CALCULUS-BASED PHYSICS-2: ELECTRICITY, MAGNETISM, AND THERMODYNAMICS (PHYS180-02): UNIT 1

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UNIT 0 REVIEW

Physics - $\phi\upsilon\sigma\iota\kappa\acute{\eta}$ - "phusiké": *knowledge of nature*
from $\phi\acute{\upsilon}\sigma\iota\varsigma$ - "phúsis": *nature* **Reading: Chapters 1 and 2 (for Unit 1)**

1. Estimation/Approximation
    - Estimating the correct order of magnitude
    - Building complex quantities
    - Unit analysis
2. Review of concepts from Newtonian mechanics
    - Kinematics and Newton's Laws
    - Work-energy theorem, energy conservation
    - Momentum, conservation of momentum

Two molucules collide elastically. Which of the following is true?

- A: Both potential energy and momentum are conserved for each molecule
- B: Only the momentum is conserved for each molecule
- C: Momentum and kinetic energy are conserved for each molecule
- D: Neither momentum nor energy is conserved for each molecule

Suppose a molecule is headed towards the wall of a container with speed v and mass m. If it collides elastically with the wall and returns in the exact same direction from which it came, what is the change in momentum of the molecule?

- A: mv
- B: $\frac{1}{2}mv^2$
- C: mv^2
- D: $2mv$

Do you remember how to take the derivative of an exponential function? Let $f(t) = \exp(\alpha t)$. What is $f'(t)$?

- A: $\exp(\alpha t)$
- B: $\alpha \exp(\alpha t)$
- C: $\exp(\alpha t)/\alpha$
- D: $\exp(2\alpha t)$

What about multiplying exponentials? What is $f(t)g(t)$, if $f(t) = \exp(\alpha t)$ and $g(t) = \exp(\beta t)$?

- A: $\exp(\alpha\beta t)$
- B: $\exp(\frac{\alpha}{\beta} t)$
- C: $\exp(\frac{\beta}{\alpha} t)$
- D: $\exp((\alpha + \beta)t)$

UNIT 1 SUMMARY

Reading: Chapters 1 and 2

1. Temperature, Heat, and the 0th Law of Thermodynamics
2. Heat flow and transfer mechanisms
3. Kinetic Theory of Gases

JITT - READING QUIZ RESULTS

temperature, heat, and the 0th law of thermodynamics

Figure 1: The zeroeth law of thermodynamics. We need this idea to have a firm understanding of temperature readings, because a **thermometer** is itself a thermal system.

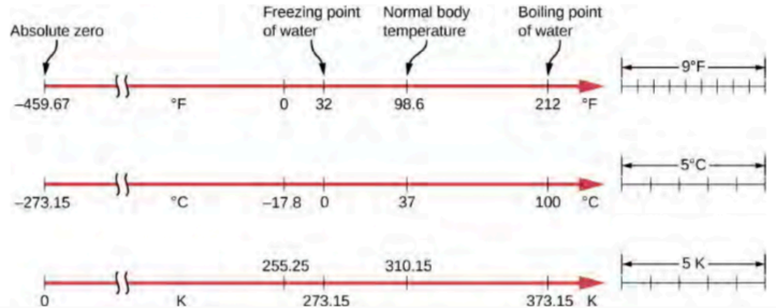

Figure 2: Three temperature scales.

To convert from...	Use this equation...
Celsius to Fahrenheit	$T_F = \frac{9}{5}T_C + 32$
Fahrenheit to Celsius	$T_C = \frac{5}{9}(T_F - 32)$
Celsius to Kelvin	$T_K = T_C + 273.15$
Kelvin to Celsius	$T_C = T_K - 273.15$
Fahrenheit to Kelvin	$T_K = \frac{5}{9}(T_F - 32) + 273.15$
Kelvin to Fahrenheit	$T_F = \frac{9}{5}(T_K - 273.15) + 32$

Figure 3: Three temperature scales.

Suppose the temperature of a system is raised by 10° F. Which of the following is true?

- A: The increase is more than 10 degrees in °C.
- B: The increase is smaller than 10 degrees in °C.
- C: The increase is the same in °C.
- D: Depends on the initial temperature in °F.

Suppose the temperature of a system is raised by 10°C. Which of the following is true?

- A: The increase is more than 10 degrees in °K.
- B: The increase is smaller than 10 degrees in °K.
- C: The increase is the same in °K.
- D: Depends on the initial temperature in °C.

The formula for conversion from Celcius temperature to Fahrenheit temperatures is $T_{\mathrm{F}} = \frac{9}{5}T_{\mathrm{C}} + 32$. Which of the following is true?

- A: $0° - 10°$C is comparable to room temperature
- B: $35° - 40°$C is comparable to human body temperature
- C: $30° - 35°$C is comparable to human body temperature
- D: $15° - 20°$C outdoors would correspond to hot weather

How do thermometers work? What is temperature, really? *Temperature is a macroscopic indication of microscopic kinetic energy*. We need the idea of **thermal expansion**:

$$\frac{dL}{dT} = \alpha L \tag{1}$$

In Eq. 1, T is the temperature, L is the length of an object, and α is the coefficient of linear thermal expansion, in units of inverse degrees.

Material	**Coefficient of Linear Expansion** α **(1/°C)**
Solids	
Aluminum	25×10^{-6}
Brass	19×10^{-6}
Copper	17×10^{-6}
Gold	14×10^{-6}
Iron or steel	12×10^{-6}
Invar (nickel-iron alloy)	0.9×10^{-6}
Lead	29×10^{-6}
Silver	18×10^{-6}
Glass (ordinary)	9×10^{-6}
Glass (Pyrex®)	3×10^{-6}
Quartz	0.4×10^{-6}
Concrete, brick	$\sim 12 \times 10^{-6}$
Marble (average)	2.5×10^{-6}

Figure 4: Linear thermal expansion coefficients.

CONCLUSION

Reading: Chapters 1 and 2

1. Temperature, Heat, and the 0th Law of Thermodynamics
2. Heat flow and transfer mechanisms
3. Kinetic Theory of Gases

ANSWERS

ANSWERS

- Momentum and kinetic energy are conserved for each molecule
- $2mv$
- $\alpha \exp(\alpha t)$
- $\exp((\alpha+\beta)t)$
- The increase is smaller than 10 degrees in °C
- The increase is the same in °K
- $35° - 40°$C is comparable to human body temperature
- ...