Vernier Gas Chromatograph Mini GC™

(Order Code: GC-MINI)

Introduction

The Vernier Gas Chromatograph, or "Mini GC," is an instrument for separating, analyzing, and identifying substances contained in a volatile liquid or gaseous sample. The Mini GC can detect and distinguish between families of compounds, including alcohols, aldehydes, ketones, aromatic hydrocarbons, carboxylic acids, chlorinated hydrocarbons, esters, ethers, and nitriles (see Appendix A for more details). It has all of the key components of a traditional gas chromatograph, including an injection port, temperature and pressure controls, a capillary column through which different substances pass at different rates depending on various chemical and physical properties, and a sensor for detecting the arrival of compounds. It has a patented MEMS chip sensor that allows for room air to be used as a carrier gas.

The Mini GC connects to the USB port on a computer or the LabQuest handheld. Both Vernier Logger *Pro* and LabQuest App software allow students to easily control data-collection parameters, then collect data in real time. After the peaks are detected, the software allows you to determine retention times and/or integrate peaks to help quantify the relative amount of each compound present in the sample.

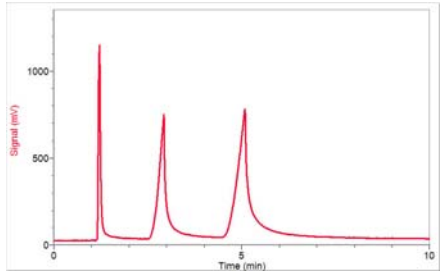
What is included with the Mini GC?

- One Mini GC unit (with 11 m Restek GC column installed)
- AC Power Adapter
- Two Syringes (1.0 µL volume)
- Two extra Septa (a third Septum is already installed in your Mini GC)
- Two extra Mini GC intake-valve plastic caps (a third cap is already on the unit)
- One USB cable
- One Lab Manual: *Gas Chromatography Investigations with the Mini GC*™
- User's Guide (this document)
- One carrying case

Important: We strongly recommend that you read the entire manual thoroughly before using the Mini GC for the first time. There are precautions and usage suggestions throughout this manual that are important to know about, prior to doing your first data collection. Please wear the appropriate personal safety equipment and use the instrument in accordance with the instructions in this manual to prevent any injury.

Caution: The Vernier Mini GC gas chromatograph is designed to analyze volatile compounds. These compounds may be toxic or highly flammable; therefore, follow the manufacturer's instructions when operating this instrument. Serious personal injury may result from improper use of this instrument. Due to the small amounts of analytes, there is no hazard that exhaust from the chromatograph could cause a fire when used according to the instructions. To minimize exposure to vapors, use this instrument in well-ventilated areas. Refer to the Material Safety Data Sheet for each compound to be injected into the chromatograph. For personal protection, we recommend that open reagent containers be handled in a hood or well-ventilated area.

Logger *Pro* 3 or LabQuest App Software Requirements



Logger *Pro* 3 (version 3.8 or newer) software is required if you are using a computer. LabQuest App version 1.3 or newer is required if you are using a LabQuest. (You can check the LabQuest version by tapping the Home icon, tapping Control Panel, and then tapping System Information).

If you own an earlier version of Logger *Pro* 3 software or LabQuest App, you can upgrade to the current version at no cost by visiting our web site for updates: www.vernier.com/downloads/

Note: If you use National Instruments LabVIEW software, you can obtain a LabVIEW VI for collecting with the Mini GC. Go to: www.vernier.com/labview/.

Using the Mini GC with a Computer or with LabQuest

1. If you will be collecting data on a computer, be sure you are using Logger *Pro* software, version 3.8 or newer.

   If you will be collecting data on LabQuest, make sure the LabQuest unit has been updated to version 1.3 or newer.
2. For your initial trial, obtain a glass syringe and a set of vials of one or more of the following five ketones: acetone, 2-butanone, 2-pentanone, 2-hexanone, or 4-methyl-2-pentanone (or a mixture of any of these 5 ketones. You will test acetone, and also use it to clean the syringe needle.

