Welcome to our CHEM 4 lecture

Review clicker question: Units raised to a power

Go to LearningCatalytics.com Session ID =

1) How many water molecules are there in an ice cube with a volume of 27.0 in^3? Pure ice contains 3.342 x 10^{22} water molecules per gram of ice; the density of ice = 0.92 g/cm^3.

A) 2.1 x 10^{24} molecules

B) 2.11 x 10^{24} molecules

C) 3.8 x 10^{25} molecules

D) 1.4 x 10^{25} molecules

E) 3.80 x 10^{25} molecules

F) 2.5 x 10^{26} molecules

Hint: Turn this into a conversion factor

Answer: Flowchart: $in^3 \rightarrow cm^3 \rightarrow g \rightarrow$ molecules

Calculation:

This is from cubing: 2.54 cm = 1 in

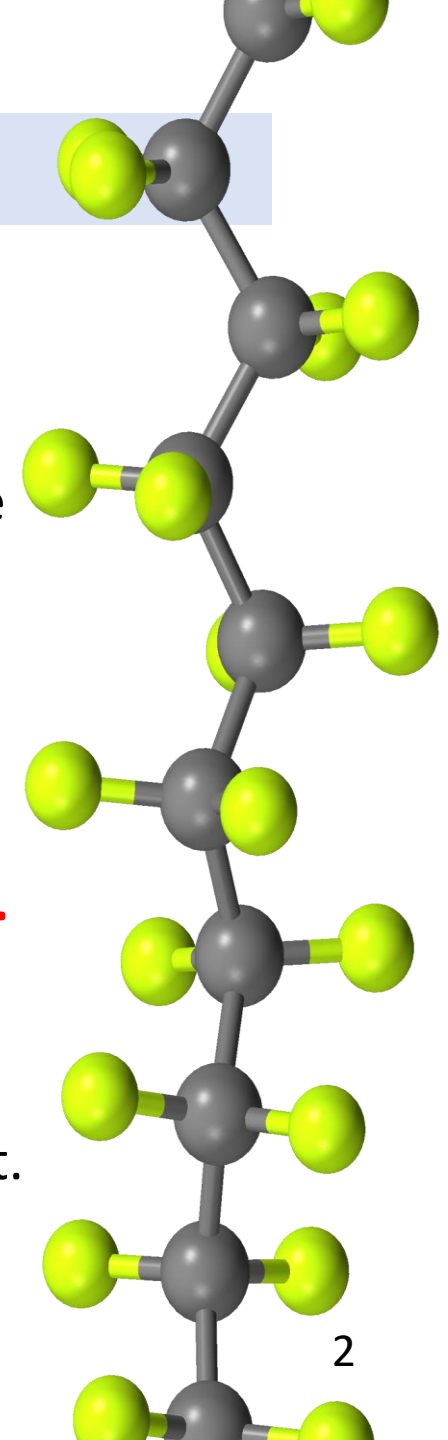
$$(27.0\ \cancel{in^3})\left(\frac{16.387\ \cancel{cm^3}}{1\ \cancel{in^3}}\right)\left(\frac{0.92\ \cancel{g}}{1\ \cancel{cm^3}}\right)\left(\frac{3.342 \times 10^{22}\ \text{molecules}}{1\ \cancel{g}}\right) = 1.36038 \times 10^{25} = \mathbf{1.4 \times 10^{25}\ molecules}$$

3sf *∞ sf* *2sf* *4sf*

Keep 2sf

Key to Success in CHEM 4

- ✓ Visit our CHEM 4 website regularly: tinyurl.com/SacStateChem4
- ✓ Attend every lecture having completed the assigned reading.
- ✓ Review our PowerPoint slides and/or lecture recordings after each class (they are posted on the above website in the calendar section)
- ✓ Keep up with daily homework. **However, all students will automatically receive full credit for all late homework this semester.**
- ✓ Complete all of the practice exams.
- ✓ **Talk to your Commit to Study peer mentor about how you are doing in CHEM 4.**
- ✓ 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.



