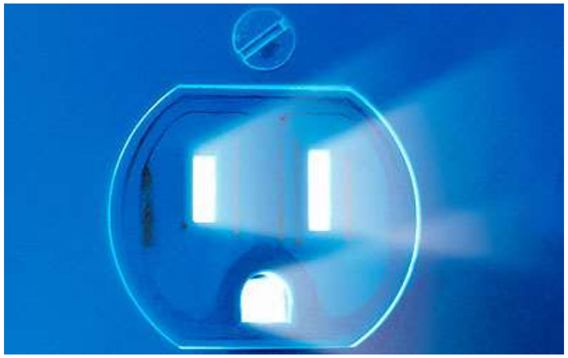

Dimensional Analysis

Cost of Energy

Consumable Energy

	**Gasoline**	***Potential Energy (fuel)***	***$1.85 / gallon***
	**Natural Gas**	***Potential Energy (fuel)***	***$0.91668 / Therm***
	**Electricity**	***Kinetic Energy***	***$0.076 / kWh***

Consumable Energy
What's the cheapest?

Gasoline — ***$1.85 / gallon***

Natural Gas — ***$0.91668 / Therm***

Electricity — ***$0.076 / kWh***

Different Units!

Not comparable.

Consumable Energy
What's the cheapest?

Gasoline $\frac{\$1.85}{\text{gallon}}$ → $\frac{\$}{MJ}$

Natural Gas $\frac{\$0.91668}{\text{Therm}}$ → $\frac{\$}{MJ}$

Electricity $\frac{\$0.076}{\text{kWh}}$ → $\frac{\$}{MJ}$

Compare

Unit Conversion: *Natural Gas*

Natural Gas $\dfrac{\$0.91668}{\text{Therm}}$

Conversion Factors

1 Therm = 105,480,400 J

1,000,000 J = 1 MJ *(exactly)*

5 Sig. Figs. | *7 Sig. Figs.* | *Exact Number*

$$\frac{\$0.91668}{\text{Therm}} \times \frac{1\ \text{Therm}}{105{,}480{,}400\ \text{J}} \times \frac{1{,}000{,}000\ \text{J}}{1\ \text{MJ}} =$$

$$0.00869052\ \frac{\$}{\text{MJ}} = 8.6905 \times 10^{-3}\ \frac{\$}{\text{MJ}}$$

5 Sig. Figs. | *5 Sig. Figs.*

Unit Conversion: *Electricity*

Conversion Factors

1000 W = 1 kW		*(exactly)*
1 Wh	= 3600 J	(exactly)
1,000,000 J = 1 MJ		*(exactly)*

Electricity $\frac{\$0.076}{kWh}$

2 Sig. Figs. — *Exact* — *Exact* — *Exact*

$$\frac{\$0.076}{\cancel{kWh}} \times \frac{1\ \cancel{kW}}{1000\ \cancel{W}} \times \frac{1\ \cancel{Wh}}{3600\ \cancel{J}} \times \frac{1{,}000{,}000\ \cancel{J}}{1\ MJ} =$$

$$0.02111111\ \frac{\$}{MJ} = 2.1 \times 10^{-2}\ \frac{\$}{MJ}$$

2Sig. Figs. — *2Sig. Figs.*

Unit Conversion: *Gasoline*

Conversion Factors

- 1 gallon = 3.7854 Liter
- 1 Wh = 3600 J (exactly)
- 1 Liter = 9700 Wh
- 1,000,000 J = 1 MJ *(exactly)*

Gasoline $\frac{\$1.85}{\text{gallon}}$

3 Sig. Figs.

$$\frac{\$1.85}{\cancel{\text{gallon}}} \times \frac{1\ \cancel{\text{gallon}}}{3.7854\ \cancel{\text{Liter}}} \times \frac{1\ \cancel{\text{Liter}}}{9700\ \cancel{\text{Wh}}} \times \frac{1\ \cancel{\text{Wh}}}{3600\ \cancel{\text{J}}} \times \frac{1{,}000{,}000\ \cancel{\text{J}}}{1\ \text{MJ}}$$

5 Sig. Figs. | *2 Sig. Figs.* | *Exact* | *Exact*

$$0.01399541\ \frac{\$}{\text{MJ}} = 1.4 \times 10^{-2}\ \frac{\$}{\text{MJ}}$$

2Sig. Figs. | *2Sig. Figs.*

Consumable Energy
What's the cheapest?

Gasoline $\dfrac{\$1.85}{\text{gallon}}$ ⇒ $2.1 \times 10^{-2}\ \dfrac{\$}{\text{MJ}}$

Largest (expensive)

Natural Gas $\dfrac{\$0.91668}{\text{Therm}}$ ⇒ $8.6905 \times 10^{-3}\ \dfrac{\$}{\text{MJ}}$

Smallest (cheapest)

Electricity $\dfrac{\$0.076}{\text{kWh}}$ ⇒ $1.4 \times 10^{-2}\ \dfrac{\$}{\text{MJ}}$

In between

Conversion Factors: *Memorize*

Metric Prefixes

pico	(p)	$\times 10^{-12}$
nano	(n)	$\times 10^{-9}$
micro	(μ)	$\times 10^{-6}$
milli	(m)	$\times 10^{-3}$
centi	(c)	$\times 10^{-2}$
kilo	(k)	$\times 10^{3}$
Mega	(M)	$\times 10^{6}$

Conversion Factors: *(exact)*

1 mL = 1×10^{-3} L

1 μm = 1×10^{-6} m

1 kg = 1×10^{3} g

1 MJ = 1×10^{6} J

1 mL = 1cm^3 = 1 cc *(exactly)*

1 inch = 2.54 cm *(exactly)*

Dimensional Analysis: One More Example

Small Block V8 Engine

265 cubic inches = 265 $inch^3$

$$\underset{\text{3 s.f.}}{\frac{265\ inch^3}{1}} \times \underset{\text{Exact}}{\frac{2.54\ cm}{1\ inch}} \times \underset{\text{Exact}}{\frac{2.54\ cm}{1\ inch}} \times \underset{\text{Exact}}{\frac{2.54\ cm}{1\ inch}} = \underset{\text{3 s.f.}}{4342.57\ cm^3}$$

$$\underset{\text{3 s.f.}}{\frac{4342.57\ cm^3}{1}} \times \underset{\text{Exact}}{\frac{1\ mL}{1\ cm^3}} \times \underset{\text{Exact}}{\frac{1\ L}{1000\ mL}} = \underset{\text{3 s.f.}}{4.34\ L}$$