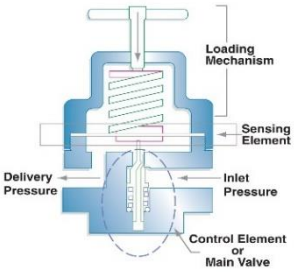
SOP: GAS REGULATOR INSTALLATION & MAINTENANCE

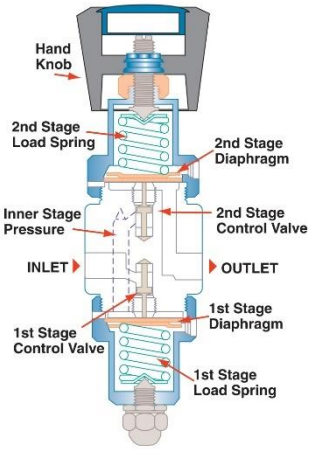
WHAT IS A REGULATOR?

A regulator guides pressurised gas from the cylinder and delivers it at a specific pressure and flow rate suitable for the specific instrument, gas-line manifold or reaction mixture. Two-stage regulators contain an intermediate pressure stage, delivering a more stable flow rate regardless of how full the supply cylinder is. Regulators are calibrated mechanical items that are sensitive and if not properly used/maintained parts can wear out, leak, or fail unexpectedly.



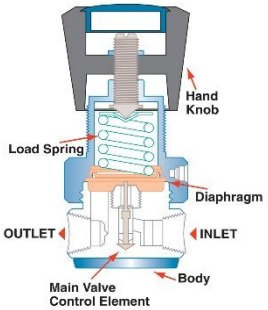
There are three basic operating components in most regulators: a **loading mechanism**, a **sensing element**, and a **control element**. They work together to accomplish pressure reduction. Most regulators use a spring as the loading mechanism. When the regulator “hand knob”/dial is turned, the "2nd stage load spring” is compressed. The force placed on the spring is communicated to the sensing element/“2nd stage diaphragm”. Most regulators use a diaphragm made of elastomers or metal as the sensing element. The control valves accomplishes the reduction of inlet pressure to outlet pressure. This change in force on the sensing element is communicated to the control element causing it to move away from the regulator seat to achieve the outlet pressure.

There are regulators for **general use** (used with gases that are <99.995% pure) and for **high-purity gas** work use (usually made from brass and used for gases that are >99.995% pure and used for applications where maintaining system purity is the main concern).



There are two types of regulators:

- **Dual Stage Regulators** reduce the source pressure down to the desired delivery pressure in two steps. Each stage consists of a spring, diaphragm, and control valve. The first stage reduces the inlet pressure to about three times the maximum working pressure. The final pressure reduction occurs in the second stage. The advantage of a dual stage regulator is its ability to deliver a constant pressure, even with a decrease in inlet pressure and best suited for applications such as gas supply to analytical instruments, where constant delivery pressure is critical.

