

# Warm Up: Unit 5, Momentum I

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## 1 Memory Bank

- $F = -\frac{dU}{dx}$  ... 1D definition of a conservative force.
- Note: Net work is zero along a closed path for a conservative force.
- $dF_x/dy = dF_y/dx$  for conservative forces.
- $\vec{p} = m\vec{v}$  ... Definition of momentum.
- $\vec{p}_f = \vec{p}_i$  ... Momentum conservation: no net forces.

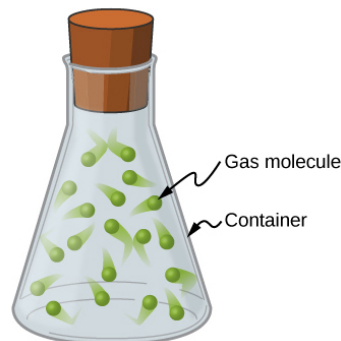


Figure 1: A beaker full of gas molecules.

## 2 Conservative Forces

1. Determine if each of the following forces are conservative. *Hint: Draw each of them in a 2D coordinate system.*
  - A:  $\vec{F} = F_0\hat{i}$
  - B:  $\vec{F} = F_0\hat{j}$
  - C:  $\vec{F} = Ax\hat{i} + By\hat{j}$
  - D:  $\vec{F} = Ay\hat{i} + Bx\hat{j}$
2. Consider the 2D potential  $U(x, y) = k(x + y)$ . (a) What is the associated force,  $\vec{F}$ ? (b) If a system is released from (2, 2), what will be the kinetic energy at the origin?

in momentum,  $\Delta\vec{p} = \vec{p}_f - \vec{p}_i$ ?<sup>1</sup>

## 4 Momentum Conservation

1. Two molecules collide and stick together, forming one larger molecule. Each molecule weighs  $20 \times 10^{-25}$  kg. One has a velocity of  $350 \text{ m s}^{-1}$ , and the other has a velocity of  $-350 \text{ m s}^{-1}$ . (a) What is the total initial momentum (adding the two momenta)? (b) What is the final speed of the big new molecule?

## 3 Momentum

1. A gas molecule has a mass of  $20 \times 10^{-25}$  kg and a speed of  $350 \text{ m s}^{-1}$ . What is the momentum in  $\text{kg m s}^{-1}$ ?
2. Suppose this molecule collides with the side of the glass beaker, turns around, and flies off in exactly the opposite direction at the same speed. What is the *change*

<sup>1</sup>This is the origin of the **kinetic theory of gases** in PHYS185.