Welcome to Jeff's CHEM 4 lecture!

We'll be starting in just a bit…

While you are waiting:

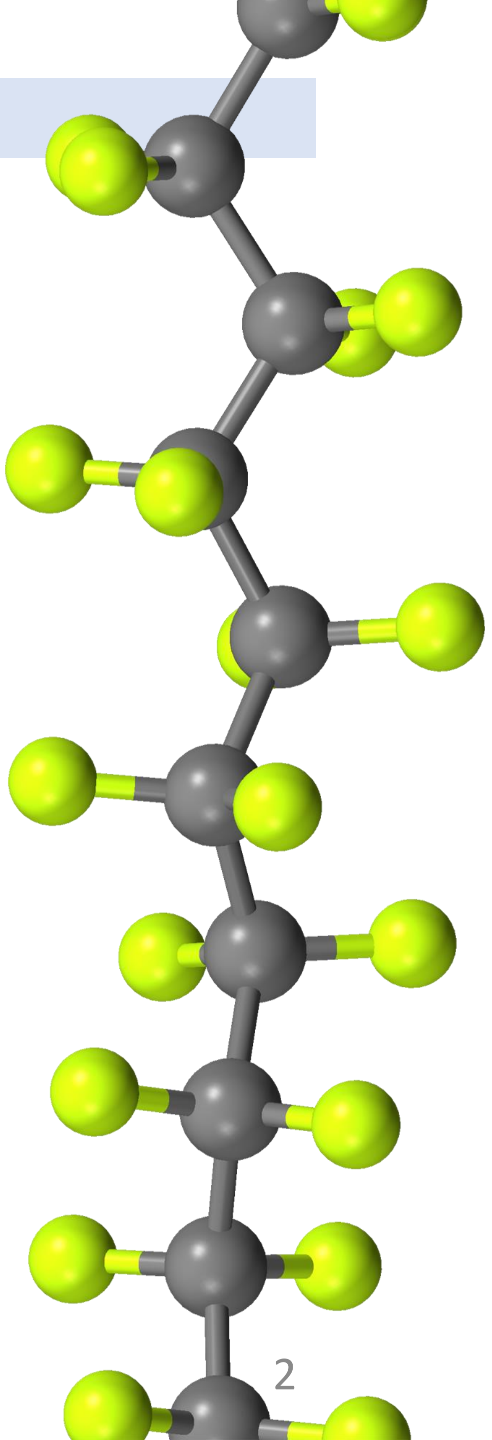
Go to LearningCatalytics.com to prepare for today's clicker questions. Login with your MasteringChemistry login. **Session ID =** 72825650

Exam #2 results

What to improve? Here's our checklist of key behaviors that lead to success in CHEM 4:

- ✓ Visit our CHEM 4 website regularly: tinyurl.com/SacStateChem4
- ✓ Study efficiently with a focus on the homework:
  - ✓ (1) do the assigned reading, then (2) attend lecture, then (3) review the lecture slides or video. You should then be ready to do the homework.
  - ✓ If you do (1) - (3) and start the required homework and have trouble, then put aside the homework and redo (1) and (3). Then try the optional homework.
  - ✓ If you still have trouble, put the homework aside and come to my office hours.
  - ✓ Remember is it okay if the homework is late, the most important thing is that you are really understanding the homework.
- ✓ Get help when needed:
  - ✓ Put together a weekly study group.
  - ✓ Jeff's office hours: MWF 9 – 9:30 am and 11 – 11:30 am; and by appointment.
  - ✓ PAL office hours: link is on our CHEM 4 website.
- ✓ Complete all of the practice exams.

- ✓ Everyone deserves a second chance! C2S program allows you to drop lowest exam.



Changes to tentative schedule

- Kept all lectures and review sessions
- Asynchronous lecture for 7.8 cont.
- Note final exam dates and plan accordingly

