CARE AND HANDLING OF LABORATORY GLASSWARE

REUSABLE LABWARE

Glass: The Invisible Container

From the 16th Century to today, chemical research teams have used glass containers for a very basic reason: the glass container is transparent, almost invisible. And so the contents and the reaction are clearly visible. But because chemists must heat, cool and mix chemical substances, ordinary glass is not always adequate for laboratory work. A laboratory requires special glass.

For 75 years, Corning has developed special glasses for use in the laboratory. PYREX®, PYREXPLUS™, COREX®, VYCOR®, and CORNING® brand Labware are products which have been designed to meet chemists' specifications.

PYREX® brand Labware is made from particular formulas that are ideal for most laboratory applications. The glass compositions give PYREX® brand products special properties:

Except for bottles, jars or other items with heavy walls, PYREX® brand Labware can be heated directly on hot plates or above bunsen burners with low risk of thermal breakage because its thermal expansion is very low.

PYREX® brand Labware resists chemical attack. It reacts only with hydrofluoric or phosphoric acid or a strong, hot alkali.*

PYREX® brand Labware is designed for maximum mechanical strength.

PYREX® brand Labware comes in a wide variety of laboratory shapes, sizes and degrees of accuracy—a design to meet every experimental need.

While we feel PYREX® brand laboratory glassware is the best all-purpose glassware for most laboratory applications, you may require the advantages of other special glasses for certain scientific procedures:

PYREXPLUS™ brand labware is PYREX® brand laboratory glassware with tough transparent plastic vinyl coating to increase durability and help contain spills should the glass vessel break.

VYCOR® brand Glassware is 96% silica glass. It outperforms PYREX® brand Glassware in terms of very high service temperatures, and thermal shock resistance.

PYREX® brand Low Actinic Labware, with a light filtering red stain, will protect ultraviolet-sensitive materials.

COREX® brand Labware is considerably stronger than even PYREX® brand Labware and will last much longer.

In selecting your Labware, study the various types available from Corning. See if one particular design or glass appears to fit your specific requirements. While the glass composition is important, you should also be concerned with the shape which ideally fits your needs—something Corning has spent years researching. Emphasis on small details has made CORNING® Labware the most widely accepted in the world.

The following pages contain a glossary of terms and information on the technical properties of various glasses and suggestions on the use and care of labware.

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

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 glassy 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 a gas flame.

Lap: (1) An imperfection; a fold in the surface of a glass article caused by incorrect flow 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 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: Ŧ is the symbol used to designate interchangeable glass joints, stoppers, and stopcocks complying with the requirements of ASTM E 676, and requirements of ATSM E 675. All mating parts are finished to a 1:10 taper.

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

Ṥ is the designation for tapered stopcocks using a fluorocarbon plug complying with ASTM E 911. All mating parts are finished to a 1:5 taper.

The size of a particular piece appears after the appropriate symbol. Due primarily to the greater variety equipped with Ŧ fittings, a number of different types of identifications are used, as follows:

Joints: a two part number, Ŧ 24/40, with 24 being the approximate diameter in mm. at the large end of the taper and 40 the axial length of taper, also in mm.

Stopcocks: a single number, Ŧ 2, with 2 being the approximate diameter in mm. of the hole or holes through the plug.

Bottles: a single number, Ŧ 19, with 19 being the approximate diameter in mm. of the opening at top of neck.

Flasks: (other than most boiling flasks) a single number Ŧ 19, with 19 again being the approximate diameter in mm. at top of neck. For dimensional details of the various stoppers, see the individual listing in Corning's general catalog of laboratory products.

The complete designation of a spherical joint also consists of a two-part number Ş 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 Ŧ stopcocks. Thus, Ṥ 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), while the "lower end" refers to the temperature at which it is sufficiently viscous to hold its formed shape (generally corresponding to a viscosity greater then 10^6 poises). For comparative purposes, 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.

DESCRIPTION OF VOLUMETRIC WARE

The accuracy of volumetric ware depends on the precision used in calibrating it, using the correct type of ware, 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.

Types of Ware

Certified Ware: Certified Ware is calibrated to Class A specifications. Each piece is furnished with an individual certificate guaranteeing this accuracy.

Class A Ware: Class A Ware is manufactured to the same tolerance as Certified Ware but is not certified.

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 Corning's laboratory 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 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. Major calibrations on burets, pipets, and cylinders nearly encircle the body, intermediate lines go two-thirds around and minor lines at least half way. 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 may 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 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.

Corning's laboratory products are calibrated in accordance with clause 7.3.2.1 of ASTM E 542 which states: "The position of the 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."

