ADVANCED PLACEMENT PHYSICS B EQUATIONS DEVELOPED FOR 2012

NEWTONIAN MECHANICS

Kinematics	$v = v_0 + at$
Kinematics	$x = x_0 + v_0 t + \frac{1}{2}at^2$
Kinematics	$v^2 = v_0^2 + 2a(x - x_0)$
FORCE	$\Sigma \mathbf{F} = \mathbf{F}_{net} = m\mathbf{a}$
Friction	$F_{fric} \le \mu N$
Cent. acceler.	$a_c = \frac{v^2}{r}$
TORQUE	$\tau = rF \sin\theta$
Momentum	$\mathbf{p} = m\mathbf{v}$
Impulse	$\mathbf{J} = \mathbf{F}\Delta t = \Delta\mathbf{p}$
Kinetic E	$K = \frac{1}{2}mv^2$
Potential E	$\Delta U_g = mgh$
WORK	$W = F\Delta r \cos\theta$
Power	$P_{avg} = \frac{W}{\Delta t}$
Power	$P = Fv\cos\theta$
Force (spring)	$\mathbf{F}_s = -k\mathbf{x}$
Potential E (spring)	$U_s = \frac{1}{2}kx^2$
Period spring	$T_s = 2\pi\sqrt{\frac{m}{k}}$
Period (pendulum)	$T_p = 2\pi\sqrt{\frac{\ell}{g}}$
Period	$T = \frac{1}{f}$
Force of Gravitation	$F_G = -\frac{Gm_1m_2}{r^2}$
Gravit. Potential energy	$U_G = -\frac{Gm_1m_2}{r}$

a = acceleration
F = force
f = frequency
h = height
J = impulse
K = kinetic energy
k = spring constant
ℓ = length
m = mass
N = normal force
P = power
p = momentum
r = radius or distance
T = period
t = time
U = potential energy
v = velocity or speed
W = work done on a system
x = position
μ = coefficient of friction
θ = angle
τ = torque

ELECTRICITY AND MAGNETISM

$F = \frac{kq_1q_2}{r^2}$	Electric Force
$\mathbf{E} = \frac{\mathbf{F}}{q}$	Electric Field
$U_E = qV = \frac{kq_1q_2}{r}$	Electric Potential Energy
$E_{avg} = -\frac{V}{d}$	Electric Field (plates)
$V = k\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \ldots\right)$	voltage
$C = \frac{Q}{V}$	Capacitance
$C = \frac{\epsilon_0 A}{d}$	Capacitance
$U_c = \frac{1}{2}QV = \frac{1}{2}CV^2$	Potential Energy for capacitance
$I_{avg} = \frac{\Delta Q}{\Delta t}$	Current
$R = \frac{\rho\ell}{A}$	Resistance
$V = IR$	Voltage (Ohm's Law)
$P = IV$	Power
$C_p = C_1 + C_2 + C_3 + \ldots$	capacitors in parallel
$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$	capacitors in series
$R_s = R_1 + R_2 + R_3 + \ldots$	resisters in series
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$	resisters in parallel
$F_B = qvB\sin\theta$	Magnetic Force (in charge)
$F_B = BI\ell\sin\theta$	Magnetic Force (in wire)
$B = \frac{\mu_0}{2\pi}\frac{I}{r}$	Magnetic Field
$\phi_m = BA\cos\theta$	Magnetic flux
$\mathcal{E}_{avg} = -\frac{\Delta\phi_m}{\Delta t}$	emf
$\mathcal{E} = B\ell v$	emf for rectangular wire

A = area
B = magnetic field
C = capacitance
d = distance
E = electric field
$\mathcal{E}$ = emf
F = force
I = current
ℓ = length
P = power
Q = charge
q = point charge
R = resistance
r = distance
t = time
U = potential (stored) energy
V = electric potential or potential difference
v = velocity or speed
ρ = resistivity
θ = angle
ϕ_m = magnetic flux

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FLUID MECHANICS AND THERMAL PHYSICS

Density: $\rho = m/V$

Hydrostatic pressure: $P = P_0 + \rho g h$

Buoyancy Force: $F_{buoy} = \rho V g$

Continuity Equation: $A_1 v_1 = A_2 v_2$

Bernoulli's equation: $P + \rho g y + \frac{1}{2}\rho v^2 = \text{const.}$

Thermal expansion: $\Delta \ell = \alpha \ell_0 \Delta T$

Heat transfer: $H = \frac{kA\Delta T}{L}$

Pressure: $P = \frac{F}{A}$

Ideal Gas Law: $PV = nRT = Nk_B T$

Molecular Kinetic Energy: $K_{avg} = \frac{3}{2}k_B T$

Speed of a gas molecule: $v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3k_B T}{\mu}}$

Work done on a system: $W = -P\Delta V$

1st Law of Thermodynamics: $\Delta U = Q + W$

Efficiency of heat engine: $e = \left|\frac{W}{Q_H}\right|$

Efficiency of ideal (Carnot) engine: $e_c = \frac{T_H - T_C}{T_H}$

A = area
e = efficiency
F = force
h = depth
H = rate of heat transfer
k = thermal conductivity
K_{avg} = average molecular kinetic energy
ℓ = length
L = thickness
m = mass
M = molar mass
n = number of moles
N = number of molecules
P = pressure
Q = heat transferred to a system
T = temperature
U = internal energy
V = volume
v = velocity or speed
v_{rms} = root-mean-square velocity
W = work done on a system
y = height
α = coefficient of linear expansion
μ = mass of molecule
ρ = density

ATOMIC AND NUCLEAR PHYSICS

Energy of a photon: $E = hf = pc$

Kinetic energy of photon: $K_{max} = hf - \phi$

de Broglie wavelength: $\lambda = \frac{h}{p}$

Energy-mass conversion: $\Delta E = (\Delta m)c^2$

E = energy
f = frequency
K = kinetic energy
m = mass
p = momentum
λ = wavelength
ϕ = work function

WAVES AND OPTICS

$v = f\lambda$ — speed of a wave

$n = \frac{c}{v}$ — index of refraction

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ — Snell's Law

$\sin\theta_c = \frac{n_2}{n_1}$ — critical angle

$\frac{1}{s_i} + \frac{1}{s_0} = \frac{1}{f}$ — Len/Mirror equation

$M = \frac{h_i}{h_0} = -\frac{s_i}{s_0}$ — Magnification

$f = \frac{R}{2}$

$d\sin\theta = m\lambda$ — Location of bright spots

$x_m \approx \frac{m\lambda L}{d}$ — Position of bright spots

d = separation
f = frequency or focal length
h = height
L = distance
M = magnification
m = an integer
n = index of refraction
R = radius of curvature
s = distance
v = speed
x = position
λ = wavelength
θ = angle

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = \frac{1}{2}bh$

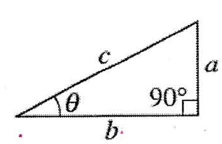
Circle
$A = \pi r^2$
$C = 2\pi r$

Rectangular Solid
$V = \ell w h$

Cylinder
$V = \pi r^2 \ell$
$S = 2\pi r\ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

Right Triangle
$a^2 + b^2 = c^2$
$\sin\theta = \frac{a}{c}$
$\cos\theta = \frac{b}{c}$
$\tan\theta = \frac{a}{b}$



A = area
C = circumference
V = volume
S = surface area
b = base
h = height
ℓ = length
w = width
r = radius