

# PH202 Recitation 6

Thermo Part 3 and Fluids

## Warm-Up 1: 1 minute

- Say the equation in words

$$P_i = P_o + \rho_f g d$$

# Warm-Up 1 Solution

## Pressure at a Depth

Pressure at a depth

Pressure above the top of the fluid

Fluid Density

Gravity

Depth

$$P_i = P_o + \rho_f g d$$

*In words:* The **pressure at a depth** is equal to the **pressure at the top of the fluid**, plus the product of the **density of the fluid**, **gravity**, and the **depth** below the top of the fluid.

## Warm-Up 2: 1 minute

- Say the equation in words

$$|\vec{F}^B| = \rho_f V_d g$$

# Warm-Up 2 Solution

## Buoyancy

The diagram illustrates the equation for buoyant force:  $|\vec{F}^B| = \rho_f V_d g$ . Each variable is linked to a descriptive label by an arrow: 'Buoyant Force' points to  $|\vec{F}^B|$ , 'Density of the Fluid' points to  $\rho_f$ , 'Volume of Displaced Fluid' points to  $V_d$ , and 'gravity' points to  $g$ . The variables  $\rho_f$ ,  $V_d$ , and  $g$  are color-coded to match their respective labels.

$$|\vec{F}^B| = \rho_f V_d g$$

*In words:* The **buoyant force** is equal to the product of the **density** of the fluid, the **volume of displaced fluid**, and **gravity**.

# Warm-Up 3: 1 minute

- Say the equation in words

$$P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2$$
The image shows the Bernoulli equation with several arrows pointing to its components. A downward arrow points to  $P_1$ . An upward arrow points to  $\rho$  in the first term, and two arrows point to  $v_1$  in the first term. A downward arrow points to  $\rho$  in the second term, and two arrows point to  $y_1$  in the second term. An upward arrow points to  $P_2$ . A downward arrow points to  $\rho$  in the third term, and two arrows point to  $v_2$  in the third term. A downward arrow points to  $\rho$  in the fourth term, and two arrows point to  $y_2$  in the fourth term.

# Warm-Up 3 Solution

## Bernoulli's Principle

The diagram shows the Bernoulli equation:  $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$ . Labels in boxes with arrows point to the variables:  $P_1$  (Pressure),  $\rho$  (Density),  $v_1$  (Velocity),  $g$  (Gravity),  $y_1$  (Position),  $P_2$  (Pressure),  $\rho$  (Density),  $v_2$  (Velocity),  $g$  (Gravity), and  $y_2$  (Position).

*In words:* Along a laminar flow streamline, the **pressure** at one point, plus  $\frac{1}{2}$  the **density** times the square of the velocity of the fluid at that point, plus the **density** multiplied by gravity and the vertical position, is equal to a constant. That means the summation of those same three terms is equal at another point along the streamline.

## Question 1: 7 minutes

- A. Calculate the depth of water needed to have a pressure of 1 atm.
- B. What if it were mercury instead of water (density of mercury is  $13,690\text{kg/m}^3$ )?

## Question 2: 7 minutes

- Most IV infusions work using gravity. What is the minimum height that an IV bag must be placed above an entry point for the IV fluid to flow? Assume the bag is collapsible and that blood has a pressure of 18mm Hg and there is 133Pa per 1mm Hg.

## Question 3: 7 minutes

- A barber raises a customer in a hydraulic chair. The barber uses a force of  $150\text{N}$  on a piston that has an area of  $0.01\text{m}^2$ . The chair is attached to a piston of area of  $0.1\text{m}^2$ . If the mass of the chair is  $5\text{kg}$ , what is the mass of the customer?



## Question 4: 7 minutes

- A fisherman with mass 75kg falls asleep on a chair (5kg). The chair has 4 legs on the ground with each leg having a radius of 2cm. What is the pressure exerted on the ground?



## Question 5: 7 minutes

- There is 1 mol of a monatomic ideal gas that is in a 4-step cycle. All processes are either isobaric or isochoric. The gas starts at a pressure of 100,000Pa and volume of 0.020m<sup>3</sup>. The pressure is then doubled isochorically. After that, the volume is then tripled isobarically. Then, the pressure is halved isochorically. Finally, the volume is then cut in to a third its value to get back to the original state.
  - A. Sketch the PV diagram
  - B. Determine the temperature at each point
  - C. Calculate  $W$ ,  $Q$ , and  $\Delta E$  for each step of the cycle and the whole cycle