GLASS TECHNICAL DATA

Corning products are made from different glass compositions 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: The most widely known of Corning's family of Borosilicate glasses, comes closest to being the ideal glass for most laboratory applications.

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 relatively heavy walls giving it mechanical strength, while retaining reasonable heat resistance. It is the best glass available for laboratory use.

PYREXPLUS™ brand Labware

PYREXPLUS™ laboratory glassware is Code No. 7740 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.

PYREX® brand Low Actinic Ware

Code No. 7740 Glass with a Red Ultraviolet Shielding Stain: This glassware is generally made from Code No. 7740 glass with a red stain fired into the exterior surface. PYREX® brand Low Actinic glassware was originally developed for work in the vitamin field, but it has found other uses in applications with chemicals sensitive to light in the 300 to 500 nanometer range.

COREX® brand Labware

Code No. 0331 Glass: Manufactured from our Code No. 0331 alumino-silicate glass, these products have been given a special chemical strengthening treatment which makes them stronger than ware made with our Code No. 7440 glass. While somewhat higher in price, the added strength has made them more economical because of their longer service life. Products made from Corning Code No. 0331 glass should not be heated over 300°C.

VYCOR® brand Labware

Code No. 7913 Glass: This glassware has several exceptional properties. Since it is 96% silica, it is similar to fused quartz in its thermal properties. It may be used at much higher temperatures than Code No. 7740 borosilicate glass and will withstand considerably more thermal shock. Being of a very simple composition, only five elements, it is used for very critical analytical work.

Thermal Properties

Table No. 1 shows the thermal properties of Code Nos. 7740, 7913 and 0331 glasses. The strain point represents the extreme upper limit of serviceability for annealed glass. Except for Code No. 7913, the practical maximum service temperature will always be below this point.

Table No. 1
Relative Thermal Properties

	Glass 7740	Glass 7913	Glass 0331
Coef. of Expan. 0–300 C.	32.5	7.5	*
Strain Point	510	890 C.	*
Annealing Point	560	1020 C.	*
Softening Point	821	1530 C.	*

*These reference points are meaningless for Code No. 0331 glass. As it is chemically strengthened, it is not suitable for direct heating or reworking. The chemical tempering will remain, provided the glass is not heated above 300°C.

Table No. 2
Relative Chemical Durability

	5% NaOH	5% HCl
Glass No. 7740	5.0	0.005
Glass No. 7913	4.0	0.020
Glass No. 0331	4.0	0.100

Weight Loss mg/cm² (a) in 24 hours at 95°C.

(a) Milligrams of glass removed per cm² surface area exposed to reagent.

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 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 a general rule, the coefficient of expansion indicates the thermal shock resistance of the glass. The lower the expansion, the greater is the resistance of the glass to sudden temperature changes.

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 2 gives some representative figures for the glasses.

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.

SUGGESTIONS FOR SAFE USE OF GLASS LABWARE

Heating and Cooling

Always watch evaporation work closely. A vessel, heated after evaporation has already occurred, may crack.

Do not put hot glassware on cold or wet surfaces, or cold glassware on hot surfaces. It may break with the temperature change. Although PYREX® and VYCOR® brand products can take extreme temperatures, always use caution.

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

Cool all labware slowly to prevent breakage, unless you are using VYCOR® which can go from high heat to ice water with no damage.

Glassware with thick walls, such as bottles and jars, should not be heated over a direct flame or comparable heat source. We suggest the use of our 16790 VYCOR® immersion heater.

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

Do not look down into any vessel being heated. A reaction might cause the contents to be ejected.

PYREXPLUS™ brand 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 above 80°C 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 130°C (266°F) and should not be exposed to elevated temperature in a vacuum greater than 5 inches Hg (127 mm Hg).

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.

Heat Sources

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

Bunsen Burners: Adjust 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 stand 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 in 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.

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

On a hot plate, the entire top surface heats. In addition, the surface remains warm for some time after you have turned the hot plate off. Be careful with any hot plate that has recently been used.

In hot plates that are electrical, be sure to check the wire and the connector plug for wear. If signs of wear appear, have the plug and/or wire replaced immediately. Do not use the hot plate until it is repaired. A frayed wire or damaged plug can cause a severe electrical shock.

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

There are special features about CORNING® Hot Plates. First, the top of the hot plate is made of a ceramic material that resists chemical attack, is easy to clean, and provides even heat. The top of the hot plate overhangs the body to keep solutions from spilling into the body of the unit. The PYROCERAM® top on a CORNING® Hot Plate turns a pale yellow when heated above 400°F.

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

Mixing and Stirring

Use a rubber policeman on glass or metal stirring rods, or use TEFLON® rods to prevent scratching the inside of a vessel.

