Technical Information

Warnings and Suggestions for the Safe Use of PYREX® and PYREXPLUS® Brand Labware

Personal Safety in the Lab

Lab safety is one of the most critical concerns of any lab. To help improve lab safety, Corning has compiled these common sense suggestions concerning the safe use of labware.

General Precautions

Never Drink From a Beaker

A standard beaker or other laboratory vessel used specifically for drinking is a personal health hazard in the laboratory. Use disposable or recyclable cups. Never drink from any standard laboratory product to avoid any possibility of personal injury or health hazard.

Chemicals

Use Chemicals Carefully

When working with volatile materials, remember that heat causes expansion, and confinement of expansion results in explosion. Remember also that danger exists, even though external heat is not applied.

Do not mix sulfuric acid with water inside a cylinder. The heat from the reaction can break the base of the vessel because of the thickness of the base and the seal.

Perchloric acid is especially dangerous because it explodes on contact with organic materials. Do not use perchloric acid around wooden benches or tables. Keep perchloric acid bottles on glass or ceramic trays having enough volume to hold all the acid in case the bottle breaks. Always wear protective clothing when working with perchloric acid.

Glass will be chemically attacked by hydrofluoric acid, hot phosphoric acid, and strong hot alkalis, so it should never be used to contain or to process these materials.

Always flush the outside of acid bottles with water before opening. Do not put the stopper on the counter top where someone else may come in contact with acid residue.

Mercury is highly toxic. Special care is needed when dealing with mercury. Even a small amount of mercury in the bottom of a drawer can poison the room atmosphere. Mercury toxicity is cumulative, and the element's ability to amalgamate with a number of metals is well known. After an accident involving mercury, the area should be cleaned carefully until there are no globules remaining. All mercury containers should be well labeled and kept tightly closed.

NOTE: Broken glassware should be disposed of as sharps. When disposing of sharps, or sharps that have been in contact with potentially infectious materials, ensure compliance with your facility guidelines, as well as local, state, and federal regulations.

Identifying Chemicals

DO NOT taste chemicals for identification. Smell chemicals only when necessary and only by wafting a small amount of vapor toward the nose.

Label with Care

Never fill a receptacle with material other than that specified by the label. Label all containers before filling. Dispose of the contents of unlabeled containers properly.

Handling Glassware

Handle Glassware Carefully

Hold beakers, bottles, and flasks by the sides and bottoms rather than by the tops. The rims of beakers or necks of bottles and flasks may break if used as lifting points. Be especially careful with multiple neck flasks.

Avoid Over Tightening Clamps

To avoid breakage while clamping glassware, use coated clamps to prevent glass-to-metal contact, and do not use excessive force to tighten clamps.

Heating

Safe Heat Sources

Be sure to check laboratory or instruction manuals when working with heat sources.

Bunsen Burners

Adjust the Bunsen burner to get a large soft flame. It will heat slowly but also more uniformly. Uniform heat is a critical factor for some chemical reactions.

Adjust the ring or clamp holding the glassware so that the flame touches the glass below the liquid level. Heating above the liquid level does nothing to promote even heating of the solution and could cause thermal shock and breakage of the vessel. A ceramic-centered wire gauze on the ring will diffuse the burner flame to provide more even heat.

Rotate test tubes to avoid overheating one particular area. Uniform heating may be critical to your experiment.

Heat all liquids slowly. Fast heating may cause bumping, which in turn may cause the solution to splatter.

Do not heat glassware directly on electrical heating elements. Excessive stress will be induced in the glass, and this can result in vessel breakage.

Hot Plates

There are several types of hot plates. Some are electrical; some are water heated. They may be ceramic or metal topped. You should consult your instruction manual before using a hot plate for the first time.

Always use a hot plate larger than the vessel being heated.

Thick-walled items, such as jars, bottles, cylinders, and filter flasks, should never be heated on hot plates.

For information on Corning brand hot plates and hot plate stirrers, see the Equipment section.

Evaporation

Evaporation work should be observed carefully. Be careful when handling a vessel that has been heated after evaporation has occurred. It may crack unexpectedly.

Heating Thick-walled Vessels

Glassware with thick walls such as bottles and jars should not be heated over a direct flame or comparable heat source.

Scratched Glassware

Do not heat glassware that is etched, cracked, nicked, or scratched. It is more prone to break.

For additional information, see Temperature section.

Mixing and Stirring

Use a rubber policeman on glass, or use PTFE rods to prevent scratching the inside of a vessel.

Do not look down into any vessel being heated or containing chemicals. Do not point a vessel's open end at another person.

A reaction may cause the contents to be ejected.

Spattering from acids, caustic materials and strong oxidizing solutions on the skin or clothing should be washed off immediately with large quantities of water.

Pipetting

Do Not Pipet by Mouth

For your safety, we suggest using a mechanical pipetting device, such as a rubber bulb or other pipetting aids available from laboratory suppliers. Do not draw any liquids into a pipet by mouth. Serious injury could result.

Temperature and Temperature Extremes

Avoid Extremes

Although PYREX® brand products can take extreme temperatures, always use caution.

Do not put hot glassware on cold or wet surfaces, or cold glassware on hot surfaces. It may break with temperature change. Cool all labware slowly to prevent breakage.

Protection from Temperature Extremes

Burns are caused by heat, ultraviolet, or infrared rays and also by extremely cold materials. Use goggles and limit your exposure time when working with extra-visual radiation. Never touch dry ice or liquid gases with your bare hands. Use tongs or gloves to remove all glassware from heat. Hot glass can cause severe burns. Protective gloves, safety shoes, aprons, and goggles should be worn in case of chemical accidents, spilling, or splattering.

Exposure to Heat

The recommended temperature use range for PYREXPLUS® labware is 10°C to 80°C. PYREXPLUS labware is designed to withstand the temperatures associated with steam sterilization. Do not place over direct heat or an open flame. Prolonged exposure to dry heat above 80°C may cause the coating to become brittle and thus reduce the useful life of the vessel. A brown appearance or hardness to the touch are signs that the coating has become brittle and the product should be disposed of.

The upper dry heat temperature limit for PYREXPLUS labware is 110°C (230°F). PYREXPLUS labware should not be exposed to elevated temperature in a vacuum greater than 5 inches Hg (127 mm Hg).

Vacuum and Pressure Warning

Because of variations in conditions, Corning cannot guarantee any glassware against breakage under vacuum or pressure. Adequate precautions should be taken to protect personnel doing such work. We have included suggestions on personal safety in the lab, see the Safety section.

Ventilation

Work In A Well-ventilated Area

When working with chlorine, hydrogen sulfide, carbon monoxide, hydrogen cyanide, and other very toxic substances, always use a protective mask or perform these experiments under a fume hood in a well-ventilated area.

Safety Features and Benefits of PYREX® and PYREXPLUS® Brand Labware

This section provides product information for the various types of glass labware products made by Corning. In addition, we have provided tips and additional suggestions on the safe use and care of your lab products.

PYREX® Labware

PYREX glass has proven itself to be tough and reliable for over 100 years of demanding use in the laboratory environment. The PYREX name is associated with high quality, corrosion- and heat-resistant laboratory glassware throughout the world.

Corning products are designed and produced with safety in mind. It is important to remember that most labware products are designed for specific applications. Be sure you have the right piece of ware for the use you have in mind. Using a laboratory glassware product for applications other than those it was designed for can be dangerous.

Beakers

PYREX brand beakers are manufactured with uniform wall thickness, and offer an optimum balance between thermal shock resistance and mechanical strength.

Large, permanent marking spots on PYREX beakers allow the user to record more data on the vessel to help identify the contents quickly and easily.

Most impact breakage occurs on a beaker's rim. PYREX brand beakers have extra glass in the rim for added strength. The pour spout is gently sloped rather than hooked, minimizing breakage. The low-flare spout allows controlled pouring.

Centrifuge Tubes

PYREX brand centrifuge tubes are made from durable Code No. 7740 borosilicate glass with special design consideration given to stress points caused by centrifugal forces. Before centrifuging hazardous chemicals or expensive samples, consult the nomogram on page 121 for computing relative centrifugal forces (RCF) to determine safe centrifugation rates.

Cylinders

The most important specification for graduated cylinders is tolerance. Selected tubing and careful calibrations assure meeting tolerances in PYREX brand cylinders. In addition, Corning was the first to put hexagonal bases on cylinders to keep them from rolling off a lab bench. Legibility was improved by designing Lifetime Red™ panel cylinders.

Two cylinders of special safety interest are the 3046 and 3050 graduated cylinders. Both feature a reinforced bead of glass near the top of the rim. The reinforced bead helps to reduce breakage if the cylinder is upset. These cylinders are available in 10 mL, 25 mL, 50 mL, 100 mL, and 250 mL capacities.

Flasks

Uniform wall thickness, characteristic of all round bottom PYREX flasks, allows the vessels to satisfy various mixing, heating, and boiling requirements commonly encountered in most laboratory work.

The thick walls of Corning filter flasks provide the mechanical strength needed for vacuum work. Consequently, filter flasks should never be heated. For this reason, the words "Filter Flask" appear on the product.

Standard Erlenmeyer flasks are suitable for moderate heating, though they are primarily intended for mixing applications.

