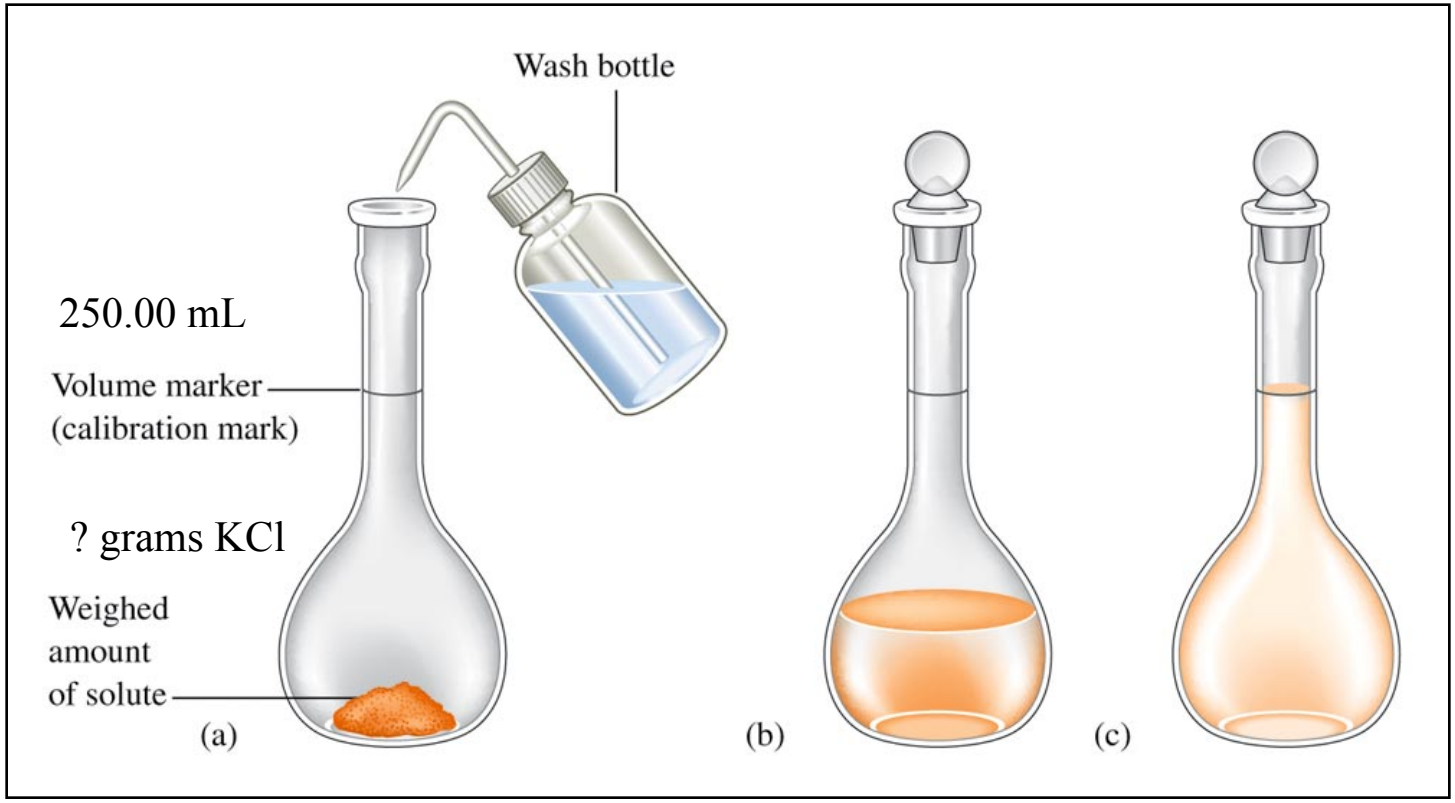
Solutions II

(Solutions/ Molarity)

