{2+})$.

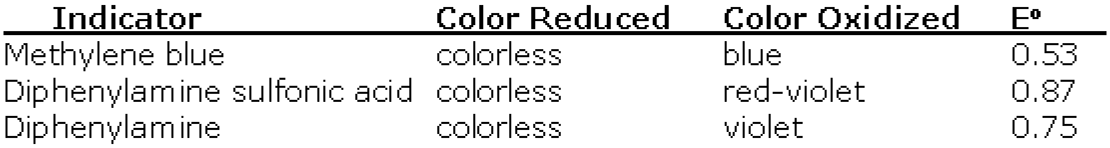
○ (b) $7E^+ = 2E^o(MnO_4^-|Mn^{2+}) + 5E^o(Sn^{4+}|Sn^{2+})$.

○ (c) $7E^+ = 5E^o(MnO_4^-|Mn^{2+}) + 2E^o(Sn^{4+}|Sn^{2+}) + 0.05916 \log[H^+]^8$.

---

6 of 16

6. Given the following data, select the best indicator for the titration of iron(II) with thallium(III), using a S.C.E. reference electrode.



Indicator	Color Reduced	Color Oxidized	E°
Methylene blue	colorless	blue	0.53
Diphenylamine sulfonic acid	colorless	red-violet	0.87
Diphenylamine	colorless	violet	0.75

○ (a) Methylene blue

○ (b) Diphenylamine sulfonic acid

○ (c) Diphenylamine

---

7 of 16

7. Which of the following represents a disproportionation?

○ (a) $Cu^{2+} + Cu(s) \rightleftharpoons 2Cu^+$

○ (b) $IO_3^- + 8I^- + 6\ H^+ \rightleftharpoons 3I_3^- + 3\ H_2O$

○ (c) $2H_2O_2 \rightleftharpoons 2H_2O + O_2(g)$

---

8 of 16

8. A student wants a standard iodine solution. Which of the following procedures would *not* be correct?

○ (a) Prepare the standard solution directly from a known weight of iodine dissolved in a known volume.

○ (b) Make an approximate solution and standardize it against As_4O_6.

○ (c) React a known quantity of KIO_3 with a small excess of I^- and dilute to a known volume.

---

9 of 16

9. Which of the following titrants would give the sharpest change in voltage (i.e., the steepest titration curve) for a given analyte?

○ (a) MnO_4^-

○ (b) I_3^-

○ (c) $Cr_2O_7^{2-}$

---

10 of 16

10. Which of the following titrations would give a titration curve symmetric around the equivalence point?

○ (a) $Na_2S_2O_3$ titrated with I_2.

○ (b) Ascorbic acid titrated with I_2.

○ (c) As_4O_6 titrated with I_2.

---

11 of 16

11. A Jones Reductor is used to adjust the oxidation state of the analyte before it is titrated. An example of this use would be

○ (a) the conversion of Mn^{2+} to MnO_4^- to be titrated with standard Fe^{2+}.

○ (b) the reduction of Fe^{3+} to Fe^{2+} to be titrated with MnO_4^-.

○ (c) the addition of stannous chloride ($SnCl_2$) to Fe^{3+} in hot HCl to reduce the iron to Fe^{2+}.

---

12 of 16

12. A 20.0 mL solution of 0.00500 M Pb^{2+} in 1 M HCl was titrated with 0.0200 M Ce^{4+} to give Pb^{4+} and Ce^{3+}. What is the equivalence point volume of Ce^{4+} to be added?

○ (a) 10 mL

○ (b) 20 mL

○ (c) 5 mL

---

13 of 16

13. A 20.0 mL solution of 0.00500 M Pb^{2+} in 1 M HCl was titrated with 0.0200 M Ce^{4+} to give Pb^{4+} and Ce^{3+}. Which expression is correct for the potential of the indicator electrode at the equivalence point? $E°$ for $Ce^{4+}|Ce^{3+}$ = 1.47 V and $E°$ for $Pb^{4+}|Pb^{2+}$ = 0.139 V.

○ (a) $2E_c = 1.609 \text{ V} - 0.059\log([Pb^{2+}][Ce^{3+}]^2|[Ce^{4+}]^2[Pb^{4+}])$

○ (b) $3E_c = 1.748 \text{ V} - 0.059\log([Pb^{2+}][Ce^{3+}]^2|[Ce^{4+}]^2[Pb^{4+}])$

○ (c) $3E_c = 1.609 \text{ V} - 0.059\log([Pb^{2+}][Ce^{3+}]^2|[Ce^{4+}]^2[Pb^{4+}])$

---

14 of 16

14. A 20.0 mL solution of 0.00500 M Pb^{2+} in 1 M HCl was titrated with 0.0200 M Ce^{4+} to give Pb^{4+} and Ce^{3+}. What are the correct concentration relationships at the equivalence point?

○ (a) $[Pb^{4+}] = [Ce^{3+}]$ and $[Pb^{2+}] = [Ce^{4+}]$

○ (b) $\frac{1}{2}[Pb^{4+}] = [Ce^{3+}]$ and $\frac{1}{2}[Pb^{2+}] = [Ce^{4+}]$

○ (c) $[Pb^{4+}] = \frac{1}{2}[Ce^{3+}]$ and $[Pb^{2+}] = \frac{1}{2}[Ce^{4+}]$

---

15 of 16

15. A 20.0 mL solution of 0.00500 M Pb^{2+} in 1 M HCl was titrated with 0.0200 M Ce^{4+} to give Pb^{4+} and Ce^{3+}. Calculate the cell potential versus a S.C.E. at the equivalence point? $E°$ for $Ce^{4+}|Ce^{3+}$ = 1.470 V and $E°$ for $Pb^{4+}|Pb^{2+}$ = 0.139 V.

○ (a) 1.507 V

○ (b) 0.583 V

○ (c) 0.342 V

---

16 of 16

16. If you are titrating a mixture of tin(II) and platinum with a Ce^{4+} solution, which species will be oxidized first? *E*° for $Ce^{4+}|Ce^{3+}$ = 1.47 V, *E*° for $Pt^{2+}|Pt$ = 1.18 V, and *E*° for $Sn^{4+}|Sn^{2+}$ = 0.139 V.

○ (a) Sn^{4+}

○ (b) Sn^{2+}

○ (c) Pt

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Answer Sheet: Chapter______16_________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 16-Electroanalytical Techniques

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1 of 18

To drive an electrolytic cell, a voltage must be supplied to overcome the spontaneous voltage of the cell and which of the following:

○ (a) the overpotential of the cell.

○ (b) the overpotential and the ohmic potential.

○ (c) the overpotential, the ohmic potential, and the concentration polarization.

---

2 of 18

Ohmic potential is

○ (a) the voltage needed to overcome electrical resistance (R) of the solution in the electrochemical cell when a current (I) is flowing.

○ (b) the voltage required to overcome the activation energy for a reaction at an electrode.

○ (c) when the concentrations of reactants and products are not the same at the surface of the electrode as they are in the bulk solution.

---

3 of 18

Which of the following procedures would introduce an error in polarography?

○ (a) Purging the analyte solution with nitrogen for ten minutes before the measurement.

○ (b) Bubbling nitrogen through the analyte solution during the measurement.

○ (c) Keeping nitrogen flowing over the analyte surface during the measurement.

---

4 of 18

In polarography, which of the following is measured?

○ (a) Faradaic current

○ (b) Charging current

○ (c) Capacitor current

---

5 of 18

What is the maximum number of grams of copper you would expect to deposit on a platinum cathode (initial weight 27.325 g) from 100.0 mL of 0.2500 M Cu^{2+} solution?

○ (a) 1.589 gram
○ (b) 28.91 gram
○ (c) 1588 gram

---

6 of 18

How long will it take to deposit all the copper in 100.0 mL of 0.2500 M Cu^{2+} solution, using a current of 1.200 A?

○ (a) 1005 s
○ (b) 2010 s
○ (c) 4020 s

---

7 of 18

Mercaptans (RSH) can be titrated with electrically generated Ag^+ in the reaction $Ag^+ + RSH \longrightarrow AgSR(s) + H^+$. Using a silver anode, a current of 0.0121 A flowed for 120 seconds through 50.0 mL of a mercaptan solution. Calculate the molarity of the RSH solution.

○ (a) 1.50×10^{-5} molar
○ (b) 3.00×10^{-4} molar
○ (c) 3.00×10^{-7} molar

---

8 of 18

In a 3-electrode cell

○ (a) the working electrode is always the cathode.
○ (b) voltage is measured between the reference and auxiliary electrodes.
○ (c) current flows between the working and auxiliary electrodes.

---

9 of 18

In voltammetry,

○ (a) the concentration of the analyte is depleted only in the immediate vicinity of the working electrode.

○ (b) the concentration of the analyte is depleted throughout the solution.

○ (c) there is no depletion of the concentration of the analyte.

---

10 of 18

In a voltammetric analysis, 50.0 mL of sample containing the analyte gave a peak current of 2.50 μA. When 10.0 mL of 0.0500 M standard were added to the sample, the peak current increased to 3.00 μA. Find the molarity of the analyte in the unknown.

○ (a) 0.0403 molar.

○ (b) 0.0499 molar.

○ (c) 0.0227 molar.

---

11 of 18

In polarography, the analyte reaches the working electrode by

○ (a) convection.

○ (b) diffusion.

○ (c) electrostatic attraction.