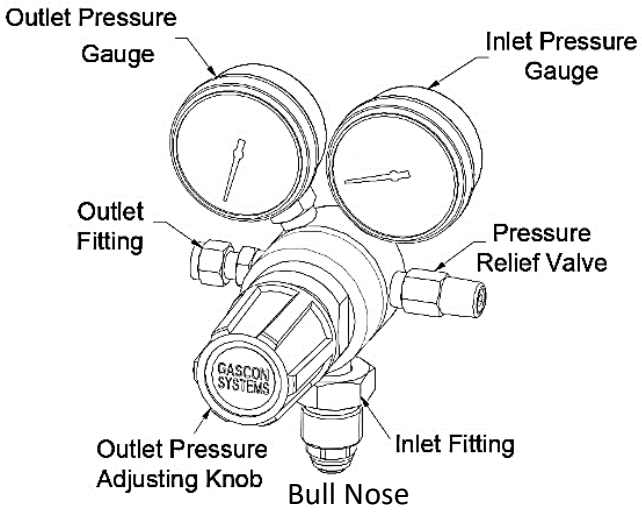


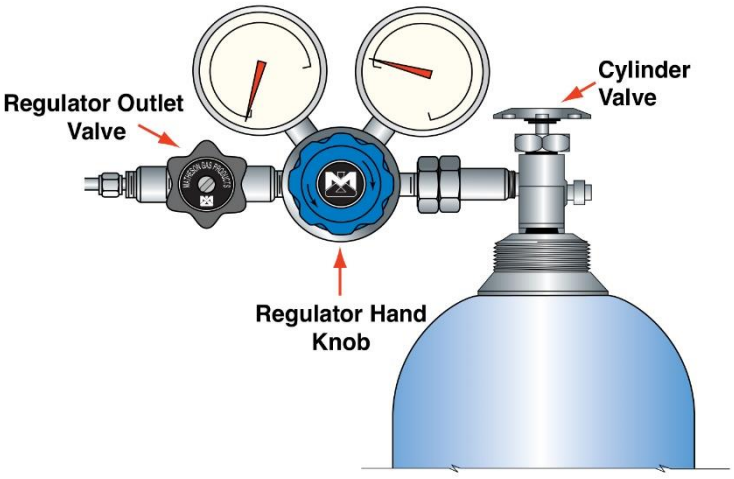
- **Single Stage Regulators** accomplish the pressure reduction in a single step. Delivery pressure cannot be as tightly controlled as with a dual stage regulator. As the pressure in a cylinder decreases the flow rate decreases. These regulators should only be used where an operator can monitor and adjust pressure as needed, or where the regulator is supplied with a nearly constant source pressure.

INSTRUCTIONS FOR INSTALLING & USING A GAS REGULATOR

MATERIALS NEEDED

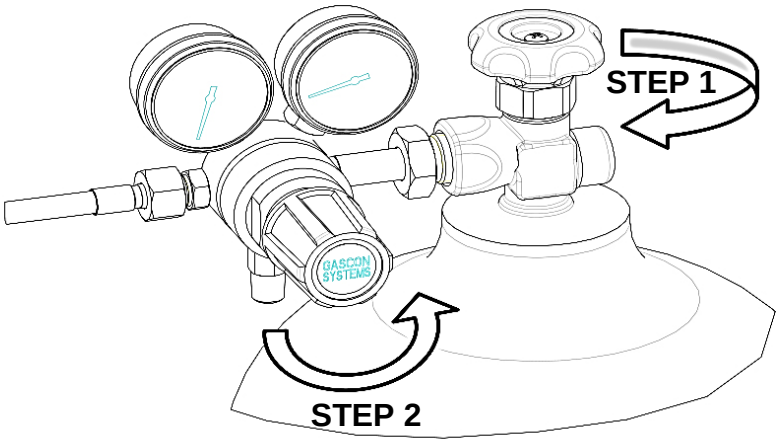
- Preferably a non-adjustable crescent wrench of the right size. (*Adjustable wrenches if not tight may damage brass nuts. Pliers should never be used*).
- Gas cylinder cart/trolley
- Leak detection “Snoop” solution in a squeeze/spray bottle: prepared by adding a few drops of liquid soap to water in a squeeze bottle. *(Note: a dedicated snoop solution should be obtained from suppliers for cylinders carrying oxygen gas. Using a surfactant solution may cause a fire)*
- Teflon tape (optional). See section on Teflon tape.
- PPE: Lab coat, safety glasses, work gloves, sturdy shoes.
- Special Safety: Gas sensors.
- Regulator for specific gas.



