

## **Hong Kong Diploma of Secondary Education Examination**

### **Physics**

The following list of data, formulae and relationships will be provided in the question papers for candidates' reference:

## List of data, formulae and relationships

### Data

molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$	
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$	
acceleration due to gravity	$g = 9.81 \text{ m s}^{-2}$ (close to the Earth)	
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
charge of electron	$q_e = 1.60 \times 10^{-19} \text{ C}$	
electron rest mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$	
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$	
atomic mass unit	$u = 1.661 \times 10^{-27} \text{ kg}$	(1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11} \text{ m}$	
light year	$\text{ly} = 9.46 \times 10^{15} \text{ m}$	
parsec	$\text{pc} = 3.09 \times 10^{16} \text{ m} = 3.26 \text{ ly} = 206265 \text{ AU}$	
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	

### Rectilinear motion

For uniformly accelerated motion :

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

### Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles,  $\sin \theta \approx \tan \theta \approx \theta$  (in radians)

<p><b>Astronomy and Space Science</b></p> <p><math>U = -\frac{GMm}{r}</math>      gravitational potential energy</p> <p><math>P = \sigma AT^4</math>      Stefan's law</p> <p><math>\left  \frac{\Delta f}{f_0} \right  \approx \frac{v}{c} \approx \left  \frac{\Delta \lambda}{\lambda_0} \right </math>      Doppler effect</p>	<p><b>Energy and Use of Energy</b></p> <p><math>E = \frac{\Phi}{A}</math>      illuminance</p> <p><math>\frac{Q}{t} = \kappa \frac{A(T_H - T_C)}{d}</math>      rate of energy transfer by conduction</p> <p><math>U = \frac{\kappa}{d}</math>      thermal transmittance U-value</p> <p><math>P = \frac{1}{2} \rho A v^3</math>      maximum power by wind turbine</p>
<p><b>Atomic World</b></p> <p><math>\frac{1}{2} m_e v_{\max}^2 = hf - \phi</math>      Einstein's photoelectric equation</p> <p><math>E_n = -\frac{1}{n^2} \left\{ \frac{m_e q_e^4}{8h^2 \epsilon_0^2} \right\} = -\frac{13.6}{n^2} \text{ eV}</math>      energy level equation for hydrogen atom</p> <p><math>\lambda = \frac{h}{p} = \frac{h}{mv}</math>      de Broglie formula</p> <p><math>\theta \approx \frac{1.22\lambda}{d}</math>      Rayleigh criterion (resolving power)</p>	<p><b>Medical Physics</b></p> <p><math>\theta \approx \frac{1.22\lambda}{d}</math>      Rayleigh criterion (resolving power)</p> <p>power = <math>\frac{1}{f}</math>      power of a lens</p> <p><math>L = 10 \log \frac{I}{I_0}</math>      intensity level (dB)</p> <p><math>Z = \rho c</math>      acoustic impedance</p> <p><math>\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}</math>      intensity reflection coefficient</p> <p><math>I = I_0 e^{-\mu x}</math>      transmitted intensity through a medium</p>

A1.	$E = mc \Delta T$	energy transfer during heating and cooling	D1.	$F = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2}$	Coulomb's law
A2.	$E = l \Delta m$	energy transfer during change of state	D2.	$E = \frac{Q}{4\pi\epsilon_0 r^2}$	electric field strength due to a point charge
A3.	$pV = nRT$	equation of state for an ideal gas	D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
A4.	$pV = \frac{1}{3} Nmc^2$	kinetic theory equation	D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy	D5.	$R = R_1 + R_2$	resistors in series
			D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
B1.	$F = m \frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force	D7.	$P = IV = I^2 R$	power in a circuit
B2.	moment = $F \times d$	moment of a force	D8.	$F = BQv \sin \theta$	force on a moving charge in a magnetic field
B3.	$E_P = mgh$	gravitational potential energy	D9.	$F = BIl \sin \theta$	force on a current-carrying conductor in a magnetic field
B4.	$E_K = \frac{1}{2} mv^2$	kinetic energy	D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
B5.	$P = Fv$	mechanical power	D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration	D12.	$\mathcal{E} = N \frac{\Delta \Phi}{\Delta t}$	induced e.m.f.
B7.	$F = \frac{Gm_1 m_2}{r^2}$	Newton's law of gravitation	D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
C1.	$\Delta y = \frac{\lambda D}{a}$	fringe separation in double-slit interference	E1.	$N = N_0 e^{-kt}$	law of radioactive decay
C2.	$d \sin \theta = n\lambda$	diffraction grating equation	E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens	E3.	$A = kN$	activity and the number of undecayed nuclei
			E4.	$\Delta E = \Delta mc^2$	mass-energy relationship