---

12 of 18

Compared to sampled current polarography, square wave polarography is

○ (a) more sensitive.

○ (b) less able to differentiate between analyte species.

○ (c) slower.

---

13 of 18

The advantage of anodic stripping polarography is

○ (a) results may be obtained very rapidly compared to other voltammetry techniques.

○ (b) that it is the most sensitive of all of the voltammetry techniques.

○ (c) that the current at the working electrode is proportional to analyte concentration.

---

14 of 18

In electrogravimetric analysis, the analyte is

○ (a) quantitatively deposited on the electrode by coulometry.
○ (b) quantitatively deposited on the electrode by electrolysis.
○ (c) deposited on the electrode by electrolysis.

---

15 of 18

A Karl Fischer titration is used to

○ (a) measure traces of oxygen in purified solvents, foods, etc.
○ (b) measure traces of bacteria in purified solvents, foods, etc.
○ (c) measure traces of water in purified solvents, foods, etc.

---

16 of 18

Cyclic voltammetry is used to

○ (a) characterize the redox behavior of compounds and to elucidate the kinetics of electrode reactions.
○ (b) characterize the redox behavior of compounds.
○ (c) characterize the electrolytic behavior of compounds.

---

17 of 18

Coulometry is a form of chemical analysis based on

○ (a) counting the electrons used in a reaction.
○ (b) counting the moles of analyte used in a reaction.
○ (c) controlling the electrons used in a reaction.

---

18 of 18

Coulometric titrations are a

○ (a) variable-current method.

○ (b) square-current method.

○ (c) constant-current method.

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Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 17-Fundamentals of Spectrophotometry

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1 of 20

Light with a wavelength of 800 nm has energy of

○ (a) 2.48×10^{-19} J.
○ (b) 2.48×10^{-28} J.
○ (c) 5.30×10^{-31} J.

---

2 of 20

Light with a frequency of 1.07×10^{15} Hz has a wavenumber (in cm^{-1}) of

○ (a) 3.57×10^{6} cm^{-1}.
○ (b) 2.80×10^{-7} cm^{-1}.
○ (c) 3.57×10^{4} cm^{-1}.

---

3 of 20

If a sample transmits 75.0% of the incident light, it has an absorbance of

○ (a) 0.125.
○ (b) 1.880.
○ (c) –0.125.

---

4 of 20

A liquid sample absorbs light of wavelength 510 nm. The solution will appear

○ (a) green.
○ (b) purple.
○ (c) colorless.

---

5 of 20

A sample in a 1.00 mm cell transmits 75.0% of the incident light at 510 nm. If the solution is 0.0750 M, its molar absorptivity (M^{-1} cm^{-1}) is

○ (a) 1.0 x l0^{-4} M^{-1} cm^{-1}.

○ (b) 1.67 M^{-1} cm^{-1}.

○ (c) 16.7 M^{-1} cm^{-1}.

---

6 of 20

A cuvet should be

○ (a) thoroughly rinsed and dried with an absorbent towel before use.

○ (b) rinsed and allowed to drain before use.

○ (c) rinsed and oven dried before use.

---

7 of 20

A sample absorbs too strongly at a particular wavelength. You could decrease the absorbance at that wavelength by each of the following *except*

○ (a) quantitatively diluting the solution.

○ (b) using a cuvet with a shorter path length.

○ (c) decreasing the molar absorptivity.

---

8 of 20

Spectrophotometric analysis based on Beer's Law

○ (a) must be done using a double beam instrument.

○ (b) requires the use of monochromatic light.

○ (c) can only be done in the visible region of the spectrum.

---

9 of 20

Which of the following is a source of error in a spectrophotometric analysis of a blue liquid?

○ (a) using the same cuvet for sample and blank

○ (b) plotting absorbance versus concentration expressed as ppm analyte

○ (c) using a wavelength of 450 nm

---

10 of 20

Electromagnetic radiation in the range from 200 to 800 nm causes

○ (a) electronic, vibrational and rotational excitation.

○ (b) vibrational and rotational excitation.

○ (c) rotational excitation.

---

11 of 20

Beer's law effectively states that the relationship between the absorbance of a solution and the concentration of the absorbing species in a solution is linear. This relationship is most likely to fail when

○ (a) the absorbing species is very dilute.

○ (b) the absorbing species participates in a concentration-dependent chemical equilibrium.

○ (c) a mixture of ions are present in the solution evaluated.

---

12 of 20

Which of the following is *not* true regarding emission spectra?

○ (a) Emission spectra are generated by molecules that emit radiation at the same wavelength as the radiation they absorb.

○ (b) Luminescence measurements are inherently more sensitive than absorption measurements.

○ (c) Emission spectra are normally measured at a detector positioned at 90° to the incident light.

---

13 of 20

Which of the following types of transition would require the shortest wavelength radiation?

○ (a) Rotational transitions

○ (b) Vibrational transitions

○ (c) Electronic transitions

---

14 of 20

A molecule that has absorbed a photon of energy in the visible range could move from the excited electronic state S_1 to a highly excited vibrational level of the ground state (S_0) with the same energy. This process is

○ (a) fluorescence.
○ (b) internal conversion.
○ (c) intersystem crossing.

---

15 of 20

Compared to the incident (exciting) radiation, fluorescent emission will have a

○ (a) higher energy.
○ (b) higher frequency.
○ (c) longer wavelength.

---

16 of 20

Which of the following is true?

○ (a) The radiational transition $S_1 \rightarrow S_0$ is called fluorescence, and the radiational transition $T_1 \rightarrow S_0$ is called phosphorescence.
○ (b) The radiational transition $S_1 \rightarrow S_0$ is called phosphorescence, and the radiational transition $T_1 \rightarrow S_0$ is called fluorescence.
○ (c) The radiational transition $S_1 \rightarrow S_0$ is called fluorescence, and the radiational transition $T_1 \rightarrow S_1$ is called phosphorescence.

---

17 of 20

A sample and its blank had a percent transmittance of 45.4% and 97.5%, respectively. What is the absorbance due to the analyte?

○ (a) 0.011
○ (b) 0.343
○ (c) 0.332

---

18 of 20

Which of the following is proportional to concentration?

○ (a) percent transmittance

○ (b) transmittance

○ (c) absorbance

---

19 of 20

There is an analogous Beer's Law equation for fluorescence: $F = Kc$, where F is the fluorescence emission intensity, K is a proportionality constant, and c is the concentration. What is K, if $F = 512$ at 370 nm for a $1.5 \text{ X } 10^{-6}$ M solution of pyrene?

○ (a) 3.4×10^{8} M

○ (b) 3.4×10^{8} M^{-1}

○ (c) 2.9×10^{-9} M^{-1}

---

20 of 20

The absorbance of a 2.31×10^{-5} M solution of a compound is 0.822 at 266 nm in a 1.00 mm cuvet. What is the sample's percent transmittance?

○ (a) 15.1%

○ (b) 0.151

○ (c) 664%

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 18-Applications of Spectrophotometry

---

1 of 14

At 510 nm, the molar absorptivities for two complexes (A and B) are 36,400 and 5250 $M^{-1}cm^{-1}$, respectively. The absorbance in a 1.00 mm cuvet of a solution with [A] = 1.00 x 10^{-4} M and [B] = 2.00 x 10^{-4} M would be

○ (a) 0.469.

○ (b) 4.69.

○ (c) 0.780.

---

2 of 14

A solution containing two complexes (X and Y) was analyzed with a Spectronic 20 instrument using 1.00 cm cells. Experimentally, it was determined that complex X has a molar absorptivity of 52,800 $M^{-1}cm^{-1}$ at 460 nm, while complex Y has a molar absorptivity of 2,160 $M^{-1}cm^{-1}$ at this wavelength. The absorbance of the solution at 460 nm was recorded as 0.462. A second reading was taken at 680 nm where the molar absorptivity of complex X was reported to be 16,800 $M^{-1}cm^{-1}$, and the molar absorptivity of complex Y is 1,082 $M^{-1}cm^{-1}$. The absorbance of the solution at 680 nm was found to be 0.185. Calculate the concentration of complex X in the solution.

○ (a) 8.75 x 10^{-6} Molar

○ (b) 9.73 x 10^{-5} Molar

○ (c) 4.77 x 10^{-6} Molar

---

3 of 14

The presence of an isobestic point indicates

○ (a) that there are at least two different compounds present in the solution being evaluated.

○ (b) that one absorbing species is being converted to another absorbing species during a chemical reaction.

○ (c) that three or more absorbing species have an intersecting absorbance at a specific wavelength.

---

4 of 14

Chemists often will use a Scatchard plot to determine the equilibrium constant for a chemical reaction. In the reaction P + X ↔ PX, which of the following best illustrates a Scatchard Plot?

○ (a) A graph of $\Delta A/[X]$ versus ΔA will be a straight line with a slope of $-K$ when ΔA = (the observed absorbance) – (the initial absorbance) for each point in the titration of P with X.

○ (b) A graph of ΔA versus [X] will be a straight line with a slope of $-K$ when ΔA = (the observed absorbance) – (the initial absorbance) for each point in the titration of P with X.

○ (c) A graph of [PX]/[X] versus [PX] will be a straight line with a slope of $-K$.

---

5 of 14

The method of continuous variation (Job's method)

○ (a) may be used instead of a Scatchard plot to determine the equilibrium constant for a given chemical reaction.

○ (b) may be used to isolate individual components of a multi-component system when each component absorbs at a different wavelength.