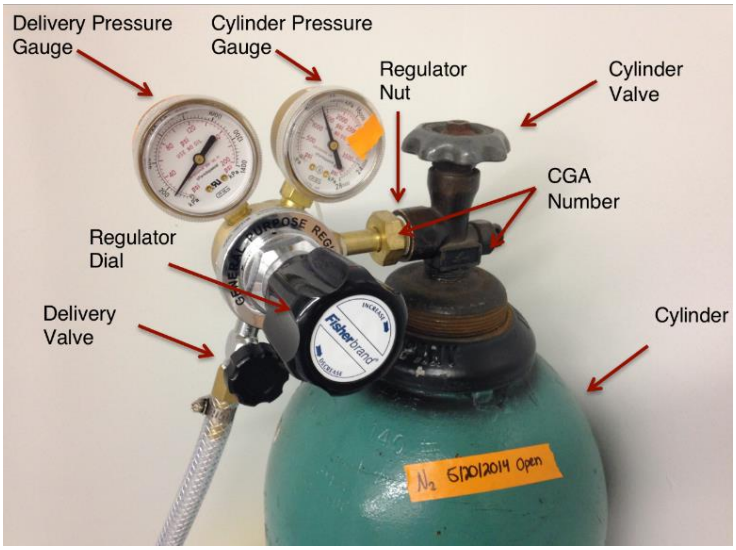


DISCONNECTING A REGULATOR

Turning Off Cylinder Valve



Non-Adjustable
Crescent Wrench

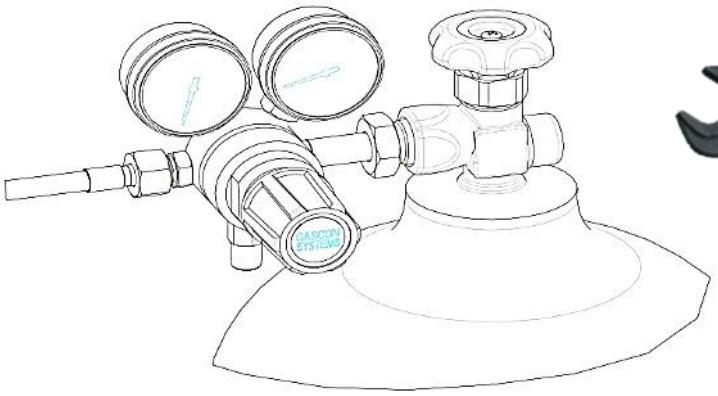


1. **ALWAYS START BY** ensuring the gas cylinder tank valve (found on top of the gas cylinder) is closed by hand and not by mechanical means.
2. Open regulator dial (or control valve) to purge system.
3. If a gas delivery valve is part of system - slowly open the valve.
4. Watch and ensure the pressure gauges drop to zero.
5. Close regulator dial (or control valve) anticlockwise.
6. ***If using a corrosive gas, purge the system with a dry inert gas first.***
7. Using the crescent wrench (not pliers!) loosen regulator nut which connects the regulator to the cylinder.
8. If there is any residual pressure, a hiss will be heard as a small amount of gas in the regulator is released.
9. After loosening the regulator nut, unscrew the rest of the way by hand.
10. Make sure to support the weight of the regulator with the other hand as the regulato nut is unscrewed.
11. *If required - disconnect the delivery hose from equipment.*
12. If an empty cylinder is exchanged, it must be properly labelled as empty and returned to the Faculty Stores Gas storage area where a full cylinder can be collected.
13. **DO NOT** store empty gas cylinders in the laboratory!