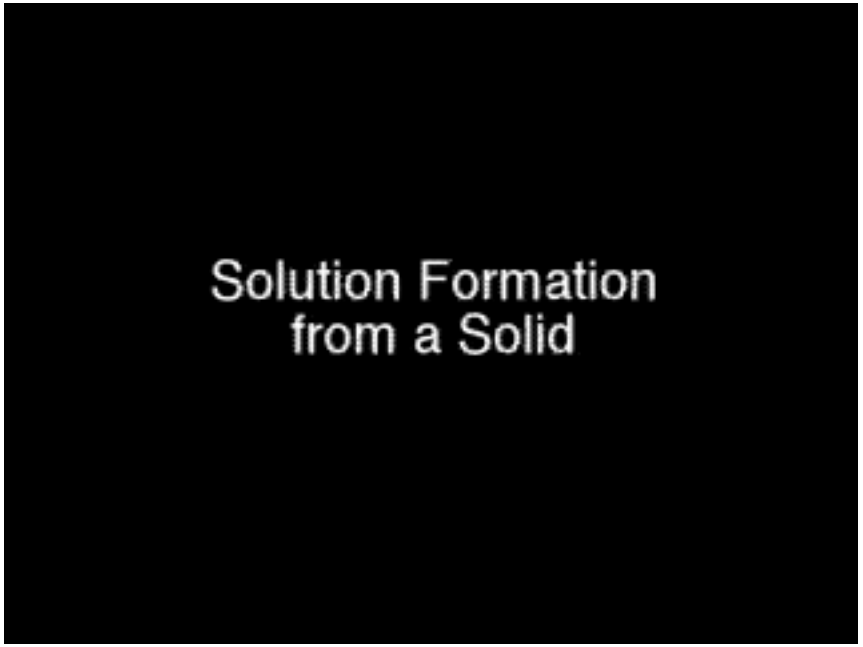
Applications & Calculations

Dr. Ron Rusay

Preparing a Standard Solution of a Targeted Molarity, M (mol/L)



Preparation of Solutions used in chemistry



Molarity (M) = Moles solute / Liter (Solution)

QUESTION

A 51.24-g sample of $Ba(OH)_2$ [MM= 171.3 g/mol] is dissolved in enough water to make 1.20 liters of solution. What is the molarity of the solution?

a) 0.300 M

b) 3.33 M

c) 0.278 M

d) 2.49×10^{-1} mol/L

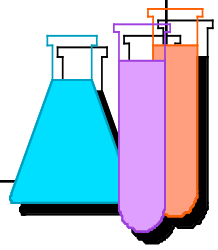
e) 42.7 g/mL

Solution Concentration

- *The following formula can be used in dilution calculations:*

$$M_1V_1 = M_2V_2$$

- *A concentrated stock solution is much easier to prepare and then dilute rather than preparing a dilute solution directly. Concentrated sulfuric acid is 18.0M. What volume would be needed to prepare 250.mL of a 1.50M solution?*
- $V_1 = M_2V_2 / M_1$
- $V_1 = 1.50\ M \times 250.\ mL / 18.0\ M$
- $V_1 = 20.8\ mL$



