90.27 - Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes.

9027.10 - Gas or smoke analysis apparatus

9027.20 - Chromatographs and electrophoresis instruments

9027.30 - Spectrometers, spectrophotometers and spectrographs using optical radiations (UV, visible, IR)

9027.50 - Other instruments and apparatus using optical radiations (UV, visible, IR)

9027.80 - Other instruments and apparatus

9027.90 - Microtomes; parts and accessories

This heading includes :

(1) **Polarimeters**. Instruments for measuring the angle through which the plane of polarisation of a ray of light is rotated in passing through an optically active substance. They consist essentially of a source of light, an optical device comprising polarising and analysing prisms, a tube holder in which the substance to be analysed is placed, an observation eyepiece and a measuring scale.

In addition to the essential optical elements of a conventional polarimeter, **electronic polarimeters** are also fitted with a photoelectric cell.

(2) **Half-shadow polarimeters** for analysing plane or elliptically polarised light.

(3) **Saccharimeters**. These are special polarimeters designed for determining the strength of sugar solutions.

(4) **Refractometers**. These are instruments for determining the refractive index of liquids or solids (one of the most important constants in determining the purity of substances). They consist essentially of a system of prisms, observing and reading eyepieces, and a device for controlling the temperature (since this greatly affects the refractive index). They are widely used, particularly in food industries (for testing oils, butter and other fatty substances, analysing jam, fruit juices, etc.), in the glass industry, in oil refineries and in biology (for measuring the protein content of blood plasma or discharges, etc.).

Most refractometers are mounted on a base or stand; others are of the hand type, while yet another type is intended for fixing on the side of manufacturing vats.

(5) **Spectrometers**. These instruments are used to measure the wave-lengths of emission and absorption spectra. They consist essentially of an adjustable slit collimator (through which the beam of light to be analysed passes), one or more adjustable prisms, a telescope and a prism table. Some spectrometers (particularly those used for infra-red or ultra-violet rays) are fitted with prisms or with diffraction gratings.

This group includes : **spectroscopes** for the observation of spectra; **spectrographs** for recording the spectrum on a photographic plate or film (**spectrograms**); **monochromators**, instruments for isolating a particular line in a line spectrum or for isolating certain parts of a continuous spectrum.

But the heading **excludes** spectroheliographs and spectrohelioscopes, used for solar observation (**heading 90.05**); spectrum projectors, for examining an enlarged spectrogram projected on to a screen (**heading 90.08**); micrometric microscopes and spectrocomparators incorporating microscopes (for comparative examination of spectrograms by optical observation) (**heading 90.11**) and spectrum analysers for measuring or checking electrical quantities (**heading 90.30**).

(6) **Mass spectrographs** and similar apparatus for analysing the isotopic constitution, etc., of materials. But the heading **excludes** calutrons for isotopic separation (**heading 84.01**).

(7) **Colorimeters**. The term " colorimeter " is applied to two distinct classes of instruments. One class is used to determine the colour of a substance (liquid or solid) by matching its colour against that produced by three primary colours (red, green and blue) mixed in variable but measurable proportions. The other class of colorimeters is used in chemical or biochemical analysis to determine the concentration of a substance present in a solution by a comparison of the colour of the substance (or of the colour of the substance after treatment with a reagent) with that of coloured standard plates or of a standard liquid. In one type of colorimeter of the latter class, the solution under test and a standard solution are contained in two glass tubes which are viewed by means of two prisms through an eyepiece. Certain of these instruments are based on the use of a photoelectric cell. In some instruments of this type a paper tape is used with a reagent changing its colour after reaction with a gas. These instruments use two photoelectric cells measuring the colour before and after reaction with the gas.

This group also covers other optical analysis apparatus such as **nephelometers** and **turbidimeters** (for determining the cloudiness of solutions), **absorptiometers**, **fluorimeters** (for determining fluorescence, widely used for analyses of vitamin, alkaloid contents, etc.), **blancometers** and **opacimeters** (specially used for measuring the degree of whiteness, opacity or brilliance of paper pulp, paper, etc.).