Note: More detail on this experiment can be found in Experiment 1, "Using a Gas Chromatograph: Identifying Unknown Compounds," in the accompanying lab manual, *Gas Chromatography Investigations with the Mini GC™*.

Important: The glass syringe is fragile and can be easily damaged. Be careful not to bend the needle or bend the plunger. If the plunger is accidentally pulled out of the glass barrel, reinserting it is extremely difficult, sometimes impossible.

3. Prepare the Vernier Mini GC for data collection.
   a. Turn on the Mini GC, using its on-off switch on the left side (see Figure 5).
   b. Connect the USB cable of the Mini GC to the USB port on your computer or LabQuest.
   c. Start the data-collection program, and then choose New from the File menu (to ensure software settings are set to default values).
   d. Click Collect in Logger *Pro*, or tap ► in LabQuest, to bring up the Temperature-Pressure profile. This screen will look something like this:

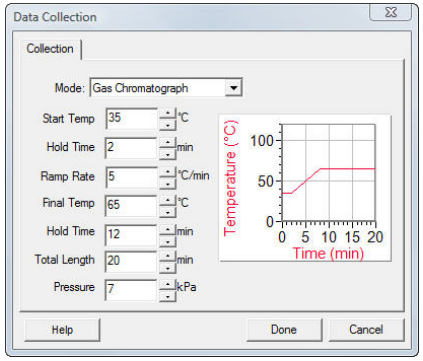


Figure 1 *Temperature-Pressure*

   e. Set the Temperature-Pressure values to:

Start temperature	35°C
Hold time	2 min
Ramp rate	5°C/min
Final temperature	55°C
Hold time	9 min
Total length	15.0 min
Pressure[1]	5.0 kPa

   f. Select Done to initiate the Mini GC warm up. **Note:** A new message will appear, "Do not inject until GC is ready", and the LED on the Mini GC is red. The Mini GC will take a few minutes to warm up and stabilize. When the Mini GC is ready for injection in Step 7, the message will read, "Inject and select Collect simultaneously", and the LED will turn to green. Continue with Step 4 during warm up.

[1] Pressure values entered here represent the pressure *above* ambient air pressure.

4. Follow the steps below to clean and flush the syringe with acetone. **Important**: The glass syringe is fragile. Be careful not to bend the needle or bend the plunger. Never pull the plunger back more than 50% of its total volume. Be careful not to bend the plunger as you press it down.
   a. Depress the plunger fully.
   b. Submerge the tip of the syringe needle into the vial of acetone.
   c. Pull back the plunger to fill the barrel about 1/3 full of acetone.
   d. Expel the liquid onto a Kimwipe® or a paper towel.
   e. Repeat Steps a–d at least two times, until you are comfortable pulling up a liquid into the syringe and measuring the volume in the syringe barrel. Use a Kimwipe or a paper towel to carefully pat around the tip of the syringe needle.

5. Follow the process in Step 4 to clean and flush the syringe with 2-butanone (or another available ketone), the first ketone sample to be injected into the Mini GC.

6. Collect a volume of 2-butanone for injection.
   a. Submerge the needle into the vial of 2-butanone one last time.
   b. Draw up approximately 0.2 µL of liquid. It is not critical that the volume be exactly 0.2 µL; a tiny bit more or less volume is all right.
   c. After collecting your sample, gently wipe the needle from barrel to tip, with a Kimwipe.

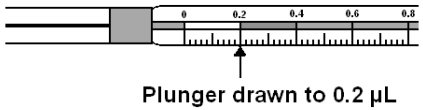


Figure 2

7. Prepare for injection and the start of data collection. It is important for you and your lab partner to divide the tasks in this step. One person will operate the syringe and the other person will operate the computer controls.
   a. When the Mini GC has reached the correct start temperature and pressure, the message reads, "Inject and select Collect simultaneously," and the LED on the Mini GC is green.
   b. To insert the needle of the syringe into the injection port of the Mini GC, hold the syringe with one hand and steady the needle with your other hand.