QUESTION

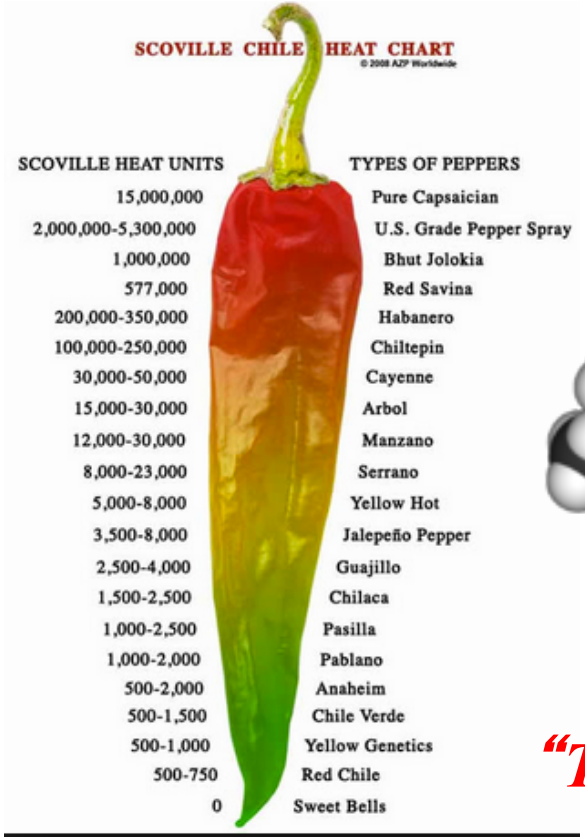
What volume of 18.0 M sulfuric acid must be used to prepare 15.5 L of 0.195 M H_2SO_4?

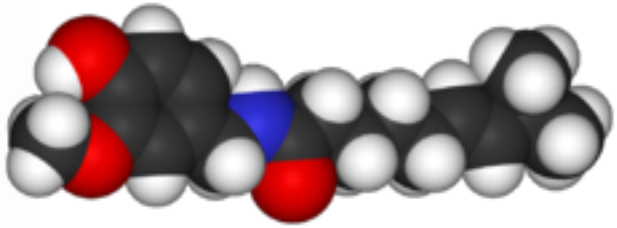
A) 168 mL
B) 0.336 L
C) 92.3 mL
D) 226 mL
E) None of these