CONNECTING/ATTACHING REGULATOR ON NEW GAS CYLINDER

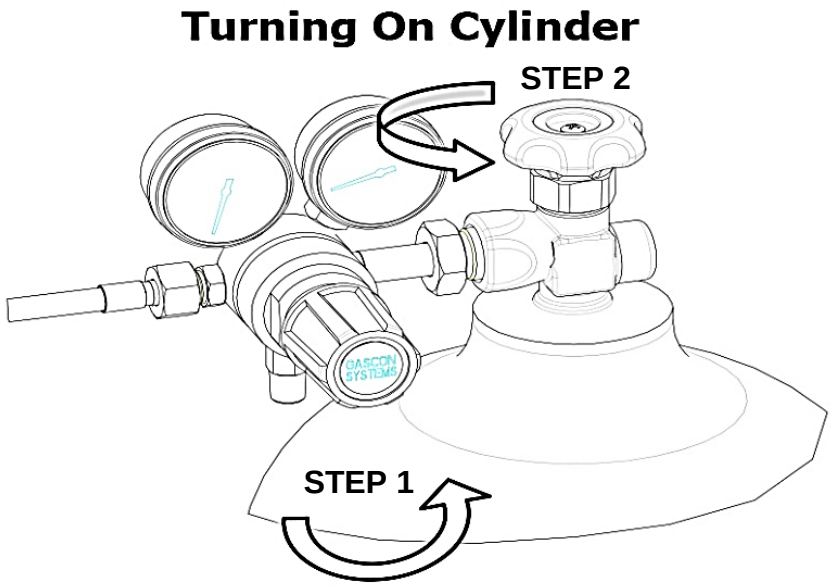
1. Note: **NEVER** use a regulator that is incompatible with the gas being dispensed.
2. The cylinders and regulators for flammable/poisonous gasses are **reverse threaded** to ensure that they are only used together. The nuts on these regulators will also often be marked with a series of ***notches***.
3. Change cylinders and ensure new one is secured (with chain) and the contents label facing out - so as to be visible in an emergency/evacuation.
4. Remove the new cylinder valve's plastic covering.
5. When re-using already "opened" gas cylinders, keep in mind that impurities maybe introduced into the system. ***It is thus important to purge the system to remove any unwanted atmospheric impurities.***
6. Inspect regulator valve and cylinder thread and if required, the washer's / O-ring's condition - for damaged threads, traces of dirt, dust, oil, grease, general damage or wear-and-tear. Remove any loose debris from the threads and seat.
7. Replace washer /O-ring if necessary.
8. With the cylinder valve outlet pointing away from the user, other people in the vicinity and sources of ignitions, do a quick purge of the cylinder by slowly (and just for a second) opening and closing the cylinder's valve.
9. Align the regulator's bull nose with cylinder threads (making sure the washer/O-ring is in place), push bull nose into the cylinder's thread and hand-tighten the regulator nut while supporting the weight of the r

Fitting the Regulator



Non-Adjustable
Crescent Wrench

10. Use a crescent wrench to fully tighten the regulator nut - usually another ¼ - ½ of a turn after hand tightening.
11. DO NOT overtighten the regulator nut as this can damage the valve seat.
12. If the regulator has not been used recently (or unsure of the pressure setting), left turn the regulator dial all the way to the left - it will be set to its lowest pressure delivery setting.
13. Lubricants should NEVER be used on connections.
14. Teflon tape is not required.
15. Reconnect the delivery hose to equipment – if removed.
16. Stand at an angle to the cylinder pressure gauge face and open the cylinder valve slowly - sudden pressurization can cause the glass face to shatter.
17. Open the cylinder valve until the cylinder pressure gauge needle indicates pressure.
18. It is NOT NECESSARY OR DESIRABLE to turn the valve to the FULL open position.
19. Complete leak testing.
20. **TAKE NOTE**: Make sure the cylinder valve is closed whenever not dispensing gas through the regulator.



LEAK TESTING

- Laboratory gases are flammable, asphyxiants or even toxic and leaks must be avoided.
- Once the regulator has been attached, the connections should be leak tested.
- If part of system - ensure the regulator's delivery valve is closed.
- If working with a toxic/flammable gas, ensure gas cylinder is in a well-ventilated area and if applicable, a suitable gas detector is on your person.
- Open the cylinder valve slowly. The cylinder pressure gauge should increase to about 2000 psi for most cylinders.
- The delivery pressure gauge should read 0 psi (***the delivery gauge should not read pressure unless the regulator dial is open***).
- Make a note of the pressure.
- Then close the cylinder's valve. If the pressure does not drop over the course of a few minutes there are no concerning leaks between the cylinder and the regulator.
- Next, open the cylinder valve again and then the regulator dial (and if present, the delivery valve on the regulator).
- Again make note of the pressure. Close the cylinder valve and ensure that the pressure does not drop over a few minutes by watching both the delivery and pressure gauges.
- If a slow leak is suspected, use a snoop solution (soap/surfactant solution) and spray a small amount around all connection nuts (or wherever a possible leakage may be).
- Make note where soap bubbles forms, usually indicates the location of leaks.