○ (c) may be used to identify the stoichiometry of the predominant complex in a system when several complexes at equilibrium may be present.

---

6 of 14

Which of the following best describes the application of flow analysis?

○ (a) A sample is injected into a moving liquid stream to which reagents can be added. After suitable time, the reacted sample reaches a detector.

○ (b) A sample is injected into a moving liquid stream to which reagents can be added. After suitable time, the reacted sample reaches a detector. This process enables replicate measurements to be completed rapidly (e.g. 20 to 60 seconds).

○ (c) A sample is injected into a moving liquid stream to which reagents can be added. After suitable time, the reacted sample reaches a detector. This process enables replicate measurements to be completed rapidly (e.g. 20 to 60 seconds). In addition, different flow paths may be assembled to allow many different types of analysis to occur on the same sample.

---

7 of 14

Why are infrared spectra customarily recorded on a transmittance scale rather than an absorbance scale?

○ (a) Because the analytical application of infrared spectra allows percent transmittance to be plotted against the concentration of the analyte to produce a straight line.

○ (b) Because the transmittance scale allows the peak to appear below the baseline rather than above the baseline of the graph.

○ (c) Because weak and strong bands can be displayed on the same scale.

---

8 of 14

Cramer's rule is a method using determents to solve simultaneous equations. A constant D is divided into individual matrices that have been generated from the coefficients of the equations. Given the following three simultaneous equations, x + y + 3z = 0, 2x y + 2z = 2, and x + 2y + 4z = −1, the value of x would be represented by:

○ A.
|0 1 3|
|2 −1 2|
|-1 2 4|
____________= x
|1 1 3|
|2 −1 2|
|1 2 4|

○ B.
|1 1 3 |
|2 −1 2|= x
|1 2 4|

○ C.
|1 0 3 |
|2 2 2 |
|1 −1 4|
____________= x
|1 1 3 |
|2 −1 2|
|1 2 4|

---

9 of 14

Luminescence is useful in analytical chemistry because

○ (a) molecular oxygen does not interfere with the emitting species enabling luminescence measurements in the field to be taken easily.

○ (b) signals obtained from the analyte are sufficiently large and do not require amplification.

○ (c) Luminescence is useful because the intensity is proportional to the concentration to the emitting species if concentrations are low enough.

---

10 of 14

When measured in a 1.00 cm cuvet, a 8.50 x 10^{-5} M solution of species A exhibited absorbances of 0.129 and 0.764 at 475 nm and 700 nm, respectively. A 4.65 X 10^{-5} M solution of species B gave absorbances of 0.567 and 0.083 at 475 nm and 700 nm, respectively. Both species were dissolved in the same solvent, and the solvent's absorbance was 0.005 and 0.000 at 475 nm and 700 nm, respectively. Which expressions are correct?

○ (a) For species A: $A_{475\text{ nm}} = 0.124$ and $A_{700\text{ nm}} = 0.764$
○ (b) For species A: $A_{475\text{ nm}} = 0.129$ and $A_{700\text{ nm}} = 0.764$
○ (c) For species A: $A_{475\text{ nm}} = 0.129$ and $A_{700\text{ nm}} = 0.759$

---

11 of 14

When measured in a 1.00 cm cuvet, a 8.50 X 10^{-5} M solution of species A exhibited absorbances of 0.129 and 0.764 at 475 nm and 700 nm, respectively. A 4.65 X 10^{-5} M solution of species B gave absorbances of 0.567 and 0.083 at 475 nm and 700 nm, respectively. Both species were dissolved in the same solvent, and the solvent's absorbance was 0.005 and 0.000 at 475 nm and 700 nm, respectively. Calculate the molar absorptivities for species A.

○ (a) $\varepsilon_{475\text{ nm}} = 8988\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 1459\text{ cm}^{-1}\text{M}^{-1}$
○ (b) $\varepsilon_{475\text{ nm}} = 1518\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 8988\text{ cm}^{-1}\text{M}^{-1}$
○ (c) $\varepsilon_{475\text{ nm}} = 1459\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 8988\text{ cm}^{-1}\text{M}^{-1}$

---

12 of 14

When measured in a 1.00 cm cuvet, a 8.50 x 10^{-5} M solution of species A exhibited absorbances of 0.129 and 0.764 at 475 nm and 700 nm, respectively. A 4.65 X 10^{-5} M solution of species B gave absorbances of 0.567 and 0.083 at 475 nm and 700 nm, respectively. Both species were dissolved in the same solvent, and the solvent's absorbance was 0.005 and 0.000 at 475 nm and 700 nm, respectively. Calculate the molar absorptivities for species B.

○ (a) $\varepsilon_{475\text{ nm}} = 12{,}194\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 1785\text{ cm}^{-1}\text{M}^{-1}$
○ (b) $\varepsilon_{475\text{ nm}} = 12{,}086\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 1785\text{ cm}^{-1}\text{M}^{-1}$
○ (c) $\varepsilon_{475\text{ nm}} = 1785\text{ cm}^{-1}\text{M}^{-1}$ and $\varepsilon_{700\text{ nm}} = 12{,}086\text{ cm}^{-1}\text{M}^{-1}$

---

13 of 14

When measured in a 1.00 cm cuvet, a 8.50 x 10^{-5} M solution of species A exhibited absorbances of 0.129 and 0.764 at 475 nm and 700 nm, respectively. A 4.65 X 10^{-5} M solution of species B gave absorbances of 0.567 and 0.083 at 475 nm and 700 nm, respectively. Both species were dissolved in the same solvent, and the solvent's absorbance was 0.005 and 0.000 at 475 nm and 700 nm, respectively, in either a 1.00 or 1.25 cm cuvet. What is the correct expression for a mixture of A and B, if the solution yielded the following absorbance data in a 1.25 cm cuvet: 0.502 at 475 nm and 0.912 at 700 nm.

○ (a) At 475 nm: (0.497)/1.00 cm = (1459 $cm^{-1}M^{-1}$ c_A) + (12,086 $cm^{-1}M^{-1}$ c_B) At 700 nm: (0.912)/1.00 cm = (8988 $cm^{-1}M^{-1}$ c_A) + (1785 $cm^{-1}M^{-1}$ c_B)

○ (b) At 475 nm: (0.502)/1.00 cm = (1459 $cm^{-1}M^{-1}$ c_A) + (12,086 $cm^{-1}M^{-1}$ c_B) At 700 nm: (0.912)/1.00 cm = (8988 $cm^{-1}M^{-1}$ c_A) + (1785 $cm^{-1}M^{-1}$ c_B)

○ (c) At 475 nm: (0.497)/1.25 cm = (1459 $cm^{-1}M^{-1}$ c_A) + (12,086 $cm^{-1}M^{-1}$ c_B) At 700 nm: (0.912)/1.25 cm = (8988 $cm^{-1}M^{-1}$ c_A) + (1785 $cm^{-1}M^{-1}$ c_B)

---

14 of 14

When measured in a 1.00 cm cuvet, a 8.50 x 10^{-5} M solution of species A exhibited absorbances of 0.129 and 0.764 at 475 nm and 700 nm, respectively. A 4.65 x 10^{-5} M solution of species B gave absorbances of 0.567 and 0.083 at 475 nm and 700 nm, respectively. Both species were dissolved in the same solvent, and the solvent's absorbance was 0.005 and 0.000 at 475 nm and 700 nm, respectively, in either a 1 or 1.25 cm cuvet. Calculate the concentrations of A and B in a solution that yielded the following absorbance data in a 1.25 cm cuvet: 0.502 at 475 nm and 0.912 at 700 nm.

○ (a) c_B = 7.65 x 10^{-5} molar and c_A = 2.37 x 10^{-5} molar

○ (b) c_B = 2.37 x 10^{-5} molar and c_A = 7.65 x 10^{-5} molar

○ (c) c_B = 4.65 x 10^{-5} molar and c_A = 8.50 x 10^{-5} molar

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Answer Sheet: Chapter_____19__________

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Date_____________________________

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A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 19-Spectrophotometers

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1 of 15

A deuterium arc lamp is commonly used as a source for which region of the electromagnetic spectrum?

○ (a) Infrared

○ (b) Visible

○ (c) Ultraviolet

---

2 of 15

Diffraction refers to

○ (a) bending of light by a prism.

○ (b) bending of light by a grating.

○ (c) dispersion of light by a lens.

---

3 of 15

The difference in pathlength traveled by two rays from a reflection grating is 600 nm. Constructive interference would occur with radiation of wavelength

○ (a) 300 nm.

○ (b) 400 nm.

○ (c) 250 nm.

---

4 of 15

Resolution of two closely spaced wavelengths depends on the

○ (a) intensity of the incident light.

○ (b) width of the entrance slit.

○ (c) width of the exit slit.

---

5 of 15

Compared to a dispersive spectrometer, a diode array spectrometer

○ (a) is faster.

○ (b) is less subject to drifting source intensity.

○ (c) has better resolution.

---

6 of 15

Stray light hitting the detector will produce erroneous results when the absorbance of a solution is measured. Calculate the apparent absorbance of a solution, if the measured absorbance is 0.750 and 2.00% stray light has entered the system.

○ (a) 0.712

○ (b) 0.194

○ (c) 0.178

---

7 of 15

Which of the following is *not* an advantage of Fourier transform spectroscopy?

○ (a) Fourier transform spectroscopy offers improved signal-to-noise ratio.

○ (b) Fourier transform spectroscopy allows for the acquisition of spectra in a very short time.