Stopcocks and Joints

PYREX Brand All Glass Stopcocks

General purpose PYREX brand glass stopcocks with the ₸ symbol are manufactured with 1:10 tapers and finishes as specified in ASTM E-675. They feature interchangeable solid glass plugs. PYREX brand glass stopcocks with hollow, blown-glass plugs are lapped to the outer shell, thus insuring uniformity between mating surfaces. They can function safely to 10^4 torr. (mm of Hg) of vacuum with minimal leakage.

PYREX Glass-bodied Stopcocks with PTFE Plugs

These general purpose stopcocks are marked with the ₸ symbol and manufactured with 1:5 tapers and finishes as specified by ASTM. Because no lubricant is needed, they are ideal for applications where grease contamination is a factor.

Rotaflo® Stopcocks

The Rotaflo stopcock can be used under varying conditions, ranging from general purpose to high vacuum applications. These stopcocks are ideal for applications where contamination is a factor; only PTFE and borosilicate glass come in contact with liquids or gases.

The Hi-Vac Rotaflo stopcock is designed to function safely to 10^3 torr. (mm of Hg) of vacuum with minimal leakage. They can be used at temperatures ranging from -20°C to 200°C and autoclaved at 20 psi and 126°C.

Joining and Separating Glass Apparatus

When pieces are not to be used for an extended period of time, take apart stopcocks, ground joints, flask stoppers, and joints to prevent sticking. Remove the grease from the joints. PTFE stoppers and stopcocks should be loosened slightly.

For easy storage and reuse, put a strip of thin paper between ground joint surfaces.

Freeing Seized Ground Joints

If a ground joint sticks, this procedure will generally free it. Immerse the joint in a glass container of freshly poured carbonated liquid. You will be able to see the liquid penetrate between the ground surfaces. When the surfaces are wet (allow 5 to 10 minutes submersion), remove the joint and rinse with tap water. Wipe away excess water.

Then gently warm the wall of the outer joint by rotating it for 15 to 20 seconds over a low Bunsen burner flame. Wear heat-resistant gloves to avoid burns. Be sure that 50% of the inner surface is wet before inserting the joint in the flame. Remove from the flame and gently twist the two members apart. If they do not come apart, repeat the procedure. Never use force when separating joints by this method.

Lubricating Stopcocks and Stoppers

Glass stopcocks on burets and separatory funnels should be lubricated frequently to prevent sticking. If one does stick, a stopcock plug remover, available from laboratory supply houses, should be used.

Wet both tubing and stopper with glycerin or water when trying to insert glass tubing into a rubber stopper. Wear a protective glove and wrap glass in a towel to prevent injury.

Fire polish rough ends of glass tubing before inserting into flexible tubing or through a stopper.

If it becomes impossible to remove a thermometer from a rubber stopper, it is best to cut away the stopper rather than to risk breaking the thermometer.

In using lubricants, it is advisable to apply a light coat of grease completely around the upper part of the joint. Use only a small amount and avoid greasing that part of the joint that contacts the inner part of the apparatus.

Types of Lubricants

Three types of lubricant are commonly used on standard taper joints. (a) A hydrocarbon grease is the most widely used. It can be easily removed by most laboratory solvents, including acetone. (b) Because hydrocarbon grease is so easily removable, silicone grease is often preferred for higher temperature or high vacuum applications. It can be removed readily with chlorinated solvents. (c) For long-term reflux or extraction reactions, a water-soluble, organic-insoluble grease, such as glycerin is suitable. Water will clean glycerin.

Volumetric Ware

The accuracy of volumetric ware depends on the care used in calibrating it, using the correct type of ware for the application, handling the ware properly, and insuring the ware is clean. Calibration of volumetric ware is usually done at 20°C, and the ware should be used at approximately this temperature. Refrigerated liquids should be allowed to come to room temperature before measuring them. Under normal use and care, the calibration of volumetric ware will not change. Do not expose volumetric ware to excessive heat, approaching PYREX® upper service limit.

Types of Ware

Serialized/Certified Ware: Certified Ware is calibrated to Class A specifications. Each piece is individually serialized and furnished with a Certificate of Identification and Capacity, traceable to NIST standards, guaranteeing its calibration.

Class A Ware: Class A Ware is manufactured to tolerances established by ASTM E-694 for volumetric ware, ASTM E-542 for calibration of volumetric ware, and ASTM E-288 for volumetric flasks. Utilizes the same tolerances as certified ware but is not certified and has no certificate.

Class B Ware: Class B Ware is generally calibrated to twice the tolerance of Class A Ware.

Other Types: There are also some specifications for other calibrated glassware, set by various federal bureaus or professional societies. Tolerances for these and references to the specifications are found in this catalog under individual product descriptions.

Calibrated Ware Markings

Lines on graduated ware may be acid etched, wheel engraved, abrasive blasted, enameled, or permanently stained into the glass. Etched or engraved lines are usually colored by fired-in enamels. The width of the lines should not exceed 0.4 mm for subdivided ware or 0.6 mm for single-line ware. In addition to the lines, the ware should be marked with its capacity, the temperature at which it should be used, and whether the piece was calibrated T.C. ("to contain") or T.D. ("to deliver") the stated volume. T.C. means that the ware is calibrated so that the the mark indicates the volume held in the container. T.D. means the mark indicates the amount of air-free distilled water at 20°C that is delivered when it is poured out. Numbers indicating volume at certain lines are placed immediately above the line. Volumetric flask markings must cover at least 90% of the neck circumference.

Reading Volumetric Ware

ASTM E-542 details the method of reading the meniscus as follows: For all apparatus calibrated by this procedure, the reading or setting is made on the lowest point of the meniscus. In order that the lowest point be observed, it is necessary to place a shade of some dark material immediately below the meniscus, which renders the profile of the meniscus dark and clearly visible against a light background. A convenient device for this purpose is a collar-shaped section of this thick black rubber tubing cut open at one side and of such size as to clasp the tube firmly. Alternatively, black paper may be used.

Coming laboratory products are calibrated in accordance with clause 7.3.2.1 of ASTM E-542, which states: *The position of fhe lowest point of the meniscus with reference to the graduation line is horizontally tangent to the plane of the upper edge of the graduation line. The position of the meniscus is obtained by having the eye in the same plane of the upper edge of the graduation line.*

PYREXPLUS® Labware

PYREXPLUS laboratory glassware is PYREX brand borosilicate glass labware which has been coated with a tough, transparent plastic vinyl. The coating, which is applied to the outside of the vessel, helps prevent exterior surface abrasion. It also helps minimize the loss of contents and helps contain glass fragments if the glass vessel is broken. The recommended temperature use range for PYREXPLUS labware is 10°C to 80°C.

See page 123 for additional information on the use and care of PYREXPLUS labware.

Suggestions for Cleaning

Good laboratory technique demands clean glassware, because the most carefully executed piece of work may give an erroneous result if dirty glassware is used. In all instances, glassware must be physically clean, chemically clean, and in many cases, bacteriologically clean or sterile.

All glassware must be absolutely grease-free. The safest criteria of cleanliness is uniform wetting of the surface by distilled water. This is especially important in glassware used for measuring the volume of liquids. Grease and other contaminating materials will prevent the glass from becoming uniformly wetted. This in turn will alter the volume of residue adhering to the walls of the glass container and thus affect the volume of liquid delivered. Furthermore, in pipets and burets, the meniscus will be distorted and the correct adjustments cannot be made. The presence of small amounts of impurities may also alter the meniscus.

Cleaning

Wash labware as quickly as possible after use. If a thorough cleaning is not possible immediately, put glassware to soak in water. If labware is not cleaned immediately, it may become impossible to remove the residue.

Most new glassware is slightly alkaline in reaction. For precision chemical tests, new glassware should be soaked several hours in acid water (a 1% solution of hydrochloric or nitric acid) before washing.

Brushes with wooden or plastic handles are recommended, as they will not scratch or abrade the glass surface.

Glassware Cleaners

When washing, soap, detergent, or cleaning powder (with or without an abrasive) may be used. Cleaners for glassware include Alconox, Tide, and Fab. The water should be hot. For glassware that is exceptionally dirty, a cleaning powder with a mild abrasive action will give more satisfactory results. The abrasive should not scratch the glass. During the washing, all parts of the glassware should be thoroughly scrubbed with a brush. This means that a full set of brushes must be at hand—brushes to fit large and small test tubes, burets, funnels, graduates, and various sizes of flasks and bottles. Motor-driven revolving brushes are valuable when a large number of tubes or bottles are processed. Do not use cleaning brushes that are so worn that the spine hits the glass. Serious scratches may result. Scratched glass is more prone to break during experiments. Any mark in the uniform surface of glassware is a potential breaking point, especially when the piece is heated. Do not allow acid to come into contact with a piece of glassware before the detergent (or soap) is thoroughly removed. If this happens, a film of grease may be formed.

Safe Use of Chromic Acid

If glassware becomes unduly clouded or dirty or contains coagulated organic matter, it must be cleansed with chromic acid cleaning solution.[1] The dichromate should be handled with extreme care, because it is a powerful corrosive and carcinogen.

When chromic acid solution is used, the item may be rinsed with the cleaning solution or it may be filled and allowed to stand. The length of time it is allowed to stand depends on the amount of contamination on the glassware. Relatively clean glassware may require only a few minutes of exposure; if debris is present, such as blood clots, it may be necessary to let the glassware stand all night. Due to the intense corrosive action of the chromic acid solution, it is good practice to place the stock bottle, as well as the glassware being treated, in flat glass pans or pans made from lead or coated with lead, or plastic polymer pans determined compatible with the concentration of chromic acid you are using. Extra care must be taken to be sure chromic acid solution is disposed of properly.