Solution Dilution

Solution Applications

Scoville Units / Capsaicin





Capsaicin: $C_{18}H_{27}NO_3$

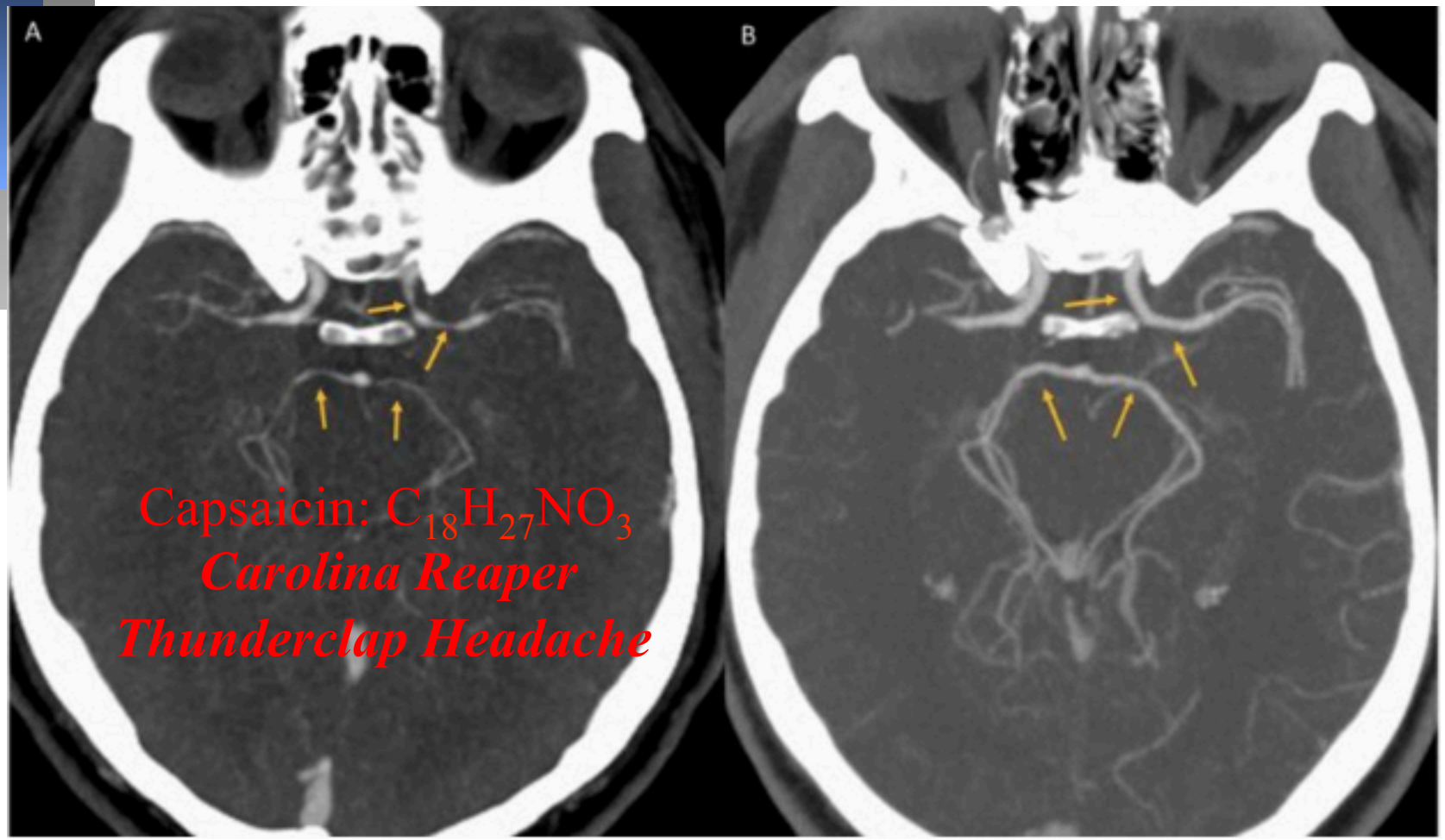
Carolina Reaper

"Thunderclap Headache"

http://en.wikipedia.org/wiki/Scoville_scale

https://www.youtube.com/watch?v=hrF3jVppfr4

Reversible Cerebral Vasoconstriction Syndrome (RVS)



https://www.youtube.com/watch?v=hrF3jVppfr4

QUESTION

What happens to the number of moles of $C_{12}H_{22}O_{11}$ (sucrose) when 100.0 mL of a 0.20 M solution is diluted to a final concentration of 0.10 M?

A) The number of moles of $C_{12}H_{22}O_{11}$ decreases.

B) The number of moles of $C_{12}H_{22}O_{11}$ increases.

C) The number of moles of $C_{12}H_{22}O_{11}$ does not change.

D) There is insufficient information to answer the question.

Solution Applications

A solution of barium chloride was prepared by dissolving 26.0287 g in water to make 500.00 mL of solution. What is the concentration of the barium chloride solution? $\mathbf{M_{BaCl2} = ?}$

$M_{BaCl2} =$

$= [26.0287 g_{BaCl2} / 500.00 mL][1 mol_{BaCl2} / 208.23 g_{BaCl2}] [1000 mL / L]$

$= 0.25000 \text{ mol / L}$

Solution Applications

10.00 mL of this solution was diluted to make exactly 250.00 mL of solution which was then used to react with a solution of potassium sulfate. What is the concentration of the diluted solution. $\boldsymbol{M_2 = ?}$

$\boldsymbol{M_{BaCl2} = M_1}$

$\boldsymbol{M_2 = M_1V_1 / V_2}$

$\boldsymbol{M_2 = 0.25000\ M\ x\ 10.00\ mL / 250.00\ mL}$

$\boldsymbol{M_2 = 0.010000\ M}$

QUESTION

A 51.24-g sample of $Ba(OH)_2$ is dissolved in enough water to make 1.20 liters of solution. How many mL of this solution must be diluted with water in order to make 1.00 liter of 0.100 molar $Ba(OH)_2$?

a) 400. mL

b) 333 mL

c) 278 mL

d) 1.20×10^3 mL

e) 285 mL

(Chem 120 Prep)

