

# **UNIT 1**

## **AP Chem Foundations Topic#1**

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**Foundations**

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**Formula Page**Measurements**Topic#1**

- SI Units - kilogram (kg), meter (m), second (s), Kelvin (K), and mole (mol)
  - 1 meter = 100cm =  $1 \times 10^3$ mm =  $1 \times 10^6$ μm =  $1 \times 10^9$ nm =  $1.0 \times 10^{10}$ Å =  $1.0 \times 10^{12}$ pm
  - 1 liter = 1dm<sup>3</sup> = 1000mL = 1000cm<sup>3</sup> (1.0mL = 1.0cm<sup>3</sup>)
- Significant Figures (sig figs)
- Dimensional Analysis
  - conversion factor
- Temperature
  - K = °C + 273
  - °F = 1.8°C + 32
- Density
  - $d = m/V$

Notes for me:

- Illustrate significant zeros (0.00123040)
- Illustrate density as a conversion factor ( $d_{Al} - 2.70\text{g/cm}^3$ )
- Demonstrate zeros as significant or not
- Uncertain digit

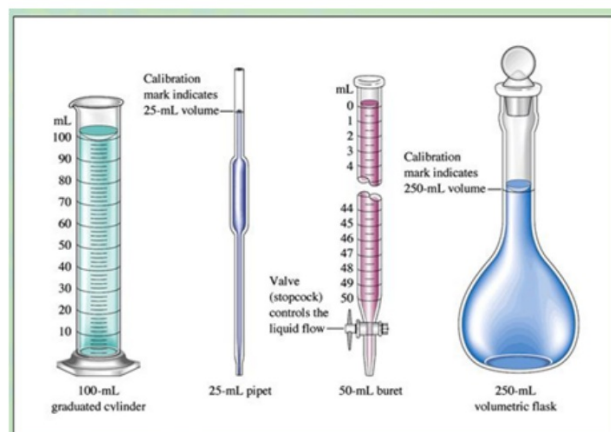
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1. In analyzing a sample of polluted water, a chemist measured out a 25.00mL water sample with a pipet (see figure). At another point in the analysis, the chemist used a graduated cylinder (see figure) to measure 25mL of a solution. What is the difference between the two measurements 25.00mL and 25mL?



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2. To check the accuracy of a graduated cylinder, as student filled the cylinder to the 25mL mark using water delivered from a buret (see figure) and then read the volume delivered. Following are the results of five trials:

Trial	Volume(Graduated Cylinder)	Volume (Buret)
1	25mL	26.54mL
2	25mL	26.51 mL
3	25mL	26.60 mL
4	25mL	26.49 mL
5	25mL	26.57 mL
Average	25mL	26.54 mL

Is the graduated cylinder accurate?

3. Give the significant figures for each of the following results.
- a) A student extraction procedure on tea yields 0.0105g of caffeine.
  - b) A student records a mass of 0.050080g in an analysis.
  - c) In an experiment a span of time is determined to be  $8.050 \times 10^{-3}$ s.
4. Write the number of significant figures for each of the following measurements:
- a) 3.00mL
  - b) 0.00290g
  - c) 50.00m
  - d) 0.070kg
  - e) 400L

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5. Combine the masses 0.0562kg, 124.213g, and 1635mg. The answer should be reported as: \_\_\_\_\_ g.
6. Carry out the following mathematical operations, and give each result with the correct number of significant figures.
- a)  $1.05 \times 10^{-3} \div 6.135$
  - b)  $21 - 13.8$
  - c) As part of a lab assignment to determine the value of the gas constant ( $R$ ), a student measured the pressure ( $P$ ) as 2.560atm, the temperature ( $T$ ) as 275.15K, and the volume ( $V$ ) as 8.8L. Using  $R = PV/T$ , solve for  $R$  in correct significant figures and label.