#10 **Nov 2**	**Exam #2**	Rd: 6.1-6.3 Mole	Rd: 6.4 Mole
#11 **Nov 9**	Rd: 6.5 Mole	**No Class:** Veteran's Day	Rd: 6.6-6.7 Mass percent
#12 **Nov 16**	Rd: 6.8-6.9 Empirical formulas	Rd: 3.7, 7.1-7.4 Chemical reactions	Rd: 7.5-7.7 Solutions/NIE
#13 **Nov 23**	Rd: 7.8 Acid base	**Asynchronous lecture:** Rd: 7.8 cont. Gas reactions	**No Class:** Thanksgiving Holiday
#14 **Nov 30**	Rd: 7.9-7.10 Types of reactions	**Review Session:** **Exam #3**	**Exam #3**
#15 **Dec 7**	Rd: 8.1-8.4 Reaction calculations	Rd: 8.5-8.6 Limiting reactants	**Review Session:** **Final Exam**
#16 **Dec 14**	**Final Exam for MWF 8 am lecture:** 8 – 10 am		**Final Exam for MWF 10 am lecture:** 8 – 10 am

CHEM 4 lecture

Wednesday – November 4, 2020

Sec 6.1 – 6.3

Mole and molar mass

Reading clicker question: Sec 6.1 – 6.3
Go to LearningCatalytics.com Session ID = 72825650

1) Which statement is false?

   A) "1 mole = 6.022 x 10^{23} things" in the same way that "1 dozen = 12 things".

   B) Another name for the "mole" is "Avogadro's number".

   C) Avogadro's number converts between the number of moles of a substance and the number of atoms.

   D) Molar mass can be used to directly convert between the mass of a sample and the number of atoms present in the sample.

   E) The numerical value of the mole is equal to the number of atoms in exactly 12 g of pure carbon-12.

   F) An element's molar mass tells us the mass of 1 mole of atoms of that element.

Sec 6.1-6.3: Two new conversion factors

1) **Avogadro's number**

- Also called **mole**. Abbreviated **mol** or $\mathbf{N_A}$.
- Named after Amedeo Avogadro (1776–1856)
- Defined as the number of C atoms in exactly 12 g of carbon-12.
- Leads to measured value: 1 mole = 6.022×10^{23} *(4 sf)*
- Leads to the conversion factor: $$\frac{1 \text{ mole things}}{6.022 \times 10^{23} \text{ things}}$$
- Technically, can have a mole of anything, but it is greater than the number of grains of sand on earth or the number of stars in the universe, so it is only practical for atoms and molecules…

www.britannica.com/

Sample calculation: Using Avogadro's number

Ex. You have 18 moles of carbon. How many carbon atoms is this?

We know that 1 mole of C has 6.022×10^{23} C atoms, so… $\frac{1\text{mole C}}{6.022 \text{ x } 10^{23}\text{C atoms}}$

$$(18\ \cancel{\text{moles C}})\left(\frac{6.022 \text{ x } 10^{23}\ \text{C atoms}}{1\ \cancel{\text{mole C}}}\right) = 1.08396 \text{ x } 10^{25} \quad = \mathbf{1.1 \text{ x } 10^{25}\ \text{C atoms}}$$

2sf 4sf Keep 2sf

If you get stuck, imagine you had 18 *dozen* C atoms and you were asked to find how many C atoms you have… you'd multiple by 12 since there are 12 atoms/dozen:

$$(18\ \cancel{\text{dozen C}})\left(\frac{12\ \text{C atoms}}{1\ \cancel{\text{dozen C}}}\right) = 216\ \text{C atoms} = 2.2 \text{ x } 10^2\ \text{C atoms}$$

Instead you multiplied by 6.022×10^{23} since there are 6.022×10^{23} atoms/mole.

Clicker question: Using Avogadro's number
Go to LearningCatalytics.com   Session ID = 72825650

2) Calculate the number of moles of Br if you have 1.06×10^{24} Br atoms.

$\boxed{\text{A) } 1.76 \text{ mol Br}}$
B) 1.760 mol Br
C) 1.76×10^{46} mol Br
D) 1.760×10^{46} mol Br
E) 6.38×10^{47} mol Br
F) 6.383×10^{47} mol Br

Answer:

Flowchart: atoms Br → moles Br $\left(\frac{1 \text{ mole Br}}{6.022 \times 10^{23} \text{ Br atoms}}\right)$

Calculation: $(1.06 \times 10^{24} \cancel{\text{Br atoms}}) \left(\frac{1 \text{ mole Br}}{6.022 \times 10^{23} \cancel{\text{Br atoms}}}\right) = 1.76|0212554$ moles Br

3sf   *4sf*   *Keep 3sf*

- When you are ÷ by an exponent in the denominator, be sure to put it in ( ).
- So, in your calculator, type ÷ (6.022×10^{23})