Prerequisites for CHEM 1A/1E

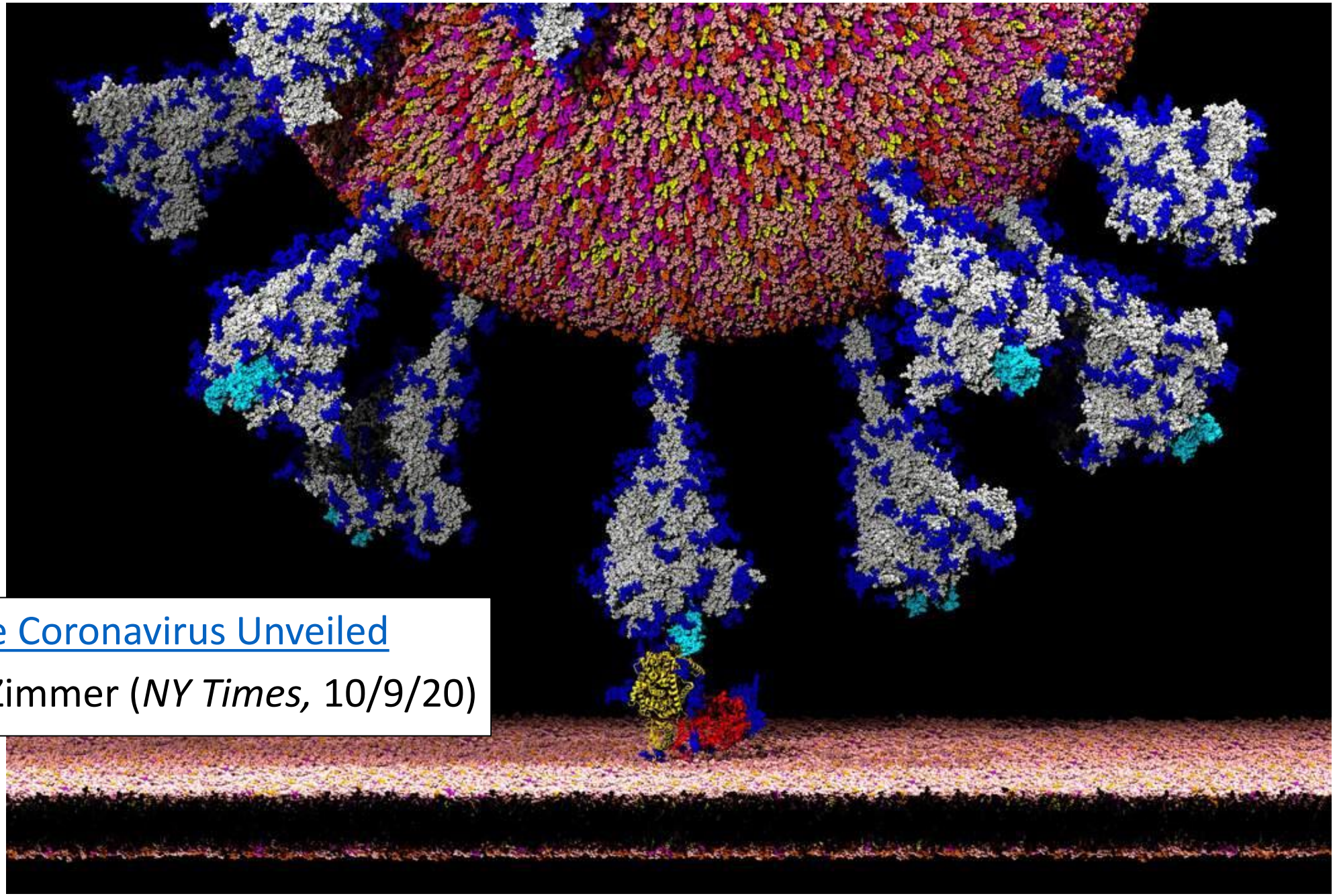
Students can meet the *chemistry prerequisite* in any of the following ways:

- ~~Having a Chemistry Diagnostic Score of 35 or higher.~~ (not available during COVID)
- Completed CHEM ALEKS (CARA) with 85% of the topics completed.
- Passing CHEM 4 or CHEM 6A with a ***grade of C or better***.
- Having obtained D to a C- in CHEM 4 AND completing 85% or the topics successfully in CARA.