Special types of precipitates may require removal with nitric acid, aqua regia, or fuming sulfuric acid. These are very corrosive substances and should be used only when required.

Removing Grease

Grease is best removed by boiling in a weak solution of sodium carbonate. Acetone or any other fat solvent may be used. Strong alkalis should not be used. Silicone grease is mast easily removed by soaking the stopcock plug or barrel for 2 hours in warm decahydronaphthalene.

Drain and rinse with acetone or use fuming sulfuric acid for 30 minutes. Be sure to rinse off all of the cleaning agents.

Rinsing

It is imperative that all soap, detergents, and other cleaning fluids be removed from glassware before use. This is especially important with the detergents, slight traces of which will interfere with serologic and cultural reactions.

After cleaning, rinse the glassware with running tap water. When test tubes, graduates, flasks, and similar containers are rinsed with tap water, allow the water to run into and over them for a short time, then partially fill each piece with water, thoroughly shake, and empty, and repeat at least six times. Pipets and burets are best rinsed by attaching a piece of rubber tubing to the faucet and then attaching the delivery end of the pipets or burets to a hose, allowing the water to run through

[1] Chromic acid cleaning solution: Use powdered commercial or technical grade sodium dichromate or potassium dichromate. If the compound is in the form of crystals, grind to a fine powder in a mortar. To 20 grams of the powder in a liter beaker, add a little water, sufficient to make a thin paste. Slowly add approximately 300 mL of commercial concentrated sulfuric acid, stirring well. Transfer to a glass-stoppered bottle.

Larger amounts can be made in the same proportions. Use the clear supernatant solution. Chromic acid solution can be used repeatedly until it begins to turn a greenish color. Dispose of in accordance with appropriate regulations. Dilute with large volumes of water before discarding, or carefully neutralize the diluted solution with sodium hydroxide. Chromic acid solution is strongly acidic and will burn the skin severely. Use care in handling it.

them. If the tap water is very hard, it is best to run it through a deionizer before using.

Rinse the glassware in a large bath of distilled water. Rinse with distilled water. To conserve distilled water, use a five gallon bottle as a reservoir. Store it on a shelf near your clean up area. Attach a siphon to it and use it for replenishing the reservoir with used distilled water.

For sensitive microbiologic assays, meticulous cleaning must be followed by rinsing 12 times in distilled water.

Sterilizing Contaminated Glassware

Glassware which is contaminated with blood clots, such as serology tubes, culture media, petri dishes, etc., must be sterilized before cleaning. It can best be processed in the laboratory by placing it in a large bucket or boiler filled with water, to which 1% to 2% soft soap or detergent has been added, and boiled for 30 minutes. The glassware can then be rinsed in tap water, scrubbed with detergent, rinsed again.

You may autoclave glassware or sterilize it in large steam ovens or similar apparatus. If viruses or spore-bearing bacteria are present, autoclaving is absolutely necessary.

Handling and Storing

To prevent breakage when rinsing or washing pipets, cylinders, or burets, be careful not to let tips hit the sink or the water tap.

Dry test tubes, culture tubes, flasks, and other labware by hanging them on wooden pegs or placing them in baskets with their mouths downward and allowing them to dry in the air; or place them in baskets to dry in an oven.[2] Drying temperatures should not exceed 140°C. Line the drying basket with a clean cloth to keep the vessel mouths clean.

Dry burets, pipets, and cylinders by standing them on a folded towel. Protect clean glassware from dust. This is done best by plugging with cotton, corking, taping a heavy piece of paper over the mouth, or placing the glassware in a dust-free cabinet.

Store glassware in specially designed racks. Avoid breakage by keeping pieces separated.

Do not store alkaline liquids in volumetric flasks or burets. Stoppers or stopcocks may stick.

Cleaning Specific Types of Glass Labware

Proper care and handling of PYREX® and PYREXPLUS® labware will greatly increase its life and increase the safety of your workplace.

PYREXPLUS Labware

Autoclaving

PYREXPLUS labware can be successfully sterilized using liquids or dry cycle sterilization which involves no vacuum or low vacuum (<5 inches Hg).

Recommended cycles for automated autoclaves are:

	Autoclave Type	
Autoclave Cycle	Gravity	Prevacuum
Liquid	Yes	Yes
Dry	Yes	No
Prevac	–	No

CAUTION: Always autoclave vessels with loose caps or closures.

Steam sterilization time should not exceed 15 minutes at 121°C (250°F). Drying time should not exceed 15 minutes at 110°C (230°F). The actual cavity temperature of the autoclave should be checked to be sure the autoclave temperature does not exceed the recommended sterilization and drying temperature.

Autoclaving – Cloudiness

Should the coating appear clouded due to dissolved moisture, simply let dry overnight at room temperature or briefly heat to 110°C (230°F).

Cleaning

As is common practice, clean all glassware before use. Any nonabrasive glassware detergent may be used for hand or automatic dishwasher cleaning. If using a dishwasher or glassware dryer, care should be taken to be sure the drying temperature does not exceed 110°C (230°F). Exposure to dry heat should be minimized.

Avoid brushes and cleaning pads which could abrade the glass or damage the coating. If using a chromic acid cleaning solution minimize contact of the solution with the coating.

Labeling and Marking

Use water-based markers for temporary marking or labeling of the PYREXPLUS labware coating. Solvent-based markers, dyes, and stains cannot be removed from the coating.

NOTE: A slight "plastic" odor may be detected when handling PYREXPLUS labware. This is due to additives in the plastic coating which are responsible for its superior performance. The odor is normal and will not affect the inertness of the inside borosilicate glass surface.

For additional information on the use and care of PYREXPLUS labware, see page 123.

Burets

Remove the stopcock or rubber tip and wash the buret with detergent and water. Rinse with tap water until all the dirt is removed. Then rinse with distilled water and dry. Wash the stopcock or rubber tip separately. Before a glass stopcock is placed in the buret, lubricate the joint with stopcock lubricant. Use only a small amount of lubricant. Burets should always be covered when not in use.

[2] Do not apply heat directly to empty glassware which is used in volumetric measurements. Such glassware should be dried at temperatures of no more than 80°C to 90°C.

Culture Tubes

Culture tubes which have been used previously must be sterilized before cleaning. The best method for sterilizing culture tubes is by autoclaving for 30 minutes at 121°C (15 p.s.i. pressure). Media which solidifies on cooling should be poured out while the tubes are hot. After the tubes are emptied, brush with detergent and water, rinse thoroughly with tap water, rinse with distilled water, place in a basket, and dry.

If tubes are to be filled with a media which is sterilized by autoclaving, do not plug until the media is added. Thus, both media and tubes are sterilized with one autoclaving.

If the tubes are to be filled with sterile media, plug and sterilize the tubes in the autoclave or dry air sterilizer before adding the media.

Dishes and Culture Bottles

Sterilize and clean as detailed under Culture Tubes. Wrap in heavy paper or place in a Petri dish can. Sterilize in the autoclave or dry air sterilizer.

Pipets

Place pipets, tips down, in a cylinder or tall jar of water immediately after use. Do not drop them into the jar. This may break or chip the tips and render the pipets useless for accurate measurements. A pad of cotton or glass wool at the bottom of the jar will help to prevent breaking of the tips. Be certain that the water level is high enough to immerse the greater portion or all of each pipet. The pipets may then be drained and placed in a cylinder or jar of dissolved detergent or, if exceptionally dirty, in a jar of chromic acid cleaning solution. After soaking for several hours or overnight, drain the pipets and run tap water over and through them until all traces of dirt are removed. Soak the pipets in distilled water for at least 1 hour. Remove from the distilled water, rinse, dry the outside with a cloth, shake the water out, and dry.

Blood Cell Count Diluting Pipets

After use, rinse thoroughly with cool tap water, distilled water, alcohol, or acetone, and then ether.

Dry by suction. Do not blow into the pipets, as this will cause moisture to condense on the inside of the pipet.

To remove particles of coagulated blood or dirt, a cleaning solution should be used. One type of solution will suffice in one case, whereas a stronger solution may be required in another. It is best to fill the pipet with the cleaning solution and allow to stand overnight. Sodium hypochlorite (laundry bleach) or a detergent may be used. Hydrogen peroxide is also useful. In difficult cases, use concentrated nitric acid. Some particles may require loosening with a horse hair or piece of fine wire. Take care not to scratch the inside of the pipet.

Automatic Pipet Washers

Where a large number of pipets are used daily, it is convenient to use an automatic pipet washer. Some of these, such as those made of metal, can be connected directly by permanent fixtures to the hot and cold water supplies. Others, such as those made with polyethylene, can be attached to the water supplies by a rubber hose. Polyethylene baskets and jars may be used for soaking and rinsing pipets in chromic acid cleaning solution. Electrically heated metallic pipet dryers are also available.

After drying, place pipets in a dust-free drawer. Wrap serologic and bacteriologic pipets in paper or place in pipet cans and sterilize in the dry air sterilizer. Pipets used for transferring infectious material should have a cotton plug placed in the top end of the pipet before sterilizing. The plug will prevent the material being measured from being drawn accidentally into the pipetting device.