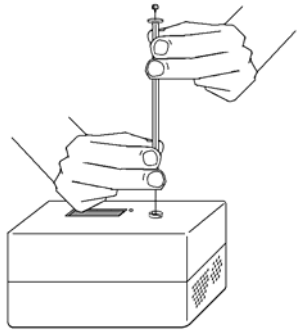


Figure 3

Important: Supporting the needle guard and the lower part of the needle with two fingers, as shown in Figure 3, can prevent the possible bending of the needle! Insert the needle into the injection port until the needle stop is fully seated. If the needle sticks, rotate it slightly while inserting. Do not move the plunger yet.

c. Simultaneously, depress the syringe plunger and select Collect to begin data collection. Pull the needle out of the injection port immediately.

8. While the data collection proceeds, repeat Step 4 to thoroughly clean the syringe and needle. It may take more than three flushes to feel the syringe plunger move smoothly again, which is your indicator that the syringe and needle are both suitably clean.

9. Data collection will end after fifteen minutes.

10. Analyze your chromatogram.
    a. Choose Peak Integration from the Analyze menu.
    b. Select and integrate the left-most peak. To do this, drag from a little before the peak to a point far enough to the right that includes all of the peak. Then choose Add. **Note:** Prior to integrating, it is also possible to drag across a peak and then use the Zoom button to zoom in on the peak.

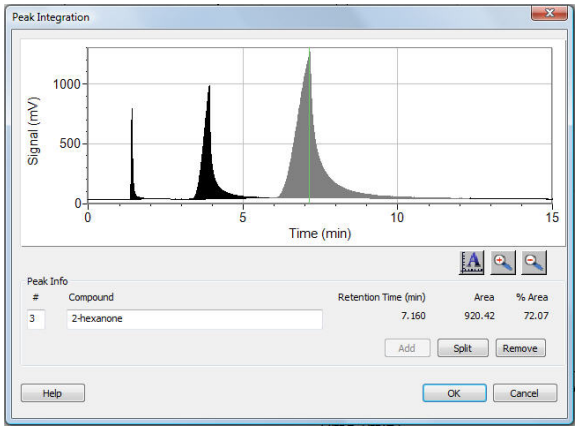


Figure 4 *Peak integration in Vernier software*

c. To analyze another peak on the same graph, repeat Step b.
d. When you are finished with all peaks, select OK to return to the graph.

11. Using Logger *Pro* or LabQuest App, you can do any of the following:
    a. You can choose to Store a run. (In Logger *Pro*, choose Store Latest Run from the Experiment menu. In LabQuest App, tap the File Cabinet icon.)
    b. You can choose to save this chromatogram and peak analysis for later use, with a unique file name, by choosing Save from the File menu.
    c. Print your chromatogram and peak analysis table.
    d. You can rename run names, or peak names in the software.

1.0 Product Description and Principles of Operation

Figure 5 *Side view of Vernier Mini GC*

Figure 1 shows a side view of the Vernier Mini GC. The power input jack, power switch, USB connection to the computer or LabQuest, and column ventilation grill are shown in this view.

Principles of Operation: The Vernier Mini GC is designed to separate mixtures of gases or volatile liquids and identify components of the mixtures by their specific retention times. The chromatograph uses ambient air supplied from a pump to carry a small sample of vapor through a stainless steel column. The chromatograph can used with traditional carrier gases such as helium and nitrogen.

The column is a general purpose column designed to study solvent impurities, distillation, gases, natural gas odorants, sulfur compounds, essential oils, hydrocarbons, semivolatiles, pesticides, and oxygenates. The column is heated using an electric current. Temperature of the column is monitored by a built-in resistance temperature detector (RTD) for accurate temperature measurement. The column assembly also has an independent thermistor to protect against overheating.