- The presence of soap bubbles and decrease in pressure may be due to a loose/poor connection(s) - try tighten all regulator nuts slightly more with crescent wrench.
- If the connection keeps leaking, turn off the gas starting from the gas cylinder side and disconnect the regulator.
- Check for damage to the face of the fitting, for debris in the cylinder valve connection or for a missing washer.
- If there are no leaks, open the cylinder pressure gauge until full pressure is reached (***the regulator valve does not need to be fully open***).
- To adjust the pressure (i.e. opening the tank to allow gas flow), slowly turn the regulator dial (or hand knob) clockwise whilst monitoring the delivery pressure gauge until desired delivery pressure is achieved.
- **DO NOT EXCEED THE MAXIMUM DELIVERY PRESSURE FOR THE REGULATOR OR THE SYSTEM.**
- Both the cylinder pressure and delivery pressure should be monitored occasionally. The tank pressure will steadily drop as the gas is depleted, and a replacement cylinder should be ordered well before the current tank runs out of gas.
- The delivery pressure will change slightly over as a function of the tank pressure.

TEFLON TAPE

- Different laboratories follow different guidelines for the use of “Teflon tape”, which is a thin, white pliable film of poly(tetrafluoroethylene) and free from hydrocarbons.
- In some groups, Teflon tape is used frequently when installing regulators, while in others this practice is not allowed.
- Some regulator manufacturers warn against the use of Teflon tape.
- Small particles can get into the regulator with the potential to cause a leak, malfunction and/or reading error.
- Those in favour of Teflon tape point to improved seals and more reliable operation when applied properly.
- Those against the use of Teflon tape argue that properly maintained cylinders and regulators should make a tight metal-metal connection without leaks and warn that improper application of Teflon tape can stress the regulator components.
- ***When using Teflon tape:*** Make sure that any old bits of tape are completely removed from the threads of both the regulator and the cylinder.
- Use a plastic object to gently scrape off tape if needed (DO NOT use razor blades, syringe needles, or other metal tools causing damage to the delicate threads).
- Apply one (and only one) complete wrap of new Teflon tape to the exposed threads usually the nut on the regulator), working opposite to the direction of tightening it.
- Use the thinnest tapes possible and do not wrap multiple times: thick layers of Teflon tape will put strain on the regulator as it is tightened.Use the thinnest tapes possible and do not wrap multiple times: thick layers of Teflon tape will put strain on the regulator/connection as it is tightened, which may l

TROUBLESHOOTING

Gauge shows to be on pressure, why does it not deliver that pressure?
Regulators have springs inside that control the maximum delivery pressure possible. The gauge does not dictate the maximum delivery pressure.

Can I dial to 2 psi when the gauge goes all the way up to 200 psi?
Not reliably. The delivery of gas will fluctuate greatly if the delivery range is too high.

Will my regulator control gas flow?
Not well. Pressure regulators control pressure - not flow. A flow valve will be needed to control flow.

Why does my gas regulator hum sometimes?
Regulator hum indicates that the seat and stem dampers are worn or inoperative. It is also possible that an improperly ranged regulator is being used.

Does CO_2 require a washer?
Yes, a small nylon or Teflon washer is required. If the washer is not present or severely deformed, the connection will leak.

Single Stage vs. Dual Stage Regulator?
Dual stage regulators control pressure better and do not really cost much more. Single stage regulators tend to increase delivery pressure as cylinder pressure decreases. Most equipment manufacturers recommend and sell dual stage regulators.

