3B SCIENTIFIC® PHYSICS

U-Tube Manometer D 1009714

Instruction manual

01/17 ALF

1. Safety instructions

There is a risk of injury if the U-tube manometer breaks.

- Do not subject the glass to any mechanical stresses.
- If the tube is filled with mercury, safety regulations for the use of mercury must be observed.

2. Description

U-tube manometer D is a simple form of pressure gauge which is used to measure small pressures or differences in pressure.

It consists of a U-shaped glass tube, open at both ends, mounted on a medium density fibreboard (MDF) panel which also supports a scale divided into millimetres and centimetres. The tube is left unfilled.

3. Technical data

Length of straight tube sections:	50 cm
Measuring range:	0 – 50 cm of water or 0 to 5 kPa
Tube diameter:	10 mm
Dimensions:	200x150x530 mm^3 approx.
Weight:	820 g approx.

4. Principle of operation

Pressure *p* is defined as the quotient of the force *F* acting at right angles to a plane and the area *A* of that plane.

$$p = \frac{F}{A}$$

The unit is therefore N/m², also named pascal (Pa). Pressure is also measured in bars (bar), torrs (Torr), physical atmospheres (atm), technical atmospheres (at) and millimetres of mercury (mmHg).

The absolute pressure p_{abs} is the pressure measured with respect to the zero pressure in a vacuum. Atmospheric pressure p_{amb} is the pressure of air over and above the absolute pressure. The difference between the atmospheric pressure and absolute pressure is called pressure over atmospheric p_e.

Pressure over atmospheric is positive when the air pressure is less than the absolute pressure and negative otherwise. If it is negative then it can be called underpressure or partial vacuum.

This manometer is a U-tube open at both ends and partially filled with a liquid impervious to air. It is mainly used for measure small pressures and pressure differences. The pressure in a closed container to be measured acts on the fluid in one arm of the tube. The other open arm is subject only to atmospheric pressure. The fluid then rises on one side so that there is a difference in height Δ*h* between the two sides. From Δ*h* and the density ρ of the fluid in the tube, it is possible to calculate pressure over atmospheric p_e in the closed container:

p_e (mbars) = 0.0981 * ρ (g/cm³) * Δ*h* (mm)

	Pa	bars	mbars	torrs	atm	at
1 Pa	1	10^{-5}	10^{-2}	$7.5*10^{-3}$	$9.87*10^{-6}$	$1.02*10^{-5}$
1 bar	10^{5}	1	10^{3}	750	0.987	1.02
1 mbar	10^{2}	10^{-3}	1	0.75	$0.987*10^{-3}$	$1.02*10^{-3}$
1 Torr	133	$1.33*10^{-3}$	1.33	1	$1.32*10^{-3}$	$1.36*10^{-3}$
1 atm	101325	1.01325	1013.25	760	1	1.033
1 at	98100	0.981	981	736	0.968	1

5. Operation

5.1 Filling the U-tube manometer

The tube can be filled with dyed distilled water, mercury or petroleum.

- The manometer tube is to be filled with liquid slowly using a funnel until both sides of the tube are filled up to half way.
- When filling with mercury, the tube should be placed in a collecting basin.
- To empty the manometer of mercury, tip it out over a collecting basin while using a funnel to pour the mercury into a storage bottle.

5.2 Measurement

- For small differences between the pressure and atmospheric pressure, the recommended filling would be dyed distilled water or petroleum.
- Use a hose to connect the manometer to the vessel for which the pressure is to be measured.

The column of fluid will rise on one side of the U-tube.

- Read off the difference in height Δ*h*.
- Calculate the pressure (see section 4 above).

5.3 Cleaning

- If the tube is contaminated with mercury, remove the mercury and clean the tube with a 20% solution of nitric acid.
- First rinse it with tap water, then with distilled water and dry it well.
- After filling with petroleum and then with mercury make sure you clean the manometer thoroughly.