○ (c) Fourier transform spectroscopy is applicable to all important regions of the electromagnetic spectrum.

---

8 of 15

What is an Optode?

○ (a) A device used to increase the number of electrons produced by a photosensitive material.

○ (b) A device created by placing a chemically sensitive layer at the end of an optical fiber.

○ (c) An optical device used to disperse light into its component wavelengths.

---

9 of 15

Selecting the appropriate wavelength and bandwidth for a spectrophotometric analysis is very important. Which of the following is a correct statement regarding the bandwidth?

○ (a) The bandwidth should be as large as possible.

○ (b) The bandwidth should be as small as possible.

○ (c) The bandwidth should be as large as possible but small compared with the band being measured.

---

10 of 15

A number of things can happen to light when it strikes a sample. Which of the following best represents what happens to light when it strikes a sample?

○ (a) Light striking a sample can be transmitted or absorbed.

○ (b) Light striking a sample can be transmitted, absorbed, or reflected.

○ (c) Light striking a sample can be transmitted, absorbed, reflected, or scattered.

---

11 of 15

Which depicts the correct order for the parts in the schematic of a general scanning spectrophotometer?

○ (a) Light source, wavelength selector, sample compartment, light detector, and read-out device.

○ (b) Light source, sample compartment, wavelength selector, light detector, and read-out device.

○ (c) Light source, sample compartment, wavelength selector, and light detector.

---

12 of 15

Which statement is correct for a double-beam spectrophotometer?

○ (a) Light passes through the sample and reference, directed by a fixed mirror, (the chopper).

○ (b) Light alternately passes through the sample and reference, directed by a rotating mirror, (the chopper).

○ (c) Light alternately passes through the detector, directed by a rotating mirror, (the chopper).

---

13 of 15

Which statement is correct concerning lasers?

○ (a) Lasers provide isolated lines of multiple wavelengths for many applications.

○ (b) Lasers provide nonisolated lines of variable wavelength for many applications.

○ (c) Lasers provide isolated lines of a single wavelength for many applications.

---

14 of 15

Which statement is correct?

○ (a) Monochromatic light is a single wavelength, and polychromatic light is many wavelengths.

○ (b) Monochromatic gratings pass a single wavelength of light, and polychromatic gratings pass many wavelengths of light.

○ (c) Monochromatic light is black light, and polychromatic light is white light.

---

15 of 15

Which statement is correct concerning detectors?

○ (a) A photodiode is a very sensitive device in which electrons emitted from the photosensitive surface strike a second surface called a dynode, which is positive with to respect to the photosensitive emitter.

○ (b) A photomultiplier tube is a very sensitive device in which electrons emitted from the photosensitive surface strike a second surface called a dynode, which is positive with respect to the photosensitive emitter.

○ (c) A charge-coupled device is a very sensitive device in which electrons emitted from the photosensitive surface strike a second surface called a dynode, which is positive with to respect to the photosensitive emitter.

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Answer Sheet: Chapter___20____________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 20-Atomic Spectroscopy

---

1 of 15

In atomic emission spectroscopy, it is desirable to have a high concentration of the element in the form of

○ (a) atoms in the ground state.

○ (b) atoms in the excited state.

○ (c) ions.

---

2 of 15

A rich flame in atomic absorption spectroscopy would

○ (a) decrease the concentration of metal oxides in the flames.

○ (b) be hotter than a lean flame.

○ (c) be preferred for refractory elements.

---

3 of 15

Compared to a flame, a graphite furnace

○ (a) has lower sensitivity.

○ (b) requires less sample.

○ (c) operates at a higher temperature.

---

4 of 15

The temperature of a graphite furnace is

○ (a) isothermal at approximately 2500 °C.

○ (b) programmed to move at a constant rate from room temperature to approximately 2500 °C.

○ (c) programmed to move in steps from room temperature to approximately 2500 °C.

---

5 of 15

For a given element, the atomization method that can detect the lowest concentration is

○ (a) flame.
○ (b) furnace.
○ (c) plasma.

---

6 of 15

A matrix modifier such as $Mg(NO_3)_2$ is used to

○ (a) prevent premature evaporation of the analyte.
○ (b) prevent ionization of the analyte.
○ (c) prevent formation of metal oxides.

---

7 of 15

A higher temperature in the atomizer would

○ (a) be a benefit in atomic absorption.
○ (b) be a benefit in atomic emission.
○ (c) have a negative effect on both atomic absorption and atomic emission.

---

8 of 15

A sample containing an unknown concentration of Ca^{2+} gave an absorbance of 0.250 in atomic absorption. "Spiking" the sample with enough Ca^{2+} to increase the concentration by 0.200 M, without significantly diluting the sample, gave an absorbance of 0.450. The concentration of Ca^{2+} in the original sample was

○ (a) 0.111 molar.
○ (b) 0.077 molar.
○ (c) 0.250 molar.

---

9 of 15

Doppler broadening is due to

○ (a) movement of atoms toward and away from the source.
○ (b) collisions between atoms in the flame.

○ (c) increasing line width of the incident light.

---

10 of 15

Hollow cathode lamps

○ (a) are used for atomic absorption and ICP-MS.
○ (b) are used for atomic emission.
○ (c) differ for each element studied.

---

11 of 15

The general types of atomic spectroscopy are

○ (a) absorption, flame, and emission.
○ (b) absorption, phosphorescence, and emission.
○ (c) absorption, fluorescence, and emission.

---

12 of 15

The optical spectra of liquids and solids are typically

○ (a) ~1000 nm, and the spectra of gaseous atoms are ~0.001 nm.
○ (b) ~100 nm, and the spectra of gaseous atoms are ~0.0001 nm.
○ (c) ~0.0001 nm, and the spectra of gaseous atoms are ~100 nm.

---

13 of 15

The Boltzmann distribution describes

○ (a) the relative error of different states at thermal equilibrium.
○ (b) the relative populations of different states at thermal equilibrium.
○ (c) the relative populations of different states at chemical equilibrium.

---

14 of 15

The Heisenberg uncertainty principle says that

○ (a) the shorter the lifetime of the excited state, the more uncertain is its energy.

○ (b) the longer the lifetime of the excited state, the more uncertain is its energy.

○ (c) the shorter the lifetime of the ground state, the more uncertain is its energy.

---

15 of 15

Atomic spectroscopy must provide background correction to

○ (a) distinguish interfering signal from absorption, emission, and optical scattering of the sample matrix, the flame, plasma, or white-hot graphite furnace.

○ (b) distinguish analyte signal from absorption, emission, and optical scattering of the sample matrix, the flame, plasma, or white-hot graphite furnace.

○ (c) distinguish analyte signal from absorption, emission, and optical scattering of the sample.

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Answer Sheet: Chapter____21___________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 21-Mass Spectrometry

---

1 of 15

The resolving power (*R*) of a mass spectrometer is computed by dividing the mass of the 1st peak of two adjacent peaks by the mass difference between the two peaks. If a mass spectrometer were to resolve N_2^+ (mass = 28.0061 Dalton) and CO^+ (mass = 27.9949 Dalton), the resolving power would be

○ (a) 2,500.

○ (b) 4.00×10^{-4}.

○ (c) 0.9996.

---

2 of 15

The mass spectrum of a compound containing nitrogen had an $M^{+}\cdot$ nominal mass of 93. This means that

○ (a) the compound contains an even number of nitrogens.

○ (b) the compound contains an odd number of nitrogens.

○ (c) the compound contains an even number of nitrogens and an odd number of chlorines.

---

3 of 15

In the mass spectrum of a compound containing only carbon and hydrogen, the most intense peak was found at *m/z* = 78. This peak is designated at the $M^{+}\cdot$peak. The M + 1 peak was determined to be 13% of the M^+ peak. Using the information below, how many carbon atoms should be contained in the compound?

Element	X + 1
H	0.012*n*
C	1.08*n*
N	0.369*n*

○ (a) 6 carbons atoms

○ (b) 12 carbons atoms

○ (c) 18 carbon atoms

---

4 of 15

If the composition of a molecular ion is known, and you wish to propose a structure for the molecular ion, the number of rings + double bonds may be calculated. A compound with a composition C_8H_8NBrCl contains how many double bonds and rings?

○ (a) 4.5

○ (b) 4

○ (c) 5

---

5 of 15

With electron ionization of the sample in a mass spectrometer, the sample will fragment into pieces which are recorded by the detector. Some fragments are more probable than others. Which of the following fragments is *least* likely to be found in a mass spectrum?

○ (a) $\cdot CH_2$

○ (b) $\cdot CH_3$

○ (c) $\cdot C_3H_9$

---

6 of 15

The nominal mass of a molecule or ion is

○ (a) the weighted average of the masses of the isotopes of an element.

○ (b) the sum of atomic masses listed in the periodic table.

○ (c) the integer mass of the species with the most abundant isotope of each of the constituent atoms.

---

7 of 15

Which of the following best describes a magnetic sector mass spectrometer?

○ (a) The instrument uses a magnetic field, the strength of which may be changed to allow ions of a selected *m/z* ratio to pass from the source to the detector.

○ (b) The instrument uses four parallel metal rods to which are applied varied voltages and a radio frequency, to separate ions of *m/z* units.

○ (c) The instrument accelerates ions into a drift region.

---

8 of 15

The difference between chemical ionization and electron ionization is

○ (a) chemical ionization produces more fragmentation of the molecules and thus makes the spectrum easier to interpret.