Brass vs. Stainless Steel
Brass regulators are acceptable for ultra-high purity applications. Stainless steel bodies do not make regulators cleaner in regard to the gas flow. Stainless steel diaphragms are used in all high-purity regulators regardless of their body material. **Stainless Steel** body regulators are needed for **corrosive gases** and **harsh external** environments.

Do I need to use Teflon tape for my cylinder to regulator connection?
No, all cylinder connections are designed to connect without the use of Teflon tape. Some connections use washers, but most connections use metal-to-metal contact to form a leak free connection.

When I turn the regulator's dial counter-clockwise (to reduce pressure) the delivery pressure does not change?
The regulator will not reduce its delivery pressure unless the gas is flowing through the regulator. If the downstream segment of the system is static, the pressure will not drop unless the system is vented. However, the pressure will increase if a higher pressure is used when the system is static.

How tight should my cylinder connection be?
Tight enough not to leak. Try not to use channel lock pliers to tighten the regulator - it will ruin the regulator nut and most likely cause it to leak!!!

HEALTH & SAFETY ISSUE

Potential Hazards:

- Falling over of gas cylinders if not secured
- High Pressure gasses used with no regulator causing rupture/explosion
- Potential Toxic/Flammable gases using explosion/firePotential Toxic/Flammable gases causing explosion/fire

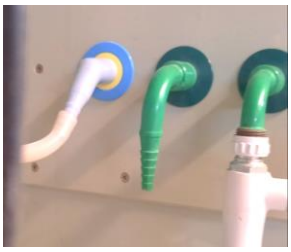
IMPORTANT:

- Know the hazards specific to the gas to be used.
- Install of gas sensors when using toxic/asphyxiant gases – ensure they are regularly/annually calibrated.
- Use lab trolley/cart to move cylinders upright and properly secured.
- Properly secure gas cylinders at standing/connection area.
- Use the regulator specific for the gas in the cylinder. In particular, an oxygen regulator should NEVER be used for any other gas. If it has been, it must be NEVER used for oxygen again. Cross-contamination of internal parts (especially with grease or oil) could cause a rapid oxidation and fire.
- Oxygen requires a dedicated snoop solution (not soap-based) due to fire risk.
- Use a crescent wrench for loosening and tightening nuts.
- NEVER use oil or grease to make fitting and tightening easier.
- Be aware of any special purging, ventilation, lab or equipment specific procedures or other requirements that may be in addition to those listed in this SOP.
- Ensure the desired delivery pressure is known for the system, apparatus or equipment.
- Wear of correct PPE, where necessary.
- An adaptor between a cylinder and a pressure-reducing regulator is prohibited.
- The delivery ***pressure gauge's midpoint should be considered the upper end of its useable delivery pressure range***.
- Some regulators (e.g. CO_2) require a washer to be inserted betw ıd regulator. Check to see if this is required and present.

- All connections must be able to withstand the maximum delivery pressure of the regulator - compression fittings are required for copper and stainless-steel tubing, hose barbs are normally used for plastic tubing.
- Do not "purge" cylinders of toxic or corrosive gases unless into a e.g. fume hood.
- When the cylinder is not actively in use (connected to a piece of equipment and properly supported), the gas cylinder valve needs to be closed and regulator removed.
- Never use a regulator with the pressure adjustment dial fully screwed in.
- If higher pressures or flow rates are required, select a suitable regulator.
- If a hissing sound is heard from the regulator, immediately close the cylinder valve and have the regulator serviced.
- Have regulator/s inspected and serviced at least on an annual basis by a certified service provider.
- Consider changing the regulator once every 5 years, especially if in full-time use.

CHEMISTRY RESEARCH LAB SETUP

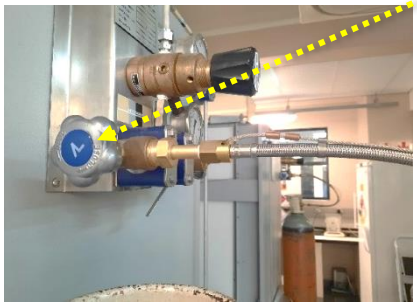
- Each fume hood has an external set of taps and gas control valves to deliver e.g. nitrogen gas to experiments inside fume hood.