Sec 6.1-6.3: Two new conversion factors

2) **Molar mass**

- Defined as the mass of 1 mole of that substance.
- Units are grams per mole (g/mol).
- Just like a dozen apples has a different mass than a dozen cars, each element has its own molar mass.
- An element's molar mass can be found by taking its atomic mass from the periodic table and changing the units from "amu" to "g/mol".
- For example, from Periodic table: 1 Br atom = 79.90 amu

$$6.022 \times 10^{23} \text{ Br atoms} = \boxed{1 \text{ mol Br atoms} = 79.90 \text{ g}}$$

- Leads to the conversion factor: $\dfrac{79.90 \text{ g Br}}{1 \text{ mole Br}}$ *(measurement with 4 sf)*

Sample calculation: Using molar mass

Ex. Find the mass, in grams, of 5.06 moles of S.

Answer: moles S → g S

Looking at the periodic table:

16
S
32.07

So, the molar mass of S: $\frac{32.07 \text{ g S}}{1 \text{ mol S}}$

- This is incredibly useful since we can go into a lab and weigh out this much sulfur.
- Essentially, we know how many S atoms we have by weighing the mass.

$$(5.06\ \cancel{\text{moles S}})\left(\frac{32.07 \text{ g S}}{1\ \cancel{\text{mole S}}}\right) = 162.2742 \text{ g S} = \boxed{162 \text{ g S}}$$

3sf *4sf* *Keep 3sf*

Clicker question: Using molar mass

Go to LearningCatalytics.com   Session ID = 72825650

3) How many moles of Ne are in a 85-g sample?

A) 1.7×10^{3} mol Ne

B) 4.212 mol Ne

C) 5.1×10^{25} mol Ne

D) 4.2 mol Ne

E) 1.715×10^{3} mol Ne

F) 1.4×10^{-22} mol Ne

10
Ne
20.18

Answer:

Flowchart: g Ne → moles Ne

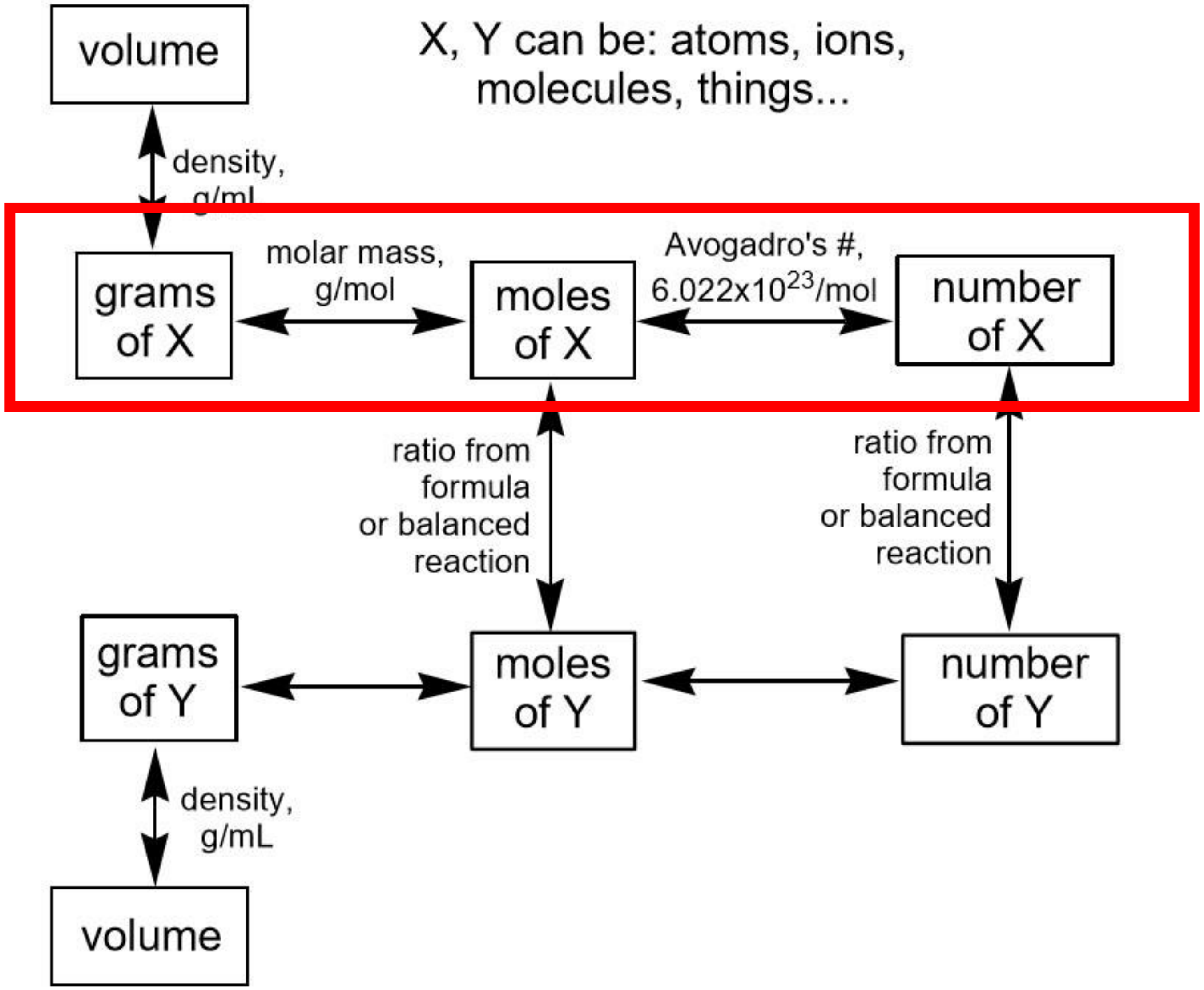
$$\left(\frac{20.18\ \text{g Ne}}{1\ \text{mole Ne}}\right)$$

