

Physics 3B Week 3: Kinetic Theory of Gases

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Name: Andrea Silvestri

ID#: _____

Who did you work with? (You must list 1 or 2 names.):

1. _____ 2. _____

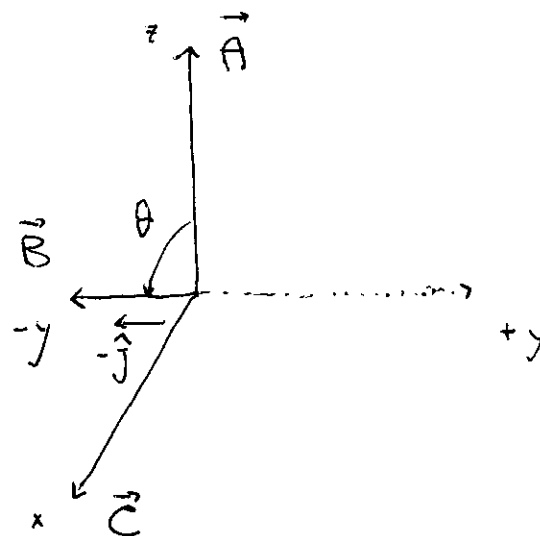
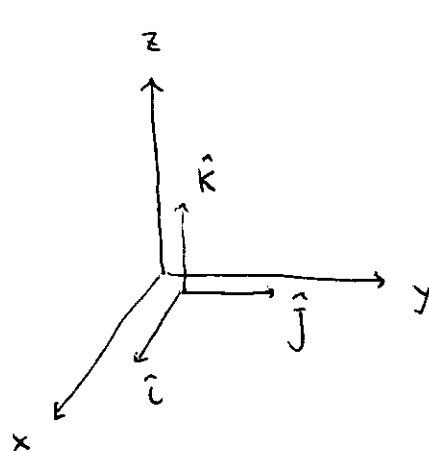
TA: Andrea Silvestri

Date: January 23, 2008

Day: Wednesday Hour: 8:00 - 12:50

1. Problem 1

Vector $\mathbf{A} = 7 \hat{k}$ and vector $\mathbf{B} = -2 \hat{j}$, calculate magnitude and direction of $\mathbf{C} = \mathbf{A} \times \mathbf{B}$, and draw the vectors in a Cartesian coordinate system, labeling all vectors ($\mathbf{A}$, $\mathbf{B}$, and $\mathbf{C}$):



$\vec{C}$ points to the POSITIVE x -direction

$$|\mathbf{C}| = |\mathbf{A}||\mathbf{B}| \sin \theta = 7 \cdot 2 \sin 90^\circ = 14$$

$$\boxed{\vec{C} = +14 \hat{i}}$$

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2. Problem 2

A copper container of volume 75 gallons is completely filled with mercury at temperature 15.0°C . How much mercury will spill over the container if the temperature increases to 44.0°C ? (Hint: Look at Table 16.1 of your textbook for corresponding expansion coefficients of the materials.) Ignore the thickness of the walls.

$$\text{Given } \left\{ \begin{array}{l} \alpha_{\text{Cu}} = 17 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}; \quad V_{\text{Cu}} = 75 \text{ gal.}; \quad \beta_{\text{Hg}} = 1.82 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}; \\ T_i = 15^\circ\text{C}; \quad T_f = 44^\circ\text{C}; \end{array} \right.$$

Solve for $\Delta V_{\text{spill}} = ?$

$$\text{mercury expansion: } \Delta V_{\text{Hg}} = V_f^{\text{Hg}} - V_i = \beta V_i \Delta T$$

$$\text{copper expansion: } \Delta V_{\text{Cu}} = V_f^{\text{Cu}} - V_i = 3\alpha V_i \Delta T$$

the mercury will spill by the difference of these volumes:

$$\begin{aligned} \Delta V_{\text{spill}} &= \Delta V_{\text{Hg}} - \Delta V_{\text{Cu}} \\ &= \beta V_i \Delta T - 3\alpha V_i \Delta T = (\beta - 3\alpha) V_i \Delta T \end{aligned}$$

therefore:

$$\Delta V_{\text{spill}} = [1.82 \times 10^{-4} \text{ } ^\circ\text{C}^{-1} - 3(17 \times 10^{-6}) \text{ } ^\circ\text{C}^{-1}] \times (75 \text{ gal.}) \times (44 - 15)^\circ\text{C}$$

$$\Delta V_{\text{spill}} = 0.285 \text{ gal.} = 1.08 \text{ L} = 1.08 \times 10^{-3} \text{ m}^3$$