

AP[®] PHYSICS 2 TABLE OF INFORMATION

CONSTANTS AND CONVERSION FACTORS	
Proton mass, $m_p = 1.67 \times 10^{-27}$ kg Neutron mass, $m_n = 1.67 \times 10^{-27}$ kg Electron mass, $m_e = 9.11 \times 10^{-31}$ kg Avogadro's number, $N_0 = 6.02 \times 10^{23}$ mol ⁻¹ Universal gas constant, $R = 8.31$ J/(mol·K) Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K	Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C 1 electron volt, $1 \text{ eV} = 1.60 \times 10^{-19}$ J Speed of light, $c = 3.00 \times 10^8$ m/s Universal gravitational constant, $G = 6.67 \times 10^{-11}$ m ³ /kg·s ² Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s ²
1 unified atomic mass unit, Planck's constant, Vacuum permittivity, Coulomb's law constant, $k = 1/4\pi\epsilon_0 = 9.0 \times 10^9$ N·m ² /C ² Vacuum permeability, Magnetic constant, $k' = \mu_0/4\pi = 1 \times 10^{-7}$ (T·m)/A 1 atmosphere pressure,	$1 \text{ u} = 1.66 \times 10^{-27}$ kg = 931 MeV/c ² $h = 6.63 \times 10^{-34}$ J·s = 4.14 × 10 ⁻¹⁵ eV·s $hc = 1.99 \times 10^{-25}$ J·m = 1.24 × 10 ³ eV·nm $\epsilon_0 = 8.85 \times 10^{-12}$ C ² /N·m ² $\mu_0 = 4\pi \times 10^{-7}$ (T·m)/A $1 \text{ atm} = 1.0 \times 10^5$ N/m ² = 1.0 × 10 ⁵ Pa

UNIT SYMBOLS	meter, m	mole, mol	watt, W	farad, F
	kilogram, kg	hertz, Hz	coulomb, C	tesla, T
	second, s	newton, N	volt, V	degree Celsius, °C
	ampere, A	pascal, Pa	ohm, Ω	electron volt, eV
	kelvin, K	joule, J	henry, H	

PREFIXES		
Factor	Prefix	Symbol
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES							
θ	0°	30°	37°	45°	53°	60°	90°
$\sin \theta$	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
$\cos \theta$	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0
$\tan \theta$	0	$\sqrt{3}/3$	3/4	1	4/3	$\sqrt{3}$	∞

The following conventions are used in this exam.

- I. The frame of reference of any problem is assumed to be inertial unless otherwise stated.
- II. In all situations, positive work is defined as work done on a system.
- III. The direction of current is conventional current: the direction in which positive charge would drift.
- IV. Assume all batteries and meters are ideal unless otherwise stated.
- V. Assume edge effects for the electric field of a parallel plate capacitor unless otherwise stated.
- VI. For any isolated electrically charged object, the electric potential is defined as zero at infinite distance from the charged object

AP[®] PHYSICS 2 EQUATIONS

MECHANICS

$v_x = v_{x0} + a_x t$	$a = \text{acceleration}$
$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$	$A = \text{amplitude}$
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	$d = \text{distance}$
$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$	$E = \text{energy}$
$ \vec{F}_f \leq \mu \vec{F}_n $	$F = \text{force}$
$a_c = \frac{v^2}{r}$	$f = \text{frequency}$
$\vec{p} = m\vec{v}$	$I = \text{rotational inertia}$
$\Delta\vec{p} = \vec{F} \Delta t$	$K = \text{kinetic energy}$
$K = \frac{1}{2} m v^2$	$k = \text{spring constant}$
$\Delta E = W = F_{\parallel} d = F d \cos \theta$	$L = \text{angular momentum}$
$P = \frac{\Delta E}{\Delta t}$	$\ell = \text{length}$
$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$	$m = \text{mass}$
$\omega = \omega_0 + \alpha t$	$P = \text{power}$
$x = A \cos(\omega t) = A \cos(2\pi f t)$	$p = \text{momentum}$
$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$	$r = \text{radius or separation}$
$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$	$T = \text{period}$
$\tau = r_{\perp} F = r F \sin \theta$	$t = \text{time}$
$L = I \omega$	$U = \text{potential energy}$
$\Delta L = \tau \Delta t$	$v = \text{speed}$
$K = \frac{1}{2} I \omega^2$	$W = \text{work done on a system}$
$ \vec{F}_s = k \vec{x} $	$x = \text{position}$
	$y = \text{height}$
	$\alpha = \text{angular acceleration}$
	$\mu = \text{coefficient of friction}$
	$\theta = \text{angle}$
	$\tau = \text{torque}$
	$\omega = \text{angular speed}$
	$U_s = \frac{1}{2} k x^2$
	$\Delta U_g = m g \Delta y$
	$T = \frac{2\pi}{\omega} = \frac{1}{f}$
	$T_s = 2\pi \sqrt{\frac{m}{k}}$
	$T_p = 2\pi \sqrt{\frac{\ell}{g}}$
	$ \vec{F}_g = G \frac{m_1 m_2}{r^2}$
	$\vec{g} = \frac{\vec{F}_g}{m}$
	$U_G = -\frac{G m_1 m_2}{r}$