Serological Tubes

Serological tubes should be chemically clean but need not be sterile. However, specimens of blood which are to be kept for some time at room temperature should be collected in a sterile container. It may be expedient to sterilize all tubes.

To clean and sterilize tubes containing blood, discard the clots in a waste container and place the tubes in a large basket. Put the basket, with others, in a large bucket or boiler. Cover with water, add a fair quantity of soft soap or detergent, and boil for 30 minutes. Rinse the tubes, clean with a brush, rinse, and dry with the usual precautions.

It is imperative when washing serological glassware that all acids, alkali, and detergents be completely removed. Acids, alkalis, and detergents in small amounts interfere with serologic reactions.

Serologic tubes and glassware should be kept separate from all other glassware and used only for serologic procedures.

Slides and Cover Glass

It is especially important that microscope slides and cover glass used for the preparation of blood films or bacteriologic smears be perfectly clean and free from scratches.

Slides should be washed, placed in glacial acetic acid for 10 minutes, rinsed with distilled water, and wiped dry with clean paper towels or cloth. Once the slides have been washed, place them in a wide jar of alcohol. As needed, remove from the jar and wipe dry. If the slides are dry stored, wash them with alcohol before use.

NOTE: Broken glassware should be disposed of as sharps. When disposing of sharps, or sharps that have been in contact with potentially infectious materials, ensure compliance with your facility guidelines, as well as local, state, and federal regulations.

Glass Technical Data

The products in this catalog are made from different glass compositions or composite materials which are sold under a variety of brand names. The following pages summarize some of the properties of these glasses.

PYREX® Brand Labware

Code No. 7740 Glass

Of the hundreds of commercial glasses produced, Code No. 7740 borosilicate glass comes closest to being the ideal glass for most laboratory applications.

With proper care, it will withstand nearly all temperatures used in normal laboratory use. It is highly resistant to chemical attack. Its low coefficient of expansion allows it to be manufactured with heavy walls, giving it mechanical strength while retaining reasonable heat resistance. And, it is a glass that can be fabricated more easily than most other glasses, thus making it more economical.

PYREX Brand Low Actinic Labware

Code No. 7740 Glass with a Red Ultraviolet Shielding Stain

PYREX Low Actinic Labware is made from Code. No. 7740 glass with copper replacing the sodium in the glass matrix at the surface. The resulting product is as durable as the base glass. PYREX Low Actinic Labware was originally developed for work in the vitamin field, but it has found other uses in applications with chemicals sensitive to light in the 3,000 to 5,000 Angstrom range.

PYREXPLUS® Brand Labware

Code No. 7740 Glass with a Vinyl Coating

PYREXPLUS brand labware is Code No. 7740 PYREX brand borosilicate glass labware with a tough transparent vinyl coating. It is designed to resist exterior surface abrasion. It also helps minimize loss of contents if the glass vessel is accidentally broken.

Chemical Properties, Light Transmittance, and Pressure Data

Chemical Durability

The resistance to attack of different glasses by various chemicals may vary depending to a great extent upon temperature and pH values. The best way to determine which glass is most satisfactory is by simultaneous testing. Table 1 gives some representative figures for the glasses in this catalog.

The coating of PYREXPLUS brand labware is designed to resist leakage resulting from a brief chemical exposure that might occur if the vessel is broken. Prolonged and/or repeated chemical exposure of the coating to aldehydes, ketones, chlorinated solvents, and concentrated acids should be avoided.

Table 1. Relative Chemical Durability

Weight loss in milligrams of glass removed per cm^2 surface area exposed to reagent (mg/cm^2) in 24 hours at 95°C.

Glass Code No.	5% NaOH	5% HCl
7740	5.0	0.005

Chemical Composition

The chemical composition of glasses is probably of interest only to those who are concerned with extremely precise determinations.

Transmittance Data

The transmittance of low actinic glassware is as follows:

Wave Length A	% Transmittance
3,000	0
4,000	0-1
5,000	2-4

The visible light transmittance (400 to 760 nm) of Code No. 7740 glass is 92% at 2 mm thickness.

Code No. 7740
Corning Trademark: PYREX®

Common Names

Borosilicate, low expansion, Type I Glass

Standards

Type I, Class A borosilicate conforming to federal specification DD-G-54 lb and ASTM E-438. Also meets the U.S. Pharmacopoeia specifications for Type I borosilicate glass.

Composition

Compound	Approx. Amount (%)
SiO_2	80.6
B_2O_3	13.0
Na_2O	4.1
Al_2O_3	2.3

Properties

Coefficient of Expansion	32.5 x 10^{-7} cm/cm/°C
Strain Point	510°C
Anneal Point	560°C
Soften Point	821°C
Density	2.53 g/cm^3
Youngs Modulus	76 X 10^3 Kg/mm^2
Refraction Index	1.474 @ Sodium D Line
Temperature Limits	490°C (Extreme Service) 230°C (Normal Service)
Maximum Thermal Shock	160°C

Applications

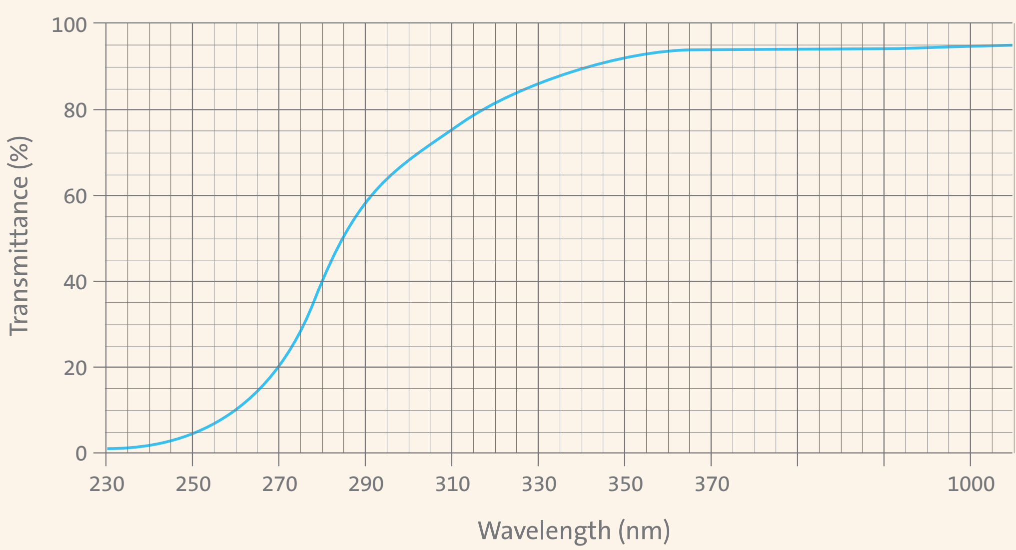
Designed for use in all products requiring very high resistance to strong acids, alkalis, and products intended for use in heat applications such as autoclaves, hot plates, and open flame.

Products

Beakers, burets, bottles, centrifuge tubes, condensers, cylinders, desiccators, dishes, flasks, fritted ware, funnels, ground joints, jars, stopcocks, tubing, and other assorted products.

Warnings

1. Thick-walled ware, such as bottles, jars, and desiccators, should not be heated over a flame, a hot plate, or other comparable source of heat.
2. Do not use hydrofluoric or hot phosphoric acid in glass.
3. Do not use scratched or abraded glassware.
4. Hot alkalis will etch glass.



Code No. 7740 Transmittance
Approximately 1 mm thick

Code No. 7789
Corning Trademark: PYREX®

Common Names

Borosilicate, low expansion, Type I Glass

Standards

Type I, Class A Borosilicate conforming to federal specification DD-G-54 lb and ASTM E-438 (except for K_2O content). This glass also meets the U.S. Pharmacopoeia specifications for Type I Borosilicate Glass.

Composition

Compound	Approx. Amount (%)
SiO_2	81
B_2O_3	13
Na_2O	4
Al_2O_3	2

Properties

Coefficient of Expansion	32.5 x 10^{-7} cm/cm/°C
Strain Point	510°C
Anneal Point	560°C
Soften Point	815°C
Density	2.22 g/cm^3
Youngs Modulus	6.4 X 10^3 Kg/mm^2
Refraction Index	1.474 @ Sodium D Line
Temperature Limits	Not Available
Maximum Thermal Shock	160°C

Applications

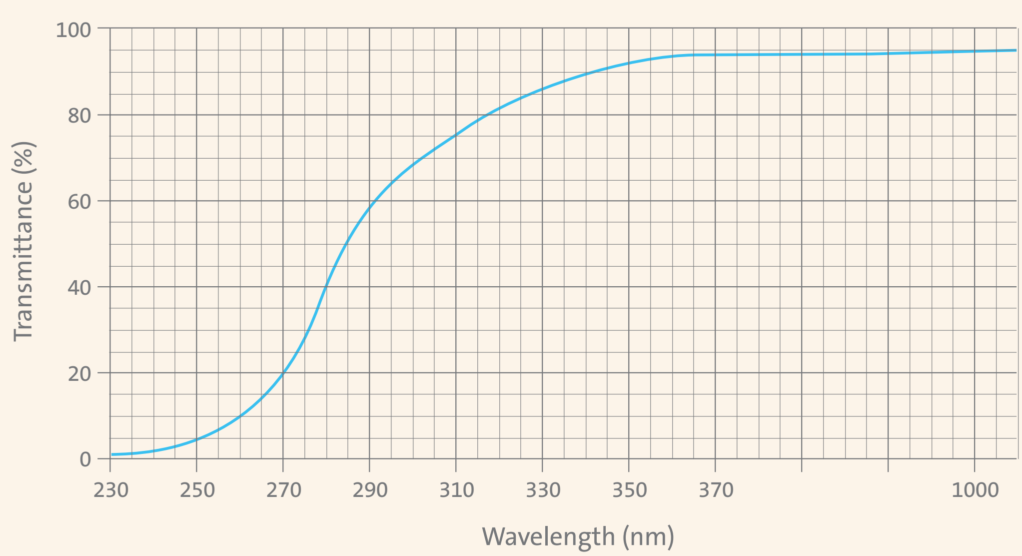
Designed for use in all products requiring very high resistance to strong acids and alkalis. Products may be autoclaved. Code No. 7740 glass can be sealed to this glass.

