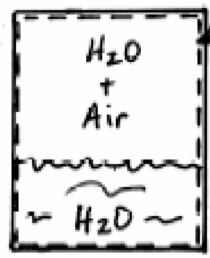
Examples

Separate the list P, F, $\forall$, KE, *v*, ρ, T, a, m, L, t and V into intensive, extensive and non-properties.

Solution:
Intensive properties are independent upon mass: P, v, ρ, T
Extensive properties scales with mass: $\forall$, m, KE
Non-properties: F, **a**, L, t, **V**

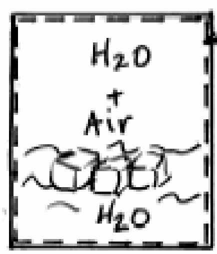
Comment: You could claim that acceleration **a** and velocity **V** are physical properties for the dynamic motion of the mass, but not thermal properties.

Problem 1.6



system boundary

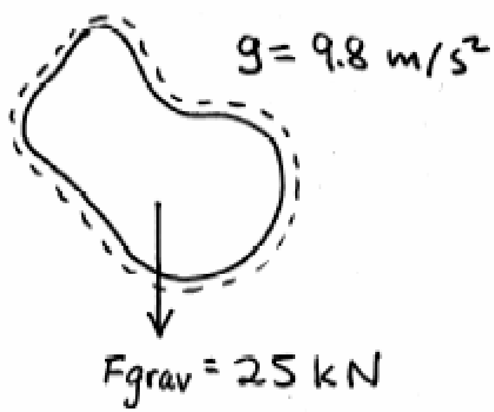
- two phases are present (liquid and gas).
- not a pure substance because composition is different in each phase.



system boundary

- three phases are present (solid, liquid, and gas).
- not a pure subtance because composition of gas phases is different than that of the solid and liquid phases.

Problem 1.11



$$m = \frac{F_{grav}}{g} = \left(\frac{25\ kN}{9.8\ m/s^2}\right)\left|\frac{1000\ N}{kN}\right|\left|\frac{1\ kg\,m/s^2}{1\ N}\right|$$

$$= 2551\ kg \longleftarrow m$$

A mass of 2 lbm has acceleration of 5 ft/s2, what is the needed force in lbf?

Solution:
Newton's 2nd law: F = ma
F = ma = 2 lbm × 5 ft/s2 = 10 lbm ft/s2
= 10/32.174 lbf = **0.31 lbf**

What pressure difference does a 10 m column of atmospheric air show?
(ρ_{air} = 1.2 kg/m^3)

Solution:
The pressure difference for a column is $\Delta P = \rho g H$.

ΔP = 1.2 kg/m^3 × 9.81 ms^{-2} × 10 m = 117.7 Pa = **0.12 kPa**

You dive 5m down in the ocean. What is the absolute pressure there? (Temperature of water is 275K)

Solution:
The pressure difference for a column is from $\Delta P = \rho g H$ and the density of water is from Table A.19.

$\Delta P = \rho g H$
$= 999.9 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 5 \text{ m}$
$= 49045.095 \text{ Pa} = 49.045 \text{ kPa}$

$P_{ocean} = P_{atm.} + \Delta P$
$= 101.325 + 48.903$
= **150 kPa**

A manometer shows a pressure difference of 1 m of liquid mercury. Find ΔP in kPa if liquid mercury is at 300K.

Solution:
Table A-19: ρ = 13 580 kg/m3

The pressure difference ΔP balances the column of height L so

$\Delta P = \rho g L = 13\,580 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 1.0 \text{ m} = 133.2 \times 10^3 \text{ Pa}$ **= 133.2kPa**

What is the temperature of –5F in degrees Rankine?

Solution:
The offset from Fahrenheit to Rankine is 459.67 R, so we get

$T_R = R_F + 459.67 = -5 + 459.67$
= **454.7 R**

What is the smallest temperature in degrees Fahrenheit you can have? Rankine?

Solution:
The lowest temperature is absolute zero which is at zero degrees Rankine at which point the temperature in Fahrenheit is negative

T_R = 0 R = **−459.67 F**

An escalator brings four people of total 300 kg, 25 m up in a building. Explain what happens with respect to energy transfer and stored energy.

Solution: The four people (300 kg) have their potential energy raised, which is how the energy is stored. The energy is supplied as electrical power to the motor that pulls the escalator with a cable.