ELECTRICITY AND MAGNETISM

$ \vec{F}_E = \frac{1}{4\pi\epsilon_0} \frac{ q_1 q_2 }{r^2}$	$A = \text{area}$
$\vec{E} = \frac{\vec{F}_E}{q}$	$B = \text{magnetic field}$
$ \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{ q }{r^2}$	$C = \text{capacitance}$
$\Delta U_E = q \Delta V$	$d = \text{distance}$
$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$	$E = \text{electric field}$
$ \vec{E} = \left \frac{\Delta V}{\Delta r} \right $	$\mathcal{E} = \text{emf}$
$\Delta V = \frac{Q}{C}$	$F = \text{force}$
$C = \kappa \epsilon_0 \frac{A}{d}$	$I = \text{current}$
$E = \frac{Q}{\epsilon_0 A}$	$\ell = \text{length}$
$U_C = \frac{1}{2} Q \Delta V = \frac{1}{2} C (\Delta V)^2$	$P = \text{power}$
$I = \frac{\Delta Q}{\Delta t}$	$Q = \text{charge}$
$R = \frac{\rho \ell}{A}$	$q = \text{point charge}$
$P = I \Delta V$	$R = \text{resistance}$
$I = \frac{\Delta V}{R}$	$r = \text{separation}$
$R_s = \sum_i R_i$	$t = \text{time}$
$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$	$U = \text{potential (stored) energy}$
$C_p = \sum_i C_i$	$V = \text{electric potential}$
$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	$v = \text{speed}$
$B = \frac{\mu_0 I}{2\pi r}$	$\kappa = \text{dielectric constant}$
	$\rho = \text{resistivity}$
	$\theta = \text{angle}$
	$\Phi = \text{flux}$
	$\vec{F}_M = q\vec{v} \times \vec{B}$
	$ \vec{F}_M = q\vec{v} \sin \theta \vec{B} $
	$\vec{F}_M = I\vec{\ell} \times \vec{B}$
	$ \vec{F}_M = I\vec{\ell} \sin \theta \vec{B} $
	$\Phi_B = \vec{B} \cdot \vec{A}$
	$\Phi_B = \vec{B} \cos \theta \vec{A} $
	$\mathcal{E} = -\frac{\Delta \Phi_B}{\Delta t}$
	$\mathcal{E} = B \ell v$

AP[®] PHYSICS 2 EQUATIONS

FLUID MECHANICS AND THERMAL PHYSICS

$$\rho = \frac{m}{V}$$

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

$$P = P_0 + \rho gh$$

$$F_b = \rho Vg$$

$$A_1 v_1 = A_2 v_2$$

$$P_1 + \rho g y_1 + \frac{1}{2} \rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2} \rho v_2^2$$

$$\frac{Q}{\Delta t} = \frac{kA \Delta T}{L}$$

$$PV = nRT = Nk_B T$$

$$K = \frac{3}{2} k_B T$$

$$W = -P \Delta V$$

$$\Delta U = Q + W$$

A = area
F = force
h = depth
k = thermal conductivity
K = kinetic energy
L = thickness
m = mass
n = number of moles
N = number of molecules
P = pressure
Q = energy transferred to a system by heating
T = temperature
t = time
U = internal energy
V = volume
v = speed
W = work done on a system
y = height
ρ = density

MODERN PHYSICS

$$E = hf$$

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

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

$$E = mc^2$$

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

WAVES AND OPTICS

$$\lambda = \frac{v}{f}$$

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

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

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

$$|M| = \left| \frac{h_i}{h_o} \right| = \left| \frac{s_i}{s_o} \right|$$

$$\Delta L = m\lambda$$

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

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

GEOMETRY AND TRIGONOMETRY

Rectangle
A = *bh*

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

Circle
A = πr^2
C = $2\pi r$

Rectangular solid
V = ℓwh

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

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

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

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

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

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

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