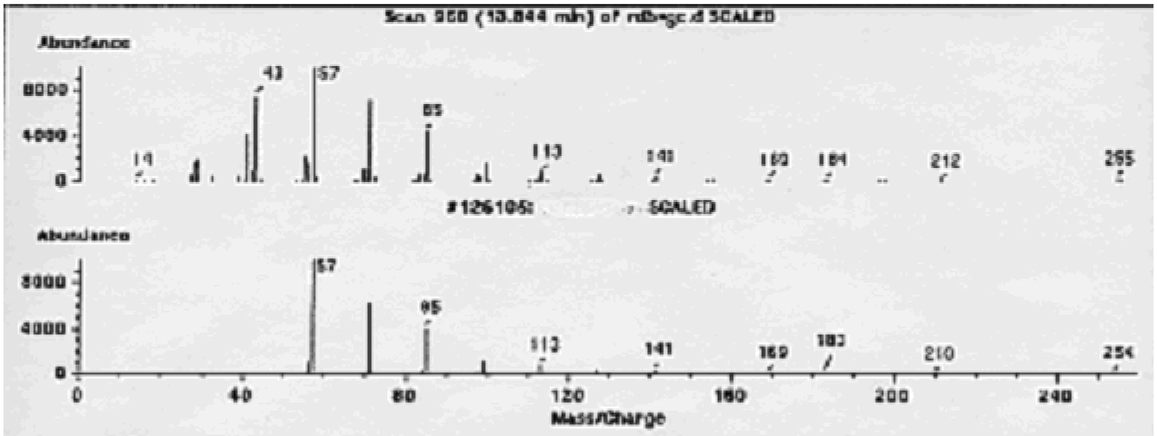
○ (b) Chemical ionization yields less fragmentation than electron ionization.

○ (c) Chemical ionization involves accelerating electrons to interact with incoming molecules while electron ionization uses an ionized reagent gas to produce *m/z* units.

---

9 of 15

The mass spectrum shown below was generated by analyzing a peak emerging from a gas chromatograph at 13.54 minutes. The top set of points was the actual data recorded; the bottom set of data was taken from the spectrum library as a match for this compound. Which of the following choices is the best choice for the identification of this compound?



○ (a) $C_{16}H_{34}$

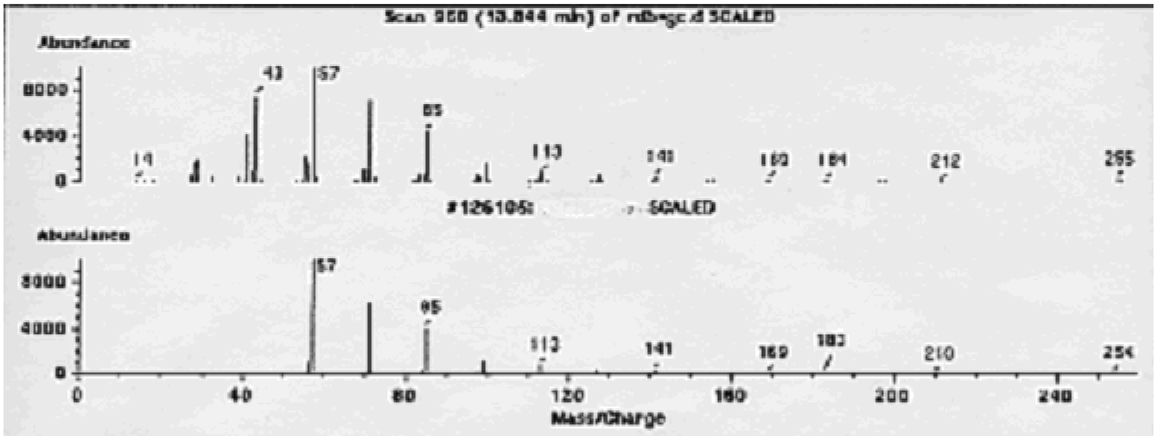
○ (b) $C_{18}H_{38}$

○ (c) $C_{20}H_{42}$

---

10 of 15

The mass spectrum shown below was generated by analyzing a peak emerging from a gas chromatograph at 13.84 minutes. The top set of points was the actual recorded data. The bottom set of data was taken from the spectrum library as a match for this compound. Look carefully at the mass to charge peaks present. A common small molecule fragment produced by the electron ionization of the compound is



○ (a) C_2H_4.
○ (b) C_2H_6.
○ (c) C_3H_8.

11 of 15

The time-of-flight instrument is

○ (a) not capable of high acquisition rates and has a nearly unlimited upper-mass range.
○ (b) capable of high acquisition rates with a limited upper-mass range.
○ (c) capable of high acquisition rates and has a nearly unlimited upper-mass range.

12 of 15

Mass spectrometry has long been used to

○ (a) measure isotopes and decipher organic structures.
○ (b) measure isotopes and decipher inorganic structures.
○ (c) measure gases and decipher inorganic structures.

13 of 15

The most intense peak in a mass spectrum is called

○ (a) the mass spectrum.
○ (b) the mass-to-charge ratio.

○ (c) the base peak.

---

14 of 15

Which is a detector of choice for gas chromatography?

○ (a) transmission quadruple mass spectrometer
○ (b) magnetic sector mass spectrometer
○ (c) double-focusing mass spectrometer

---

15 of 15

The main limitation on resolving power of a time-of-flight mass spectrometer is

○ (a) that all ions emerge from the source with the same kinetic energy.
○ (b) that all ions do not emerge from the source with different kinetic energy.
○ (c) that all ions do not emerge from the source with the same kinetic energy.

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Answer Sheet: Chapter______22_________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 22-Introduction to Analytical Separations

---

1 of 16

An organic chemist is planning to extract 1.00 gram of an organic compound dissolved in 200.0 mL of water into a diethyl ether solvent. The distribution coefficient for this system is 9.5 favoring the ether solvent. If the chemist washes the aqueous solution three times with 50.0 mL of diethyl ether, what percent of the original organic compound remains in the aqueous solvent?

○ (a) 29.63%

○ (b) 2.60%

○ (c) 0.00169%

---

2 of 16

The distribution coefficient for metal ion extraction depends on

○ (a) the volume of organic and aqueous solvents used, as well as the number of times the sample is extracted.

○ (b) the concentration of the ligand.

○ (c) the concentration of the ligand and the pH of the solution.

---

3 of 16

In which type of chromatograph is the interaction between the analyte and the stationary phase due to the size of the molecule only?

○ (a) adsorption chromatography

○ (b) partition chromatography

○ (c) gel permeation chromatography

---

4 of 16

Which type of chromatography uses a liquid stationary phase?

○ (a) adsorption chromatography

○ (b) ion-exchange chromatography

○ (c) partition chromatography

---

5 of 16

Retention time is defined as

○ (a) the time needed for an individual band of analyte to be eluted.

○ (b) the time needed for all solutes in a sample to be eluted.

○ (c) the time needed after injection for an individual solute to be eluted.

---

6 of 16

To improve a chromatographic separation, you must

○ (a) increase the number of theoretical plates on the column.

○ (b) increase the height of the theoretical plates on the column.

○ (c) increase both the number and the height of the theoretical plates on the column.

---

7 of 16

In a given chromatographic column,

○ (a) different solutes behave as if there are a different number of theoretical plates for each.

○ (b) the number of theoretical plates is the same for all solutes.

○ (c) efficiency is improved by increasing plate height.

---

8 of 16

If you wish to change your column to separate double the mass of your sample and still maintain the same resolution without changing the column length, you would need

○ (a) a column with twice the radius of the original column.

○ (b) a flow rate twice the rate in the original column.

○ (c) double the volume of solvent added to the solute before application on the column.

---

9 of 16

Increasing the flow rate of the mobile phase would

○ (a) increase longitudinal diffusion.
○ (b) increase broadening due to mass transfer.
○ (c) increase broadening due to multiple paths.

---

10 of 16

In comparing open tubular columns to packed columns with a gaseous mobile phase,

○ (a) a packed column is generally much longer than an open tubular column.
○ (b) both are used for preparative separation.
○ (c) the packed column does not give as good resolution as the open tubular column.

---

11 of 16

A solute with a retention time of 325 seconds has a base width of 15 seconds. The column is 11,500 cm long. The column has how many theoretical plates?

○ (a) 7,512
○ (b) 625
○ (c) 15.3

---

12 of 16

A single extraction with 100 mL of $CHCl_3$ extracts or removes 88.5% of the weak acid, HA, from 50.0 mL of aqueous solution. What is the distribution coefficient, D, for HA at a pH = 3.00? The K_a for HA is 3.5×10^{-5}.

○ (a) 0.065
○ (b) 3.98
○ (c) 3.85

---

13 of 16

A single extraction with 100 mL of $CHCl_3$ extracts or removes 88.5% of the weak acid, HA, from 50 mL of aqueous solution. What is the partition coefficient, K, for HA at a pH = 3.00? The K_a for HA is 3.5×10^{-5}.

○ (a) 0.067

○ (b) 3.98
○ (c) 3.85

---

14 of 16

A single extraction with 100 mL of $CHCl_3$ extracts or removes 88.5% of the weak acid, HA (K_a = 3.5 x 10^{-5}), from 50 mL of aqueous solution at a pH = 3.00. If a student carries out the same extraction at a pH = 7.00 and reports that fraction remaining in the aqueous phase is 0.01, is this result reasonable?

