

TABLE OF INFORMATION FOR 2002

CONSTANTS AND CONVERSION FACTORS		UNITS		PREFIXES			
		Name	Symbol	Factor	Prefix	Symbol	
1 unified atomic mass unit,	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$ $= 931 \text{ MeV}/c^2$	meter	m	$10^9$	giga	G	
Proton mass,	$m_p = 1.67 \times 10^{-27} \text{ kg}$	kilogram	kg	$10^6$	mega	M	
Neutron mass,	$m_n = 1.67 \times 10^{-27} \text{ kg}$	second	s	$10^3$	kilo	k	
Electron mass,	$m_e = 9.11 \times 10^{-31} \text{ kg}$	ampere	A	$10^{-2}$	centi	c	
Magnitude of the electron charge,	$e = 1.60 \times 10^{-19} \text{ C}$	kelvin	K	$10^{-3}$	milli	m	
Avogadro's number,	$N_0 = 6.02 \times 10^{23} \text{ mol}^{-1}$	mole	mol	$10^{-6}$	micro	$\mu$	
Universal gas constant,	$R = 8.31 \text{ J}/(\text{mol} \cdot \text{K})$	hertz	Hz	$10^{-9}$	nano	n	
Boltzmann's constant,	$k_B = 1.38 \times 10^{-23} \text{ J/K}$	newton	N	$10^{-12}$	pico	p	
Speed of light,	$c = 3.00 \times 10^8 \text{ m/s}$	pascal	Pa	VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES			
Planck's constant,	$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$ $= 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$	joule	J				
	$hc = 1.99 \times 10^{-25} \text{ J} \cdot \text{m}$ $= 1.24 \times 10^3 \text{ eV} \cdot \text{nm}$	watt	W				
Vacuum permittivity,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$	coulomb	C				
Coulomb's law constant,	$k = 1/4\pi\epsilon_0 = 9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$	volt	V				
Vacuum permeability,	$\mu_0 = 4\pi \times 10^{-7} (\text{T} \cdot \text{m})/\text{A}$	ohm	$\Omega$				
Magnetic constant,	$k' = \mu_0/4\pi = 10^{-7} (\text{T} \cdot \text{m})/\text{A}$	henry	H				
Universal gravitational constant,	$G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2$	farad	F				
Acceleration due to gravity at the Earth's surface,	$g = 9.8 \text{ m/s}^2$	tesla	T				
1 atmosphere pressure,	$1 \text{ atm} = 1.0 \times 10^5 \text{ N/m}^2$ $= 1.0 \times 10^5 \text{ Pa}$	degree					
1 electron volt,	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	Celsius	$^\circ\text{C}$				
		electron-volt	eV	$\theta$	$\sin \theta$	$\cos \theta$	$\tan \theta$
				$0^\circ$	0	1	0
				$30^\circ$	1/2	$\sqrt{3}/2$	$\sqrt{3}/3$
				$37^\circ$	3/5	4/5	3/4
				$45^\circ$	$\sqrt{2}/2$	$\sqrt{2}/2$	1
				$53^\circ$	4/5	3/5	4/3
				$60^\circ$	$\sqrt{3}/2$	1/2	$\sqrt{3}$
				$90^\circ$	1	0	$\infty$

The following conventions are used in this examination.

- I. Unless otherwise stated, the frame of reference of any problem is assumed to be inertial.
- II. The direction of any electric current is the direction of flow of positive charge (conventional current).
- III. For any isolated electric charge, the electric potential is defined as zero at an infinite distance from the charge.
- \*IV. For mechanics and thermodynamics equations,  $W$  represents the work done on a system.

\*Not on the Table of Information for Physics C, since Thermodynamics is not a Physics C topic.