7. You want to order a bicycle with a 25.5in frame, but sizes in the catalog are given only in centimeters. What size should you order? (Ans: 64.8cm)

8. A student has entered a 10.0km run. How long is the run in miles? (Ans: 6.22 miles)



9. A Japanese car is advertised as having a gas mileage of 15km/L. Convert this rating to miles per gallon. (Ans: 35 mi/gal)
10. The latest model Corvette has an engine displacement of 6.20L. What is the displacement in units of cubic inches? (Ans: 378in<sup>3</sup>)

<b>Formula Page</b>	<b>Foundations Topic#1</b>	<b><math>K = ^\circ C + 273.15</math>   <math>^\circ F = 1.8^\circ C + 32</math></b>
	11. Normal body temperature is 98.6°F. Convert this temperature to the Celsius and Kelvin scales. (Ans: 37.0°C and 310.2K)	
	12. Convert -89.45°C to Kelvin. (Ans: 183.70K)	
	13. One interesting feature of the Celsius and Fahrenheit scales is that -40°C and -40°F represent the same temperature. Verify that this is true.	
	14. Liquid nitrogen, which is often used as a coolant for low-temperature experiments, has a boiling point of 77K. What is the temperature on the Fahrenheit scale? (Ans: -321°F)	

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15. A 5.75mL sample of mercury has a measured mass of 77.05g. The density is \_\_\_\_\_.

Mercury's accepted density is  $13.53\text{g}\cdot\text{mL}^{-1}$ . The % error in your measurement is: \_\_\_\_\_

What is the volume of 25.7g of mercury? (Ans:  $13.4\text{g}/\text{mL}$ ; 0.7%; 1.90mL)

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16. A chemist, trying to identify an unknown liquid, finds that  $25.00\text{cm}^3$  of the substance has a mass of  $19.625\text{g}$  at  $20^\circ\text{C}$ . The following are the names and densities of the compounds that might be the liquid:

Compound	Density ( $\text{g}/\text{cm}^3$ ) at $20^\circ\text{C}$
chloroform	1.492
diethyl ether	0.714
ethanol	0.789
isopropyl alcohol	0.785
toluene	0.867

Which of these compounds is the most likely to be the unknown liquid?

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17. Is this person with the illustrated dart throw accurate? Is this person precise?



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**Matter**

- Anything with a mass and a volume
- Phases: solid (*s*) [definite V and shape], liquid (*l*) [definite V, no definite shape], and gas (*g*) [no definite V or shape]
- Types:
  - Pure substances: elements and compounds
  - Mixtures: heterogeneous and homogeneous (solutions: solute (minor part) and solvent (major part))
  - Uniform substances: element, compound, and homogeneous mixtures
  - Non-uniform substances: heterogeneous mixtures
- Techniques to separate a mixture
  - distillation - using vapor pressure (VP) to separate liquids (use boiling point of separate)
  - filtration - separating of solid and a liquid
  - chromatography - using a mobile phase (liquid or gas) and a stationary phase (solid); components of the mixture have different affinities (attraction) for the two phases and thus move through the system at different rates. A component with a high affinity for the mobile phase moves quickly through the system while a component with a high affinity for the stationary phase moves more slowly.
    - paper chromatography
    - thin layer chromatography (TLC)

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**Matter**

Distillation

Aim: To study the process of separation of  
a mixture of two miscible liquids.