At the end of the column is a Seacoast Science chemicapacitor sensor. The sensor is a micromachined sensor chip coated with a chemoselective polymer. The polymer absorbs analytes exiting the column. Analyte absorption by the polymer coating is measured by the detector circuitry. **While the sensor is designed to detect a wide range of analytes, it does not detect low-polarity compounds such as alkanes.**

2.0 Specifications

The Vernier Mini GC is designed for use in an educational or research laboratory. Ambient temperature range for safe operation is 5°C to 40°C, and safe range of ambient relative humidity of 0 to 95%. The Mini GC should not be immersed or sprayed with liquids. Power for the chromatograph is supplied by an external power supply. The Mini GC has a back-lit liquid-crystal display that advises the user as to its current status.

2.1 Chromatograph Hardware

Column	11 meter general purpose chromatography column coated with a silicone polymer
Column operating temperature	30°C to 120°C with a maximum heating ramp of 10°C/min
Sensor	Chemicapacitive sensor
Dimensions/Weight	108 mm height, 191 mm length, 133 mm width; 1.3 kg
Power requirements	24 VDC, 2.5 A from an external power supply
Utility	External power supply rated for 100–240 VAC, 1.5 A 50–60 Hz
Carrier gas	Ambient air or optional inert gas
Environmental conditions	Temperature: 5°C to 40°C Humidity: 95% or less, (non-condensing environment)
Liquid Injection volume	0.01 to 1.0µL
Operating pressure (above ambient pressure)	1 to 21 kPa

3.0 Installation

The Vernier Mini GC should be used in a room that is well ventilated to allow for normal heating and cooling. Do not use the Mini GC in the presence of flammable vapors.

3.1 Unpacking and Setup

Open the lid of the Mini GC carrying case. Remove the power supply, USB cable and the Mini GC unit from the carton. Remove the ties holding the electrical cords. (You may wish to store separately the *Gas Chromatography Investigations* lab book, the 2 extra septa, and 2 extra plastic valve caps for use at a later time.)

To avoid damage to the Vernier Mini GC, place the instrument on a flat surface away from:

1. Excessive dust
2. Liquids or mists
3. Strong vibration
4. Strong magnetic fields, electric fields, and/or high frequencies

Figure 6 shows the rear panel of the instrument with a view of hose connections.

- **OUT** – the OUT connection is the exhaust port and should be directed away from the user.
- **IN 1** – is the inlet for room air used during normal operation of the Mini GC. Vernier sells an optional cartridge to dry the carrier air (Inlet Air Drying Assembly, order code GC-DRY).

- **IN 2** – is an inlet for inert carrier gas (optional, see section 3.4 of this booklet).

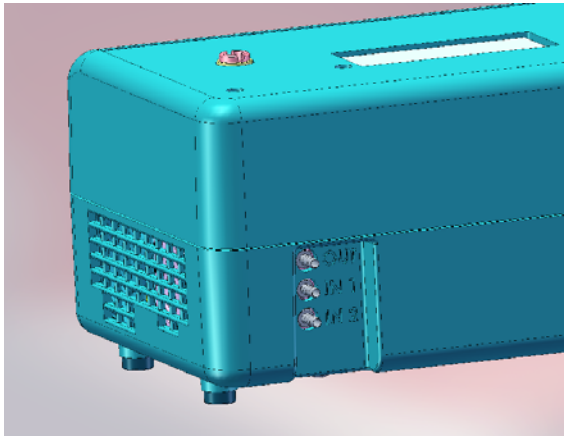


Figure 6. *Rear view of Vernier Mini GC*

3.2 Powering up instrument

Explanation of symbols:

	USB connector to LabQuest or computer
	Power connector (24 Volt DC, 3 A)
	Power on
	Power off

To operate the gas chromatograph, plug the low-voltage jack of the power supply into the power socket on the side of the gas chromatograph; insert the 120 VAC plug into an outlet. Connect the mini jack of the USB cable to the instrument and the standard USB jack into the Vernier LabQuest handheld or computer with Logger *Pro*. Turn on the power switch for both the Mini GC (located on left side panel) and the LabQuest or computer. The order in which you turn them on does not matter.