## ADVANCED PLACEMENT PHYSICS B EQUATIONS FOR 2002

### NEWTONIAN MECHANICS

$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2} at^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$\Sigma \mathbf{F} = \mathbf{F}_{net} = m\mathbf{a}$$

$$F_{fric} \leq \mu N$$

$$a_c = \frac{v^2}{r}$$

$$\tau = rF \sin \theta$$

$$\mathbf{p} = m\mathbf{v}$$

$$\mathbf{J} = \mathbf{F}\Delta t = \Delta \mathbf{p}$$

$$K = \frac{1}{2} mv^2$$

$$\Delta U_g = mgh$$

$$W = \mathbf{F} \cdot \Delta \mathbf{r} = F\Delta r \cos \theta$$

$$P_{avg} = \frac{W}{\Delta t}$$

$$P = \mathbf{F} \cdot \mathbf{v} = Fv \cos \theta$$

$$\mathbf{F}_s = -k\mathbf{x}$$

$$U_s = \frac{1}{2} kx^2$$

$$T_s = 2\pi\sqrt{\frac{m}{k}}$$

$$T_p = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T = \frac{1}{f}$$

$$F_G = -\frac{Gm_1m_2}{r^2}$$

$$U_G = -\frac{Gm_1m_2}{r}$$

$a$  = acceleration  
 $F$  = force  
 $f$  = frequency  
 $h$  = height  
 $J$  = impulse  
 $K$  = kinetic energy  
 $k$  = spring constant  
 $\ell$  = length  
 $m$  = mass  
 $N$  = normal force  
 $P$  = power  
 $p$  = momentum  
 $r$  = radius or distance  
 $\mathbf{r}$  = position vector  
 $T$  = period  
 $t$  = time  
 $U$  = potential energy  
 $v$  = velocity or speed  
 $W$  = work done on a system  
 $x$  = position  
 $\mu$  = coefficient of friction  
 $\theta$  = angle  
 $\tau$  = torque

### ELECTRICITY AND MAGNETISM

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2}$$

$$\mathbf{E} = \frac{\mathbf{F}}{q}$$

$$U_E = qV = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r}$$

$$E_{avg} = -\frac{V}{d}$$

$$V = \frac{1}{4\pi\epsilon_0} \sum_i \frac{q_i}{r_i}$$

$$C = \frac{Q}{V}$$

$$C = \frac{\epsilon_0 A}{d}$$

$$U_c = \frac{1}{2} QV = \frac{1}{2} CV^2$$

$$I_{avg} = \frac{\Delta Q}{\Delta t}$$

$$R = \frac{\rho\ell}{A}$$

$$V = IR$$

$$P = IV$$

$$C_p = \sum_i C_i$$

$$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$$

$$R_s = \sum_i R_i$$

$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$

$$F_B = qvB \sin \theta$$

$$F_B = BI\ell \sin \theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$\phi_m = \mathbf{B} \cdot \mathbf{A} = BA \cos \theta$$

$$\mathcal{E}_{avg} = -\frac{\Delta\phi_m}{\Delta t}$$

$$\mathcal{E} = B\ell v$$

$A$  = area  
 $B$  = magnetic field  
 $C$  = capacitance  
 $d$  = distance  
 $E$  = electric field  
 $\mathcal{E}$  = emf  
 $F$  = force  
 $I$  = current  
 $\ell$  = 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  
 $\rho$  = resistivity  
 $\phi_m$  = magnetic flux

