



Molar Volume of Nitrogen Gas

- Put on lab coat, safety goggles
- Place your school bag in the drawer
- Hand in “Lab Safety Certification and Identification” with photo, sign, and write down phone number
- Clean and oven dry 2 small test tubes; use after cooled

Collect:

- Ring stand (back of lab, underneath the windows)
- 2 extension clamps (front of lab, drawer of long table)
- 250 mL Erlenmeyer flask
- 500 mL Florence flask
- Rubber tube with glass tube

Do not take the extension clamp off the stand on your lab bench



Objective

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- To determine the **molar volume of nitrogen gas at STP** by using chemical reactions and the ideal gas law

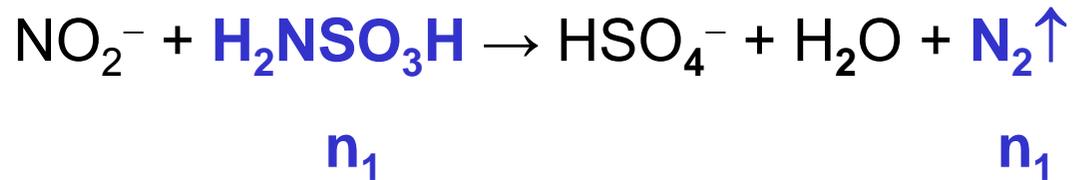
Introduction:

- **Molar volume:** the volume of a mole of substance
- **Standard temperature and pressure (STP):** 0° C, 1 atm
- Molar volume of an ideal gas is 22.414 L at STP



The Reaction

- Limiting reactant: **sulfamic acid** ($\text{H}_2\text{NSO}_3\text{H}$, n_1 mol)
- Excess reactant: **sodium nitrite** (NaNO_2)
- Chemical reaction:



- Using the number of mole of nitrogen gas (n_1), room temperature (T_1), volume (V_1) and partial pressure of nitrogen (P_{N_2}), and the ideal gas law to determine the molar volume of nitrogen gas at STP (V_{STP})

$$\frac{1 \text{ (atm)} \times V_{\text{STP}} \text{ (L)}}{1 \text{ (mol)} \times 273.15 \text{ (K)}} = \frac{P_{\text{N}_2} \times (V + \Delta V)}{n_1 \times T_1} = \frac{(P_{\text{atm}} - P_{\text{H}_2\text{O}}) \times \Delta V}{n_1 \times T_1}$$



Procedure 1: Measuring and Setting Up

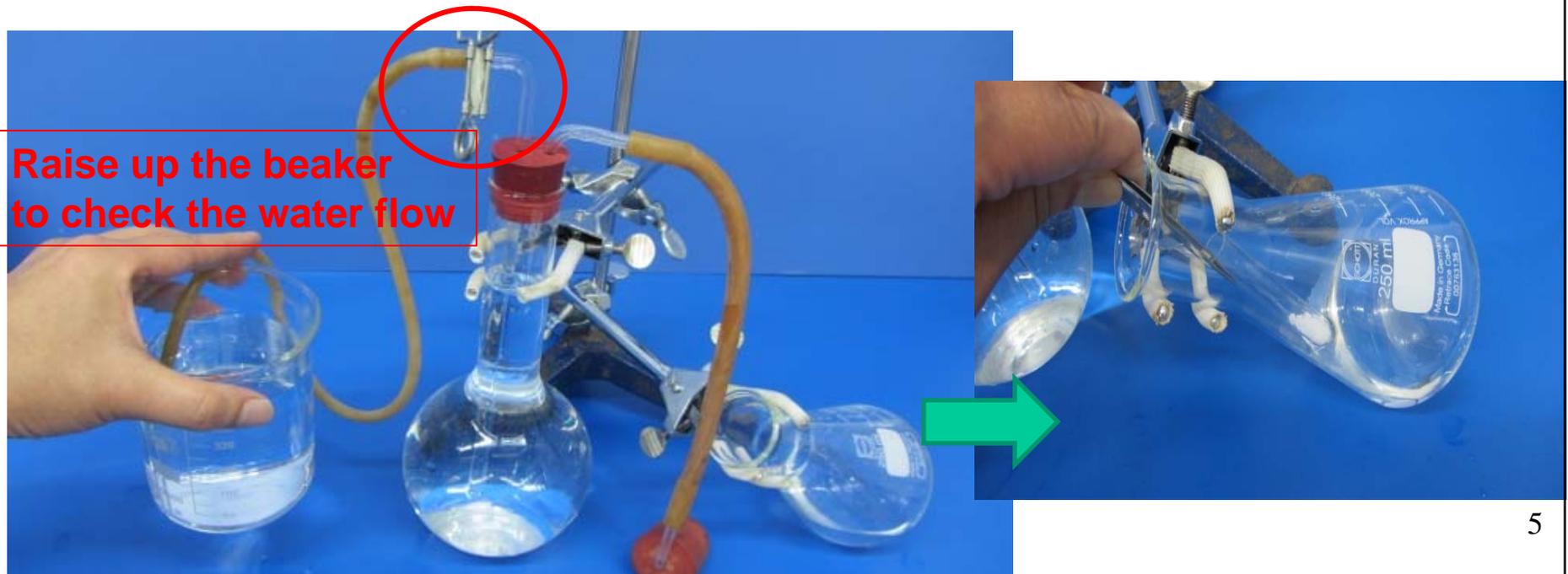
- Flask A
1 g NaNO_2 dissolved in 50 mL **distilled water**
- Small test tube:
1.0~1.1 g $\text{H}_2\text{NSO}_3\text{H}$ (limiting reactant, record accurate weight)
- Fill the rubber tube C with water and clamp tight





