The AP Physics C: Mechanics equation sheet, annotated

Given in both sections (College Board, 2025): G = 6.67 x 10^-11 N·m²/kg²; g = 9.8 m/s² = 9.8 N/kg; prefixes tera to pico; units Hz, J, kg, m, N, s, W; sin, cos, tan for 0°, 30°, 37°, 45°, 53°, 60°, 90° (37° and 53° are the 3-4-5 triangle). Conventions: inertial frame, no air resistance, ideal springs and strings unless stated.

Translational	Use when
$v_x = v_x0 + a_xt$; $x = x0 + v_x0t + \frac{1}{2}a_xt^2$; $v_x^2 = v_x0^2 + 2a_x(x - x0)$	constant acceleration only
$\Delta x = \int v_x\,dt$; $\Delta v_x = \int a_x\,dt$	v(t) or a(t) varies: integrate (area under the graph)
$x_{cm} = \Sigma m_i x_i/\Sigma m_i$; $r_{cm} = \int r\,dm/\int dm$; $\lambda = dm/d\ell$	centre of mass of points; of a continuous body; non-uniform rods ($dm = \lambda\,d\ell$)
$a_{sys} = \Sigma F/m_{sys} = F_{net}/m_{sys}$	Newton's second law for the system
$\lvert F_g\rvert = Gm1m2/r^2$; $\lvert F_f\rvert \le \mu\lvert F_N\rvert$; $F_s = -k\Delta x$	gravitation (centre to centre); friction (≤ static, = kinetic); springs (restoring)
$a_c = v^2/r = r\omega^2$; $T = 1/f$	circular motion
$K = \frac{1}{2}mv^2$; $W = \int F\cdot dr$; $\Delta K = \Sigma W_i = \Sigma F_{//,i}d_i$	energy; work by a variable force; the work-energy theorem
$\Delta U = -\int F_c\cdot dr$; $F_x = -dU/dx$	U from a conservative force; force as minus the slope of U(x); equilibrium where dU/dx = 0
$U_s = \frac{1}{2}k(\Delta x)^2$; $U_G = -Gm1m2/r$; $\Delta U_g = mg\Delta y$	spring energy; gravity with zero at infinity (orbits); gravity near the surface
$P_{avg} = W/\Delta t = \Delta E/\Delta t$; $P_{inst} = dW/dt$	power (P = F·v is not printed)
$p = mv$; $F_{net} = dp/dt$; $J = \int F_{net}\,dt = \Delta p$; $v_{cm} = \Sigma p_i/\Sigma m_i$	momentum; variable mass or force; impulse (area under F-t); the centre of mass moves at constant velocity if no external force

Rotational (twin of)	Use when
$\omega = d\theta/dt$; $\alpha = d\omega/dt$; $\omega = \omega0 + \alpha t$; $\theta = \theta0 + \omega0t + \frac{1}{2}\alpha t^2$; $\omega^2 = \omega0^2 + 2\alpha(\theta - \theta0)$	angular kinematics (twins of v, a and the three equations)
$v = r\omega$; $a_T = r\alpha$; $\Delta x_{cm} = r\Delta\theta$	rim speed and tangential acceleration; rolling without slipping
$\tau = r \times F$; $\alpha_{sys} = \Sigma\tau/I_{sys} = \tau_{net}/I_{sys}$	torque ($rF\sin\theta$); Newton's second law for rotation (twin of a = F/m)
$I_{tot} = \Sigma I_i = \Sigma m_i r_i^2$; $I = \int r^2\,dm$; $I' = I_{cm} + Md^2$	adding inertias; deriving I for a rod or disc; the parallel-axis theorem (rod about its end: 1/12 + 1/4 = 1/3 ML^2)
$K_{rot} = \frac{1}{2}I\omega^2$; $W = \int\tau\cdot d\theta$	rotational energy (rolling: $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$); rotational work
$L = r \times p = I\omega$; $\Delta L = \int\tau\,dt$	angular momentum (conserved when net torque is zero: skaters, bullet into a door); angular impulse
$T = 2\pi/\omega = 1/f$; $T_s = 2\pi\sqrt{(m/k)}$; $T_p = 2\pi\sqrt{(\ell/g)}$; $T_{phys} = 2\pi\sqrt{(I/(mgd))}$	periods: any oscillation; mass on a spring; simple pendulum (small angles); physical pendulum, d = pivot to centre of mass
$x = x_{max}\cos(\omega t + \varphi)$	SHM position; differentiate for v and a (not printed): $v = -\omega x_{max}\sin(\omega t + \varphi)$, $a = -\omega^2 x$

From sciencewithshobha.com/blog/ap-physics-c-equation-sheet-explained-every-equation-on-the-official-mechanics-sheet-annotated-what-each-symbol-means-when-to-use-it-and-what-is-not-on-the-sheet/ · 1-on-1 online science and AP tutoring, KS2 to A level, Grades 5 to 12, free 30-minute first class.

