A-Level Physics

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

Mechanics and materials

$v = u + at, \quad s = ut + \frac{1}{2}at^2, \quad v^2 = u^2 + 2as$ constant acceleration only 匀加速公式

$F = ma = \frac{\Delta p}{\Delta t}, \quad p = mv$ resultant force = rate of change of momentum 动量

$W = Fs\cos\theta, \quad P = Fv, \quad E_k = \frac{1}{2}mv^2$ power = force × velocity

stress $\sigma = \frac{F}{A}$, strain $\varepsilon = \frac{\Delta L}{L}$ 应力与应变

$E = \frac{\sigma}{\varepsilon} = \frac{FL}{A\,\Delta L}$ Young modulus = gradient of the stress-strain graph 杨氏模量

$E_{\text{elastic}} = \frac{1}{2}Fx = \frac{1}{2}kx^2$ area under a force-extension graph

Conservation of momentum in all collisions; kinetic energy conserved only when elastic.

Circular motion and gravitation

$\omega = \frac{2\pi}{T} = 2\pi f, \quad v = r\omega$ 角速度

$a = \frac{v^2}{r} = r\omega^2, \quad F = \frac{mv^2}{r}$ centripetal –directed towards the centre 向心力

$F = \frac{GMm}{r^2}, \quad g = \frac{GM}{r^2}$ 万有引力

$\phi = -\frac{GM}{r}, \quad v = \sqrt{\frac{GM}{r}}$ gravitational potential; orbital speed

$T^2 = \frac{4\pi^2}{GM}r^3$ Kepler's third law (circular orbit)

Oscillations and waves

$a = -\omega^2 x$ defining condition of SHM 简谐运动

$x = x_0\cos\omega t, \quad v = \pm\omega\sqrt{x_0^2 - x^2}$ $v_{\max} = \omega x_0$ at the centre

$E_{\text{total}} = \frac{1}{2}m\omega^2 x_0^2$

Resonance and damping 共振与阻尼: resonance = maximum amplitude when the driving frequency equals the natural frequency; damping reduces amplitude and lowers the resonant peak

$v = f\lambda$, intensity $\propto$ amplitude^2

$d\sin\theta = n\lambda$ diffraction grating; two-source fringes $\lambda = \frac{ax}{D}$ 衍射光栅

Thermal and ideal gases

$pV = nRT = NkT$ 理想气体

$pV = \frac{1}{3}Nm\langle c^2\rangle, \quad \frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ mean kinetic energy $\propto$ absolute temperature

$Q = mc\Delta\theta, \quad Q = mL$ L = specific latent heat 比热容

$\Delta U = q + w$ first law of thermodynamics; internal energy of an ideal gas depends only on T

Fields and electricity

$E = \frac{V}{d} = \frac{F}{q}, \quad E = \frac{Q}{4\pi\varepsilon_0 r^2}$ 电场

$V = \frac{Q}{4\pi\varepsilon_0 r}, \quad F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$ Coulomb's law 电势

$C = \frac{Q}{V}, \quad W = \frac{1}{2}QV = \frac{1}{2}CV^2$ 电容

decay: $V = V_0e^{-t/RC}$ capacitor discharge; time constant $\tau = RC$

$V = IR, \quad P = VI = I^2R, \quad R = \frac{\rho L}{A}$ 电阻率

$\varepsilon = I(R + r)$ e.m.f. = terminal p.d. + lost volts across internal resistance r

Magnetic fields and induction

$F = BIL\sin\theta, \quad F = BQv$ force on a current / a moving charge 磁场力

$\Phi = BA$, flux linkage $= N\Phi$ 磁通量

$\varepsilon = -\frac{d(N\Phi)}{dt}$ Faraday's law; the minus sign is Lenz's law 法拉第定律

Fleming's left hand = motor (force); right hand = generator (induced current).

Quantum and nuclear

$E = hf = \frac{hc}{\lambda}$ 光子能量

$hf = \varphi + E_{k,\max}$ photoelectric equation; φ = work function 光电效应

$\lambda = \frac{h}{p} = \frac{h}{mv}$ 德布罗意波长

$\Delta E = \Delta mc^2$ mass defect $\times c^2$ = binding energy 质能方程

$A = \lambda N = A_0e^{-\lambda t}, \quad t_{1/2} = \frac{\ln 2}{\lambda}$ 放射性衰变

Binding energy per nucleon peaks at iron-56; fusion (light nuclei) and fission (heavy nuclei) both move towards it, releasing energy.