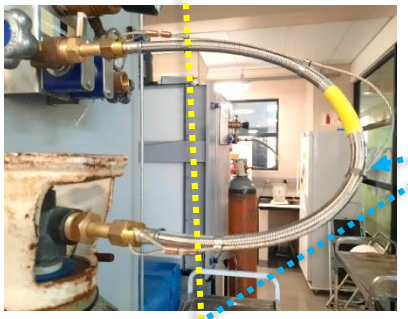


- In **labs 7A, B and D** gas cylinders are connected to a fixed regulator connected to a fixed gas pipeline which feeds fume hoods with gas connected to it.
- The gas cylinder is connected via steel delivery pipe to a Acetylene style cylinder valve to the installed regulator. The latter should be mostly nitrogen regulators, but it has been found some oxygen regulators are also used to feed nitrogen with.

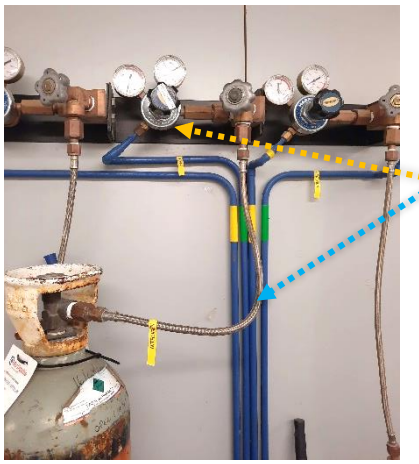
Set-up in LABS 7A & B

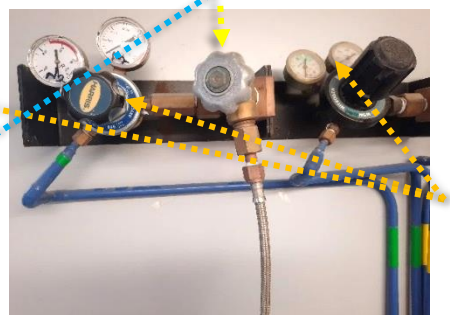
Acetylene Cylinder (AC) Valve





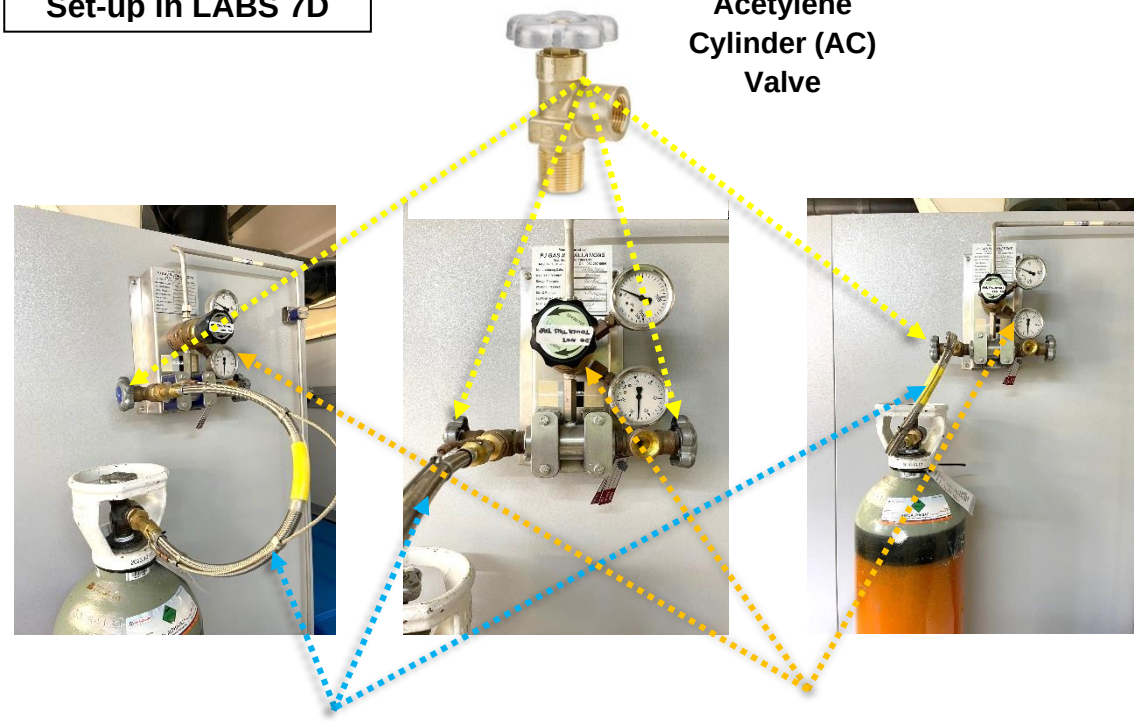
Steel Connection Tube





Fixed Regulator

Set-up in LABS 7D



CHANGING A GAS CYLINDER IN THESE LABS

DISCONNECTING

1. **ALWAYS START BY:** Shutting the gas cylinder tank valve on top of the gas cylinder until it seals – hand tighten.
2. Ensure AC and regulator valve is open.
3. Open fume hood gas delivery/adjusting tap slowly in order to purge system.
4. Monitor the gauges, ensuring that the pressure drops to zero before removing the regulator.
5. Close: 1) fume hood delivery tap/valve, 2) regulator control valve (anticlockwise) and 3) AC valve.
6. Using a crescent wrench (not pliers!) loosen steel pipe nut which connects the AC valve to the cylinder.
7. If there is any residual pressure, a hissing sound is heard as a small amount of gas in the regulator is released.
8. After loosening the regulator nut, unscrew the rest of the way by hand.
9. If exchanging an empty cylinder, it must be properly labelled as empty and returned to the Faculty Stores Gas storage area, where a full cylinder can be collected.
10. **DO NOT** store empty gas cylinders in the laboratory!

CONNECTING

1. Make sure the new gas cylinder's valve is closed by hand tightening it.