Products

Reagent bottles in sizes 125 mL through 2000 mL. Also used in Cat. No. 1395 series media bottles.

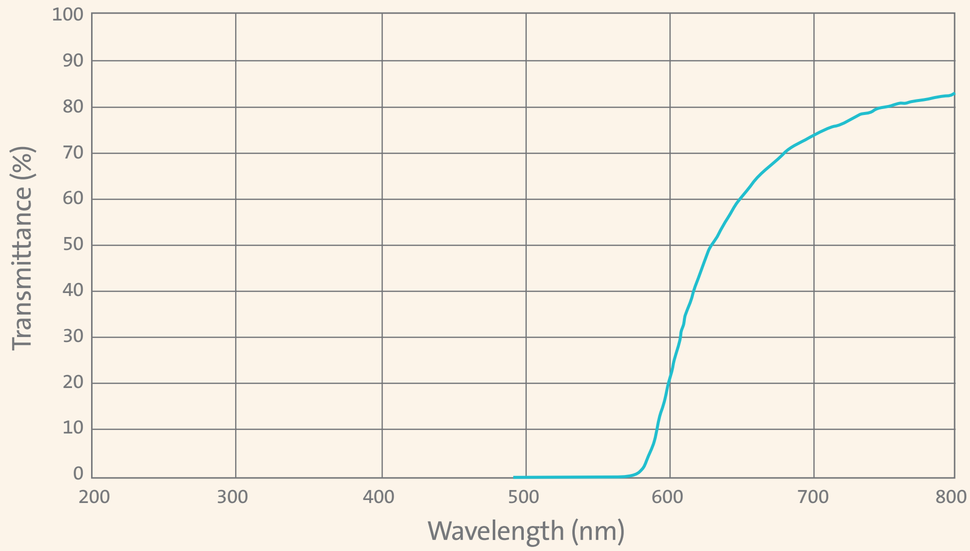
Warnings

1. Not recommended for use on hot plates.
2. Do not use hydrofluoric or hot phosphoric acid in glass.
3. Do not use scratched or abraded glassware.
4. Hot alkalis will etch glass.



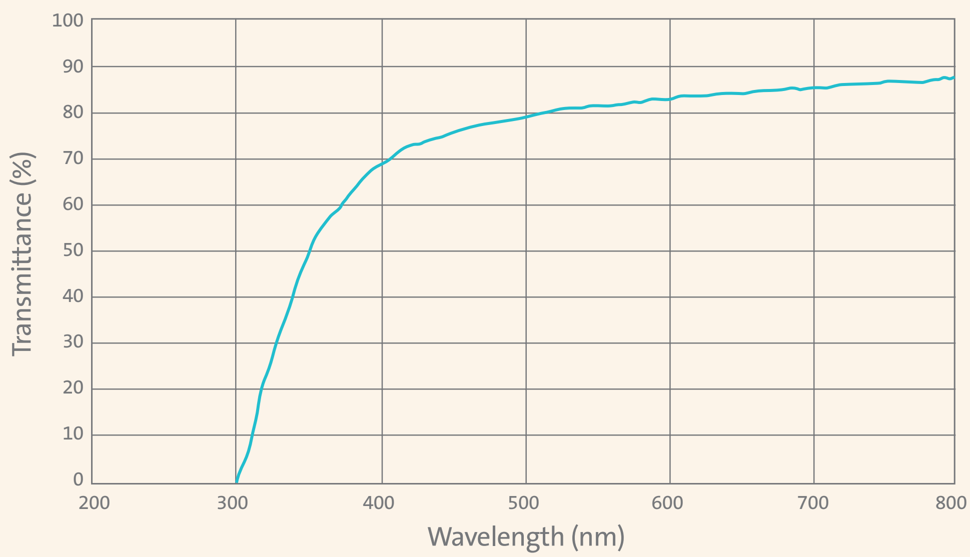
Code No. 7789 Transmittance
Approximately 1 mm thick

Transmission/Wavelength for PYREX® Brand Low Actinic Labware



Transmittance data for low actinic product
Approximately 2.80 mm thick

Transmission/Wavelength for PYREXPLUS® Brand Labware



Transmittance data for PYREXPLUS product
Approximately 3.15 mm thick

Properties of Corning® Glasses

For the convenience of those interested in the properties of glasses manufactured by Corning, data on some representative glasses are listed on this page.

			7740	7800	0071
1. Glass Code			**7740**	**7800**	**0071**
2. Type			Borosilicate	Borosilicate	Soda Lime
3. Color			Clear	Clear	Clear
4. Principal Use			General	Pharmaceutical	Jar
5. Forms Usually Available			BPSTU	T	
6. Corrosion Resistance		Class	1		
		Weathering	1	1	
		Water	1	1	
		Acid	1	1	
7. Thermal Expansion (Multiply by 10^{-7} cm/cm/°C)		0°C-300°C	32.5	55	90
		25°C to Setting Point	35	53	
8. Upper Working Temperatures (mechanical considerations only)	Annealed	Normal Service (°C)	230	200	
		Extreme Service (°C)	490	460	
	Tempered	Normal Service (°C)	260		
		Extreme Service (°C)	290		
9. Thermal Shock Resistance Plates 15 x 15 cm Annealed		3.2 mm Thick (°C)	160		
		6.4 mm Thick (°C)	130		
		12.7 mm Thick (°C)	90		
10. Thermal Stress Resistance (°C)			54	33	
11. Viscosity Data		Strain Point (°C)	510	521	495
		Annealing Point (°C)	560	565	537
		Softening Point (°C)	821	785	726
		Working Point (°C)	1252	1189	
12. Knoop Hardness KHN_{100}				487	
13. Density g/cm³			2.23	2.34	2.47
14. Young's Modulus (Multiply by 10^3 Kg/mm²)			6.4		
Poison's Ratio			.20		
15. $\log_{10}$ of Volume Resistivity (ohm-cm)		25°C	15.0		
		250°C	8.1	7.0	
		350°C	6.6	5.7	
16. Dielectric Properties at 1 MHz 20°C		Power Factor (%)	0.50		
		Dielectric Constant	4.6		
		Loss Factor (%)	2.6		
17. Refractive index			1.474	1.491	1.512
Stress-Optical Coefficient, $\frac{nm/cm}{Kg/mm^2}$			394	319	273

Refer to next page for footnote references (Thermal Properties).

Thermal Properties

The table on the previous page indicates the thermal properties for various Corning® glasses. The strain point represents the extreme upper limit of serviceability for annealed glass. A practical maximum service temperature will always be below this point.

The annealing point is the temperature, at the upper end of the annealing range, at which the internal stress is reduced to a commercially acceptable value over a short period of time.

In an annealing operation, the glass is slowly cooled from above the annealing point to somewhat below the strain point.

The softening point is the temperature at which a small diameter fiber of the glass will elongate under its own weight. As one moves above this temperature, the glass becomes more workable. As a general rule, the coefficient of expansion indicates the thermal shock resistance of the glass. The lower the expansion, the greater the resistance of the glass to sudden temperature changes.

Footnote References for "Properties of Corning Glasses"

(See previous page.)

Line 5

B-Blown Ware
U-Panels
P-Pressed Ware
S-Plate Glass
T-Tubing and Rod

Line 6

These borosilicate glasses may rate differently, if subjected to excessive heat treatment.

Line 8

Normal service no breakage from excessive thermal shock is assumed. Extreme limits glass will be very vulnerable to thermal shock. Recommendations in this range are based on mechanical stability considerations only. Tests should be made before adopting final designs. These data are approximate only.

Line 9

These data are approximate only. Based on plunging sample into cold water after oven heating resistance of 100°C (212°F), which means no breakage if heated to 100°C (212°F) and plunged into water at 10°C (50°F). Tempered samples have over twice the resistance of annealed glass.

Line 10

Resistance in °C (°F) is the temperature differential between the two surfaces of a tube or a constrained place that will cause a tensile stress of 0.7 kg/mm (1000 psi) on the cooler surface.

Line 11

These data are subject to normal manufacturing variations.

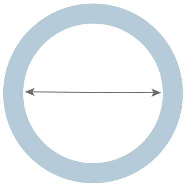
Line 12

Determined by revised ASTM standard.

Line 17

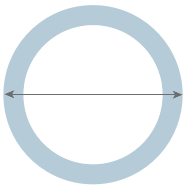
Refractive index may be at either the sodium yellow line (589.3 nm) or helium yellow line (587.6 nm). Values at these wavelengths do not vary in the first three places beyond the decimal point.

