

# The P5: Phantastic Physics Phormulae & Phacts Phlyer

## Mechanics

$v_{(avg)} = s/t$   
 $v_f = v_i + at$   
 $s = 1/2 (v_o + v_f) t$   
 $s = v_o t + 1/2 at^2$   
 $v_f^2 = v_o^2 + 2as$   
 $F = ma$   
 $w = mg$   
 $F = (Gm_1m_2)/r^2$   
 $p = mv$   
 $J = Ft$   
 $Ft = mv$   
 $T = mg \pm ma$   
 $F_k = \mu_k F_N$   
 $F_s = \mu_s F_N$   
 $F_{net} = F_{applied} - F_{friction}$

## Energy

$W = Fscos\theta$   
 $P = W/t = Fs/t = Fv$   
 $PE = mgh$   
 $KE = 1/2 mv^2$   
 $F = kx$   
 $PEs = 1/2 kx^2$

## Internal Energy

$Q = mc\Delta T$   
 $Q_f = mH_f$   
 $Q_v = mH_v$

## Solids, Liquids, Gases

$D = m/v$   
 $P = F/A$   
 $\text{stress} = F/A$   
 $\text{strain} = \Delta L/L$   
 $Y = FL/A\Delta L$   
 $P_h = Dgh$   
 $F_b = DgV$   
 $F_1/A_1 = F_2/A_2$   
 $P_1V_1T_2 = P_2V_2T_1$   
 $\Delta L = \alpha L\Delta T$   
 $\Delta V = \beta V\Delta T$   
 $PV = nRT$

## Waves and Optics

$T = 1/f$   
 $v = f\lambda$   
 $n = c/v$   
 $\sin\theta_c = 1/n$   
 $n_1\sin\theta_1 = n_2\sin\theta_2$   
 $n_1v_1 = n_2v_2$   
 $\lambda/d = x/L$   
 $1/d_o + 1/d_i = 1/f$   
 $M = h_i/h_o = -d_i/d_o$

## Symbols

$a$  = acceleration  
 $r$  = dist. between centers  
 $F$  = force  
 $g$  = accelertion due to gravity  
 $G$  = universal gravitation constant  
 $J$  = impulse  
 $m$  = mass  
 $p$  = momentum  
 $s$  = displacement  
 $t$  = time  
 $v$  = velocity  
 $T$  = tension  
 $w$  = weight  
 $h$  = height  
 $F_c$  = centripetal force  
 $F_N$  = normal force  
 $F_k$  = force of kinetic friction  
 $F_s$  = force of static friction  
 $\mu_k$  = coefficient of kinetic friction  
 $\mu_s$  = coefficient of static friction  
 $k$  = spring constant  
 $PE$  = potential energy  
 $KE$  = kinetic energy  
 $P$  = power  
 $PEs$  = PE stored in spring  
 $W$  = work  
 $x$  = change in spring length  
 $c$  = specific heat  
 $H_f$  = heat of fusion  
 $H_v$  = heat of vaporization  
 $Q$  = amount of heat  
 $\Delta T$  = change in temperature

$D$  = density  
 $P$  = pressure  $F$  = force  
 $A$  = cross sectional area  
 $\Delta L$  = change in length  
 $L$  = original length  
 $Y$  = Young's modulus  
 $P_h$  = hydrostatic pressure  
 $F_b$  = buoyant force  
 $V$  = volume  
 $T$  = temperature  
 $\Delta V$  = change in volume  
 $\alpha$  = coefficient of linear expansion  
 $\beta$  = coefficient of volume expansion  
 $R$  = gas constant

$c$  = speed of light in a vacuum  
 $d$  = distance between slits  
 $f$  = frequency  
 $L$  = distance from slit to screen  
 $n$  = index of refraction  
 $T$  = period  
 $v$  = speed  
 $x$  = distance from center to 1st max  
 $\lambda$  = wavelength of light  
 $d_i$  = image distance  
 $d_o$  = object distance  
 $f$  = focal length  
 $M$  = magnification  
 $h_i$  = image height  
 $h_o$  = object height  
 $\theta_c$  = critical angle