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

Joining and Separating Glass Apparatus

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

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

If a ground joint sticks, this procedure will generally unstick 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 5–10 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. (Be sure that 50% of the inner surface is wet before inserting the joint in the flame.) Remove from the flame and taking care to protect your hands and fingers gently twist the two members apart. If they do not come apart, repeat the procedure. In separating joints by this method, never use force.

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 glycerine or water when trying to insert glass tubing into a rubber stopper. Also, use a protective hand towel.

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 which contacts the inner part of the apparatus.

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 glycerine, is suitable. Water will clean glycerine.

Personal Safety

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

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.

Do not use glass products if chipped, cracked, etched or scratched.

Burns are caused by heat as well as by ultraviolet or infrared rays, and extremely cold materials. Use goggles and limit your exposure time when working with extravisual 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.

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.

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 gone over carefully until there are no globules remaining. All mercury containers should be kept well-stoppered.

Never drink from a beaker. A beaker left specifically for drinking is a menace to the laboratory. Use disposable or recyclable cups. Do NOT taste chemicals for identification. Smell chemicals only when necessary and only by wafting a small amount of vapor toward the nose.

Do not draw any liquids into a pipet by mouth. Serious injury could result. Instead, use mechanical means, such as a rubber bulb or other pipetting aids available from laboratory suppliers.

Never fill a receptacle with material other than that called for by the label. Label all containers before filling. Identify contents of unlabeled containers and dispose of contents in accordance with appropriate regulations.

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

Do not look down into a test tube being heated or containing chemicals, and do not point its open end at another person. A reaction might cause the contents to be ejected, resulting in an injury.

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

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

In 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.

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. When using perchloric acid, always wear protective clothing.

Because of variations in conditions, we cannot guarantee any glassware against breakage under vacuum or pressure. Adequate precautions should be taken to protect personnel doing such work.

SUGGESTIONS FOR CLEANING AND STORING GLASS LABWARE

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; in most cases, it must be chemically clean; and in many cases, it must by 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 material.

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.

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

Larger laboratories may prefer to autoclave glassware or to sterilize it in large steam ovens or simliar apparatus. If viruses or spore-bearing bacteria are present, autoclaving is absolutely necessary.

If glassware becomes unduly clouded or dirty or contains coagulated organic matter, it must be cleansed with chromic acid cleaning solution.* The dichromate should be handled with extreme care because it is a powerful corrosive and a 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. Extra care must be taken to be sure chromic acid solution is disposed of properly.

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

When washing, soap, detergent, or cleaning powder (with or without an abrasive) may be used. Cleaners for glassware include Alconox, Dural, M & H, Lux, 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 is processed. Do not use cleaning brushes that are worn down so much 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 labware is a potential breaking point, especially when that piece of glassware 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.

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

Drain and rinse with acetone. Fuming sulfuric acid for 30 minutes may be used, also. Remember that it is important to rinse off all of the cleaning agent.

Note: for cleaning PYREXPLUS™ brand Labware see page 10.

*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.

Chromic acid solution is strongly acidic and will burn the skin severely. Use care in handling it.

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, partly fill each piece with water, thoroughly shake and empty at least six times. Pipets and burets are best rinsed by attaching a piece of rubber tubing to the faucet and then carefully attaching the delivery end of the pipets or burets to the hose and allowing the water to run through 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 and finally rinse in a small stream of the same from a 5 gallon bottle, on a shelf, fitted with a siphon. This is recommended, rather than direct rinsing at the distilled water tap, which wastes the distilled water.

For microbiologic assays, where the tests are extremely sensitive, meticulous cleaning must be followed by rinsing 12 times in distilled water.

Handling and Storing

When rinsing or washing pipets, cylinders or burets, be careful not to let tips hit the sink or the water tap. Most breakage occurs in this way.

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 and dry in an oven.** The temperature for drying should not exceed 140°C. Before placing glassware in a basket, cover the bottom of the basket with a clean folded towel or clean piece of cloth. This prevents the mouths of the tubes from becoming dirty.

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.

When storing, place pieces in racks designed especially for them. Be sure pieces do not touch each other, to avoid inadvertent mechanical damage.

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

**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 80–90 degrees C.

CLEANING SPECIFIC TYPES OF GLASS LABWARE

Pipets

Place pipets, tips down, in a cylinder or tall jar of water immediately after use. Do not drop them into the jar, since 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. At a convenient time, 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.

In laboratories where a large number of pipets are used daily, it is convenient to use an automatic pipet washer. Some of these, made of metal, are quite elaborate and can be connected directly by permanent fixtures to the hot and cold water supplies. Others, such as those made with polyethylene, are less elaborate and 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 driers are also available.