Glossary of Glass Tubing



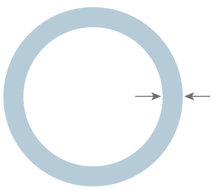
1. I.D.

Inside diameter of tubing.



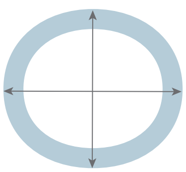
2. O.D.

Outside diameter of tubing.



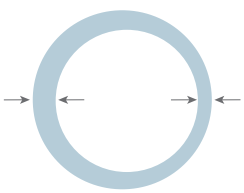
3. Wall

The normal thickness of the glass between the inside and outside surfaces of the tubing.



4. O.O.R.

The difference between the minimum and maximum O.D. measurements made at one point along a piece of tubing.



5. Siding

This is the difference between the minimum and the maximum wall thickness as measured at the end of the tube.

6. Airlines

These are elongated air bubbles within the tubing or rod. They may be buried within the glass or open on the surface.

7. Chips

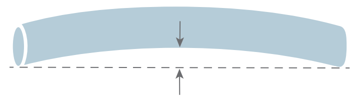
A depression on the glass surface of tubing or rod caused by flaking of the glass.

8. Stones

A piece of undissolved or crystallized refractory material or glass batch appearing in the glass as an opaque lump.

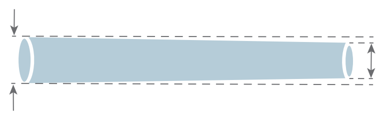
9. Bow

Bow is measured as the maximum deviation from a straight line connecting any two points on the tube.



10. Taper

The maximum gradual dimensional change in the O.D. of one end of the tubing or rod to the opposite end.



11. Check

A fissure extending into the wall of tubing or rod.

12. Scuff scratch

Abrasion which might occur during the manufacturing process, shipping, storage, or use.

13. Cord

An optical or surface effect usually in a narrow band caused by non-homogeneous glass.

14. Stress

A condition of tension or compression existing within the glass.

15. End Finishes

a. Cut at Draw – Raw ends not fire-polished or glazed.

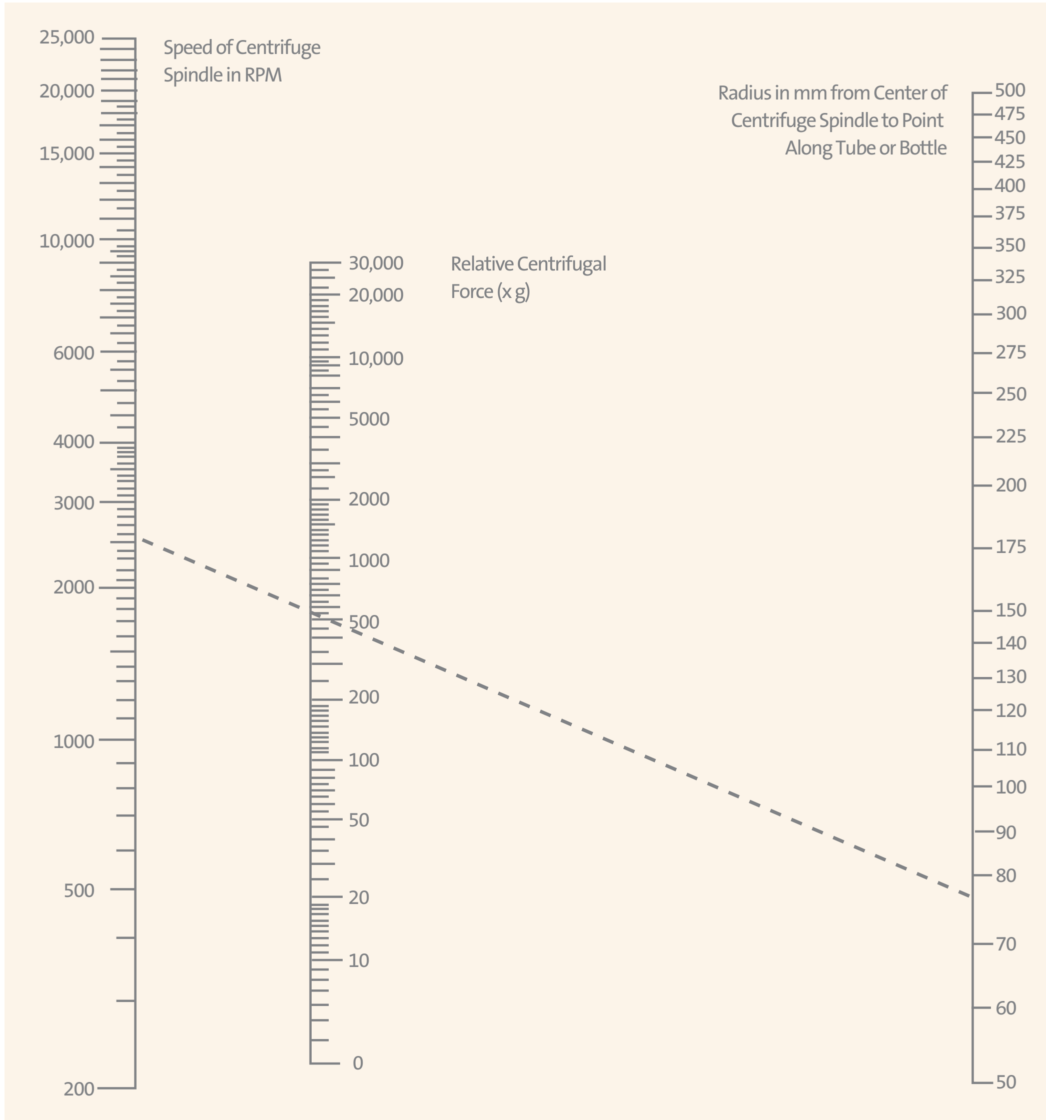
b. Cut and Fire-polished – Cut at draw. Ends fire-polished to heal sharp edges.

c. Trimmed – Tubing cut to specific length.

d. Trimmed and Glazed – Tubing cut to length and fire-polished to heal sharp edges.

e. Cut and Ground – Tubing cut to length and ends ground.

Nomogram for Computing Relative Centrifugal Force (RCF)



All data subject to normal manufacturing variations

To calculate the RCF value at any point along the tube or bottle, measure the radius, in mm, from the center of the centrifuge spindle to the particular point. Draw a line from the radius value on the right-hand column to the appropriate centrifuge speed on the left-hand column.

The RCF value is the point where the line crosses the center column. The nomogram is based on the formula:

$RCF = (11.17 \times 10^{-7}) RN^2$

where:

R = Radius in mm from centrifuge spindle to point in tube bottom

N = Speed of spindle in RPM 125

NOTE: Tubes should not be spun in excess of 1500 x g.

Guide to Fritted Ware

Porosity

There are four different porosities of PYREX® brand fritted ware available, so that precipitates varying in size can be filtered at maximum speed with no sacrifice of retention. Porosity is controlled in manufacture, and discs are individually tested and graded into these classifications. The extra coarse and coarse porosities are held toward the maximum pore diameter as listed. The medium and fine are held toward the minimum pore diameter as listed.

The porosity for the pore diameter of the filter is determined in the same manner as specified in ASTM E-128 *Maximum Pore Diameter and Permeability of Rigid Porous Filters for Laboratory Use*.

Also, where the size of the piece permits, it is marked with the ASTM designation followed by the pore range in microns as shown in the column Nominal Maximum Pore Size (µm) (Table 1).

Coloration

The "whiteness" of various fritted products may vary slightly from piece to piece due to minor color variations in the batch mix. This color variation does not affect product filtration performance nor is it frit contamination.

Proper Care of Fritted Ware

Cleaning

A new fritted filter should be washed by suction with hot hydrochloric acid and then rinsed with water before it is used. This treatment will remove loose particles of foreign matter such as dust. It is advisable to clean all PYREX brand fritted filters as soon as possible after use. This will prolong their life.

Many precipitates can be removed from the filter surface simply by rinsing from the reverse side with water under pressure not exceeding 15 lbs/sq. in. Drawing water through the filter from the reverse side with a vacuum pump is also effective. Some precipitates tend to clog the pores of a fritted filter. Treatment here must be by chemical means. A few suggestions generally found to be useful are listed in Table 2.

Operating Pressures

Fritted glassware is designed primarily for vacuum filtration or for gas flow at relatively low pressures. If used for pressure work, the MAXIMUM differential on the disc should not exceed 15 pounds per square inch. Care should be taken when preparing sample solutions to avoid trapping air. If dissolved air is present, the flow rate may be reduced by up to 50%.

Thermal Limitations

The resistance to thermal shock of fritted ware is less than that of non-porous PYREX brand labware. Therefore, articles of fritted ware should not be subjected to excessive temperature changes or to direct flame.

Dry fritted crucibles at room temperature may be placed into a drying oven operating at 150°C.

Fritted ware may be safely heated in a furnace to 500°C without ill effect, provided that the cycle of heating and cooling is gradual.

