

BASIC LAWS and CONVERSIONS

CONVERSIONS

1 kilometer = 1000 meters
 1 decimeter = 1/10 meter
 1 centimeter = 1/100 meter
 1 millimeter = 1/1000 meter
 1 liter = 1000 milliliters
 1 inch = 2.54 centimeters
 1 foot = 30.5 centimeters
 1 yard = 0.92 meters
 1 pound = 453.6 grams
 1 kilogram = 1000 grams, or 2.2 pounds

HEAT

To convert Fahrenheit to Centigrade: Subtract 32 from F, then multiply by 5/9, written $C = 5/9 (F - 32)$. Note — Centigrade is now referred to as Celsius. (Note: $212^\circ F = 100^\circ C$). To convert Centigrade to Fahrenheit: Multiply C by 9/5, then add 32, written $F = (9/5C) + 32$.

To convert Centigrade to Absolute or Kelvin scale, add 273 to C.

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Boyle's Law: $p_1 \times V_1 = p_2 \times V_2$ at constant temperature. Zero degrees Kelvin is the lowest possible temp.

In Kelvin Absolute temperature scale: water boils at 373K, freezes at 273K.

Charles' Law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ at const. press.

Combination of Charles' and Boyle's Laws:

$$\frac{V_1 p_1}{T_1} = \frac{V_2 p_2}{T_2}$$

When heated through one degree Centigrade, any gas expands $\frac{1}{273}$ of its volume

at 0 degrees Centigrade if the pressure remains constant. One BTU is the heat required to raise the temperature of 1 pound of water through 1 degree Fahrenheit.

One calorie is the heat required to raise the temperature of 1 gram of water through 1 degree Centigrade.

Specific Heat: heats required to raise the temperature of a unit mass of that substance through 1 degree. If H is total heat and M is mass, $H = M \times s \times (t_2 - t_1)$.

Heat of melting, or heat of fusion, L, is the quantity of heat needed to melt one unit weight of a substance without changing its temperature, or $H = M \times L$.

80 calories of heat is required to melt 1 gram of ice without raising its temperature.

Boiling point of liquid: that temperature at which the vapor pressure is equal to the pressure above the liquid.

0.427 kilogram-meter (kg-m) = 1 calorie

$\frac{\text{Work}}{\text{mechanical equivalent of heat}} = \text{heat}$

The work required to produce a unit quantity of heat is called the mechanical equivalent of heat.

HORSEPOWER

1 horsepower = 550 ft-lb/sec
 $\text{Horsepower} = \frac{\text{force (lb)} \times \text{distance (ft)}}{550\text{-ft-lb/sec} \times \text{time (sec)}}$
 $\text{Friction constant} = \frac{\text{friction force}}{\text{weight}}$

Work = Force $\times$ Distance moved
 work

Power = $\frac{\text{work}}{\text{time}}$

1 watt = 10,200 gram-centimeters per sec.

1 kilowatt is 1000 watts

1 kilowatt is approximately $1\frac{1}{3}$ horsepower.

Dyne is absolute metric unit of force. **Erg** is its unit of work.

1 Erg = force of 1 dyne acting through 1 centimeter.

1 Joule = 10,000,000 ergs, or about $\frac{3}{4}$ foot pounds.

The law of work when friction is neglected:

Effort force $\times$ effort distance = resistance force $\times$ resistance distance.

Mechanical advantage of a machine = $\frac{\text{resistance force}}{\text{effort force}}$

When friction is zero, mechanical advantage of a machine = $\frac{\text{resistance distance}}{\text{effort distance}}$

Mechanical advantage of a lever = $\frac{\text{resistance arm}}{\text{effort arm}}$

Moment of force = force $\times$ lever arm

Frictionless mechanical advantage of an inclined plane = $\frac{\text{height}}{\text{circumference of wheel}}$

Frictionless mechanical advantage of a wheel and axle = $\frac{\text{circumference of axle}}{\text{circumference of wheel}}$

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Acceleration of gravity = $\frac{32 \text{ ft/sec}^2}{\text{sec weight}}$
 Centripetal force = $\frac{(\text{velocity})^2}{\text{radius}}$
 acceleration of gravity

Potential energy = weight of body $\times$ elevation

Kinetic energy = $\frac{1}{2} \frac{\text{weight}}{\text{acceleration of gravity}}$

Momentum = mass of body $\times$ its velocity

Mass = $\frac{\text{weight}}{\text{acceleration of gravity}}$

Period of a pendulum: $T = 2\pi \sqrt{\frac{l}{g}}$

Wave velocity = wave frequency $\times$ wave length, or $v = n \times \lambda$

Speed of sound: 1090 feet per second in air at 0 degrees Centigrade. Velocity of sound increases 2 feet per second for each degree-Centigrade rise in temperature above zero degrees Centigrade.

ELECTRICITY

1 ampere = 1 coulomb per second

1 volt = 1 joule per coulomb

Ohm's Law: Current = $\frac{\text{potential difference}}{\text{resistance}}$

or amperes = $\frac{\text{volts}}{\text{ohms}}$ or $I = \frac{V}{R}$

Ampere = electric current; volt = potential difference; ohm = electrical resistance.

One volt potential difference will drive 1 ampere through a resistance of 1 ohm.

The resistance of a conductor can be calculated by the formula:

$$R = \frac{\rho l}{d^2} \left(\text{where } l \text{ is length, } d \text{ is diameter, and } k \text{ is constant.} \right)$$

The combined resistance of conductors connected in parallel is

$$\frac{1}{R_c} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

1 watt is the power of a current of 1 ampere when the potential difference is 1 volt.

To compute electric power: P (power in watts) = V (voltage in volts) $\times$ I (current in amperes), or $P = V \times I$.

To compute the heat (H), produced by a current (I), through a resistance (R), in a time (t), use the equation:

$$H = I^2 \times R \times t \times 0.24 \text{ cal/watt-sec.}$$

LIGHT AND LENSES

1 foot-candle: The illumination at any point on a surface 1 foot from a standard candle.

Illumination (ft-c) = $\frac{\text{intensity (candles)}}{\text{distance in feet}^2}$

Velocity of light = 186,000 miles per sec.

Index of refraction = $\frac{\text{velocity of light in air}}{\text{velocity of light in the substance}}$

Lens image equation: $\frac{1}{D_o} + \frac{1}{D_i} = \frac{1}{f}$

Magnification = $\frac{\text{image length}}{\text{object length}}$ or $\frac{\text{image distance}}{\text{object distance}}$

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