○ (a) This result is reasonable. A^- is the principal species in solution, which is less soluble in the aqueous phase. Therefore, <11.5% should remain in aqueous phase.
○ (b) This result is not reasonable. HA is the principal species in solution, which is less soluble in the aqueous phase. Therefore, >11.5% should remain in aqueous phase.
○ (c) This result is not reasonable. A^- is the principal species in solution, which is more soluble in the aqueous phase. Therefore, >11.5% should remain in aqueous phase, not 1%.

---

15 of 16

How many 50 mL extractions will it take to remove 95% of Compound A that is in 20 mL of water, if K = 0.3?

○ (a) 5.3
○ (b) 6
○ (c) 1

---

16 of 16

Assuming that V_{aq} = 50 mL and a partition coefficient of K = 4, calculate the fraction of the solute that remains in the aqueous phase after four extractions using 25 mL of organic solvent for each extraction.

○ (a) 0.33
○ (b) 1.20%
○ (c) 0.012

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Answer Sheet: Chapter______23_________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 23-Gas Chromatography

---

1 of 17

The fluid exiting a chromatographic column is called the

○ (a) eluent.
○ (b) eluate.
○ (c) analyte.

---

2 of 17

Which is the most common carrier gas for gas chromatography?

○ (a) helium
○ (b) nitrogen
○ (c) hydrogen

---

3 of 17

In a gas chromatography experiment using a non-polar stationary phase

○ (a) solutes are eluted in order of increasing boiling point.
○ (b) solutes are eluted in order of increasing vapor pressure.
○ (c) solutes are eluted in order of increasing polarity.

---

4 of 17

You can improve the separation of components in gas chromatography by

○ (a) raising the temperature of the injection port.
○ (b) raising the temperature of the column isothermally.
○ (c) raising the temperature of the column programmatically.

---

5 of 17

Solvent trapping is used for

○ (a) analysis of trace components.
○ (b) analysis of high-boiling major components.
○ (c) analysis of low-boiling major components.

---

6 of 17

Open tubular columns of less than 0.53 mm in diameter

○ (a) cannot be used for on-column injection of analyte with a standard injection needle.
○ (b) do not give resolution as good as that of wider columns.
○ (c) are excellent when used with thermal conductivity detectors.

---

7 of 17

Solutes containing halogens can best be studied in gas chromatography with

○ (a) a flame ionization detector.
○ (b) an electron capture detector.
○ (c) a flame photometric detector.

---

8 of 17

The retention index

○ (a) relates the retention time of a solute to the retention times of linear alkanes.
○ (b) for a linear alkane equals the number of carbon atoms.
○ (c) is the length of time required for a solute injected onto a column to elute from the column.

---

9 of 17

A split injection on a gas chromatograph is normally preferred when

○ (a) the analyte is less than 0.01% of the sample.
○ (b) when the analyte is greater than 0.10% of the sample.
○ (c) the analyte contains two substances with widely different retention times. Splitting

the injection allows the sample to be analyzed much more quickly.

---

10 of 17

An on-column injection is used

○ (a) when a very small amount of analyte is present in the sample.

○ (b) when the sample decomposes above its boiling point.

○ (c) when the sample is not going to be used for quantitative analysis.

---

11 of 17

Decreasing the thickness of the stationary phase leads to

○ (a) decreased plate height, decreased retention time, and decreased capacity for the analyte.

○ (b) decreased plate height, decreased retention time, and increased capacity for the analyte.

○ (c) decreased plate height, increased retention time, and decreased capacity for the analyte.

---

12 of 17

Compared with packed columns, open tubular columns offer

○ (a) higher resolution, shorter analysis time, greater sensitivity, and larger sample capacity.

○ (b) higher resolution, shorter analysis time, greater sensitivity, and lower sample capacity.

○ (c) higher resolution, longer analysis time, greater sensitivity, and larger sample capacity.

---

13 of 17

Which terms/items are associated with GC?

○ (a) Temperature programming, sample loop, and thermal conductivity.

○ (b) Temperature programming, air blank, and thermal conductivity.

○ (c) Temperature programming, reversed phase, and thermal conductivity.

---

14 of 17

In GC, separation between two different solutes occurs because

○ (a) the solutes have different solubilities in the mobile phase.
○ (b) the solutes volatilize at different rates in the injector.
○ (c) the solutes spend different amounts of time on the stationary phase.

---

15 of 17

Typical GC detectors include

○ (a) flame ionization, thermal conductivity, electron capture, and mass spectrometer.
○ (b) ultraviolet, fluorescence, amperometric, and conductivity.
○ (c) spectrophotometer, refractive index, light scattering, and electrochemical.

---

16 of 17

A TCD or thermal conductivity detector measures the

○ (a) ability of a substance to transport heat from a cold region to a hot region.
○ (b) ability of a substance to transport heat from a hot region to a cold region.
○ (c) ability of the detector to transport heat from a hot region to a cold region.

---

17 of 17

A good technique for using a GC syringe to inject liquid sample into a gas chromatograph is

○ (a) after cleaning the syringe several times with solvent, take up air, then sample, and then more air.

○ (b) after cleaning the syringe several times with nitrogen, take up solvent, then sample, and then more solvent.

○ (c) after cleaning the syringe several times with solvent, take up air, then solvent, then air, then sample, and then more air.

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Answer Sheet: Chapter______24_________

Name__________________________

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Date___________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 24-High-Performance Liquid Chromatography

---

1 of 15

HPLC stands for

○ (a) High Pressure Liquid Chromatography

○ (b) High Performance Liquid Chromatography

○ (c) Highly Placed Liquid Chromatography

---

2 of 15

A source of error in liquid chromatography is

○ (a) allowing solvent to drain below the top of the stationary phase.

○ (b) using a slow flow rate.

○ (c) filling the column with a slurry of stationary solid phase rather than with the solid phase alone.

---

3 of 15

Normal-phase liquid chromatography refers to

○ (a) the use of a nonpolar solvent as the eluent in HPLC.

○ (b) the use of a polar material as the stationary phase in a chromatographic column.

○ (c) the use of a nonpolar material as the stationary phase in a chromatographic column.

---

4 of 15

Reversed-phase HPLC of a multi-component solute usually uses

○ (a) an isocratic polar solvent.

○ (b) a gradient from more polar to less polar solvent.

○ (c) a gradient from less polar to more polar solvent.

---

5 of 15

The use of smaller stationary phase particles in liquid chromatography

○ (a) increases relative surface area, and therefore, improves resolution.

○ (b) increases the magnitude of irregular flow paths.

○ (c) decreases the resistance to solvent flow.

---

6 of 15

Which of the following statements is true for a refractive index detector in HPLC?

○ (a) It is more sensitive than a UV detector.

○ (b) It can only be used for isocratic elutions.

○ (c) It does not respond to many solutes.

---

7 of 15

An eluotropic series

○ (a) ranks solvents by their relative abilities to displace solutes from a given adsorbent.

○ (b) ranks column packing material by their relative abilities to retain solutes on the column.

○ (c) is a measure of the solvent adsorption energy.

---

8 of 15

A new chromatographic method should have the following attributes

○ (a) adequate resolution of the desired analytes, a short run time, and not be drastically affected by variations in conditions.

○ (b) adequate resolution of the desired analytes, a short-run time, not drastically affected by variations in conditions, and use a reversed-phase column for versatility.

○ (c) determine a goal, select a method of sample preparation, and choose a detector.

---

9 of 15

Dwell volume is defined as

○ (a) the volume of solvent contained in a liquid chromatographic column.

○ (b) the time required for the gradient to reach the column.

○ (c) the volume of the column between the point at which solvents are mixed and the beginning of the column.

---

10 of 15

In the selection of a detector for a chromatographic method utilizing a gradient, some possible choices would be

○ (a) ultraviolet detector, refractive index detector, or an electrochemical detector.

○ (b) ultraviolet detector, fluorescence detector, or mass spectrometer.

○ (c) refractive index detector, electrochemical detector, and conductivity detector.

---

11 of 15

Which terms/items are associated with HPLC?

○ (a) Reversed phase, air blank, and sample loop.

○ (b) Reversed phase, polymeric C_{18} bonded phase, and thermal conductivity detector.

○ (c) Reversed phase, polymeric C_{18} bonded phase, and sample loop.

---

12 of 15

Which statement is correct?

○ (a) An HPLC solvent system that begins with 20:80 acetonitrile:water and ends with 50:50 acetonitrile:water is gradient elution.

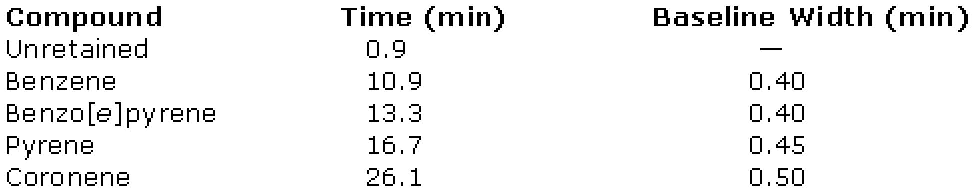
○ (b) An HPLC solvent system that begins with 20:80 acetonitrile:water and ends with 50:50 acetonitrile:water is an isocratic elution.

○ (c) An HPLC solvent system that begins with 20:80 acetonitrile:water and ends with 50:50 acetonitrile:water is an isosolvent elution.