2. Change cylinders and ensure new one is secured and the contents label facing out - to be visible.
3. Remove the new cylinder valve's plastic covering. Inspect cylinder tread.
4. Inspect the steel tube and the thread on the bull nose nut.
5. Remove any residual Teflon with plastic utensil.
6. Remove any traces of dirt, dust, loose debris from the threads and seat.

7. With the cylinder valve outlet pointing away from people, sources of ignitions and/or oxidizable material (Oxygen cylinders), do a quick purge of the cylinder by slowly and just for a second opening and closing the cylinder's valve.
8. Align and push bull nose into the cylinder's thread and hand-tighten the regulator nut.
9. Use a crescent wrench to fully tighten the regulator nut - usually another ¼ - ½ of a turn after hand tightening.
10. DO NOT overtighten it can damage the valve seat.
11. If the regulator has not been used recently — or unsure of the pressure setting — left turn the regulator dial all the way to the left - it will be set to its lowest pressure delivery setting.
12. Lubricants should NEVER be used on connections.
13. Teflon tape is not required.
14. Stand at an angle relative to the gauge face and open the cylinder tank valve slowly - sudden pressurization can cause the glass face to shatter.
15. Open the cylinder valve until the cylinder pressure gauge needle indicates pressure.
16. It is NOT NECESSARY OR DESIRABLE to turn the valve to the FULL open position.
17. Complete LEAK TESTING.
18. After leak test has been completed, open AC valve – it does not have to be fully open.
19. Open regulator valve and use fume hood delivery valve to regulate delivery rate.
20. **TAKE NOTE**: Make sure cylinder valve is closed whenever not dispensing gas.