3.3 Using the Vernier Mini GC

Operation of the GC is controlled through the LabQuest or computer software. The LabQuest App or Logger *Pro* software allows the user to:

1. Set a temperature profile, either using the default settings, or as described in student lab instructions.
2. Set a desired pressure to run the system (maximum of 20 kPa).
3. Start and stop a run.
4. Name a run and store the data.

5. Integrate the peaks and determine retention times.

Analytes are injected into the instrument through the injection port. Optimal results are obtained using the supplied 1.0 µL syringes for liquid analytes. Instructions for using syringes are contained in Appendix C.

Caution:

1. DO NOT inject more than 1.0 µL liquid analyte; injecting excess liquid may damage the sensor. **Note:** Much larger head-space *gas* volumes can safely be injected, up to 1 mL.
2. DO NOT lose the rubber cap on the gas inlet on the rear panel of the instrument; the instrument cannot develop pressure with this cap removed (two extra caps were shipped with your unit).
3. DO NOT inject the following liquids/substances into the Mini GC:
   - **Water**, or compounds with significant amounts of water impurity
   - **Amines** (or any other alkaline substances)
   - **Liquids containing compounds with large molecular weights**, larger than the molecular-weight ranges shown in Appendix A. These types of compounds can become deposited in your Mini GC's column, and degrade its performance.

3.4 Configuring the instrument for optional carrier gas

The Vernier Mini GC gas chromatograph uses ambient air as the carrier gas, supplied from an internal pump. The Mini GC may also use an inert carrier gas. The connector for an inert gas is located on the rear panel of the Mini GC (see Figure 6).

To use optional inert carrier gas:

1. Remove the plastic cap from the hose barb marked **IN 2** and move the cap to the hose barb marked **IN 1**.
2. Connect a supply of inert carrier gas by push-fitting 1/8 inch ID flexible plastic tubing onto the **IN 2** hose barb.
3. Monitoring the live pressure reading on the Mini GC's display, adjust the pressure regulator on the carrier gas until the Mini GC displays the desired value. **Caution:** Assure that the pressure value does not exceed 21 kPa (~3 psig).
4. In Logger Pro or LabQuest App software, click Collect to open up the temperature-pressure profile. Set up the temperature profile as desired. Set the pressure value to be 0.2 kPa *less than* the pressure that was set in Step 3 for the carrier gas.

To return to normal operation:

1. Shut off the inert gas supply and remove the tubing from the hose barb on the Mini GC.
2. Move the plastic cap from the **IN 1** hose barb to the **IN 2** hose barb.

Turning the instrument off

The Vernier Mini GC should be turned off with the power switch when not in use. We recommend unplugging and disconnecting the power supply, and disconnecting the USB cable while the instrument is not in use. The chromatograph has a built-in timer to turn off heating of the column and pressure from the pump after 2 hours with no communication from the LabQuest or computer.

4.0 Maintenance

To extend the life and ensure the proper functioning of the Vernier Mini GC, there are some routine cleanings and replacements that should be followed.

4.1 Column maintenance and/or replacement

The Restek MXT®–1 column is a general-purpose column that performs very well for our recommended families of reagents and laboratory exercises. It is a stainless-steel capillary column, 11 meters in length, and coated with Siltek® to make the stainless steel unreactive. MXT-1 is a nonpolar phase that has excellent properties for separating polar compounds. If separation efficiency deteriorates, conditioning the column with 0.5 µL of acetone or methanol, or running the chromatograph for 1–2 hours at 120°C and 20 kPa with air or an inert carrier gas will help to restore proper function.