(8) **Gas or smoke analysis apparatus**. These are used to analyse combustible gases or combustion by-products (burnt gases) in coke ovens, gas producers, blast furnaces, etc., in particular, for determining their content of carbon dioxide, carbon monoxide, oxygen, hydrogen, nitrogen or hydrocarbons. Electrical gas or smoke analysis apparatus are mainly for determining and measuring the content of the following gases : carbon dioxide, carbon monoxide and hydrogen, oxygen, hydrogen, sulphur dioxide, ammonia.

Some of these instruments or apparatus determine volumetrically the gases absorbed by appropriate chemical substances, or burnt. These include :

(i) **Orsat's apparatus** consisting mainly of an aspirating bottle, one or more absorption bulbs and a measuring burette.

(ii) **Combustion or explosion apparatus**. This is equipped, in addition, with a combustion or explosion pipette (platinum capillary tube, platinum or palladium wire tube, with induction sparking, etc.).

These various types of apparatus may also be used in combination.

Other models work on the basis of density, or by fractional condensation and distillation (cracking), or on the following principles :

(i) Heat conductivity of a gas.

(ii) Heating effect of combustible gases on an electrode, (e.g., carbon monoxide and hydrogen in flue gases).

(iii) Selective absorption of ultra-violet, visible, infra-red or microwave radiations by the gas.

(iv) Difference in the magnetic permeability of gases.

(v) Chemiluminescent reactions of the gas with a suitable auxiliary gas component.

(vi) Flame ionisation of hydrocarbons in a hydrogen flame.

(vii) Difference in the conductivity of a suitable liquid reagent before and after reaction with the gas.

(viii) Electrochemical reaction in cells with solid (especially zirconium oxide for oxygen analysis) or liquid electrolytes.

It should be noted that the heading includes gas or smoke analysis apparatus for use in industrial processes (i.e., directly connected to furnaces, gas generators, etc.). But apparatus consisting merely of laboratory glassware falls in **heading 70.17**.

(9) **Electronic smoke detectors**, used in furnaces, ovens, etc., for example, in which a beam of light (or infra-red) rays is directed on to a photoelectric cell. According to the density of the smoke, the passage of this beam through the smoke causes variations in the current in the photoelectric cell circuit, thus operating a graduated indicator or a recording system and, in certain cases, a regulating valve. These apparatus may be fitted with an alarm device.

Electronic smoke detectors equipped solely with an alarm fall in **heading 85.31**.

(10) **Fire damp detectors and other detectors** (e.g., for carbon dioxide). These include portable apparatus for gas detection in mines or tunnels, for detecting leaks in mains, etc.

(11) **Apparatus for dust analysis in gases**. These operate by passing a given quantity of gas through a filter disc, and weighing the filter before and after the test. This category includes **Tyndallometers** used for measuring the amount of dust in the air and for testing dust masks, filters, etc. They consist of a dust chamber covered with black glass, a light source, a photometric head with a prismatic measuring device and a graduated circular scale for measuring the angles of rotation.

(12) **Oxygen meters** for the determination of dissolved oxygen in liquids by use of a polarometric cell or by using the chemical reaction of thallium with dissolved oxygen (measurement of the change in electrolytic conductivity).

(13) **Polarographic analysers** for the determination of the components of liquids, e.g., traces of dissolved metals in water, by measuring and evaluating the current/resistance relationship of electrodes immersed in the solution.

(14) **Wet-chemical analysers** for the determination of inorganic or organic components of liquids, e.g., traces of metals, phosphates, nitrates, chlorides or integral parameters such as " Chemical Oxygen Demand " (COD) and " Total Organic Carbons " (TOC). The analyser consists of a sample preparation device, an analysing unit with, e.g., ion-sensitive electrodes, photometers or polarographs and, in automatic analysers, a control unit.

(15) **Viscometers and the like**, used to determine viscosity (i.e., the internal friction of a liquid).

They may be based on :

(i) The principle of the capillary tube, that is the measurement of the time required by the liquid to flow through the tube under constant pressure (e.g., Ostwald, Engler, etc., viscometers).

(ii) The effect of friction between a solid and a liquid.

or (iii) The time taken by a ball to fall through the liquid.

(16) **Polariscopes (strain viewers)**. These measure internal strains in glass (e.g., strains resulting from toughening, annealing, soldering, etc., which might cause the glass to break easily). They consist essentially of a chamber containing an electric lamp, a light diffusion device, a polariser and a polarising telescope. Stresses in the glass are shown as bright iridescences.

