

## Appendix D: Ideal Gas & Incompressible Substances

The ideal gas characteristics of some common gases are summarized in Table D-1. Note that the specific heat capacity values provided in Table D-1 are evaluated at 20°C using the EES cv and cp property functions. The specific heat capacity values for most gases depend on temperature and will have somewhat different values at temperatures other than 20°C.

**Table D-1: Ideal gas characteristics of some common gases; the specific heat capacities are evaluated at 20°C.**

Gas	Chemical formula	MW	R (J/kg-K)	$c_p$ (J/kg-K)	$c_v$ (J/kg-K)	$\bar{c}_p$ (J/kmol-K)	$\bar{c}_v$ (J/kmol-K)	k
Air	-	28.967	287.0	1,004.4	717.4	29,094	20,780	1.400
Argon	Ar	39.948	208.1	520.3	312.2	20,786	12,472	1.667
Butane	C <sub>4</sub> H <sub>10</sub>	58.124	143.0	1,662.8	1,519.8	96,650	88,336	1.094
Carbon dioxide	CO <sub>2</sub>	44.010	188.9	836.2	647.2	36,799	28,485	1.292
Ethane	C <sub>2</sub> H <sub>6</sub>	30.070	276.5	1,739.8	1,463.3	52,315	44,001	1.189
Helium	He	4.003	2,077.0	5,192.6	3,115.6	20,786	12,472	1.667
Hydrogen	H <sub>2</sub>	2.016	4124.2	14,330	10,207	28,891	20,576	1.404
Krypton	Kr	83.800	99.2	248.0	148.8	20,785	12,471	1.667
Methane	CH <sub>4</sub>	16.043	518.3	2,225.3	1,707.1	35,701	27,387	1.304
Neon	Ne	20.179	412.0	1,030.0	618.0	20,785	12,471	1.667
Nitrogen	N <sub>2</sub>	28.013	296.8	1,037.7	740.9	29,069	20,755	1.401
Octane	C <sub>8</sub> H <sub>18</sub>	114.23	72.8	1,622.2	1,549.4	185,307	176,993	1.047
Oxygen	O <sub>2</sub>	31.999	259.8	912.6	652.8	29,203	20,889	1.398
Propane	C <sub>3</sub> H <sub>8</sub>	44.097	188.5	1,633.4	1,444.8	72,027	63,713	1.130
Water vapor	H <sub>2</sub> O	18.016	461.5	1,867.1	1,405.6	33,638	25,324	1.328

The incompressible characteristics of some substances are summarized in Table D-2. Note that the values provided in Table D-2 are evaluated at 20°C using the EES Solid/Liquid property functions,

**Table D-2: Incompressible characteristics of some substances (at 1 atm and 20°C)**

Substance	$\rho$ (kg/m <sup>3</sup> )	$c$ (J/kg-K)	k (W/m-K)
<i>Solids</i>			
Aluminum	2703	895.8	236.1
Brass	8530	376.3	114.6
Copper	8936	383.0	401.8
Glass	2500	750.0	1.40
Gold	19,306	128.7	317.7
Lead	11,347	128.7	35.4
Plywood	545	1215	0.12
Rock (granite)	2630	775.0	2.79
Silver	10,504	234.3	429.1
304 Stainless steel	7902	471.9	14.74
<i>Liquids</i>			
Engine oil	888.1	1881	0.145
Syltherm 800 <sup>1</sup>	935.2	1608	0.135
Therminol 59 <sup>1</sup>	975.1	1681	0.121
Water (liquid)	998.2	4183	0.586

1. Commercially available heat transfer fluids