If you use our recommended procedures and substances with your Mini GC, we think you will get many years of use from the high-quality Restek column. But, if performance deteriorates after time, such that the column must be replaced, contact Vernier for an RMA number (the column cannot be replaced by the user). You will then send the unit to an RMA address, and be charged a fee for the replacement (approximately $475, as of 2009, including return postage):

Vernier Order Information: Column Assembly Replacement, order code GC-COL

4.2 Cleaning the exterior of the case

Before cleaning the case, disconnect power. For routine cleaning of the exterior of the case, use mild detergent and a damp cloth. Do not allow water to leak inside of the case as this may result in electrical shock or shorts. Abrasive cleansers should not be used to clean the instrument.

4.3 Replacing the septum

The septum should be replaced after approximately 150 injections. The septum may be replaced by unscrewing (counterclockwise) the septum retainer nut. **Note:** Two additional Septa were shipped with your new Mini GC (in a small Ziploc bag). This may be done using a coin or a large screwdriver. With the retainer nut removed, spear the defective septum with a syringe needle and lift it out. Place a new septum flat in the cavity. Screw the retainer nut to snug tightness. Overtightening the retainer nut will not give a better seal of the septum but will damage the instrument. After you have used your original septum, and the two replacements, you can order additional septa:

Vernier Order Information: Septa Replacement, pkg of 4, order code GC-SEP

4.4 Replacing the MEMS sensor

The Seacoast Science MEMS chemicapacitor sensor is a micromachined sensor chip coated with a chemoselective polymer. The polymer absorbs analytes exiting the

column. Analyte absorption by the polymer coating is measured by the detector circuitry.

The MEMS sensor should last for more than 2000 hours of operation. If performance deteriorates after time, such that the MEMS sensor must be replaced, contact Vernier for an RMA number (the column cannot be replaced by the user). You will then send the unit to an RMA address, and be charged a fee for the replacement (approximately $300, as of 2009, including return postage):

Vernier Order Information: Sensor Replacement, order code GC-SENS

4.5 Storing the instrument

Proper storage of the Vernier Mini GC will protect it from damage and maintain the life of the instrument. The manufacturer recommends flushing the column with 0.4 μL acetone or methanol followed by 15 min purge at 120°C and 20 kPa. Store the instrument in the protective case provided with instrument. Store in a cool, dry environment.

5.0 GC Troubleshooting

Error	Possible causes
Inconsistent flow	Check and replace septum
Inconsistent peak areas	Check injection volume, septum
Inconsistent retention times	Check septum, pump
No communication	Check USB cables. Or, make sure you are using correct software versions.
No power	Check to make sure power plugs are plugged in properly.

Appendix A

Classes of Compounds That Can Be Used in Vernier Mini GC

Compound Type	Typical Compounds	Range of Acceptable Boiling Points, °C
Alcohols	C_1–C_8	65–195
Aldehydes	C_2–C_8	20–170
Aromatic hydrocarbons	C_6–C_{10}	80–165
Carboxylic Acids	C_1–C_4	100–165
Halogenated hydrocarbons	C_1–C_8	65–160
Esters	C_2–C_{10}	30–120
Ethers	C_4–C_8	35–142
Ketones	C_3–C_8	55–175
Nitriles	C_2–C_5	80–140

Appendix B

To comply with certification requirements for this instrument, the manufacturer provides the following risk assessment:

Leakage: There is no risk from reagent leaks when using this instrument as intended.

Fire / flammability: To minimize risk of fire, the exhaust from the chromatograph is vented at the rear panel of the instrument. In the unlikely event that a large injection (1.0 μL) of a very flammable material such as hexane was to ignite by an ignition source placed near the sensor outlet barb, the reaction would produce 3.5 calories of energy. This energy is enough to raise the temperature of a gram of water 3.5°C or to raise the temperature of the chromatograph (1.3 kg mass) by approximately 0.0035°C. This is very small when compared against roughly 252 calories released from ignition of one blue tip match.