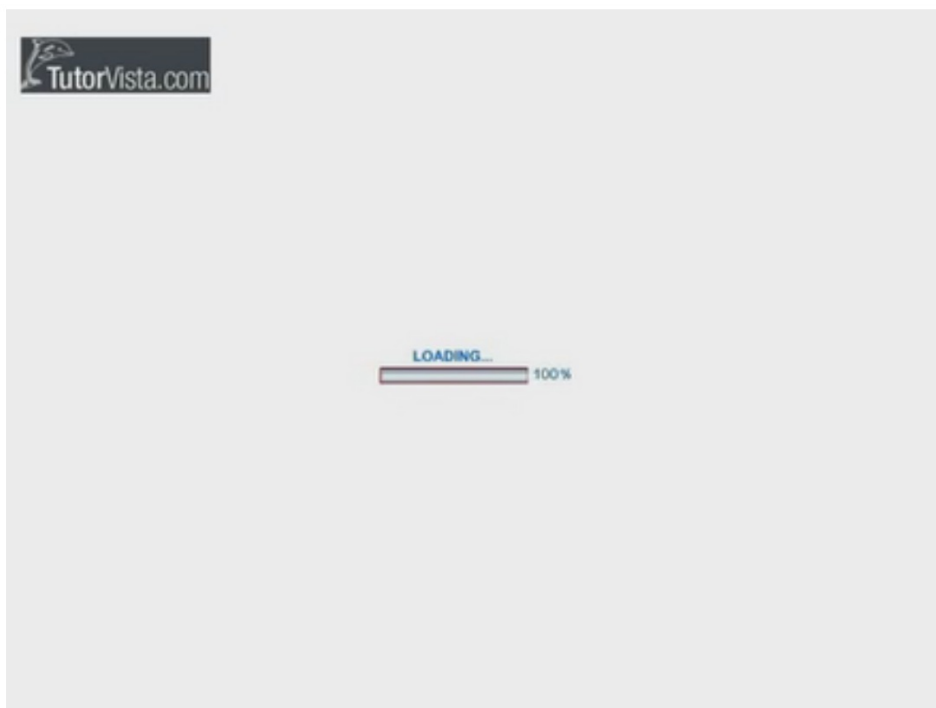
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Filtration



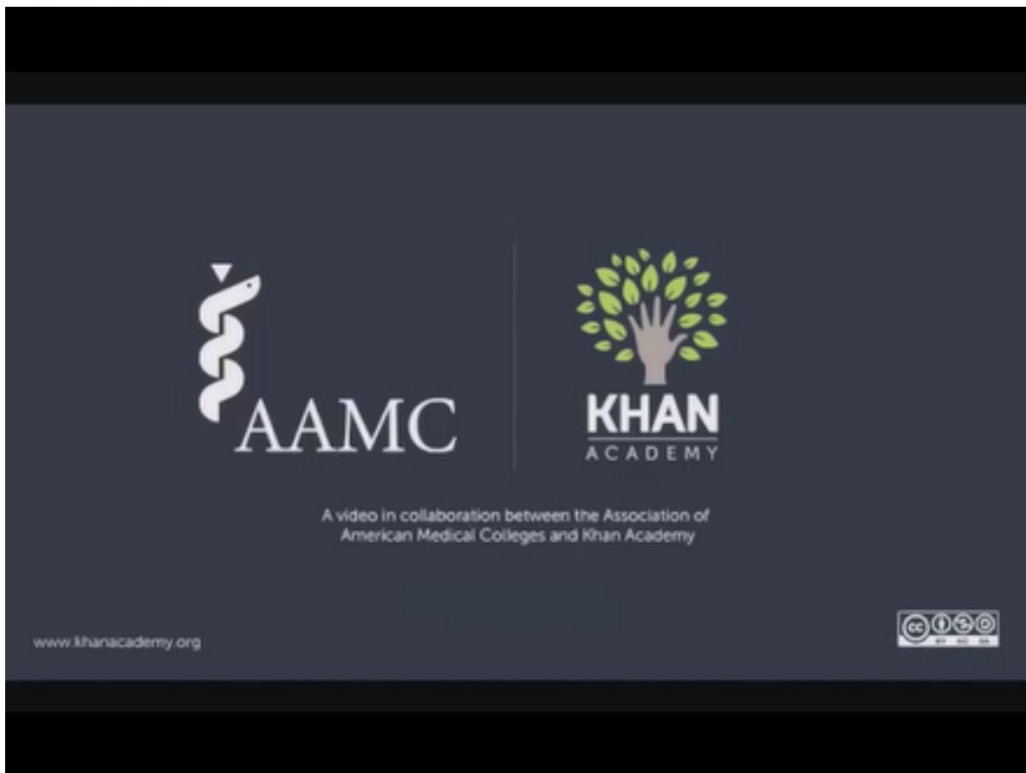


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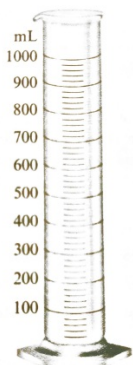
**Matter** Chromatography