After drying, place chemical 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 at 160°C for 2 hours. Pipets used for transferring infectious material should have a plug of cotton placed in the top end of the pipet before sterilizing. This plug of cotton will prevent the material being measured from being drawn accidentally into the pipetting device.

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.

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.

Before use, wash with alcohol and wipe dry. Or the slides, after acid treatment and rinsing, may be placed in a wide jar and covered with alcohol.

As needed, remove from the jar and wipe 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 it 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.

Culture Tubes

Culture tubes which have been used previously must be sterilized before cleaning. The best general method for sterilizing cultures is by autoclaving for 30 minutes at 121°C (15 lb. pressure). Media which solidify 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 medium which is sterilized by autoclaving, do not plug until the medium is added. Both medium and tubes are thus sterilized with one autoclaving.

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

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 as routine.

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 for nothing except serologic procedures.

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.

PYREXPLUS™ brand Labware

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 130°C (266°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.

SAFETY FEATURES AND REMINDERS

PYREX® Labware

PYREX® glassware has proven itself to be tough and reliable during over 75 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, but it's very 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 laboratory glassware for applications other than those it was designed for can be dangerous.

PYREXPLUS™ Labware

PYREXPLUS™ brand labware 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.

Your attention to a few details regarding the use and care of this product will maximize product life and will provide you with a safer laboratory vessel.

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 above 80°C 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 130°C (266°F). PYREXPLUS™ labware should not be exposed to elevated temperature in a vacuum greater than 5 inches Hg (127 mm Hg).

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 chemicals: The coating of PYREXPLUS™ 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.

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

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 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.

Autoclaving: PYREXPLUS™ labware can be successfully sterilized repeatedly 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	Prevacuum
Liquid	Yes	Yes
Dry	Yes	No
Prevac	—	No

CAUTION: Always autoclave vessels with loose caps or closures.

Sterilization time should not exceed 25 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: 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 130°C (266°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.

General Use and Care Recommendations

- **Do not place PYREXPLUS™ labware over direct heat or open flame.**
- **Do not expose to dry heat above 130°C (266°F).**
- **Do not autoclave above 121°C (250°F).**
- **Do not continuously expose PYREXPLUS™ labware to temperatures above 80°C.**
- **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.**

Proper care and handling of PYREXPLUS™ labware or any labware will greatly increase its life and increase the safety of your workplace.

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 beaker quickly and easily.

Most impact breakage occurs on a beaker's rim. PYREX® brand beakers have extra glass in the rim to give extra strength. The pour spout is gentle rather than hooked to minimize breakage. The low-flare spout allows controlled pouring.

Flasks

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

The thick walls of Corning's 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.

Cylinders

The most important specification for graduated cylinders is accuracy. Precision-drawn tubing and careful calibrations assure accuracy 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. Readability was improved by designing both Lifetime Red™ and Accu-Red™ 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 reduce breakage, if the cylinder upsets. These cylinders are available in 10, 25, 50, 100, and 250 mL. capacities.

PYREX® Dripless Labware

PYREX® dripless labware eliminates unwanted drips and messy pouring. A TEFLON® bonded coating around the rim allows you to pour most solutions with drop by drop accuracy. This extra control reduces the chances of burns on hands, clothes, and work surfaces. In addition, the TEFLON® bond strengthens the rim, lengthening the life of the product.

COREX® Brand Pipets

COREX® pipets are manufactured from an aluminosilicate glass that has been given a special chemical strengthening treatment. Their mechanical strength is several times that of standard borosilicate glass pipets, which reduces breakage. They also have a better balanced resistance to acids and alkalies and a far better resistance to clouding and scratching. Repeated washings of COREX® pipets for up to three years will show almost no visible etching.

COREX® Brand Centrifuge Tubes

Like COREX® pipets, COREX centrifuge tubes and bottles are chemically strengthened to withstand greater mechanical stresses than ordinary glass tubes and bottles. They stay clear longer, and they are more resistant to both acid and alkaline solutions than standard borosilicate glass.

COREX tubes offer all the best qualities of glass centrifuge tubes plus dependable strength in and out of the centrifuge.

ROTAFLO® Stopcocks

This ROTAFLO® stopcock provides an extra margin of safety and ease of use. It will not leak, and it will not freeze.

The special PTFE* surface of the plug does not require a lubricant, thus eliminating potentially contaminating greases. There are no locknuts, washers, or clips to lose. All common size plugs are interchangeable.

The ROTAFLO® stopcock permits finer adjustments, allowing greater accuracy and precision. Conventional plug bore alignment problems are eliminated.

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