## Electricity & Magnetism

$F = kq_1q_2/r^2$   
 $E = F/q$   
 $V = W/q$   
 $E = V/d$   
 $I = q/t$   
 $V = IR$   
 $P = VI = I^2R = V^2/R$   
 $W = Pt = VIt = I^2Rt$   
 $F = qVB$   
 $V = Blv$   
 $F = BIl$

## Series Circuits

$I_t = I_1 = I_2 = I_3 = \dots$   
 $V_t = V_1 + V_2 + V_3 + \dots$   
 $R_t = R_1 + R_2 + R_3 + \dots$

## Parallel Circuits

$I_t = I_1 + I_2 + I_3 + \dots$   
 $V_t = V_1 = V_2 = V_3 = \dots$   
 $1/R_t = 1/R_1 + 1/R_2 + 1/R_3 + \dots$

## Transformers

$N_p/N_s = V_p/V_s$   
 $V_p I_p = V_s I_s$

## Modern Physics

$W_o = hf_o$   
 $E_{\text{photon}} = hf$   
 $KE_{\text{max}} = hf - W_o$   
 $p = h/\lambda$   
 $E_{\text{photon}} = E_i - E_f$

$T_{1/2} = 0.693/\lambda$   
 $N = N_o e^{-\lambda t}$

## Nuclear Energy

$E = mc^2$

## Circular/Periodic Motion

$a_c = v^2/r$   
 $F_c = mv^2/r$   
 $v = 2\pi r/T$   
 $T = 2\pi (l/g)^{1/2}$  [pendulum]  
 $g = GM/d^2$   
 $v_{\text{escape}} = [2GM_E/r_e]^{1/2}$   
 $T_{\text{satellite}} = 2\pi [(r^3/GM_E)]^{1/2}$

## Symbols

$B$  = flux density  
 $F$  = force  
 $k$  = electrostatic constant  
 $V$  = electric potential difference  
 $E$  = electric field

$q$  = charge  
 $v$  = velocity  
 $l$  = length of conductor

$I$  = current  
 $R$  = resistance  
 $V$  = electric potential difference

$I_p$  = current in primary coil  
 $I_s$  = current in secondary coil  
 $N_p$  = # of turns of primary coil  
 $N_s$  = # of turns of secondary coil  
 $V_p$  = voltage of primary  
 $V_s$  = voltage of secondary

$W_o$  = work function  
 $c$  = speed of light in vacuum  
 $f$  = frequency  
 $f_o$  = threshold frequency  
 $h$  = Planck's constant  
 $p$  = momentum  
 $\lambda$  = wavelength  
 $KE$  = kinetic energy

$N$  = atoms remaining after time  $t$   
 $N_o$  = original number of atoms  
 $\lambda$  = decay constant  
 $t$  = time

$m$  = mass  
 $E$  = energy

$r$  = radius  
 $F_c$  = centripetal force  
 $v$  = velocity  
 $a_c$  = centripetal acceleration  
 $T$  = period  
 $M_E$  = mass of Earth  
 $r_E$  = radius of earth

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## Fundamental Constants

Quantity	Symbol	Value
Avogadro's number	NA	$6.02 \times 10^{23}$
Electron Charge	e	$1.6 \times 10^{-19}$
Planck's Constant	h	$6.63 \times 10^{-34} \text{ J s}$
Mass of electron	me	$9.1 \times 10^{-31} \text{ kg}$
Mass of neutron	mn	$1.67 \times 10^{-27} \text{ kg}$
Mass of proton	mp	$1.67 \times 10^{-27} \text{ kg}$
Speed of light (vacuum)	c	$3 \times 10^8 \text{ m/s}$
Universal Gravitational	G	$6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$
Universal Gas Constant	R	$8.314 \text{ J/mol K}$
Electrostatic Constant	k	$9.0 \times 10^9 \text{ N m}^2/\text{C}^2$

## Some Useful Conversion Factors

### Length

1 in = 2.54 cm  
 1 ft = 0.3048 m  
 1 mi = 5280 ft = 1.609 km  
 1 m = 3.281 ft  
 1 km = 0.6214 mi  
 1 angstrom =  $1 \times 10^{-10} \text{ m}$