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**AP Multiple Choice Review Questions**

1. When each of the following is heated to 50°C and the temperature is held constant for 5 minutes, which one undergoes *only* a physical change?  
(A) egg      (B) steak      (C) ice cream      (D) cake batter
2. A graduated cylinder contains multiple different liquid layers. Very small samples are taken from the liquids at various heights and tested for density, viscosity, and boiling point. The data are listed below.



mL mark	density (g/mL)	viscosity (Pa-s)	boiling point (°C)
1000	0.83	0.72	242.4
900	0.83	0.71	242.3
800	1.07	0.93	99.7
700	1.08	0.92	99.8
600	1.08	0.93	99.7
500	2.05	1.86	153.5
400	2.06	1.87	153.5
300	2.05	1.85	153.6
200	2.04	1.86	153.6
100	2.05	1.86	153.5

Ans:

- How many liquids are present in the graduated cylinder?  
(A) 1      (B) 2      (C) 3      (D) 4

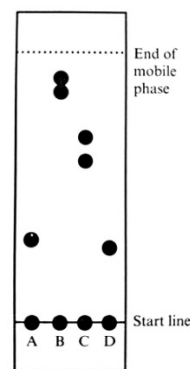
**AP Multiple Choice Review Questions**

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3. Four different kinds of ink are placed on chromatography paper, and a solvent is introduced and allowed to move up the paper.

From the diagram shown to the right, which two inks are likely to contain molecules that have the most similar molecular structures?

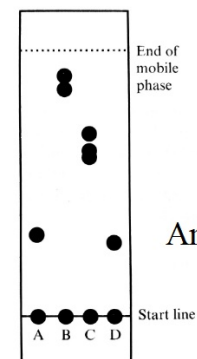
- (A) A and D      (B) B and D      (C) B and C      (D) A and C



4. Four different inks are placed on chromatography paper, and a solvent is introduced and allowed to move up the paper.

From the diagram shown to the right, which ink contains a component likely to have a molecule most similar to that of the solvent?

- (A) A      (B) B      (C) C      (D)



Ans:

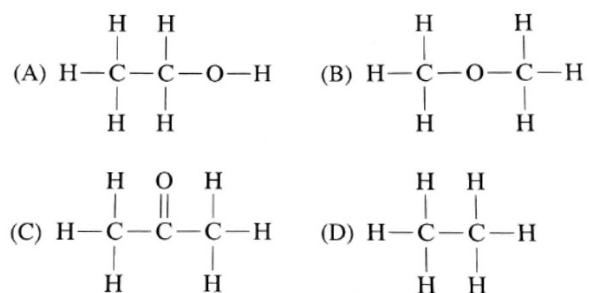
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**AP Multiple Choice Review Questions**

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5. Four substances with the following structures are placed on chromatography paper with water as the mobile phase. The paper is allowed to touch the water. After an hour, which substance will have moved the farthest on the paper? Water consists of H-O-H molecules.



Ans:

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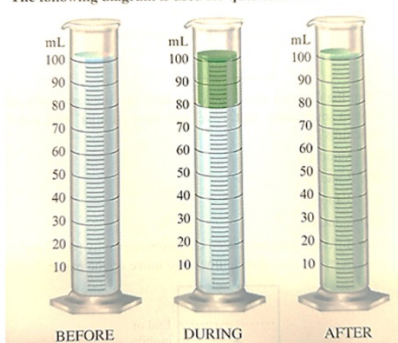
**AP Multiple Choice Review Questions**

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The following diagram is used for questions 6-8.