Electrical shock: To minimize the hazard of electrical shock, the chromatograph is powered at 24 V. Use only the power supply provided by the manufacturer to power this instrument.

Appendix C

Syringe Usage Instructions – 1.0 μL GC Syringe

Syringe Handling

1. Never pull the plunger back more than 80% of its total volume. **Warning:** Once the plunger has been pulled out, it is almost impossible reinsert. You may

want to err on the side of caution, and *never* have students pull the plunger back more than 50% (0.5 µL). This avoids having students accidentally pull the plunger from the syringe body, a costly mistake.

2. Exercise caution when depressing the plunger. Stickier chemicals can jam the syringe and depressing the plunger too rapidly can cause the plunger to bend. In the case of our 1.0 µL syringe, the plunger is a fine wire that extends into the needle. A bend in the plunger of this syringe may not be visible, but the plunger will begin to stick which can render the syringe useless.
3. If the plunger starts to catch in the syringe during sample collection or injection, follow the procedure for cleaning the syringe. NEVER force the plunger.
4. If the syringe becomes clogged, do not pump the plunger or attempt to force liquid or compressed air through it. The excessive pressure could cause the barrel to crack.
5. Avoid unnecessary movement of the plunger in a dry syringe.
6. The plunger should only be grasped by the button since any abrasions, scratches, or oil from one's fingers can interfere with proper plunger operation.
7. Always proceed carefully when inserting the syringe needle into the gas chromatograph. Occasionally, the needle will catch on the column; inserting the needle with too much force will cause it to bend, which will destroy the syringe. Rotating the syringe will alleviate this problem.
8. When wiping the needle of the syringe, pinch a lint-free wipe around the needle next to the barrel of the syringe and wipe in a single motion toward the point of the needle. Never wipe the needle toward the barrel.
9. Syringes should be regularly inspected for damage, including hairline cracks. Be sure to check the needle tip for barbs, which tear the septum, and can produce particles that clog the needle or the chromatograph's column. Cracked syringes should be discarded according to your sharps disposal procedure. Needle burrs can be smoothed with a fine emery board or carborundum.
10. Before storing a syringe, rinse it with acetone. Wipe dry all external surfaces. Store the syringe in original shipping container or shock-absorbing padding.
11. NEVER soak the syringe for an extended period in a solvent. Doing so could cause any adhesives used in the construction of the syringe to dissolve.

Tips

1. Greatest analytical accuracy is achieved when the injection volume is at least 20% of the working volume of the syringe. If the optimal syringe size is unavailable, be aware that your results will show greater variability.
2. Prior to injection, moving the syringe plunger as slowly as possible during all steps (whether liquid is involved or not) will help maintain the accuracy of the injection volume.
3. When collecting your sample, grip the syringe by the flange and plunger button only, as your body heat can affect the volume collected.

4. During insertion of the syringe needle into the gas chromatograph, support the needle with one hand and hold the flange of the syringe in the other. This reduces the chance of bending the needle.
5. If the needle seems to catch when inserting it into the gas chromatograph, turn the syringe a quarter turn and then try again.
6. When injecting into the GC, you want to depress the plunger quickly enough to ensure that the entire sample is delivered at once but carefully enough that you do not bend the plunger if the plunger sticks. The larger injection sizes require greater care during the injection.

Rinsing the Syringe

1. Submerge the tip of the syringe needle in the rinse liquid, commonly acetone or ethanol, and draw the plunger back to 50% of its total volume.
2. Remove the syringe from the rinse liquid and place the tip of the needle over an appropriate waste receptacle such as a beaker or lint-free tissue.
3. Slowly depress the plunger, ejecting all of the solution from the syringe.
4. Wipe the needle of the syringe with a fresh lint-free tissue.
5. Repeat the above steps 3 times.
6. Remove the syringe tip from the solution, replace the cap of the vial of rinse liquid, and wipe the needle of the syringe with a fresh lint-free tissue.