---

13 of 15

Listed below are retention times and peak widths for an HPLC chromatographic separation on a 10 cm C_{18} column. Calculate the theoretical number of plates for benzo[*e*]pyrene.



Compound	Time (min)	Baseline Width (min)
Unretained	0.9	—
Benzene	10.9	0.40
Benzo[*e*]pyrene	13.3	0.40
Pyrene	16.7	0.45
Coronene	26.1	0.50

○ (a) 532

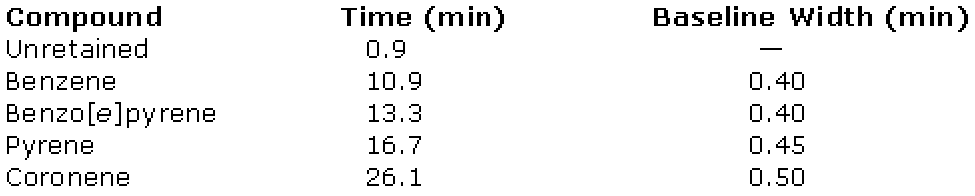
○ (b) 15,376

○ (c) 17,689

---

14 of 15

Listed below are retention times and peak widths for an HPLC chromatographic separation on a 10 cm C_{18} column. Calculate the capacity factors for pyrene and coronene.



Compound	Time (min)	Baseline Width (min)
Unretained	0.9	—
Benzene	10.9	0.40
Benzo[*e*]pyrene	13.3	0.40
Pyrene	16.7	0.45
Coronene	26.1	0.50

○ (a) Pyrene k' = 35.1 and coronene k' = 50.4

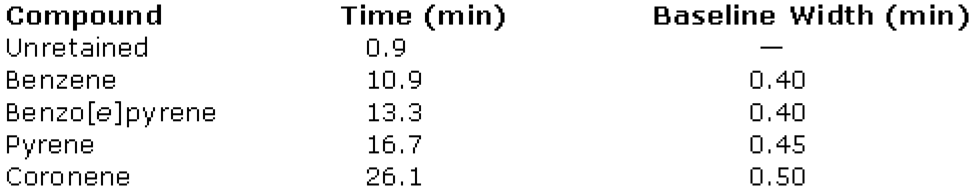
○ (b) Pyrene k' = 17.6 and coronene k' = 28.0

○ (c) Pyrene k' = 18.6 and coronene k' = 29.0

---

15 of 15

Listed below are retention times and peak widths for an HPLC chromatographic separation on a 10 cm C_{18} column. Calculate the relative retention between pyrene and coronene.



Compound	Time (min)	Baseline Width (min)
Unretained	0.9	—
Benzene	10.9	0.40
Benzo[*e*]pyrene	13.3	0.40
Pyrene	16.7	0.45
Coronene	26.1	0.50

○ (a) 0.63

○ (b) 1.59

○ (c) 1.56

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Answer Sheet: Chapter_____25__________

Name__________________________

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Date___________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 25-Chromatographic Methods and Capillary Electrophoresis

---

1 of 15

Passing a solution of $Ca(NO_3)_2$ and Na_2SO_4 through a mixed ion-exchange resin would give an eluate that is

○ (a) neutral.
○ (b) acidic.
○ (c) basic.

---

2 of 15

Passing a solution of $Ca(NO_3)_2$ and Na_2SO_4 through a cation exchange resin would give an eluate that is

○ (a) neutral.
○ (b) acidic.
○ (c) basic.

---

3 of 15

A gel-filtration column has a radius of 0.75 cm and a length of 30.0 cm. If 70% of the volume of the column is occupied by the stationary phase and the volume inside the pores, calculate the void volume.

○ (a) 53.0 mL
○ (b) 37.1 mL
○ (c) 15.9 mL

---

4 of 15

In gel-permeation chromatography, there is a linear relationship between

○ (a) retention volume and molecular mass.
○ (b) retention volume and log of the molecular mass.
○ (c) molecular mass and log of the retention volume.

---

5 of 15

In capillary electrophoresis

○ (a) anions move to the anode, cations move to the cathode, and neutral molecules do not migrate.

○ (b) anions and cations move to the cathode, neutral molecules do not migrate.

○ (c) anions, cations and neutral molecules all move to the cathode.

---

6 of 15

Two neutral molecules, A and B, are separated by micellar electrokinetic capillary chromatography. A is more soluble in the micelle than B. The order in which they arrive at the detector is

○ (a) micelle followed by A, which is followed by B.

○ (b) A followed by B, which is followed by the micelle.

○ (c) B followed by A, which is followed by the micelle.

---

7 of 15

A sample containing 2.00 x 10^{-2} mmol of $CuS0_4$ and 3.00 x 10^{-2} mmol of KNO_3 is passed through a cation-exchange column. The volume of 0.0100 M NaOH needed to titrate the eluate is

○ (a) 7.00 mL.

○ (b) 10.00 mL.

○ (c) 5.00 mL.

---

8 of 15

A suppressor column in suppressed-ion chromatography

○ (a) converts the analyte to a non-ionic form.

○ (b) converts the ionic eluent to a non-ionic form.

○ (c) separates the analyte components.

---

9 of 15

Capillary electrophoresis differs from other chromatographic methods because

- ○ (a) it uses unique detectors.
- ○ (b) there is no stationary phase.
- ○ (c) it has fewer theoretical plates.

---

10 of 15

Binding to an ion-exchange resin is stronger for

- ○ (a) ions with higher charges.
- ○ (b) ions with a larger hydrated radius.
- ○ (c) ions with a smaller "bare" radius.

---

11 of 15

In ion-exchange chromatography, the equilibrium constant is called

- ○ (a) the activity coefficient.
- ○ (b) the selectivity coefficient.
- ○ (c) the formation constant.

---

12 of 15

Three classes of ion exchangers are

- ○ (a) resins, gels, and organic.
- ○ (b) resins, epoxies, and inorganic.
- ○ (c) resins, gels, and inorganic.

---

13 of 15

In molecular exclusion or gel permeation chromatography, large molecules

- ○ (a) pass through the column slower than small molecules.
- ○ (b) pass through the column faster than small molecules.
- ○ (c) pass through the column at the same rate as small molecules.

---

14 of 15

What technique is based on a compound's specific binding to the stationary phase?

○ (a) affinity chromatography

○ (b) molecular exclusion chromatography

○ (c) ion chromatography

---

15 of 15

Micellar electrokinetic chromatography separates

○ (a) neutral molecules.

○ (b) neutral molecules and ions.

○ (c) ions.

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Name__________________________

USM ID________________________

Date___________________________

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 26-Gravimetric Analysis, Precipitation Titrations, and Combustion Analysis

---

1 of 15

When performing a gravimetric analysis in which a product is precipitated, isolated, and weighed, coprecipitation is a constant concern. Coprecipitation involves

○ (a) the precipitation of two insoluble substances simultaneously from the same solution.

○ (b) the precipitation of a normally soluble material with an insoluble material.

○ (c) The failure to separate two insoluble materials because the most soluble material begins to precipitate before the most insoluble material has been removed from the solution.

---

2 of 15

To obtain a precipitate that is useful for gravimetric analysis, the analyst tries to obtain conditions to encourage crystal growth, as opposed to the formation of a colloid. Which of the following statements aids in the formation of a crystalline precipitate?

○ (a) The solution is kept cool to slow down the movement of ions to allow crystals to form.

○ (b) The solutions are made as dilute as practical to allow crystals to form slowly.

○ (c) The solutions are mixed rapidly to allow the appropriate ions to make contact without interference of other materials.

---

3 of 15

Which of the following processes is true regarding the digestion of a solution containing a precipitate?

○ (a) Digestion tends to increase particle size of the precipitate.

○ (b) Digestion is used to slow down the coagulation of a colloidal precipitate because of the increased energy added to the solution.

○ (c) A long digestion is not recommended because the higher temperatures enable impurities to become trapped in the crystal lattice of the precipitate.

---

4 of 15

In the gravimetric analysis of iron, hydroxide may be added to a solution containing Fe^{3+} to precipitate a gelatinous mess, which is ignited to form Fe_2O_3. If 0.2864 gram of Fe_2O_3 were formed from the ignition of the precipitated mess, how many grams of $FeCO_3$ were contained in the original sample analyzed?

○ (a) 0.4155 g $FeCO_3$

○ (b) The answer cannot be computed because the sample did not contain any Fe^{2+}.

○ (c) 0.2078 g $FeCO_3$

---

5 of 15

The chloride content of a sample may be analyzed gravimetrically by adding a solution of silver nitrate to a solution containing chloride ion. The analyst typically assumes that the sample is pure NaCl to determine the quantity of silver nitrate needed for the precipitation. If an analyst dissolved a 0.2681 gram sample containing chloride ion in a dilute nitric acid solution, how many mL of 0.20 M silver nitrate should be added to the chloride solution to completely precipitate the chloride ion?

○ (a) 0.90 mL

○ (b) 23 mL

○ (c) 38 mL

---

6 of 15

In the combustion of phthalic acid [$C_6H_4(COOH)_2$], how many moles of water are produced per mole of phthalic acid burned?

○ (a) 6 mol H_2O

○ (b) 3 mol H_2O

○ (c) 4 mol H_2O

---

7 of 15

A sample contains 0.2784 grams of sodium chloride (NaCl) and 0.5486 grams of magnesium chloride ($MgCl_2$). The chloride in the sample was precipitated by the addition of 47.8 mL of a silver nitrate solution. What is the concentration of the silver nitrate solution?

