Dead-Weight Tester Pressure with Local Gravity and Air Buoyancy

Pressure from a dead-weight tester from mass, piston area, local gravity and air buoyancy, and the error made by assuming standard gravity.

Method: Pressure balance p = mg(1 − ρ_a/ρ_m)/A_e (calibration practice; OIML R 110 principle)

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass of weights and piston	10.000	kg
Effective piston area	1.0000	cm²
Local gravity	9.7866	m/s²
Air density	1.2000	kg/m³
Density of the weights	7,920.0	kg/m³

Calculated results

Parameter	Value	Unit
Generated pressure	9.7851	bar
Pressure assuming 9.80665 m/s² and no buoyancy	9.8066	bar
Error of the simple calculation	0.22006	%

Notes for this case

• Gravity in India ranges from about 9.776 to 9.790 m/s²; using standard gravity overstates pressure by up to 0.3 %. Piston area also changes with temperature and pressure (makers' coefficients).

Formula and method

$$p = \frac{m g_l (1 - \rho_a/\rho_m)}{A_e}$$

Variables

m	Mass of weights and piston	kg
A_e	Effective piston area	m²
g_l	Local gravity, in m/s²	m/s²
ρ_a	Air density	kg/m³
ρ_m	Density of the weights	kg/m³
p	Generated pressure	Pa
p_{std}	Pressure assuming 9.80665 m/s² and no buoyancy	Pa
$\Delta p/p$	Error of the simple calculation	-

Method and standards

Pressure balance.

Assumptions and limits

- Effective area at reference conditions: the makers' temperature and pressure-distortion coefficients for the piston are not applied.
- No fluid-head correction between the piston reference level and the device under test.
- Local gravity is entered in m/s² in every unit system.

References

• Pressure balance p = mg(1 − ρ_a/ρ_m)/A_e (calibration practice; OIML R 110 principle)

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/signals-calibration/dead-weight-tester-pressure

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.