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 \( e = 1.60 \times 10^{-19} \text{ C} \)
electron rest mass \( m_e = 9.11 \times 10^{-31} \text{ kg} \)
permittivity of free space \( \varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \)
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:

\[
\begin{align*}
v &= u + at \\
s &= ut + \frac{1}{2}at^2 \\
v^2 &= u^2 + 2as
\end{align*}
\]

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)

Astronomy and Space Science

\[
U = \frac{GMm}{r}
\]
gravitational potential energy
\[
P = \sigma AT^4
\]
Stefan’s law
\[
\frac{\Delta f}{f_0} \approx \frac{v}{c} \approx \frac{\Delta \lambda}{\lambda_0}
\]
Doppler effect

Energy and Use of Energy

\[
E = \frac{\Phi}{A}
\]
illuminance
\[
\frac{Q}{t} = \kappa \frac{A(T_H - T_C)}{d}
\]
rate of energy transfer by conduction
\[
U = \frac{\kappa}{d}
\]
thermal transmittance U-value
\[
P = \frac{1}{2} \rho Av^3
\]
maximum power by wind turbine

Atomic World

\[
\frac{1}{2} m_e v_{\text{max}}^2 = hf - \phi
\]
Einstein’s photoelectric equation
\[
E_n = \frac{1}{n^2} \left( \frac{m_e e^4}{8\hbar^2 e_0^2} \right) = 13.6 \text{ eV}
\]
energy level equation for hydrogen atom
\[
\lambda = \frac{h}{p} = \frac{h}{mv}
\]
de Broglie formula
\[
\theta \approx \frac{1.22\lambda}{d}
\]
Rayleigh criterion (resolving power)

Medical Physics

\[
\theta \approx \frac{1.22\lambda}{d}
\]
Rayleigh criterion (resolving power)
\[
power = \frac{1}{f}
\]
power of a lens
\[
L = 10 \log \frac{f}{I_0}
\]
intensity level (dB)
\[
Z = \rho c
\]
acoustic impedance
\[
\alpha = \frac{I_L}{I_0} = \left( \frac{Z_2 - Z_1}{Z_2 + Z_1} \right)^2
\]
intensity reflection coefficient
\[
I = I_0 e^{-\mu x}
\]
transmitted intensity through a medium
A1. \( E = mc \Delta T \) energy transfer during heating and cooling

A2. \( E = l \Delta m \) energy transfer during change of state

A3. \( pV = nRT \) equation of state for an ideal gas

A4. \( pV = \frac{1}{3} Nmc^2 \) kinetic theory equation

A5. \( E_K = \frac{3RT}{2N_A} \) molecular kinetic energy

A6. \( E_K = \frac{1}{2} Nmc^2 \) equation of state for an ideal gas

D1. \( F = \frac{Q_1 Q_2}{4 \pi \varepsilon_0 r^2} \) Coulomb’s law

D2. \( E = \frac{Q}{4 \pi \varepsilon_0 r^2} \) electric field strength due to a point charge

D3. \( E = \frac{V}{d} \) electric field between parallel plates (numerically)

D4. \( R = \frac{\rho l}{A} \) resistance and resistivity

D5. \( R = R_1 + R_2 \) resistors in series

D6. \( \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \) resistors in parallel

D7. \( P = IV = I^2 R \) power in a circuit

D8. \( F = BQv \sin \theta \) force on a moving charge in a magnetic field

D9. \( F = BIl \sin \theta \) force on a current-carrying conductor in a magnetic field

D10. \( B = \frac{\mu_0 I}{2\pi r} \) magnetic field due to a long straight wire

D11. \( B = \frac{\mu_0 NI}{l} \) magnetic field inside a long solenoid

D12. \( \varepsilon = N \frac{\Delta \Phi}{\Delta t} \) induced e.m.f.

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 width in double-slit interference

C2. \( d \sin \theta = n \lambda \) diffraction grating equation

C3. \( \frac{1}{u} + \frac{1}{v} = \frac{1}{f} \) equation for a single lens

E1. \( N = N_0 e^{-\lambda t} \) law of radioactive decay

E2. \( \lambda \approx \frac{\ln 2}{k} \) half-life and decay constant

E3. \( A = kN \) activity and the number of undecayed nuclei

E4. \( \Delta E = \Delta mc^2 \) mass-energy relationship