○ (a) 0.341M $AgNO_3$

○ (b) 0.220 M $AgNO_3$

○ (c) 0.00341 M $AgNO_3$

---

8 of 15

A sample of ore containing manganese weighed 1.2354 grams. This sample was heated in a solution of nitric acid, which dissolved the manganese ion producing manganese(III) nitrate [$Mn(NO_3)_3$]. The acidity of the solution was adjusted, and hydrogen sulfide gas was bubbled into the solution producing 0.2876 grams of manganese(III) sulfide [Mn_2S_3]. What is the percentage of manganese in the original sample?

○ (a) 12.41% Mn

○ (b) 6.19% Mn

○ (c) 3.09% Mn

---

9 of 15

A sample containing Al_2O_3 and $Na_2Cr_2O_7 \bullet 2H_2O$ was brought into the laboratory for analysis. The analyst heated a 2.2846 gram sample of this material to 100 °C for one hour, at which time only Al_2O_3 and $Na_2Cr_2O_7$ remained. This mixture was found to weigh 2.2312 grams. Calculate the percent chromium in the sample.

○ (a) 6.746% Cr

○ (b) 13.50% Cr

○ (c) 16.97% Cr

---

10 of 15

In gravimetric analysis,

○ (a) the mass of a solution is used to calculate the quantity of the original analyte.

○ (b) the mass of a product is used to calculate the quantity of the original analyte.

○ (c) the mass of a product is used to calculate the quantity of the impurity.

---

11 of 15

In gravimetric analysis, the ideal product should be

○ (a) very pure, soluble, and should possess a known composition.

○ (b) very pure, insoluble, easily filterable, and should possess an unknown composition.

○ (c) very pure, insoluble, easily filterable, and should possess a known composition.

---

12 of 15

Which statement is correct?

○ (a) *Adsorption* involves penetration beyond the surface to the inside, and *absorption* means attachment to the surface.

○ (b) *Adsorption* means attachment to the surface, and *absorption* involves penetration beyond the surface, to the inside.

○ (c) *Adsorption* involves penetration beyond the surface to the inside, and *absorption* refers to the interaction of light with matter.

---

13 of 15

Gravimetric combustion analysis is used to

○ (a) determine the oxygen and hydrogen content of organic compounds.

○ (b) determine the carbon and hydrogen content of organic compounds burned in excess He.

○ (c) determine the carbon and hydrogen content of organic compounds burned in excess O_2.

---

14 of 15

A compound weighing 2.865 g produced 1.697 g of H_2O upon combustion. Calculate the weight percent of H in the sample.

○ (a) 6.628%

○ (b) 18.989%

○ (c) 3.13%

---

15 of 15

A compound weighing 2.865 g produced 0.975 g of CO_2 upon combustion. Calculate the weight percent of C in the sample.

○ (a) 26.61%

○ (b) 0.09287%

○ (c) 9.287%

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Answer Sheet: Chapter______27_________

Name____________________________

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Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																				
Q	21	22	23	24	25	26	27	28	29	30										
A																				

Chapter 27-Sample Preparation

---

1 of 16

You and your friends are visiting the M&M candy factory at Christmas time. Just as you walk in the door, there is a terrible spill and 100,000 red M&Ms along with 60,000 green M&Ms have just spilled on the floor. You madly start grabbing M&Ms and have managed to collect 1000 of them before management catches you. How many red M&Ms have you probably picked up?

○ (a) 625

○ (b) 375

○ (c) 500

---

2 of 16

You and your friends are visiting an M&M candy factory at Christmas time. Just as you walk in the door, there is a terrible spill and 100,000 red M&Ms along with 60,000 green M&Ms have just spilled on the floor. You madly start grabbing M&Ms and have managed to collect 1000 M&Ms, 625 of them red. If you repeat this scenario many times, what will be the absolute standard deviation of red M&Ms retrieved?

○ (a) 23

○ (b) 15

○ (c) 37

---

3 of 16

The overall variance is defined as

○ (a) the sum of the standard deviation from the analytical procedure and the standard deviation of the sampling operation.

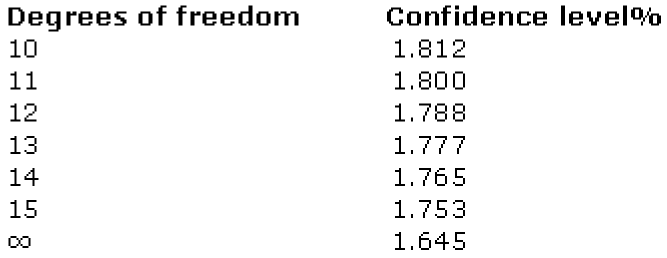
○ (b) the sum of the square of the standard deviation of the analytical procedure and the square of the standard deviation of the sampling operation.

○ (c) the square root of the sum of the square of the standard deviation of the analytical procedure plus the square of the standard deviation of the sampling operation.

---

4 of 16

An analyst is weighing out 1 gram samples and has determined that the sampling standard deviation for the process is 6%. Using the following table for confidence intervals, how many 1-g samples must be analyzed to give 90% confidence that the mean is known to within ±3%?



Degrees of freedom	Confidence level%
10	1.812
11	1.800
12	1.788
13	1.777
14	1.765
15	1.753
∞	1.645

○ (a) 11
○ (b) 12
○ (c) 13

---

5 of 16

When dissolving an inorganic material with an acid, HCl, HBr, or HF would be used to dissolve

○ (a) metals by forming a complex with the metal of interest.
○ (b) metals by utilizing the reduction potential of the metal relative to the acid.
○ (c) primarily non-metal oxides.

---

6 of 16

Which of the following material would be best dissolved in a basic flux containing $LiBO_2$?

○ (a) Acidic oxides of Si
○ (b) Cement
○ (c) Iron metal

---

7 of 16

Wet ashing refers to

○ (a) using a nonwetting agent such as KI with a flux to prevent the material from sticking to the crucible.
○ (b) the digesting of an organic material with a strong acid such as sulfuric acid in a

Kjeldahl digestion.

○ (c) heating an organic material with an acid flux.

---

8 of 16

Two methods of sample preparation that are especially useful for gas chromatography are

○ (a) solid-phase microextraction and purge and trap.

○ (b) microwave assisted extraction and supercritical fluid extraction.

○ (c) dry ashing and wet ashing.

---

9 of 16

Which of the following statements is true regarding the preparation of a sample for analysis?

○ (a) The sample is often dried at 110°C for one hour to remove surface absorbed water.

○ (b) To analyze elements such as nitrogen, phosphorous, halogens, and metals in an organic compound, a flux consisting of lithium tetraborate and sodium hydroxide is often used.

○ (c) To analyze for gold, the sample would be treated with a mixture of hydrochloric acid and nitric acid.

---

10 of 16

To validate a newly developed analytical method, the chemist would

○ (a) analyze Standard Reference Materials.

○ (b) analyze Standard Reference Materials, and verify the results by different methods.

○ (c) analyze Standard Reference Materials, verify results by different methods, and use standard additions.

---

11 of 16

The matrix effect in sample analysis is

○ (a) a change in the analytical signal caused by anything in the sample other than the analyte.

○ (b) is unimportant in analysis using destructive methods such as atomic absorption and inductively coupled plasma.

○ (c) is best minimized by preparing samples with material similar to the material analyzed.

---

12 of 16

Aqua regia is

○ (a) used to dissolve Au and Pt and is a 3:1 (vol/vol) mixture of HCl:HNO_3.

○ (b) used to dissolve Ag and Sn and is a 3:1 (vol/vol) mixture of HCl:HNO_3.

○ (c) used to dissolve Au and Pt and is a 3:1 (wt/wt) mixture of HCl:HNO_3.

---

13 of 16

Which extraction method uses a small volume of a chromatographic stationary phase?

○ (a) microwave assisted extraction

○ (b) supercritical-fluid extraction

○ (c) solid-phase extraction

---

14 of 16

You are planning a chromatography experiment that separates the colors used on the M&M candy coatings. Brown M&Ms make the most colorful chromatograms, as several colors are used in their coating. An 8 oz. bag of regular M&Ms has 250 candies (25 green, 25 orange, 25 blue, 50 red, 50 yellow, and 75 brown). If a child typically grabs 10 M&Ms in each handful from the bag, how many M&Ms will be brown?

○ (a) 3

○ (b) 1

○ (c) 2

---

15 of 16

You are planning a chromatography experiment that separates the colors used on the M&M candy coatings. Brown M&Ms make the most colorful chromatograms, as several colors are used in their coating. An 8 oz. bag of regular M&Ms has 250 candies (25 green, 25 orange, 25 blue, 50 red, 50 yellow, and 75 brown). An adult typically grabs 23 M&Ms (7 of them brown) in a handful from a bag. If this scenario is repeated many times over, what will be the absolute standard deviation of brown M&Ms retrieved?

○ (a) 5
○ (b) 2
○ (c) 7

16 of 16

Which statement is correct?

○ (a) Sampling is the process of selecting a bulk sample from the representative lot, and sample preparation is the process that converts a bulk sample into a heterogeneous laboratory sample.

○ (b) Sample preparation is the process of selecting a representative bulk sample from the lot, and sampling is the process that converts a bulk sample into a homogeneous laboratory sample.

○ (c) Sampling is the process of selecting a representative bulk sample from the lot, and sample preparation is the process that converts a bulk sample into a homogeneous laboratory sample.