## ADVANCED PLACEMENT PHYSICS B EQUATIONS FOR 2002

### FLUID MECHANICS AND THERMAL PHYSICS

$$p = p_0 + \rho gh$$

$$F_{buoy} = \rho Vg$$

$$A_1 v_1 = A_2 v_2$$

$$p + \rho gy + \frac{1}{2} \rho v^2 = \text{const.}$$

$$\Delta \ell = \alpha \ell_0 \Delta T$$

$$Q = mL$$

$$Q = mc\Delta T$$

$$p = \frac{F}{A}$$

$$pV = nRT$$

$$K_{avg} = \frac{3}{2} k_B T$$

$$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3k_B T}{\mu}}$$

$$W = -p\Delta V$$

$$Q = nc\Delta T$$

$$\Delta U = Q + W$$

$$\Delta U = nc_V \Delta T$$

$$e = \left| \frac{W}{Q_H} \right|$$

$$e_c = \frac{T_H - T_C}{T_H}$$

$A$  = area

$c$  = specific heat or molar specific heat

$e$  = efficiency

$F$  = force

$h$  = depth

$K_{avg}$  = average molecular kinetic energy

$L$  = heat of transformation

$\ell$  = length

$M$  = molecular mass

$m$  = mass of sample

$n$  = number of moles

$p$  = 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

$\alpha$  = coefficient of linear expansion

$\mu$  = mass of molecule

$\rho$  = density

### WAVES AND OPTICS

$$v = f\lambda$$

$$n = \frac{c}{v}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin \theta_c = \frac{n_2}{n_1}$$

$$\frac{1}{s_i} + \frac{1}{s_o} = \frac{1}{f}$$

$$M = \frac{h_i}{h_o} = -\frac{s_i}{s_o}$$

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

$$d \sin \theta = m\lambda$$

$$x_m \approx \frac{m\lambda L}{d}$$

$d$  = 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

$\lambda$  = wavelength

$\theta$  = angle

### ATOMIC AND NUCLEAR PHYSICS

$$E = hf = pc$$

$$K_{max} = hf - \phi$$

$$\lambda = \frac{h}{p}$$

$$\Delta E = (\Delta m)c^2$$

$E$  = energy

$f$  = frequency

$K$  = kinetic energy

$m$  = mass

$p$  = momentum

$\lambda$  = wavelength

$\phi$  = work function

### GEOMETRY AND TRIGONOMETRY

Rectangle

$$A = bh$$

Triangle

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

Circle

$$A = \pi r^2$$

$$C = 2\pi r$$

Parallelepiped

$$V = \ell wh$$

Cylinder

$$V = \pi r^2 \ell$$

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

Sphere

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

$$S = 4\pi r^2$$

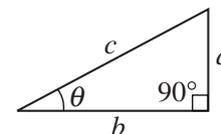
Right Triangle

$$a^2 + b^2 = c^2$$

$$\sin \theta = \frac{a}{c}$$

$$\cos \theta = \frac{b}{c}$$

$$\tan \theta = \frac{a}{b}$$



**ADVANCED PLACEMENT PHYSICS C EQUATIONS FOR 2002**

**MECHANICS**

$v = v_0 + at$	$a =$ acceleration
$x = x_0 + v_0t + \frac{1}{2}at^2$	$F =$ force
$v^2 = v_0^2 + 2a(x - x_0)$	$f =$ frequency
$\sum \mathbf{F} = \mathbf{F}_{net} = m\mathbf{a}$	$h =$ height
$\mathbf{F} = \frac{d\mathbf{p}}{dt}$	$I =$ rotational inertia
$\mathbf{J} = \int \mathbf{F} dt = \Delta\mathbf{p}$	$J =$ impulse
$\mathbf{p} = m\mathbf{v}$	$K =$ kinetic energy
$F_{fric} \leq \mu N$	$k =$ spring constant
$W = \int \mathbf{F} \cdot d\mathbf{r}$	$\ell =$ length
$K = \frac{1}{2}mv^2$	$L =$ angular momentum
$P = \frac{dW}{dt}$	$m =$ mass
$P = \mathbf{F} \cdot \mathbf{v}$	$N =$ normal force
$\Delta U_g = mgh$	$P =$ power
$a_c = \frac{v^2}{r} = \omega^2 r$	$p =$ momentum
$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$	$r =$ radius or distance
$\sum \boldsymbol{\tau} = \boldsymbol{\tau}_{net} = I\boldsymbol{\alpha}$	$\mathbf{r} =$ position vector
$I = \int r^2 dm = \sum mr^2$	$T =$ period
$\mathbf{r}_{cm} = \sum m\mathbf{r} / \sum m$	$t =$ time
$v = r\omega$	$U =$ potential energy
$\mathbf{L} = \mathbf{r} \times \mathbf{p} = I\boldsymbol{\omega}$	$v =$ velocity or speed
$K = \frac{1}{2}I\omega^2$	$W =$ work done on a system
$\omega = \omega_0 + \alpha t$	$x =$ position
$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$	$\mu =$ coefficient of friction
$\mathbf{F}_s = -k\mathbf{x}$	$\theta =$ angle
$U_s = \frac{1}{2}kx^2$	$\tau =$ torque
$T = \frac{2\pi}{\omega} = \frac{1}{f}$	$\omega =$ angular speed
$T_s = 2\pi\sqrt{\frac{m}{k}}$	$\alpha =$ angular acceleration
$T_p = 2\pi\sqrt{\frac{\ell}{g}}$	
$\mathbf{F}_G = -\frac{Gm_1m_2}{r^2}\hat{\mathbf{r}}$	
$U_G = -\frac{Gm_1m_2}{r}$	