Solution Applications

20.00 mL of a $M_2 = 0.010000\ M$ barium chloride solution required 15.50 mL of the potassium sulfate solution to react completely. $M_{K2SO4} = ?$

$$BaCl_2(aq) + K_2SO_4(aq) \rightarrow\ ?\ +\ ?$$

$$BaCl_2(aq) + K_2SO_4\ (aq) \rightarrow 2\ KCl(aq) + BaSO_4\ (s)$$

$$?M_{K2SO4} = [M_{BaCl2} x\ V_{BaCl2} / V_{K2SO4}\ ]\ [?\ mol_{K2SO4} / ?\ mol_{BaCl2}\ ]$$

$$?M_{K2SO4} = \frac{0.010000\ mol_{BaCl2}\ x\ 0.02000\ L_{BaCl2}\ x\ 1\ mol_{K2SO4}}{L_{BaCl2}\ x\ 0.01550\ L_{K2SO4}\ x\ 1\ mol_{BaCl2}}$$

$$?M_{K2SO4} = 0.01290\ mol_{K2SO4} / L_{K2SO4} = 0.01290\ M_{K2SO4}$$

Solution Applications

How many grams of potassium chloride are produced?

$BaCl_2(aq) + K_2SO_4(aq) \rightarrow \quad ? \quad + \quad ?$

$1\ BaCl_2(aq) + K_2SO_4\ (aq) \rightarrow 2\ KCl(aq) + BaSO_4\ (s)$

$?g_{KCl} = 0.010000\ mol_{BaCl2} / L_{BaCl2} \times 0.02000\ L_{BaCl2} \times 2\ mol_{KCl} / 1\ mol_{BaCl2} \times 74.55\ g_{KCl} / mol_{KCl}$

$= 0.02982\ g_{KCl}$

Solution Applications

*If **20.00** mL of a **0.10** M solution of barium chloride was reacted with **15.00** mL of a **0.20** M solution of potassium sulfate, what would be the theoretical yield of barium sulfate?*

$$BaCl_2(aq) + K_2SO_4\,(aq) \rightarrow 2\,KCl(aq) + BaSO_4\,(s)$$

Which is the Limiting Reagent?

$Mol_{BaCl2} = M_{BaCl2} \times V_{BaCl2}$

$= \dfrac{0.10\ mol_{BaCl2} / L_{BaCl2} \times 0.02000\ L_{BaCl2}}{1\ mol_{BaCl2}}$

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

$Mol_{K2SO4} = M_{K2SO4} \times V_{K2SO4}$

$= \dfrac{0.20\ mol_{K2SO4} / L_{K2SO4} \times 0.01500\ L_{K2SO4}}{1\ mol_{K2SO4}}$

$= 3.0 \times 10^{-3}$

$2.0 \times 10^{-3} < 3.0 \times 10^{-3}$

2.0×10^{-3} mol *is limiting*

Solution Applications

*If **20.00** mL of a **0.10** M solution of barium chloride was reacted with **15.00** mL of a **0.20** M solution of potassium sulfate, what would be the theoretical yield of barium sulfate?*

$$BaCl_2(aq) + K_2SO_4\ (aq) \rightarrow 2\ KCl(aq) + BaSO_4\ (s)$$

Must use the limiting reagent:

$$= \frac{0.10\ \text{mol}_{BaCl2} \times 0.02000\ \text{L}_{BaCl2} \times 1\ \text{mol}_{BaSO4} \times 233.39\ \text{g}_{BaSO4}}{\text{L}_{BaCl2} \qquad 1\ \text{mol}_{BaCl2} \qquad \text{mol}_{BaSO4}}$$

= 0.47 g

QUESTION

What mass of NaOH is required to react exactly with 25.0 mL of 1.2 M H_2SO_4?

A) 1.2 g
B) 1.8 g
C) 2.4 g
D) 3.5 g
E) None of these