The tables, what is NOT on the sheet, and a practice set

Table	Contents
Geometry and trig	$A = bh$, $\frac{1}{2}bh$, πr^2; $C = 2\pi r$; $s = r\theta$; $V = \ell wh$, $\pi r^2 \ell$ ($S = 2\pi r\ell + 2\pi r^2$), $\frac{4}{3}\pi r^3$ ($S = 4\pi r^2$); $a^2 + b^2 = c^2$, sin, cos, tan
Vectors	$\vec{A}\cdot\vec{B} = AB\cos\theta$; $\lvert\vec{A} \times \vec{B}\rvert = AB\sin\theta$; components $A\hat{i} + B\hat{j} + C\hat{k}$; $\vec{C} = \vec{A} + \vec{B}$ by components
Calculus	chain rule; d/dx of x^n, e^(ax), ln(ax), sin(ax), cos(ax); integrals of x^n ($n \neq -1$), e^(ax), $1/(x + a)$, cos(ax), sin(ax)
Identities	$\log(a \cdot b^x) = \log a + x \log b$; $\sin^2\theta + \cos^2\theta = 1$; $\sin 2\theta = 2 \sin\theta \cos\theta$; $\tan\theta = \sin\theta/\cos\theta$

Not on the sheet: know these

Missing	Know
Newton's laws in words	inertia; $F = ma$ as the sum of EXTERNAL forces; action-reaction pairs act on different bodies
Standard rotational inertias	rod about centre $1/12\ ML^2$, about end $1/3\ ML^2$; solid disc or cylinder $\frac{1}{2}MR^2$; hoop MR^2; solid sphere $2/5\ MR^2$; hollow sphere $2/3\ MR^2$
Rolling without slipping	$v_{cm} = r\omega$, $a_{cm} = r\alpha$; $K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$; friction does no work; $a = g\sin\theta/(1 + I/mr^2)$ down a ramp
Orbits	circular speed $\sqrt{(GM/r)}$; $K = \frac{1}{2}GMm/r$; total energy $-GMm/2r$; escape speed $\sqrt{(2GM/r)}$; Kepler's third law $T^2 = 4\pi^2 r^3/GM$
Drag and terminal velocity	$F = -bv$ or $-cv^2$; terminal when drag = weight (mg/b); solve $m\,dv/dt = mg - bv$
Static equilibrium	$\Sigma F = 0$ and $\Sigma\tau = 0$ about any point
Collisions	momentum always conserved; K only in elastic; 1-D elastic: relative speed reverses
SHM derivatives; projectiles	$v = -\omega x_{max}\sin(\omega t + \varphi)$, $a = -\omega^2 x$, $v_{max} = \omega x_{max}$; range $R = v^2 \sin 2\theta/g$
The derivations	where every sheet equation comes from: 'derive an expression' is the commonest free-response verb

Exam (2025-26): Section I 42 multiple choice, 85 min, 50%; Section II 4 free response, 95 min, 50%; hybrid digital (MCQ in Bluebook, FRQ handwritten); calculator allowed throughout; the sheet in both sections. The College Board has announced changes to the MCQ count and timings from May 2027: check the course page. Use the sheet to CHECK a sign or exponent, not to FIND an approach.

Practice: which sheet line, and what is missing?

1. A rod of length L and mass M pivots about one end. Which sheet lines give its rotational inertia, and what must you supply?
2. A satellite orbits at radius r. Which sheet line gives the force, and which missing fact gives the speed?
3. A force $F(x) = 3x^2$ acts from $x = 0$ to 2 m. Which line gives the work, and what is it?
4. A falling object has drag $F = -bv$. Which line sets up the equation of motion, and what is terminal velocity?
5. A skater pulls her arms in. Which line explains why she spins faster?
6. $U(x) = 4x^2 - 2x$. Which line gives the force, and where is equilibrium?

Answers

1. $I = \int r^2\,dm$ with $\lambda = M/L$ gives $1/3\ ML^2$; or $I' = I_{cm} + Md^2$ with the missing $I_{cm} = 1/12\ ML^2$ and $d = L/2$. 2. $|F_g| = Gm1m2/r^2$ with $a_c = v^2/r$ gives $v = \sqrt{(GM/r)}$, which is not printed. 3. $W = \int \vec{F}\cdot d\vec{r} = \int 3x^2\,dx$ from 0 to 2 $= x^3$ from 0 to 2 $= 8$ J. 4. $F_{net} = dp/dt$ ($m\,dv/dt = mg - bv$); terminal when $mg = bv$, $v_t = mg/b$. 5. $L = I\omega$ with $\Delta L = \int \tau\,dt = 0$: I falls, so ω rises. 6. $F_x = -dU/dx = -(8x - 2)$; equilibrium where $8x - 2 = 0$, $x = 0.25$ m (stable: U is a minimum).