ADVANCED PLACEMENT PHYSICS MECHANICS TABLE OF INFORMATION

CONSTANTS AND CONVERSION FACTORS
Universal gravitational constant, $G = 6.67 \times 10^{-11}\ \text{m}^3/(\text{kg} \cdot \text{s}^2) = 6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$
Acceleration due to gravity at Earth's surface, $g = 9.8\ \text{m/s}^2$
Magnitude of the gravitational field strength at the Earth's surface, $g = 9.8\ \text{N/kg}$

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

UNIT SYMBOLS				
	hertz,	Hz	newton,	N
	joule,	J	second,	s
	kilogram,	kg	watt,	W
	meter,	m		

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 assumptions are used in this exam.

- The frame of reference of any problem is assumed to be inertial unless otherwise stated.
- Air resistance is assumed to be negligible unless otherwise stated.
- Springs and strings are assumed to be ideal unless otherwise stated.

Source: Collegeboard.org

MECHANICS

$$v_x = v_{x0} + a_x t$$

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$

$$v_x^2 = v_{x0}^2 + 2a_x\left(x - x_0\right)$$

$$\Delta x = \int v_x\left(t\right)dt$$

$$\Delta v_x = \int a_x\left(t\right)dt$$

$$\vec{x}_{\text{cm}} = \frac{\sum m_i \vec{x}_i}{\sum m_i}$$

$$\vec{r}_{\text{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$

$$\lambda = \frac{d}{d\ell}m\left(\ell\right)$$

$$\vec{a}_{\text{sys}} = \frac{\sum \vec{F}}{m_{\text{sys}}} = \frac{\vec{F}_{\text{net}}}{m_{\text{sys}}}$$

$$\left|\vec{F}_g\right| = G\frac{m_1 m_2}{r^2}$$

$$\left|\vec{F}_f\right| \le \left|\mu \vec{F}_N\right|$$

$$\vec{F}_s = -k\Delta\vec{x}$$

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

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

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

$$W = \int_a^b \vec{F}\cdot d\vec{r}$$

$$\Delta K = \sum W_i = \sum F_{\parallel,i}d_i$$

$$\Delta U = -\int_a^b \vec{F}_{\text{cf}}(r)\cdot d\vec{r}$$

$$F_x = -\frac{dU(x)}{dx}$$

$$U_s = \frac{1}{2}k\left(\Delta x\right)^2$$

$$U_G = -G\frac{m_1 m_2}{r}$$

$$\Delta U_g = mg\Delta y$$

a = acceleration
E = energy
f = frequency
F = force
h = height
J = impulse
k = spring constant
K = kinetic energy
ℓ = length
m = mass
M = mass
p = momentum
P = power
r = radius, distance, or position
t = time
T = period
U = potential energy
v = velocity or speed
W = work
x = position or distance
y = height
λ = linear mass density
μ = coefficient of friction

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

$$P_{\text{inst}} = \frac{dW}{dt}$$

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

$$\vec{F}_{\text{net}} = \frac{d\vec{p}}{dt}$$

$$\vec{J} = \int_{t_1}^{t_2} \vec{F}_{\text{net}}\left(t\right)dt = \Delta\vec{p}$$

$$\vec{v}_{\text{cm}} = \frac{\sum \vec{p}_i}{\sum m_i} = \frac{\sum m_i \vec{v}_i}{\sum m_i}$$

$$\omega = \frac{d\theta}{dt}$$

$$\alpha = \frac{d\omega}{dt}$$

$$\omega = \omega_0 + \alpha t$$

$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega^2 = \omega_0^2 + 2\alpha\left(\theta - \theta_0\right)$$

$$v = r\omega$$

$$a_T = r\alpha$$

$$\vec{\tau} = \vec{r}\times\vec{F}$$

$$I_{\text{tot}} = \sum I_i = \sum m_i r_i^2$$

$$I = \int r^2\,dm$$

$$I' = I_{\text{cm}} + Md^2$$

$$\alpha_{\text{sys}} = \frac{\Sigma\tau}{I_{\text{sys}}} = \frac{\tau_{\text{net}}}{I_{\text{sys}}}$$

$$K_{\text{rot}} = \frac{1}{2}I\omega^2$$

$$W = \int \tau\cdot d\theta$$

$$\vec{L} = \vec{r}\times\vec{p} = I\vec{\omega}$$

$$\Delta L = \int \tau\,dt$$

$$\Delta x_{\text{cm}} = r\Delta\theta$$

$$T = \frac{2\pi}{\omega} = \frac{1}{f}$$

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

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

$$T_{\text{phys}} = 2\pi\sqrt{\frac{I}{mgd}}$$

$$x = x_{\text{max}}\cos\left(\omega t + \phi\right)$$

a = acceleration
d = distance
f = frequency
F = force
I = rotational inertia
k = spring constant
K = kinetic energy
ℓ = length
L = angular momentum
m = mass
M = mass
p = momentum
r = radius, distance, or position
t = time
T = period
v = velocity or speed
W = work
x = position or distance
α = angular acceleration
θ = angle
τ = torque
ϕ = phase angle
ω = angular frequency or angular speed

Source: Collegeboard.org

GEOMETRY AND TRIGONOMETRY

Rectangle

$A = bh$

Triangle

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

Circle

$A = \pi r^2$

$C = 2\pi r$

$s = r\theta$

Rectangular Solid

$V = \ell wh$

Cylinder

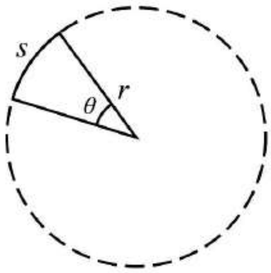
$V = \pi r^2 \ell$

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

Sphere

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

$S = 4\pi r^2$



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

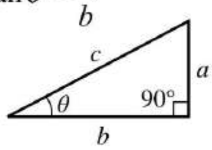
Right Triangle

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

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

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

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



VECTORS	CALCULUS	IDENTITIES
$\vec{A} \cdot \vec{B} = AB\cos\theta$	$\frac{df}{dx} = \frac{df}{du}\frac{du}{dx}$	$\log\left(a \cdot b^x\right) = \log a + x\log b$
$\left\lvert \vec{A} \times \vec{B} \right\rvert = AB\sin\theta$	$\frac{d}{dx}\left(x^n\right) = nx^{n-1}$	$\sin^2\theta + \cos^2\theta = 1$
$\vec{r} = \left(A\hat{i} + B\hat{j} + C\hat{k}\right)$	$\frac{d}{dx}\left(e^{ax}\right) = ae^{ax}$	$\sin\left(2\theta\right) = 2\sin\theta\cos\theta$
$\vec{C} = \vec{A} + \vec{B}$	$\frac{d}{dx}\left(\ln ax\right) = \frac{1}{x}$	$\frac{\sin\theta}{\cos\theta} = \tan\theta$
$\vec{C} = \left(A_x + B_x\right)\hat{i} + \left(A_y + B_y\right)\hat{j}$	$\frac{d}{dx}\left[\sin(ax)\right] = a\cos(ax)$	
	$\frac{d}{dx}\left[\cos(ax)\right] = -a\sin(ax)$	
	$\int x^n\,dx = \frac{1}{n+1}x^{n+1}, n \neq -1$	
	$\int e^{ax}\,dx = \frac{1}{a}e^{ax}$	
	$\int \frac{dx}{x+a} = \ln\lvert x+a \rvert$	
	$\int \cos(ax)\,dx = \frac{1}{a}\sin(ax)$	
	$\int \sin(ax)\,dx = -\frac{1}{a}\cos(ax)$	

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