Calculation:

$$(85\ \cancel{\text{g Ne}})\left(\frac{1\ \text{mole Ne}}{20.18\ \cancel{\text{g Ne}}}\right) = 4.2|1209\ \text{moles Ne}$$

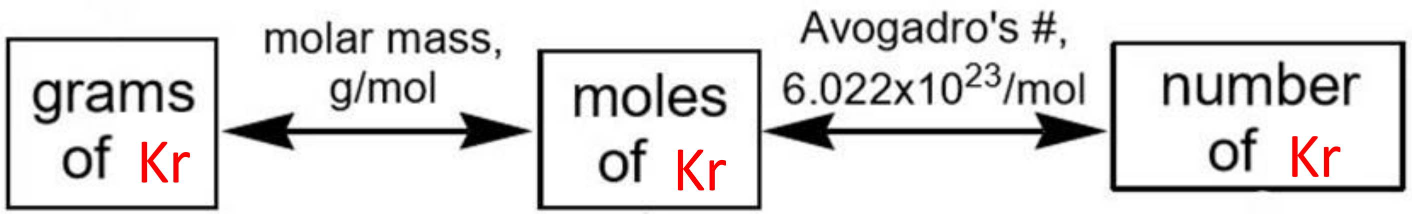
2sf *4sf* *Keep 2sf*

For harder, multiple step problems, I've posted a useful "mole flowchart" on our class website.



Clicker question: Multi-step calculation with Avogadro's # and molar mass
Go to LearningCatalytics.com Session ID = 72825650

4) What is the mass, in g, of 3.97×10^{20} Kr atoms



Flowchart: # Kr atoms → moles Kr → g Kr

36
Kr
83.80

A) 6.59×10^{-4} g Kr
B) 5.52×10^{44} g Kr
C) 3.33×10^{22} g Kr
D) 0.0333 g Kr
E) 6.59×10^{42} g Kr
F) 0.0552 g Kr

Answer:

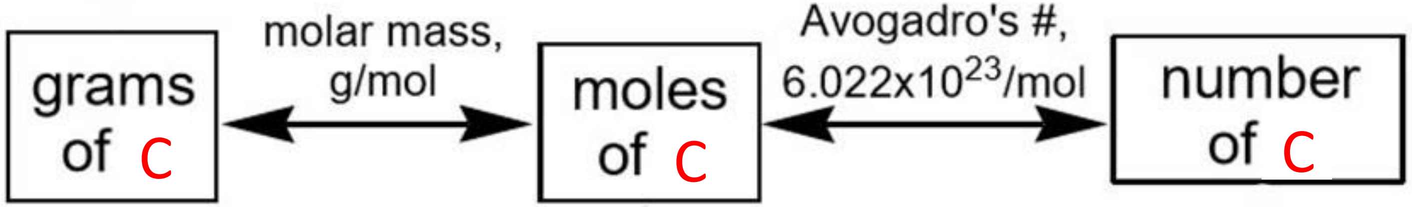
$$(3.97 \times 10^{20}\ \cancel{\text{Kr atoms}})\left(\frac{1\ \cancel{\text{mol Kr}}}{6.022 \times 10^{23}\ \cancel{\text{Kr atoms}}}\right)\left(\frac{83.80\ \text{g Kr}}{1\ \cancel{\text{mol Kr}}}\right) = 0.0552|451\ \text{g Kr}$$

