```
> restart
> with(Units)
```

```
Automatically loading the Units[Simple] subpackage
```

[*AddBaseUnit*, *AddDimension*, *AddSystem*, *AddUnit*, *CommandsOnly*, *Converter*, *GetDimension*, *GetDimensions*, *GetSystem*, *GetSystems*, *GetUnit*, *GetUnits*, *HasDimension*, *HasSystem*, *HasUnit*, *Indets*, *Natural*, *RemoveDimension*, *RemoveSystem*, *Simple*, *Split*, *Standard*, *TestDimensions*, *Unit*, *UseContexts*, *UseMode*, *UseSystem*, *UseUnit*, *UsingContexts*, *UsingSystem*] **(1)**

```
> with(ThermophysicalData);
```

[*Atmosphere*, *Chemicals*, *CoolProp*, *PHTChart*, *Property*, *PsychrometricChart*, *TemperatureEntropyChart*] **(2)**

```
> with(ScientificConstants);
```

[*AddConstant*, *AddElement*, *AddProperty*, *Constant*, *Element*, *GetConstant*, *GetConstants*, *GetElement*, *GetElements*, *GetError*, *GetIsotopes*, *GetProperties*, *GetProperty*, *GetUnit*, *GetValue*, *HasConstant*, *HasElement*, *HasProperty*, *ModifyConstant*, *ModifyElement*] **(3)**

```
> UseSystem('SI')
>
>
>
>
> # A) using Temperature object does work ==========
    ==========
>
> Temp1 := Temperature(90, Unit(degF))
```

$$Temp1 := 90\ °\mathrm{F} \quad \textbf{(4)}$$

```
>
> ρ_water := Property(density, Water, temperature = Temp1, pressure = 101325 Unit(Pa), source
    = CoolProp);
```

$$994.9569869\ \frac{\mathrm{kg}}{\mathrm{m}^3} \quad \textbf{(5)}$$

**Works properly in both Maple 2018 and Maple 2023.**

```
>
>
> # B) using temperature expression does not work ==========
    ==========
>
> ρ_water := Property(density, Water, temperature = 90 degF, pressure = 101325 Unit(Pa), source
    = CoolProp);
```

$$62.11313555\ \frac{\mathrm{lb}}{\mathrm{ft}^3} \quad \textbf{(6)}$$

**Works properly in Maple 2023. Does not work in Maple 2018.**

```
> gasLaw := P·V = n·R·T
```

$$gasLaw := P\,V = n\,R\,T \tag{7}$$

```
> GetConstant(molar_gas_constant)
```

$$molar\_gas\_constant,\ symbol = R,\ value = 8.3144598,\ uncertainty = 4.8 \times 10^{-6},\ units = \frac{J}{mol\,K} \tag{8}$$

```
> UsingSystem( )
```

$$SI \tag{9}$$

```
> gasVol := isolate(gasLaw, V)
```

$$gasVol := V = \frac{n\,R\,T}{P} \tag{10}$$

```
> # C) using Temperature object does not work ==========
  ==========
> params := n = 1 mol, T = Temperature(90, Unit(degF)), P = 101325 Pa, R
  = evalf(Constant(R, units))
```

$$params := n = \text{mol},\ T = 90\ ^\circ\text{F},\ P = 101325\ \text{Pa},\ R = 8.3144598\ \frac{\text{m}^2\,\text{kg}}{\text{s}^2\,\text{mol K}} \tag{11}$$

```
> subs(params, gasVol)
```

$$V = \frac{0.00008205733827\ (90\ ^\circ\text{F})}{\text{Pa}}\ \text{mol}\ \frac{\text{m}^2\,\text{kg}}{\text{s}^2\,\text{mol}} \tag{12}$$

**Does not work in Maple 2018 or 2023. The 90 is multiplied out with the 0.0008... but the degF unit disappears and the K unit remains. They do not get converted or cancelled. The output is red. Unknown to me what red output means.**

```
> combine(rhs((12)))
```

$$\frac{0.007385160444}{\text{Pa}}\ \text{mol}\ \frac{\text{m}^2\,\text{kg}}{\text{s}^2\,\text{mol K}}\ \text{m}$$

```
> # D) using temperature expression does work but conversion from F to K is incorrect (90F
  <> 50K)==========
> params := n = 1 mol, T = 90 degF, P = 101325 Pa, R = evalf(Constant(R, units))
```

$$params := n = \text{mol},\ T = 90\ ^\circ\text{F},\ P = 101325\ \text{Pa},\ R = 8.3144598\ \frac{\text{m}^2\,\text{kg}}{\text{s}^2\,\text{mol K}} \tag{14}$$

```
> subs(params, gasVol)
```

$$V = \frac{0.007385160444}{\text{Pa}}\ \text{mol}\ \frac{\text{m}^2\,\text{kg}}{\text{s}^2\,\text{mol K}}\ ^\circ\text{F} \tag{15}$$

```
> combine(rhs((15)))
```

$$0.007385160444\ \frac{\mathrm{m}^2\ \mathrm{kg}\ ^\circ\mathrm{F}}{\mathrm{s}^2\ \mathrm{K}\ \mathrm{Pa}}$$

**Does not work in Maple 2018 (90degF gets converted to 50K). Partially works in Maple 2023. The 90 is multiplied out with the 0.0008... and the degF unit is retained. However, the degF and K units do not combine or cancel.**

> # E) using Temperature object does not work ==========

> params := n = 1 mol, T = Temperature(305, Unit(K)), P = 101325 Pa, R = evalf(Constant(R, units))

$$params := n = \mathrm{mol},\ T = 305\ \mathrm{K},\ P = 101325\ \mathrm{Pa},\ R = 8.3144598\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{mol}\ \mathrm{K}} \quad (17)$$

> subs(params, gasVol)

$$V = \frac{0.00008205733827\ (305\ \mathrm{K})}{\mathrm{Pa}}\ \mathrm{mol}\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{mol}\ \mathrm{K}} \quad (18)$$

> combine(rhs((18)))

$$\frac{0.02502748817}{\mathrm{Pa}}\ \mathrm{mol}\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{mol}\ \mathrm{K}}\ \mathrm{m}$$

**Does not work in Maple 2018 or Maple 2023. The K unit in the numerator gets lost. The units do not combine or cancel and the output is red. Unknown to me what red output means.**

> # F) using temperature expression does work using units of degress Kelvin==========

> params := n = 1 mol, T = 305 K, P = 101325 Pa, R = evalf(Constant(R, units))

$$params := n = \mathrm{mol},\ T = 305\ \mathrm{K},\ P = 101325\ \mathrm{Pa},\ R = 8.3144598\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{mol}\ \mathrm{K}} \quad (20)$$

> subs(params, gasVol)

$$V = \frac{0.02502748817}{\mathrm{Pa}}\ \mathrm{mol}\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{mol}\ \mathrm{K}}\ \mathrm{K} \quad (21)$$

> combine(rhs((21)))

$$0.02502748817\ \frac{\mathrm{m}^2\ \mathrm{kg}}{\mathrm{s}^2\ \mathrm{Pa}} \quad (22)$$

**Works in Maple 2018 and resolves to units of cubic meters as expected. Partially works in Maple 2023. The numerical part is correct but the units do not combine or cancel to the desired cubic meters.**