

Learn these by heart before the exam. 考试前把这些内容背熟。

Kinematics

$\vec{v} = \frac{d\vec{r}}{dt}$, $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$ differentiate to go down,
integrate (with initial conditions) to go back
up 速度与加速度的定义
 $\vec{v} = \vec{v}_0 + \int \vec{a} dt$, $\vec{r} = \vec{r}_0 + \int \vec{v} dt$ 由加速度积分求运动
 $v dv = a dx$ the trick when $a = a(x)$ rather than
 $a(t)$ 当 a 依赖于 x 时

Constant- a formulas apply ONLY when a is constant.
If a depends on t , v or x , you must integrate.

Force and Translational Dynamics

$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$ 牛顿第二定律
 $F_d = -bv$ or $-cv^2$ terminal velocity is where $\sum F = 0$,
so $mg = bv_t$ 阻力
 $m \frac{dv}{dt} = mg - bv \Rightarrow v(t) = \frac{mg}{b} (1 - e^{-bt/m})$ separate
variables, integrate, apply $v(0) = 0$ 线性阻力下的落体
 $F_G = \frac{Gm_1m_2}{r^2}$, $a_c = \frac{v^2}{r}$ 万有引力与向心加速度

Free-body diagram first, choose axes along the motion,
then $\sum F = ma$ per axis.

Work, Energy, and Power

$W = \int \vec{F} \cdot d\vec{r}$, $P = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$ 功与瞬时功率
 $K = \frac{1}{2}mv^2$, $W_{\text{net}} = \Delta K$ 动能定理
 $F_x = -\frac{dU}{dx}$, $\Delta U = -\int \vec{F} \cdot d\vec{r}$ force is MINUS the
slope of the potential-energy curve 保守力与势能
 $U_g = -\frac{GMm}{r}$, $U_s = \frac{1}{2}kx^2$ the $-GMm/r$ form (zero
at infinity) is the Physics C one, not
 mgh 引力势能与弹性势能

On a $U(x)$ graph: minima are stable equilibria,
maxima unstable; turning points are where $E = U$.

Linear Momentum

$\vec{p} = m\vec{v}$, $\vec{J} = \int \vec{F} dt = \Delta\vec{p}$ 动量与冲量
 $\vec{r}_{cm} = \frac{\sum m_i \vec{r}_i}{\sum m_i}$, $\vec{r}_{cm} = \frac{1}{M} \int \vec{r} dm$ 质心

With no external force the centre of mass keeps
moving at constant velocity, whatever happens inside.

Elastic collision conserves p AND K ; perfectly
inelastic conserves only p and the bodies stick.

Torque and Rotational Dynamics

$\vec{\tau} = \vec{r} \times \vec{F}$, $\tau = rF \sin \theta$, $\sum \tau = I\alpha$ 力矩与转动定律
 $I = \int r^2 dm$ 转动惯量的积分定义
 $I_{\text{disc}} = \frac{1}{2}MR^2$, $I_{\text{rod,cm}} = \frac{1}{12}ML^2$, $I_{\text{sphere}} = \frac{2}{5}MR^2$ 常见转动惯量
 $I = I_{cm} + Md^2$ 平行轴定理
Rolling without slipping: $v_{cm} = R\omega$ and friction does
no work (the contact point is instantaneously at rest).

Energy and Momentum of Rotating Systems

$K_{\text{rot}} = \frac{1}{2}I\omega^2$, $K_{\text{total}} = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$ 转动动能与滚动总动能

$\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$, $\vec{\tau} = \frac{d\vec{L}}{dt}$ 角动量

Angular momentum is conserved when the net external
torque is zero, even in a collision that loses energy.

Kepler 2 is just conservation of L : equal areas in equal
times.

Oscillations

$\frac{d^2x}{dt^2} = -\omega^2x \Rightarrow x(t) = A \cos(\omega t + \phi)$ recognise this
differential equation and you have the period
immediately 简谐运动方程

$\omega_s = \sqrt{\frac{k}{m}}$, $\omega_p = \sqrt{\frac{g}{L}}$, $\omega_{\text{phys}} = \sqrt{\frac{mgd}{I}}$ 弹簧、单摆与复摆
 $E = \frac{1}{2}kA^2$, $v_{\text{max}} = A\omega$, $a_{\text{max}} = A\omega^2$ 简谐运动的能量与极值

To prove SHM: show the restoring force (or torque) is
proportional to $-x$ (or $-\theta$), then read ω^2 off the
coefficient.

Exam technique

Set up the integral or differential equation explicitly.
Physics C awards the setup, so write $\int$ with its limits
before evaluating.

Check limits: does your answer behave sensibly as
 $t \rightarrow \infty$, $m \rightarrow 0$, or $r \rightarrow \infty$? Say so; examiners credit
it.

Symbols before numbers. Derive an algebraic result,
then substitute once at the end.