Students can meet the *math prerequisite* in any of the following ways:

Math Prerequisite for CHEM 1A:	**Math Prerequisite for CHEM 1E:**
• A Math ALEKS PPL Score of 61 or higher • Successful completion of Math 12 or the equivalent • Current enrollment in Math 26A, Math 29 or a higher • Score of a 3 or higher on AB or BC Calculus AP Test • Ability to enroll in Math 26A or Math 29	• A Math ALEKS PPL score of 76 or higher • Successful completion of Math 29 or equivalent • Enrollment in a math course of Math 30 or higher • Score of a 3 or higher on AB or BC Calculus AP Test

- Questions can be directed to **Dr. Susan Crawford (crawford@csus.edu)** or **Dr. Roy Dixon (rdixon@csus.edu)**
- Chem department: https://www.csus.edu/college/natural-sciences-mathematics/chemistry/
- Math dept ALEKS PPL: https://www.csus.edu/college/natural-sciences-mathematics/math-placement-exam/



The Coronavirus Unveiled

by Carl Zimmer (*NY Times,* 10/9/20)

CHEM 4 lecture

Wednesday – October 21, 2020

Sec 3.8 – 3.10

Energy and temperature

Reading clicker question: Density

Go to LearningCatalytics.com Session ID =

2) Which of the following statements is false?

A) A Fahrenheit degree is the same size as a Celsius degree.

B) One nutritional Calorie is equivalent to 1000 calories.

C) Energy is the capacity to do work.

D) The products of a chemical reaction can be higher in energy than the reactants.

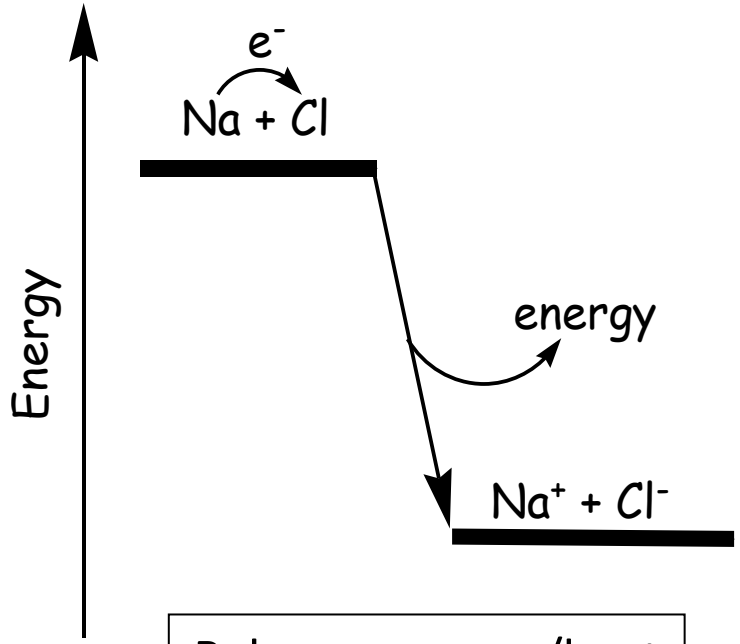
E) A substance's temperature is related to the motion of its atoms, ions or molecules.

F) A TNT explosion is an example of an exothermic process.

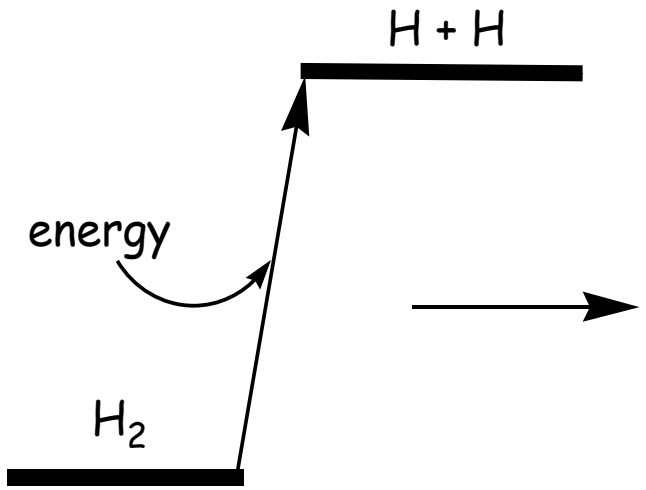
G) Absolute zero (defined as 0 K) is the coldest possible temperature.