(17) **Expansion meters**. These measure the expansion or contraction on change of temperature of steel, metal alloys, coke, etc. Most of these instruments are of the recording type (mechanical recording on a graph or photographic recording).

(18) **Apparatus for the determination of porosity or permeability** (to water, air or other gases, etc.) known as **porosimeters or permeameters** (**not** to be confused with permeameters for measuring magnetic permeability of substances). They are used for paper, textile fibres, fabrics, plastics, leather, sand, etc.

(19) **Instruments for measuring the surface or interfacial tension of liquids (e.g., torsion balances)**. The surface or interfacial tension of liquids is usually determined by one of the three following factors : the weight of a drop falling from a given capillary tube (or the number of drops having a known volume) (drop-weight method); the height of free rise of a liquid in a capillary tube of known diameter (capillary rise method); or the force required to detach a ring from the surface of a liquid.

(20) **Apparatus for measuring osmotic pressure (osmometers)**, i.e., the pressure which occurs when two miscible liquids are separated by a membrane which is partially but unequally permeable to the two liquids.

(21) **Apparatus for testing mineral oils and their derivatives** (e.g., tar, bitumen, asphalt). These include apparatus for determining the flash point, setting point, flow point, drop point, etc., of mineral oils, melting point of paraffin wax, water content, dirt content, sulphur content, consistency of greases and tars, cloud point, cold point, etc.

(22) **pH meters and rH (redoxpotential) meters**. pH meters are used to measure the factor expressing the acidity or alkalinity of a solution or mixture (pure water being the neutral standard). rH meters are used to measure the oxidising or reducing power of a solution. These instruments operate on a number of different principles; the most common type employs the electrometric system, in which electrodes are used to set up a potential difference which is proportional to the pH or rH of the solution. In addition to measuring, these instruments may also be used for automatic control.

(23) **Electrophoresis instruments**. These are based on the change in concentration occurring when a direct current is passed through a solution. The electrically charged particles migrate at different speeds according to the nature of the product.

These instruments usually incorporate a photometric device consisting of a photoelectric cell and a milliammeter graduated directly in units of optical density. They are used for analysing various solutions (proteins, amino-acids, etc.), for examining substances such as plasma, hormones, enzymes, viruses, etc., and for studying polymerisation phenomena.

(24) **Chromatographs** (such as gas-, liquid-, ion- or thin-layer chromatographs) for the determination of gas or liquid components. The gas or liquid to be analysed is passed through columns or thin layers of absorbent material and then measured by means of a detector. The characteristics of the gases or liquids under analysis are indicated by the time taken for them to pass through the columns or thin layers of absorbent material, while the quantity of the different components to be analysed is indicated by the strength of the output signal from the detector.

(25) **Electronic titration instruments** using measuring electrodes to titrate water, silver salts, halogens, etc.

(26) **Analytical instruments** –sometimes called "moisture meters for solids" **- based on the dielectric constant, electrical conductivity, absorption of electromagnetic energy or infrared radiation of substances**.

(27) **Conductivity meters** to determine the electrolytic conductivity or the concentration of salts, acids or bases dissolved in a liquid.

(28) **Photoelectric cell densitometers and microdensitometers** used to measure the density of spectrographic photographs, and for analysing any phenomenon which is recorded on a photographic emulsion.

(29) **Photometers**. Instruments for measuring the intensity of light. The light to be measured and the standard source of light are placed so that they illuminate a given surface with equal intensity. If instead of comparing two light intensities, comparison is made of their respective spectra, the instrument then used is known as a **spectrophotometer**.

Photometers are widely used for various optical processes and analyses (for determining, for example, degree of concentration, degree of brilliance or transparency of solid substances; degree of exposure of photographic plates or films (densitometers); depth of colour of transparent or opaque solid substances or solutions).

Certain photometers used in photography or cinematography are known as **exposure meters**, and are used for measuring exposure times or for determining lens apertures.

(30) **Luxmeters** (used for determining the intensity, in " lux " units, of a source of light).

(31) **Calorimeters**. These measure the amounts of heat absorbed or given off by a solid, a liquid or a gas. The main categories are :

(A) **Ice calorimeters (Bunsen's)** based on variations in volume produced by melting ice. They consist of a test-tube surrounded by ice, dipped into a tank of water, and of a graduated tube containing mercury.