Table 2. Cleaning Materials

Material	Cleaning Solution
Fatty materials	Carbon tetrachloride
Organic matter	Hot concentrated cleaning solution or hot concentrated sulfuric acid plus a few drops of sodium or potassium nitrite
Albumen	Hot ammonia or hot hydrochloric acid
Glucose	Hot mixed acid; $H_2SO_4 + HNO_3$
Copper or Iron Oxides	Hot hydrochloric acid plus potassium chlorate
Mercury Residue	Hot nitric acid
Silver Chloride	Ammonia or sodium hyposulfite
Viscose	5%-10% NaOH followed by cleaning solution
Aluminous and Siliceous Residues	2% hydrofluoric acid followed by concentrated sulfuric acid; rinse immediately with distilled water followed by a few mL of acetone. Repeat rinsing until all traces of acid are removed.

Table 1. Available Porosities

Porosity	Catalog Abbreviation	Nominal Maximum Pore Size (µm)	Principal Uses
Extra Coarse	E C	170-220	Filtration of very coarse materials. Gas dispersion, gas washing, extractor beds, support of other filter materials.
Coarse	C	40-60	Filtration of coarse materials. Gas dispersion, gas washing, gas absorption. Mercury filtration. Extraction apparatus.
Medium	M	10-15	Filtration of crystalline precipitates. Extraction apparatus. Removal of "floaters" from distilled water.
Fine	F	4-5.5	Filtration of fine precipitates. Mercury valve. Extraction apparatus.

The Use and Care of PYREXPLUS® Laboratory Glassware

PYREXPLUS® labware is designed to offer you additional safety and protection, plus extended product life, by coating the exterior surface with a PVC polymer.

Autoclaving

PYREXPLUS labware can be successfully sterilized using liquid or dry cycle sterilization which involves no vacuum or low vacuum (5 inches Hg).

Recommended cycles for automated autoclaves are:

	Autoclave Type	
Autoclave Cycle	**Gravity**	**Pre-vacuum**
Liquid	Yes	Yes
Dry	Yes	No
Pre-vac	–	No

CAUTION: Always autoclave vessels with loose caps or closures.

Sterilization time should not exceed 15 minutes at 121°C (250°F). Drying time should not exceed 15 minutes at 110°C (230°F). The actual cavity temperature of the autoclave should be checked to be sure the autoclave temperature does not exceed the recommended sterilization and drying temperature.

Autoclaving-Cloudiness

Should the coating appear clouded due to dissolved moisture, simply let dry overnight at room temperature or briefly heat to 110°C (230°F).

Cleaning

As is common practice, clean all glassware before use. Any non-abrasive glassware detergent may be used for hand or automatic dishwasher cleaning. If using a dishwasher or glassware dryer, care should be taken to be sure the drying temperature does not exceed 110°C (230°F). Exposure to dry heat should be minimized.

Avoid brushes and cleaning pads which could abrade the glass or damage the coating. If using a chromic acid cleaning solution, minimize contact of the solution with the coating.

Exposure to Chemicals

As with all PYREX® brand borosilicate glass labware, the PYREXPLUS vessel has excellent chemical inertness. The coating, however, is designed to resist leakage resulting from a brief chemical exposure that might occur if the vessel is broken. Prolonged and/or repeated chemical exposure of the coating to aldehydes, ketones, chlorinated solvents, and concentrated acids should be avoided.

Exposure to Cold

PYREXPLUS labware should not be exposed to temperatures below -20°C (-4°F). Extremely low temperatures may result in the coating becoming cracked. Exposure to temperatures below room temperature (23°C or 73°F) can temporarily reduce the ability of the coating to contain its contents if the vessel is broken.

Exposure to Heat

PYREXPLUS labware is designed to withstand the temperatures associated with steam sterilization. However, it should not be placed over direct heat or an open flame. Prolonged exposure to dry heat may also cause the coating to become brittle and thereby reduce the useful life of the vessel. A brown appearance or hardness to the touch are signs that the coating has become brittle.

The upper temperature limit for PYREXPLUS labware is 110°C (230°F). PYREXPLUS labware should not be exposed to elevated temperature in a vacuum greater than 5 inches Hg (127 mm Hg).

Exposure to Microwave

PYREXPLUS labware is completely microwave safe. However, as with any microwave vessel, be sure there is a load (water or other microwave absorbing material) in the microwave oven. Also, be sure all caps and closures are loosened.

Exposure to Ultraviolet

Prolonged and/or repeated exposure of the PYREXPLUS labware coating to direct sunlight or ultraviolet sources (such as sterilizaton lamps) is not recommended.

Exposure to Vacuum

PYREXPLUS containers (such as filter flasks and aspirator bottles) have demonstrated the ability to contain glass fragments upon implosion at room temperature. However, in keeping with safe laboratory practice, always use a safety shield around evacuated containers.

Labeling and Marking

Use water-based markers for temporary marking or labeling of the PYREXPLUS labware coating. Solvent-based markers, dyes, and stains cannot be removed from the coating.

NOTE: A slight "plastic" odor may be detected when handling PYREXPLUS labware. This is due to additives in the plastic coating which are responsible for its superior performance. The odor is normal and will not affect the inertness of the inside borosilicate glass surface.

General Use and Care Recommendations

- Proper care and handling of PYREXPLUS® labware or any labware will greatly increase its life and increase the safety of your work place.
- Do not place PYREXPLUS labware over direct heat or open flame.
- The recommended temperature use range for PYREXPLUS labware is 10°C to 80°C. Do not continuously expose PYREXPLUS labware to heat above 80°C.
- Do not expose to dry heat in a dishwasher above 110°C (230°F). Drying time should not exceed 15 minutes at 110°C (230°F).
- Do not autoclave above 121°C (250°F). Sterilizing time should not exceed 15 minutes.
- Do not refrigerate below -20°C (-4°F).
- Do not remove the protective coating. Do not use a vessel on which the coating is hardened, darkened or otherwise damaged.
- Do not use PYREXPLUS® labware to store hazardous chemicals below room temperature.
- Do not allow prolonged or repeated exposure of the coating to strong acids or solvents.
- Do not use a vessel once the glass is broken. Immediately transfer the contents of a broken vessel to an approved container and properly dispose of the broken vessel.
- Do not incinerate discarded vessels. Place in proper disposal containers.

Glass Terminology

Anneal: To prevent or remove objectionable stresses in glassware by controlled cooling.

Binder (Fibrous Glass): Substances employed to bond or hold the fibers together.

Blister: An imperfection, a relatively large bubble or gaseous inclusion.

Check: An imperfection. a surface crack in a glass article.

Chill Mark: A wrinkled surface condition on glassware, resulting from uneven contact in the mold prior to forming.

Chip: An imperfection due to breakage of a small fragment from an otherwise regular surface.

Cord: An unattenuated glass inclusion, possessing optical and other properties differing from those of the surrounding glass.

Cullet: Waste or broken glass, usually suitable as an addition to raw batch.

Devitrification: Crystallization in glass.

Dice: The more or less cubical fracture of tempered glass.

Fiber: An individual filament made by attenuating molten glass. A continuous filament is a glass fiber of great or indefinite length. A staple fiber is a glass fiber of relatively short length (generally less than 44 cm).

Fusion: Joining by heating.

Glass Ceramic: A material melted and formed as a glass, then converted largely to a crystalline form by processes of controlled devitrification.

I.D.: Inside diameter.

Lampworking: Forming glass articles from tubing and rod by heating in gas flame.

Lap: (1) An imperfection, a fold in the surface of a glass article caused by incorrect flaw during forming. (2) A process used for mating ground surfaces.

Liquidus Temperature: The maximum temperature at which an equilibrium exists between the molten glass and its primary crystalline phase.

Mat (Fibrous Glass): A layer of intertwined fibers bonded with some resinous material or other adhesive.

O.D.: Outside diameter.

Out-of-Round: Asymmetry in round glass articles.

Sealing: See Fusion.

Seed: An extremely small gaseous inclusion in glass.

Softening Point: The temperature at which a uniform fiber 0.5 mm to 1.0 mm in diameter and 22.9 cm in length elongates under its own weight at a rate of 1 mm per minute when the upper 10 cm of its length is heated in a prescribed furnace at the rate of approximately 5°C per minute. For a glass of density near 2.5, this temperature corresponds to viscosity of $10^{7.6}$ poises.

Standard Taper: ＄ is the symbol used to designate interchangeable glass joints, stoppers, and stopcocks complying with the requirements of ASTM E-676 and ASTM E-675. All mating parts are finished to a 1:10 taper.

＄ is the designation for spherical (semi-ball) joints complying with ASTM E-677.

＄ is the designation for tapered stopcocks using a fluorocarbon plug complying with ASTM E-911. All mating parts are finished to a 1:15 taper. The size of a particular piece appears after the appropriate symbol. Due primarily to the greater variety of apparatus equipped with fittings, a number of different types of identifications are used as follows:

- ***Joints:*** A two-part number, ₷ 24/40, with 24 being the approximate diameter in mm at the large end of the taper, and 40 being the axial length of taper, also in mm.
- ***Stopcocks:*** A single number, ₷ 2, with 2 being the approximate diameter in mm of the hole or holes through the plug.
- ***Bottles:*** A single number, ₷ 19, with 19 being the approximate diameter in mm of the opening at the top of neck.
- ***Flasks:*** (Other than most boiling flasks) a single number, ₷ 19, with 19 again being the approximate diameter in mm at top of neck. For dimensional details of the various stoppers, see the individual listings in Corning's general catalog of laboratory products.