Collecting a Sample

1. Remove the cap from the sample container and rinse the syringe with the solution to be injected, following the procedure outlined in the section *Rinsing the Syringe*.
2. Submerge the tip of the needle in the solution to be injected and slowly draw the plunger back by an amount larger than the intended injection volume. This excess volume will typically be somewhere around 0.1 µL. (Example: if you are attempting a 0.2 µL injection, you should withdraw between the 0.25 and 0.3 µL).
3. Remove the syringe tip from the solution and replace the cap on the sample container.
4. Holding the syringe vertically at eye level, carefully depress the plunger until the syringe holds only the desired injection volume.
5. Carefully wipe the syringe needle with a fresh lint-free tissue, making sure the tissue does not absorb any sample from inside the needle.
6. When you are satisfied with the volume of your sample, proceed to injection. If not, carefully eject the syringe contents into the appropriate waste receptacle, wipe the needle with a fresh lint-free tissue, and begin again at step 2.

Injection into the Gas Chromatograph

1. Wait for the Mini GC's status indicator light to turn green and the message "Ready for Injection" to appear before collecting your sample into the syringe.

2. As soon as your sample is loaded into the syringe, grip the syringe by the flange and pinch the needle about halfway along its length.
3. Aim the needle into the center of the brass needle guide at the top of the gas chromatograph and slowly push the needle into the injection port, *being careful not to move the plunger*. If the needle should catch, immediately stop pushing and turn the syringe a quarter turn, then resume pressure.
4. As soon as the syringe is fully inserted against the needle guard, quickly depress the plunger and simultaneously click Collect in the data-collection software.
5. Immediately pull the syringe out of the gas chromatograph.

Cleaning the Syringe

1. Never force the plunger.
2. Clean the syringe following the procedure described in *Rinsing the Syringe* using an appropriate solvent. Choose a solvent that will dissolve the contaminating substances. Common choices include acetone, methanol, methylene chloride, and acetonitrile, but other solvents may used. Non-alkaline, non-phosphate, non-detergent solvents are preferred. Do not soak the syringe in any solvent.
3. If the plunger is catching during injection, it may need to be flushed with multiple cleaning solvents.

Troubleshooting

Syringe plunger won't fully depress.

1. Follow the procedure for cleaning the syringe
2. Inspect the plunger. If it is bent and cannot be straightened, dispose of the syringe according to your sharps disposal procedure.

Appendix D

Relationship of Pressure and Column Flow Rate

If you are accustomed to setting *flow rate* rather than *column pressure* values in a temperature-pressure profile, here is an equation (and a table of typical values) representing the nearly linear relationship between these two variables:

$$\text{Flow Rate (kPa)} = 0.293 \times \text{Pressure(kPa)} - 1.15$$

Pressure (kPa)	Flowrate (mL/min)
5.0	0.31
7.5	1.05
10.0	1.78
12.5	2.51
15.0	3.24
17.5	3.97
20.0	4.71

This relationship was determined by measuring the flow rate of the exiting gas (air) when the column was heated at a constant 60°C temperature at various pressures.

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of two years from the date of shipment to the customer. Consumable items, such as the MEMS sensor, the Restek GC column, and syringes are excluded from the warranty. Damage to any part of the Vernier Mini GC product because of misuse, misapplication, neglect, alteration, accident, and/or operation contrary to design or damage resulting from natural causes, is not covered by this warranty.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Disposal Instruction: When disposing of this electronic product, do not treat it as household waste. Its disposal is subject to regulations that vary by country and region. This item should be given to an applicable collection point for the recycling of electrical and electronic equipment. By ensuring that this product is disposed of correctly, you help prevent potential negative consequences on human health or on the environment. The recycling of materials will help to conserve natural resources. For more detail information about recycling this product, contact your local city office, your disposal service or the place where you purchased it.

The symbol, show here, indicates that this product must not be disposed of in a standard waste container.

Vernier

Measure. Analyze. Learn.™

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