Background: Exothermic and endothermic reactions

- Below are potential energy diagrams for two different chemical processes: Electron transfer (left) and bond breaking (right).
- If the products are lower in PE than the reactants, the excess energy is released.
- If the reactants are lower in PE, then energy must be absorbed to convert them to products.



Releases energy/heat
= **exothermic**

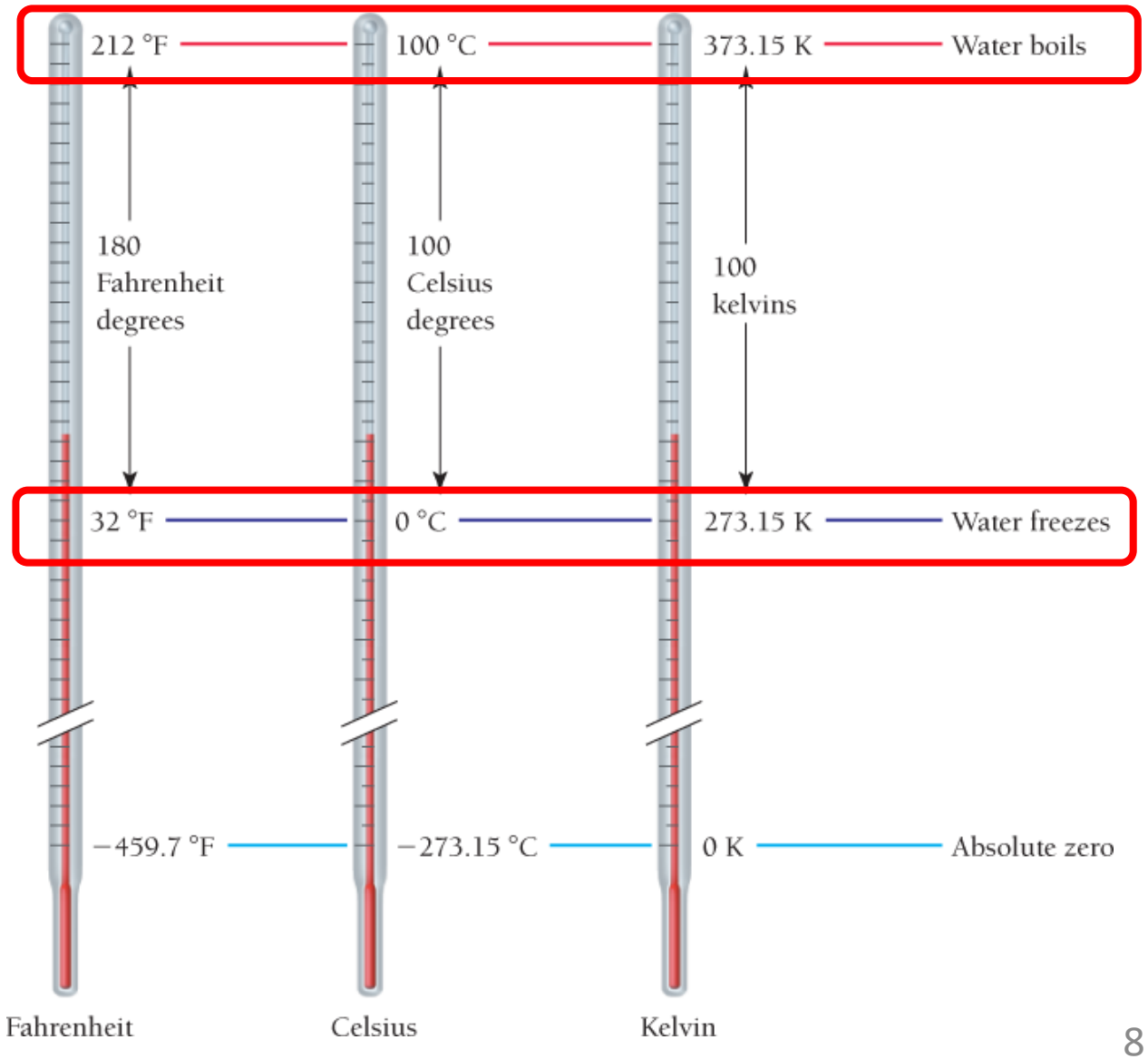


Absorbs energy/heat
= **endothermic**

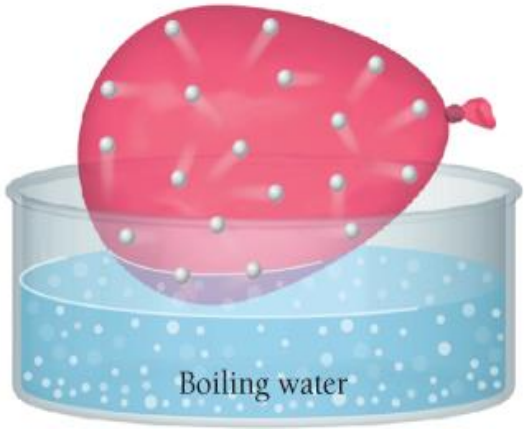
Background: Temperature scales

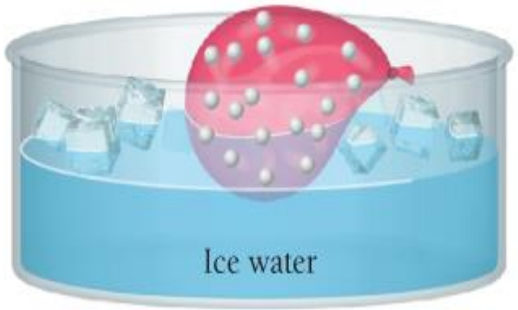
- **Fahrenheit (°F)** – The freezing point of pure water is defined as 32 °F and the boiling point of pure water is defined as 212 °F.