Procedure 2: Check the Water Flow

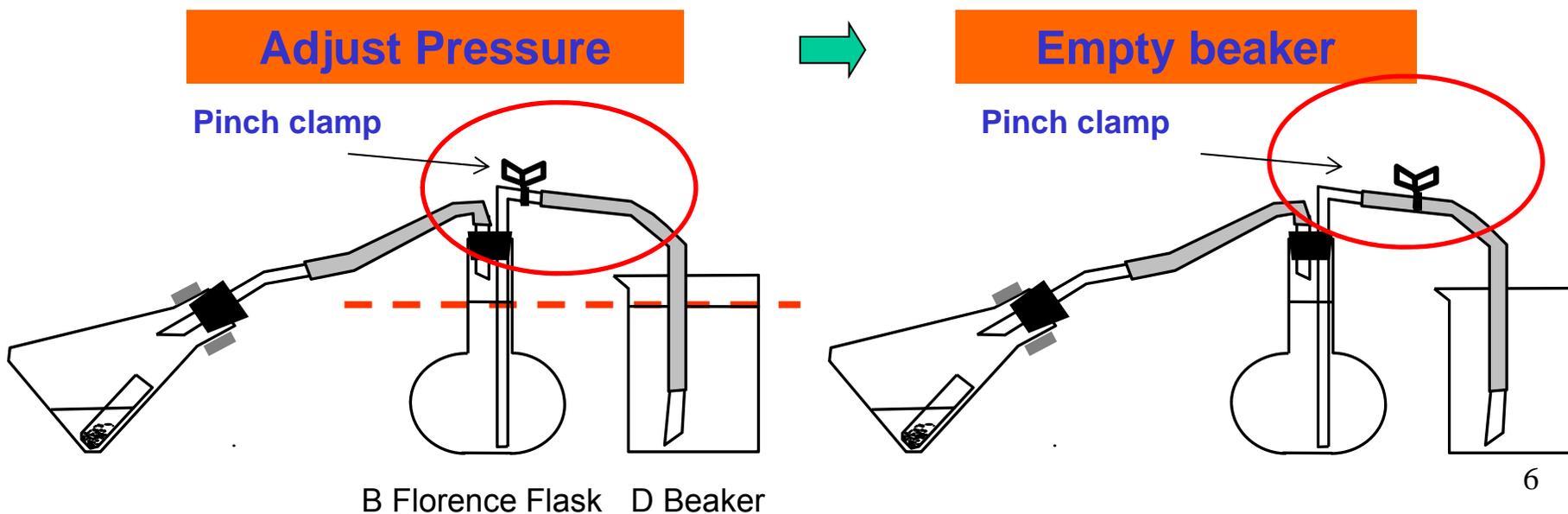
- Fill the Florence flask B and beaker D with water
- Setup the equipment as shown
- Loosen pinch clamp to check if water can flow freely between flask B and beaker D, and rubber tube C is completely filled with water, then clamp tight again
- Place the test tube into the flask A with the help of tweezers