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A 100mL graduated cylinder is filled with 100mL of water. A few drops of food coloring are added to the top of the water, without mixing. Initially, the top of the graduated cylinder appears to be very dark, while the bottom remains clear and colorless. After 5 minutes the liquid in the graduated cylinder appears to be uniformly colored.

8. Classify the contents of the graduated cylinder after the 5 minutes has elapsed.
- (A) element      (C) heterogeneous mixture  
(B) compound    (D) homogeneous mixture

6. Classify the contents in the graduated cylinder before any food coloring is added.
- (A) element      (C) heterogeneous mixture  
(B) compound    (D) homogeneous mixture
7. Classify the contents in the graduated cylinder just after the food coloring is added.
- (A) element      (C) heterogeneous mixture  
(B) compound    (D) homogeneous mixture

Ans: (

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**AP Multiple Choice Review Questions****Foundations  
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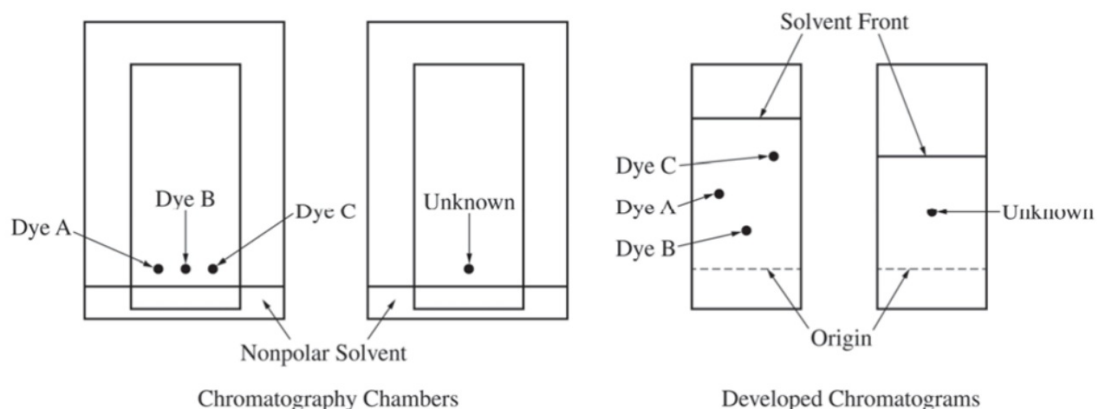
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9. Several of Jupiter's moons are believed to have a liquid layer, possibly water, below their icy surfaces. NASA and the European Space Agency are planning several interplanetary probes that will visit the moons of Jupiter. It has been suggested that a probe could land on one of the moons and drill through the surface of ice to the liquid layer. The probe would then sample the liquid at five different depths. Why will the probe test the liquid at five different depths?
- (A) to determine whether the liquid layer is water
  - (B) to determine whether the liquid layer could support life
  - (C) to determine the chemical composition of the liquid layer
  - (D) to determine whether the liquid layer is a homogeneous solution or heterogeneous mixture
10. A 10.00g piece of metal is submerged in a graduated cylinder initially containing 20.00mL of water. With the metal in the cylinder, the level of the water is recorded as 21.40mL. Determine the identity of the metal.
- (A) aluminum ( $d = 2.70\text{g/mL}$ )
  - (B) zinc ( $d = 7.13\text{g/mL}$ )
  - (C) silver ( $d = 10.49\text{g/mL}$ )
  - (D) gold ( $d = 19.32\text{g/mL}$ )

Ans:

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**AP Multiple FRQ Questions**



4. A student investigates various dyes using paper chromatography. The student has samples of three pure dyes, labeled A, B, and C, and an unknown sample that contains one of the three dyes. The student prepares the chromatography chambers shown above on the left by putting a drop of each dye at the indicated position on the chromatography paper (a polar material) and standing the paper in a nonpolar solvent. The developed chromatograms are shown above on the right.

- (a) Which dye (A, B, or C) is the least polar? Justify your answer in terms of the interactions between the dyes and the solvent or between the dyes and the paper.
- (b) Which dye is present in the unknown sample? Justify your answer.