- **Celsius (°C)** – The freezing point of pure water is defined as 0 °C and the boiling point of pure water is defined as 100 °C.
- **Kelvin (K)** – Currently has a complicated definition, but essentially is related to absolute zero.

- The Kelvin scale is shifted 273.15 from the Celsius scale; 1 K is the same size as 1 °C. The °C is larger than °F.

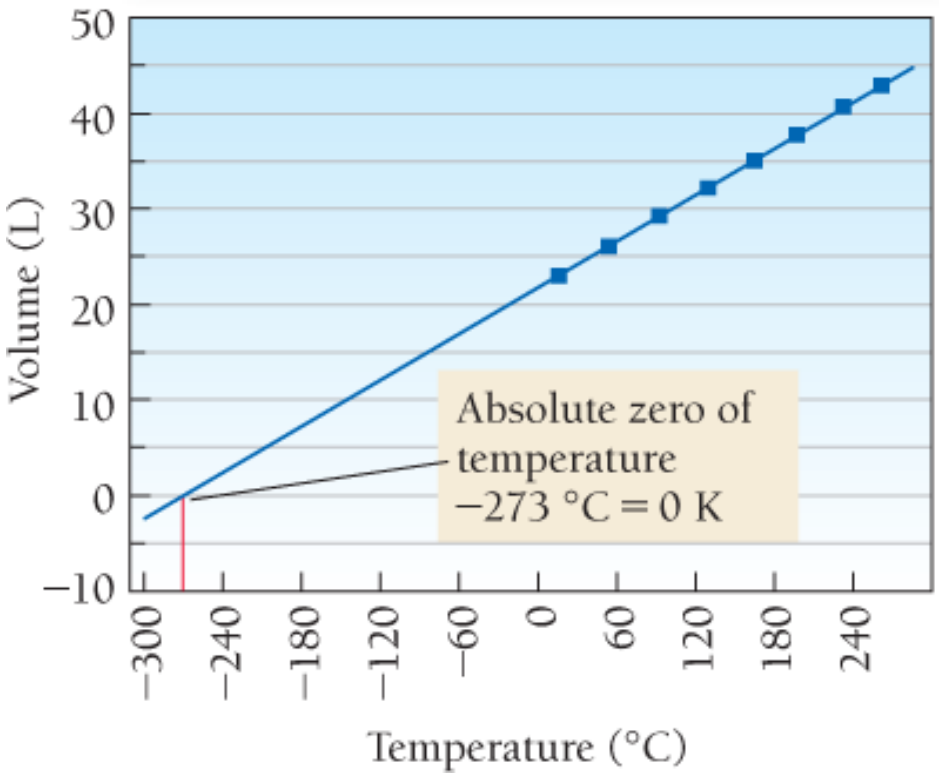


Background: Absolute zero





- When we decrease the temperature of a gas, the KE of its atoms decreases and its volume decreases.
- Extrapolating our line indicates a gas would have zero volume at -273 °C.
- This is **absolute zero**, the coldest possible temp.