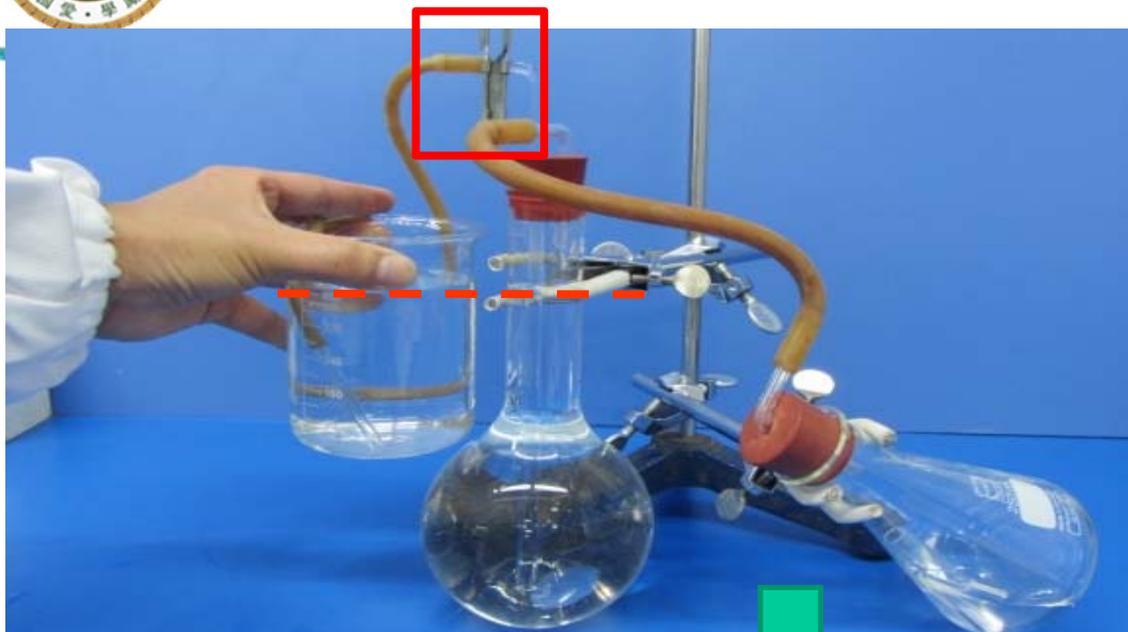
Procedure 3: Adjust the Pressure

- Check the rubber stoppers is tightly fitted
- Loosen pinch clamp, adjust the pressure of the reaction system to be equal to the atmospheric pressure by adjusting the water surface of flask B and beaker D
- Tighten clamp on rubber tube C and discard water in beaker, measure the weight of empty beaker





Adjust the Pressure of System



- Check the stoppers
- Raise up beaker to adjust the system pressure



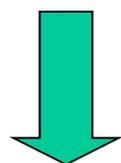
- Clamp the tube
- Weigh the empty beaker