**ELECTRICITY AND MAGNETISM**

$F = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2}$	$A =$ area
$\mathbf{E} = \frac{\mathbf{F}}{q}$	$B =$ magnetic field
$\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$	$C =$ capacitance
$E = -\frac{dV}{dr}$	$d =$ distance
$V = \frac{1}{4\pi\epsilon_0} \sum_i \frac{q_i}{r_i}$	$E =$ electric field
$U_E = qV = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r}$	$\mathcal{E} =$ emf
$C = \frac{Q}{V}$	$F =$ force
$C = \frac{\kappa\epsilon_0 A}{d}$	$I =$ current
$C_p = \sum_i C_i$	$L =$ inductance
$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	$\ell =$ length
$I = \frac{dQ}{dt}$	$n =$ number of loops of wire per unit length
$U_c = \frac{1}{2}QV = \frac{1}{2}CV^2$	$P =$ power
$R = \frac{\rho\ell}{A}$	$Q =$ charge
$V = IR$	$q =$ point charge
$R_s = \sum_i R_i$	$R =$ resistance
$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$	$r =$ distance
$P = IV$	$t =$ time
$\mathbf{F}_M = q\mathbf{v} \times \mathbf{B}$	$U =$ potential or stored energy
$\oint \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 I$	$V =$ electric potential
$\mathbf{F} = \int I d\boldsymbol{\ell} \times \mathbf{B}$	$v =$ velocity or speed
$B_s = \mu_0 nI$	$\rho =$ resistivity
$\phi_m = \int \mathbf{B} \cdot d\mathbf{A}$	$\phi_m =$ magnetic flux
$\mathcal{E} = -\frac{d\phi_m}{dt}$	$\kappa =$ dielectric constant
$\mathcal{E} = -L\frac{dI}{dt}$	
$U_L = \frac{1}{2}LI^2$	

**ADVANCED PLACEMENT PHYSICS C EQUATIONS FOR 2002**

**GEOMETRY AND TRIGONOMETRY**

Rectangle

$$A = bh$$

Triangle

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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

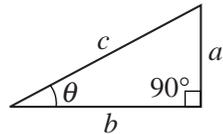
$b$  = base

$h$  = height

$\ell$  = length

$w$  = width

$r$  = radius



**CALCULUS**

$$\frac{df}{dx} = \frac{df}{du} \frac{du}{dx}$$

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

$$\frac{d}{dx}(e^x) = e^x$$

$$\frac{d}{dx}(\ln x) = \frac{1}{x}$$

$$\frac{d}{dx}(\sin x) = \cos x$$

$$\frac{d}{dx}(\cos x) = -\sin x$$

$$\int x^n dx = \frac{1}{n+1} x^{n+1}, n \neq -1$$

$$\int e^x dx = e^x$$

$$\int \frac{dx}{x} = \ln|x|$$

$$\int \cos x dx = \sin x$$

$$\int \sin x dx = -\cos x$$