(B) **Heating calorimeters (Berthelot)** based on the principle of the transfer of quantities of heat. They consist basically of a calorimetric jar filled with water inside a vat also containing water; they are equipped with stirrers and thermometers. Two current types of calorimeter are based on this same principle, i.e. :

(i) **Calorimeters for the determination of the specific heat of gases or of liquid fuels**. In these appliances, water is circulated through a compartment where a quantity of gas or liquid is burnt. The difference in the temperature of the water at the time of entry and leaving is measured.

(ii) **Bomb calorimeters**. These are used for determining the heats of combustion of materials. Basically they consist of a steel vessel (bomb), containing a known amount of the solid or fluid to be tested and also oxygen under pressure. By means of a suitable device the specimen is ignited in the oxygen and the amount of heat generated is determined by placing the bomb in a water calorimeter.

This heading also includes **calorimeters for industrial use**; these are mounted on generators producing gas with a given calorific power. However, if they are connected to regulating apparatus in order to maintain the mixed gases at the required level of calorific power, they are **excluded** (generally **heading 90.32**).

(32) **Cryoscopes and ebullioscopes other than** those having the character of laboratory glassware (**heading 70.17**).

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This heading also includes **microtomes**, instruments used in microscope work to cut very thin sections of a known thickness from substances to be examined. Microtomes may be of various types, e.g., hand type (a kind of straight razor), revolving type, sliding carriage type (horizontal or inclined plane).

PARTS AND ACCESSORIES

Subject to the provisions of Notes 1 and 2 to this Chapter (see the General Explanatory Note), the heading also covers parts and accessories identifiable as being solely or principally for use with the above-mentioned instruments and apparatus.

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The heading also **excludes** :

(a) Laboratory equipment of refractory materials (retorts, jars, crucibles, cups, baths and the like) (**heading 69.03**), and similar articles of other ceramic materials (**heading 69.09**).

(b) Laboratory glassware (**heading 70.17**). (For further details, see below.)

(c) Microscopes (**heading 90.11** or **90.12**).

(d) Precision balances (**heading 90.16**).

(e) X-ray, etc., apparatus (**heading 90.22**).

(f) Demonstrational apparatus of **heading 90.23**.

(g) Machines and appliances for carrying out tests on certain materials (**heading 90.24**).

(h) Hydrometers, thermometers, hygrometers and similar instruments of **heading 90.25**, whether or not for use in laboratories.

(ij) The apparatus of **heading 90.26**.

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90.27

Classification of goods which are potentially within the scope both of this heading and of heading 70.17 (laboratory glassware).

In these cases, classification is governed by the following considerations :

(1) If an article has the **essential character of glassware** (whether or not graduated or calibrated, and whether or not with subsidiary stoppers, connections, etc., of rubber, etc.), it is **not to be classified in this heading** even if it is normally known as a particular instrument or apparatus.

(2) In general, instruments normally cease to have the essential character of glassware when they consist partly of glass but are **mainly** of other materials, or if they consist of glass parts **incorporated or permanently fixed** in frames, mounts, cases or the like.

(3) The combination of glass parts with measuring **instruments** (e.g., pressure gauges, thermometers) may, in practice, provide grounds for considering such instruments as proper to this heading.

Accordingly, the following instruments in the form of simple calibrated glassware fall in **heading 70.17** :

Butyrometers, lactobutyrometers and similar instruments for testing dairy products; albuminometers and ureometers; eudiometers; volumenometers; nitrometers, Kipps or Kjeldahl apparatus and the like; calcimeters; cryoscopes and ebullioscopes for determining molecular weights, etc.

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This heading also **excludes** machines or apparatus (whether or not electric) of the type classified in **Section XVI**, whether or not, in view of their low output, small size and general structure, they are obviously intended for use in laboratories (e.g., for preparing or treating specimens). The heading therefore **excludes** ovens, autoclaves, drying or steaming ovens or cabinets; desiccators; crushers and mixers; centrifuges; stills, presses; filters and filter presses; stirrers; etc.

Similarly, heating apparatus (Bunsen burners, steam-heating baths, etc.), tools, laboratory furniture (e.g., laboratory benches, microscope benches, fume cupboards) and brushes are classified in their own appropriate headings (**Section XV**, **Chapter 94** or **96**).