### Mass

1 slug = 14.59 kg  
 1 kg = 1000 g =  $6.852 \times 10^{-2} \text{ slug}$   
 1 amu (u) =  $1.66 \times 10^{-27} \text{ kg}$   
 1 kg = 2.205 lb

### Time

1 day = 24 h = 1440 min =  $8.64 \times 10^4 \text{ s}$   
 1 yr = 365.24 days =  $3.156 \times 10^7 \text{ s}$

### Speed

1 mi/hr = 1.609 km/hr = 1.476 ft/s = 0.4470 m/s

1 km/hr = 0.6214 mi/hr = 0.2778 m/s = 0.9113 ft/s

### Force

1 lb = 4.448 N  
 1 N =  $10^5 \text{ dynes}$  = 0.2248 lb

## Prefixes Denoting Multiples of Ten

Prefix	Symbol	Factor
Tera	T	$10^{12}$
Giga	G	$10^9$
Mega	M	$10^6$
Kilo	k	$10^3$
Hecto	h	$10^2$
Deka	da	$10^1$
Deci	d	$10^{-1}$
Centi	c	$10^{-2}$
Milli	m	$10^{-3}$
Micro	$\mu$	$10^{-6}$
Nano	n	$10^{-9}$
Pico	p	$10^{-12}$

## Useful Physical Data

Earth Gravity 9.8 m/s<sup>2</sup> or 32.2 ft/s<sup>2</sup>  
 Atm. Pres (sea level)  $1.013 \times 10^5 \text{ Pa} = 14.70 \text{ lb/in}^2$   
 Density of air (STP) 1.29 kg/m<sup>3</sup>  
 Speed of sound in air (20°C) 343 m/s

### Water

Density (4°C)  $1.000 \times 10^3 \text{ kg/m}^3$   
 Hf  $3.35 \times 10^5 \text{ J/kg}$   
 Hv  $2.26 \times 10^6 \text{ J/kg}$   
 c 4186 J/kg °C

### Earth

Mass  $5.98 \times 10^{24} \text{ kg}$   
 Radius (eq)  $6.38 \times 10^6 \text{ m}$   
 Earth-Sun Dist  $1.50 \times 10^{11} \text{ m}$

### Moon

Mass  $7.35 \times 10^{22} \text{ kg}$   
 Radius  $1.74 \times 10^6 \text{ m}$   
 Earth-Moon Dist  $3.85 \times 10^8 \text{ m}$

### Sun

Mass  $1.99 \times 10^{30} \text{ kg}$   
 Radius  $6.96 \times 10^8 \text{ m}$

## Basic Mathematical Formulae

Area of circle =  $\pi r^2$   
 Area of rectangle = l x w  
 Circumference of circle =  $2\pi r = \pi d$   
 Surface area of a sphere =  $4\pi r^2$   
 Volume of a sphere =  $\frac{4}{3} \pi r^3$   
 Pythagorean Theorem:  $h^2 = h_o^2 + h_a^2$   
 Sine of an angle:  $\sin \theta = h_o/h$   
 Cosine of an angle:  $\cos \theta = h_a/h$   
 Tangent of an angle:  $\tan \theta = h_o/h_a$   
 Law of cosines:  $c^2 = a^2 + b^2 - 2ab \cos \theta$   
 Law of sines:  $a/\sin A = b/\sin B = c/\sin C$

Quadratic Formula:  
 If  $ax^2 + bx + c = 0$ , then \*

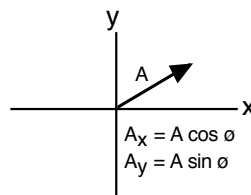
## Vectors Components

Vector<sub>x</sub> = (Vector) cos  $\theta$        $\theta$  = angle between vector and x-axis  
 Vector<sub>y</sub> = (Vector) sin  $\theta$

## SI Base Units

Quantity	Unit	Abbr.	Apparatus
length	meter	m	ruler
mass	kilogram	kg	balance
time	second	s	stopwatch
amount of substance	mole	mol	.....
temperature	kelvin	K	thermometer
electric current	ampere	A	ammeter
intensity	candela	cd	light meter

## Vector Resolution



## Rt. Triangle Trig.