- Scientists have gotten to a few thousandths of a K above absolute zero. [For comparison, outer space has a temperature of 2.7 K].
- Learn more about absolute zero in this Scientific American article.

Background: Kinetic and potential energy

	Kinetic Energy (due to motion)	**Potential Energy** (due to position)
Physics class	• We focus on the motion of whole object. • Ex: Motion of a baseball.	• We focus on the position of whole object often relative to gravitational field. • Ex: Weight attached to a pulley.
Chemistry class	• We focus on the motion of atoms making up object. • Ex: Measure the temperature of the object: Hot sample = faster moving atoms. Cold sample = slower moving atoms.	• We focus on the position of the atoms making up the object and the energy trapped in the bonds. • Ex: Energy stored in a battery or the energy stored in the bonds in gasoline.

Background: Common energy units

Energy and Temperature

1 cal = 4.184 J (exactly, ∞ sf)

1 Cal = 1000 cal = 1 kcal = 1 "nutritional calorie"

°C = (°F – 32)/1.8 (∞ sf on 32 and 1.8)

K = °C + 273.15

- 1 calorie is defined as 4.184 J
- We have use our metric prefixes with "cal" and "J", for example "kcal" and "MJ".
- The information on our food is "nutritional calories" which are **C**alories.
- **Notice:** Equations for converting K ↔ °C ↔ °F. We are not doing any in class, but it will be on the test and there are examples in the textbook and homework.

Example: If you eat the following for breakfast, how many Calories did you eat?

Grapefruit	60. Cal
Yogurt	140. Cal
Oat meal	100. Cal
Decaf Tea	2 Cal
Total	**302 Cal**

Example: What is the energy content of the above meal in Joules (J)?

Flowchart: Cal → cal → J

Calculation:

$$(302\ \text{Cal})\left(\frac{1000\ \text{cal}}{1\ \text{Cal}}\right)\left(\frac{4.184\ \text{J}}{1\ \text{cal}}\right) = 1263568 = \mathbf{1.26 \times 10^6\ J}$$

3sf *∞ sf* *∞ sf*

Keep 3sf. Use scientific notation to avoid ambiguous 0s.

Progress clicker question: Performing calculations that use density

Go to LearningCatalytics.com Session ID =

3) "Fuel value" is the amount of energy released when 1 g of the material is burned. Apples have a fuel value = 2.5 kJ/g. How many Calories are in a 4.23 oz apple?

A) 72 Cal

B) 28.7 Cal

C) 2.9×10^4 Cal

D) 7×10^1 Cal

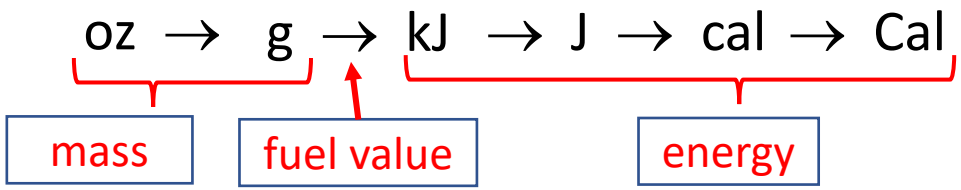
E) 7.2×10^4 Cal

F) 29 Cal

G) 71.7 Cal

H) 3×10^1 Cal

Answer: *Flowchart:*



Calculation:

$$(4.23\ \text{oz})\left(\frac{453.6\ \text{g}}{16\ \text{oz}}\right)\left(\frac{2.5\ \text{kJ}}{1\ \text{g}}\right)\left(\frac{1000\ \text{J}}{1\ \text{kJ}}\right)\left(\frac{1\ \text{cal}}{4.184\ \text{J}}\right)\left(\frac{1\ \text{Cal}}{1000\ \text{cal}}\right) = 71.65421845 = \textbf{72 Cal}$$

3sf *4sf* *2sf* *∞ sf* *∞ sf* *∞ sf* *Keep 2 sf*