3sf *4sf* *4sf* *Keep 3sf*

Clicker question: Multi-step calculation with Avogadro's # and molar mass

Go to LearningCatalytics.com Session ID = 72825650

5) Burning coal is a major source of added atmospheric CO_2, a greenhouse gas. Assuming a sample of coal is pure carbon, how many carbon atoms are in a 41 kg sample of coal?



Flowchart: kg C → $\boxed{\text{g C} \rightarrow \text{moles C} \rightarrow \text{atoms C}}$

6
C
12.01

A) 2.06×10^{21} C atoms

B) 2.1×10^{21} C atoms

C) 2.5×10^{22} C atoms

D) 3.0×10^{23} C atoms

E) 2.96×10^{23} C atoms

F) 2.06×10^{24} C atoms

G) 2.1×10^{27} C atoms

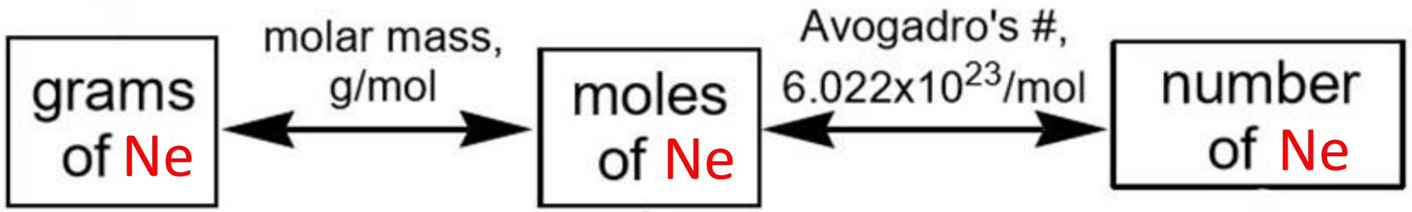
Answer:

$$(41\ \cancel{\text{kg C}})\left(\frac{10^{3}\ \cancel{\text{g C}}}{1\ \cancel{\text{kg C}}}\right)\left(\frac{1\ \cancel{\text{mol C}}}{12.01\ \cancel{\text{g C}}}\right)\left(\frac{6.022 \times 10^{23}\ \text{C atoms}}{1\ \cancel{\text{mol C}}}\right) = 2.0|55803467 \times 10^{27}\ \text{C atoms}$$

2sf *∞sf* *4sf* *4sf* *Keep 2sf*

Clicker question: Multi-step calculation with Avogadro's # and molar mass
Go to LearningCatalytics.com Session ID = 72825650

6) A sample of Ne contains 5.4 x 10^{21} atoms. What is the volume of the sample in mL? The density of Ne is 0.90 g/L.



10
Ne
20.18

Flowchart: $\boxed{\text{\# Ne atoms} \rightarrow \text{moles Ne} \rightarrow \text{g Ne}} \rightarrow \text{L Ne} \rightarrow \text{mL Ne}$

A) 1.6 x 10^2 Ne
B) 1.6 x 10^{48} Ne
C) 2.0 x 10^{48} mL Ne
D) 2.0 x 10^2 mL Ne
E) 0.49 mL Ne
F) 4.9 x 10^{45} Ne

Answer:

$$5.4 \times 10^{21}\ \cancel{\text{Ne atoms}} \left(\frac{1\ \cancel{\text{mol Ne}}}{6.022 \times 10^{23}\ \cancel{\text{Ne atoms}}}\right)\left(\frac{20.18\ \cancel{\text{g Ne}}}{1\ \cancel{\text{mol Ne}}}\right)\left(\frac{1\ \cancel{\text{L}}}{0.90\ \cancel{\text{g}}}\right)\left(\frac{1\ \text{mL}}{10^{-3}\ \cancel{\text{L}}}\right) = 20|1.0628\ \text{mL Ne}$$

2sf *4sf* *4sf* *2sf* *∞sf* *Keep 2sf*