Mole Day Challenge
Chem Honors

Name_____
Period_____ Date_____

How Big is a Mole?

1) **If the average penny is 2.0 mm thick, how far will a stack of ONE MOLE of pennies reach?** Give total distance in units of km (use good dimensional analysis starting with 1 mol pennies):

$$1\text{ mol pennies}\times\frac{6.022\times10^{23}\text{ pennies}}{1\text{ mol pennies}}\times\frac{2.0\text{ mm}}{1\text{ penny}}\times\frac{1\text{ m}}{1000\text{ mm}}\times\frac{1\text{ km}}{1000\text{ m}}=\boxed{1.2\times10^{18}\text{ km}}$$

2) Which of the following measurements is the best approximation for the distance spanned by a mole of pennies?
   a) The distance from the earth to the moon-- **4×10^{5} km**
   b) The distance from the earth to pluto-- **6×10^{9} km**
   c) The distance from the earth to the closest star outside our galaxy-- **4×10^{13} km**
   d) The distance that is spanned by the local cluster of galaxies that we are in (including the Milky Way and Andromeda, 5 million light years across) -- **4.8×10^{19} km**

3) How much would the mole of pennies be worth, in dollars? *Use good dimensional analysis.*

$$1\text{ mol pennies}\times\frac{6.022\times10^{23}\text{ pennies}}{1\text{ mol pennies}}\times\frac{\$0.01}{1\text{ penny}}=\boxed{\$6.022\times10^{21}\text{ or }\$6.022\textit{ billion trillion}}$$

4) The size of the world economy was estimated to be \$142,005.65 *trillion* in 2014 (1 world economy = $\$142.00565\times10^{12}$). How many world economies would the amount calculated above be worth? (This is the number of earth-like planets you would need to have 1 mole of pennies.) *Use good dimensional analysis.*

$$1\text{ mol pennies}\times\frac{\$6.022\times10^{21}}{1\text{ mol pennies}}\times\frac{1\text{ world economy}}{\$142.00565\times10^{12}}$$

$$=\boxed{4.241\times10^{7}\text{ world economies or over 42 }\textit{million}\text{ worlds}}$$

5) A mole of African elephants would have a mass equal to how many times the mass of Pluto? *[Hint:set up good dimensional analysis first finding the mass of 1 mole of elephants.]* The average mass of 1 African elephant = 5,443 kg; the mass of Pluto = 1.309×10^{22} kg.

$$1\text{ mol elephants}\times\frac{6.022\times10^{23}\text{ elephants}}{1\text{ mol elephants}}\times\frac{5{,}443\text{ kg}}{1\text{ elephant}}\times\frac{1\text{ Pluto}}{1.309\times10^{22}\text{ kg}}=\boxed{2.504\times10^{5}\text{ Plutos}}$$

6) A mole of baseballs would fill how many holes the volume of the moon. The diameter of a baseball = 7.40 cm and the diameter of the moon = 3,474.2 km. Remember, for a sphere, $V = 4/3\pi r^3$.

$$V_{baseball}=\tfrac{4}{3}\pi\left(\tfrac{7.40\text{ cm}}{2}\right)^3=212.2\text{ cm}^3;\quad V_{moon}=\tfrac{4}{3}\pi\left(\tfrac{3{,}474.2\text{ km}}{2}\right)^3=2.19565\times10^{10}\text{ km}^3$$

$$1\text{ mol baseballs}\times\frac{6.022\times10^{23}\text{ baseballs}}{1\text{ mol baseballs}}\times\frac{212.2\text{ cm}^3}{1\text{ baseball}}\times\left(\frac{1\times10^{-2}\text{ m}}{1\text{ cm}}\times\frac{1\text{ km}}{1\times10^{3}\text{ m}}\right)^3$$

$$\times\frac{1\text{ moon}}{2.19565\times10^{10}\text{ km}^3}=\boxed{5.82\text{ moons}}$$