The complete designation of a spherical joint also consists of a two-part number, ₷ 12/2, with 12 being the approximate diameter in mm of the ball and 2 the bore in mm of the ball and the socket.

Finally, for the fluorocarbon plug, a single number is used as with ₷ stopcocks. Thus ₷ 2 means a stopcock with a hole of approximately 2 mm in the plug.

Stone: An imperfection; crystalline contaminations in glass.

Stria: A cord of low intensity, generally of interest only in optical glass.

Tempered Glass: Glass that has been rapidly cooled from near the softening point, under rigorous control, to increase its mechanical and thermal strength.

Thermal Endurance: The relative ability of glassware to withstand thermal shock.

Weathering: Attack of a glass surface by atmospheric elements.

Working Range: The range of surface temperature in which glass is formed into ware in a specific process. The "upper end" refers to the temperature at which the glass is ready for working generally corresponding to a viscosity of 10^3 to 10^4 poises. The "lower end" refers to the temperature at which it is sufficiently viscous to hold its formed shape, generally corresponding to a viscosity greater than 10^6 poises. For comparative purposes and when no specific process is considered, the working range of glass is assumed to correspond to a viscosity range from 10^4 to $10^{7.6}$ poises.

Glass Material Terms

Standards

Three organizations currently publish standards covering the composition properties and/or testing of glasses used in the laboratory. All are similar and in some cases identical. These standards and Corning glasses are listed below:

- Federal Specification DD-G-541b and ASTM Standard E-438
- Type I, Class A Borosilicate – Code Nos. 7740 and 7789* Glass
- Type I, Class B Borosilicate – Code No. 7800 Glass
- *Type II, Soda Lime – Code No. 0071 Glass
- U.S. Pharmacopoeia Chemical Resistance – Glass Containers
- Type I highly resistant borosilicate – Code Nos. 7740, 7800, 7789, and 7799

Compositions

The information on composition is approximate percent by weight unless otherwise noted.

Properties

Annealing Point (Viscosity 10^{13} poises): The temperature at which the internal strains in glass are reduced to an acceptable limit in 15 minutes per ASTM C-336.

Coefficient of Expansion: ASTM E-228 measurement of average linear expansion for temperature changes between 0° and 300°C.

Density: Weight in grams of one cubic centimeter of glass.

Refractive Index: Measurement of the ratio between the velocity of light in air to velocity in glass.

Softening Point (Viscosity $10^{7.5}$ to 10^8 poises): The temperature at which glass will elongate under its own weight per ASTMC-338.

Strain Point (Viscosity $10^{14.5}$ poises): The temperature at which the internal stresses in glass are reduced to low values in approximately 4 hours.

Temperature Limits: Normal service is the temperature at which no breakage should occur. Extreme service is the maximum temperature limit of the glass. It will be prone to thermal failure if not in perfect condition.

Thermal Shock Limit: The maximum allowable difference in temperature between the temperature of the glass and the air, liquid or solid in contact with the glass. This figure is based on plunging an oven-heated 3.2 mm thick sample into cold water.

Transmittance: Graph showing the percent transmittance for wavelengths in the ultra-violet and visible ranges. Values are for thickness shown.

Youngs Modulus: The ASTM C-623 measurement of stress to strain ratio.

NOTE: The warnings which appear in this text apply only to specific products made from the glass compositions noted. These warnings are not all-inclusive. It is assumed that the user takes normal care and precautions while using the products.

*See Code. No. 7789 glass spec sheet for exception.

Properties of Components Used in Corning Products

Use and Care of Phenolic Caps

In order to minimize the likelihood of the liners coming out of caps, it is recommended that:

a. They be cleaned with hot water only, because detergents can attack the special nontoxic adhesive that holds them to the phenolic.

b. They not be applied to hot bottles, because a vacuum forms inside as the bottles cool and will pull the liners loose.

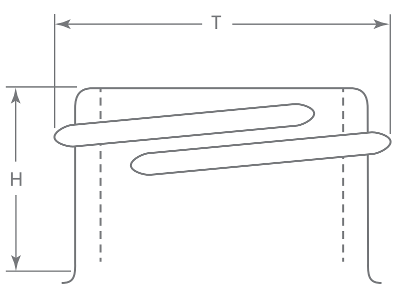
c. They not be subjected to dry heat which can destroy the liners; only steam autoclaving should be used and then not above 121°C.

Threaded Cap Information

Corning designed these screw caps for autoclaving, with heat-steam resistant resin. They are available with PTFE or white rubber liners. Disposable phenolic caps are available in bulk case pack quantities.

The Corning® cap(s) thread configuration complies with the current G.P.I. industry standard. G.P.I. refers to the "Glass Packaging Institute" which is responsible for maintaining current standards and issuing new uniform glass finishing standards to the market. G.P.I. formally replaced G.C.M.I. as the industry recognized standard.

Identification examples: 38-400 means that the diameter across the threads of the glass container are approximately 38 millimeters. The second number, 400 in this case, denotes the particular style of cap. All dimensions are approximate.



"T" Dimension (mm)	"H" Measurements (mm)			
	400	410	415	430
13			11.20	
15			13.90	
18	9.00	13.00	15.40	
20	9.50	13.80	18.50	
24	10.25	16.15	24.00	
28	10.25	17.75	27.20	
33	9.85			
38	9.85			
38*				22.0
40	10.25			

*Modified.

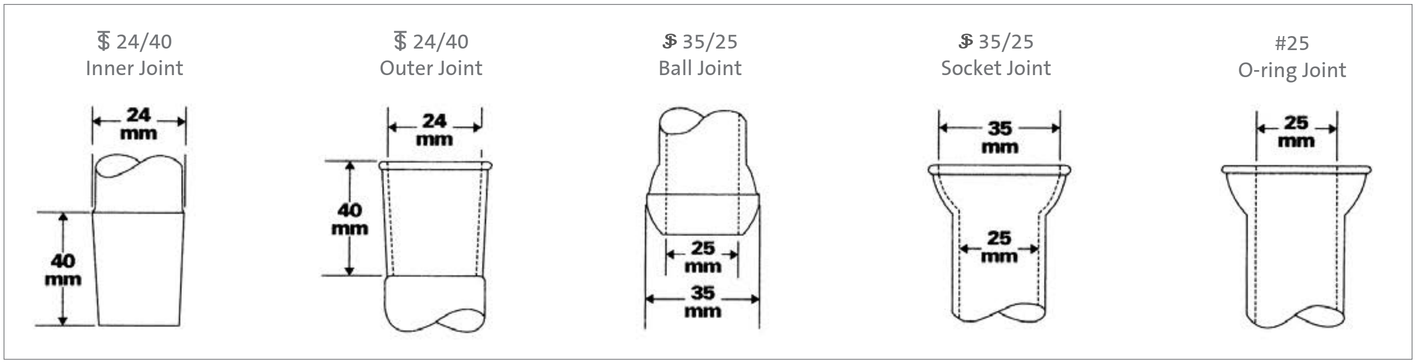
All caps should be closed "finger tight," gently compressing the inner liner for a leak-resistant fit. DO NOT over tighten; the glass threads on your applicable container may break if over-torqued.

Specifications for Joints, Threads, and Stopcocks

Standard Taper
Symbol used to designate interchangeable joints, stoppers, and stopcocks that comply with the requirements of Commercial Standard CS-21 published by N.I.S.T.

Spherical Joint
Symbol designates spherical joints that comply with CS-21.

Product Standard
Symbol designates stopcock plugs made of PTFE that meet requirements of N.I.S.T. Voluntary Product Standard PS 28-70.



Common Standard Laboratory Conversion Factors

Length

1 millimeter (mm)	0.1 centimeter (cm)
1 centimeter	0.01 meter (M)
1 centimeter	0.394 inch
1 inch	2.540 centimeters
1 meter	3.2808 feet
1 foot	0.305 meter

Area

1 square centimeter (cm)	0.1550 square inch
1 square inch	6.452 square centimeters
1 square meter (M)	10.764 square feet
1 square foot	0.09290 square meter

Mass

1 gram	0.03527 ounce (Avoirdupois)
1 ounce (Avoirdupois)	28.3495 grams
1 kilogram	2.20462 pound (Avoirdupois)
1 pound (Avoirdupois)	0.45359 kilogram

Volume

1 cubic centimeter	0.001 liter (L)
1 cubic centimeter	0.0610 cubic inch
1 cubic inch	16.3872 cubic centimeter
1 cubic meter	35.314 cubic feet
1 cubic foot	0.02832 cubic meter

Capacity

1 milliliter (mL)	0.03382 ounce (U.S. liquid)
1 ounce (U.S. liquid)	29.573 milliliters
1 liter (L)	1.05671 quarts (U.S. liquid)
1 quart (U.S. liquid)	0.94633 liter
1 liter	0.26418 gallon (U.S. liquid)
1 gallon (U.S. liquid)	3.78533 liter
1 lambda	0.001 cc/1 microliter

Power

1 watt	0.73756 foot-pound per second
1 foot-pound per second	1.3582 watts
1 watt	0.056884 BTU per minute
1 BTU per minute	17.580 watt
1 watt	0.001341 horsepower (U.S.)
1 horsepower (U.S.)	754.7 watts
1 watt	0.01433 kilogram-calorie per minute
1 kilogram-calorie per minute	69.767 watts

Temperature

°C = (°F – 32) x 5/9

°F = 9/5 x °C + 32