Start the Reaction

**Tilt the test tube
Start reaction gently**

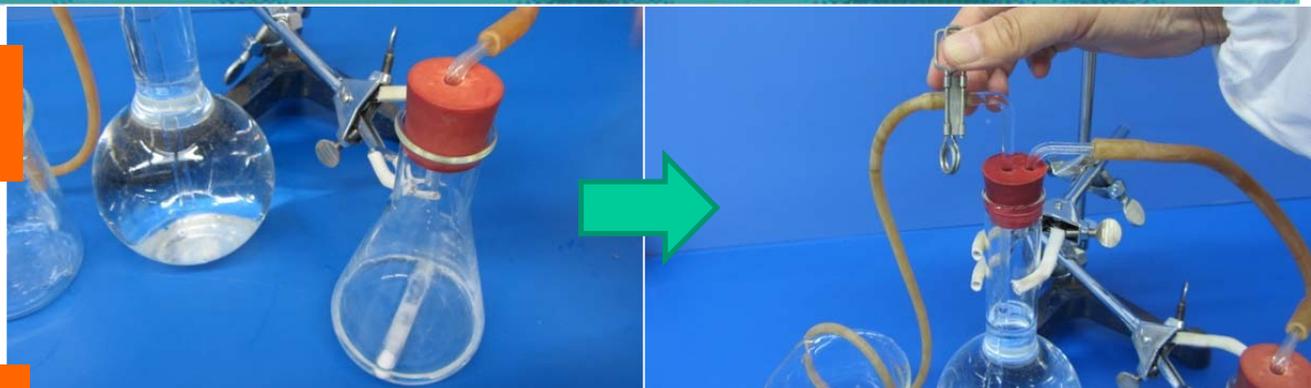


Gas evolved

**Loosen the clamp
Swirl the flask gently**



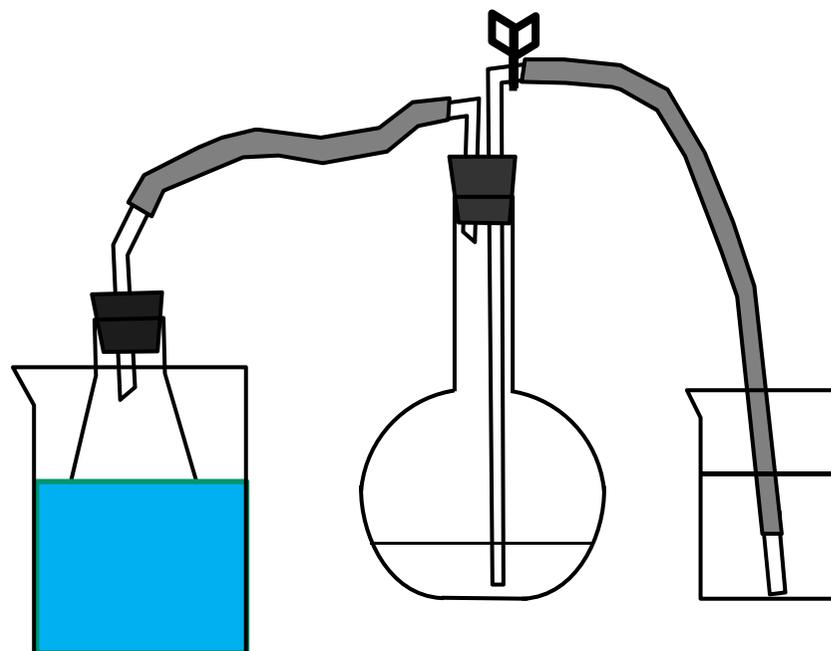
**Collect the
water displaced**





Procedure 5: Adjust to Room Temperature and Atmospheric Pressure

- Cool the flask A to room temperature
- Adjust the water levels of beaker D and flask B to be equal to make the pressure of system equal to the atmospheric pressure
- Tighten the pinch clamp
- Measure the weight of water collected in beaker D to calculate ΔV
- Record room temperature and pressure
- Pour out the reacted solution and rinse the glassware with large amounts of water immediately



1 L beaker

$\Delta V > 250 \text{ mL}$



After Reaction and Post Lab



Adjust system temp.
and pressure to room
temp. and
atmospheric pressure



Measure the wt. of
water and beaker
to calculate ΔV



Pour and flush the
waste away quickly
for NO_2 may evolved



Notice

- Any problems should be discussed with TA, do not keep trying and repeat errors by oneself, always be prepared before class
- Bring scientific calculators to every experiment
- Finish calculation and note the significant figures as well as the units used, i.e. 1.10 g, 359.12 g, and 359.12 mL.
- Hand in lab report to TA
- After the lab:
 - **Clean and return** the small test tube
 - **Clean up the lab bench** and hot plate
 - **Tucked** the chairs underneath table
 - **Count and replace** equipment in the cabinet underneath the bench according to equipment list