AS Level Physics Formula Sheet

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February 17, 2024

Contents

1 Kinematics **3**
- 1.1 Speed, Velocity and Acceleration . . . 3
- 1.2 Equations of Motion (SUVAT) . . . 3

2 Projectile Motion **3**
- 2.1 Maximum Height . . . 3
- 2.2 Time of Flight . . . 3
- 2.3 Horizontal Range . . . 4

3 Dynamics **4**
- 3.1 Newton's Laws . . . 4
- 3.2 Equilibrium . . . 4
- 3.3 Moments . . . 4
- 3.4 Principle of Conservation of Momentum . . . 4
- 3.5 Elastic Collision . . . 4
- 3.6 Kinetic Energy and Momentum . . . 5

4 Work, Power, Energy **5**
- 4.1 Gravitational Potential Energy . . . 5
- 4.2 Kinetic Energy . . . 5
- 4.3 Work . . . 5
- 4.4 Power . . . 5
- 4.5 Efficiency . . . 5

5 Fluid Dynamics **5**
- 5.1 Density . . . 5
- 5.2 Pressure . . . 6
- 5.3 Hydrostatic Pressure . . . 6
- 5.4 (*) Stoke's Law . . . 6

6 Deformation of Solids **6**
6.1 Hooke's Law . . . 6
6.2 Combination of Springs (Series) . . . 6
6.3 Combination of Springs (Parallel) . . . 7
6.4 Elastic Potential Energy . . . 7
6.5 Stress . . . 7
6.6 Tensile Strain . . . 7
6.7 Young's Modulus . . . 7

7 Electricity **7**
7.1 Electric Current . . . 7
7.2 Drift Velocity . . . 8
7.3 Potential Difference . . . 8
7.4 Electrical Resistance . . . 8
7.5 Electric Power . . . 8
7.6 Electric Energy . . . 8
7.7 Resistivity . . . 8
7.8 Internal Resistance . . . 8
7.9 Kirchhoff's Current Law (KCL) . . . 8
7.10 Kirchhoff's Voltage Law (KVL) . . . 9
7.11 Combined Resistance (Series) . . . 9
7.12 Combined Resistance (Parallel) . . . 9
7.13 Potential Dividers . . . 9

8 Waves **9**
8.1 Wave Equation . . . 9
8.2 Doppler Effect of Sound Waves . . . 9
8.3 Malu's Law . . . 9
8.4 (*) Intensity of a Wave . . . 9
8.5 Relation of Phase and Path Difference . . . 10
8.6 Constructive Interference . . . 10
8.7 Destructive Interference . . . 10
8.8 Young's Double-Slit Experiment . . . 10
8.9 Diffraction at an angle . . . 10
8.10 Stationary Waves: Closed Pipe . . . 10
8.11 Stationary Waves: Open Pipe . . . 10

9 Particle Physics **10**
9.1 α Decay . . . 10
9.2 β^- Decay . . . 11
9.3 β^+ Decay . . . 11
9.4 γ Decay . . . 11

1 Kinematics

1.1 Speed, Velocity and Acceleration

$$s = \frac{\Delta d}{\Delta t}$$

$$\vec{\boldsymbol{v}} = \frac{\Delta \vec{\boldsymbol{s}}}{\Delta t}$$

$$\vec{\boldsymbol{a}} = \frac{\Delta \vec{\boldsymbol{v}}}{\Delta t}$$

$$\vec{\boldsymbol{a}}_{avg} = \frac{\text{total displacement}}{\text{total time taken}}$$

1.2 Equations of Motion (SUVAT)

$$\vec{\boldsymbol{v}} = \vec{\boldsymbol{u}} + \vec{\boldsymbol{a}}t$$

$$\vec{\boldsymbol{s}} = \vec{\boldsymbol{u}}t + \frac{1}{2}\vec{\boldsymbol{a}}t^2$$

$$\vec{\boldsymbol{s}} = \vec{\boldsymbol{v}}t - \frac{1}{2}\vec{\boldsymbol{a}}t^2$$

$$\vec{\boldsymbol{v}}^2 = \vec{\boldsymbol{u}}^2 + 2\vec{\boldsymbol{a}}\vec{\boldsymbol{s}}$$

$$\vec{\boldsymbol{s}} = \left(\frac{\vec{\boldsymbol{u}} + \vec{\boldsymbol{v}}}{2}\right) t$$

2 Projectile Motion

2.1 Maximum Height

$$H_{max} = \frac{\vec{\boldsymbol{u}}^2 \sin^2\theta}{2g}$$

2.2 Time of Flight

$$T = \frac{2\vec{\boldsymbol{u}}\sin\theta}{g}$$

2.3 Horizontal Range

$$R = \frac{2\vec{\boldsymbol{u}}^2 \sin\theta\cos\theta}{g}$$

$$R = \frac{\vec{\boldsymbol{u}}^2 \sin(2\theta)}{g}$$

3 Dynamics

3.1 Newton's Laws

$$\vec{\boldsymbol{p}} = m\vec{\boldsymbol{v}}$$

$$\vec{\boldsymbol{F}} = \frac{\Delta\vec{\boldsymbol{p}}}{t}$$

$$\vec{\boldsymbol{F}} = \frac{m(\vec{\boldsymbol{v}} - \vec{\boldsymbol{u}})}{t}$$

$$\vec{\boldsymbol{F}} = m\vec{\boldsymbol{a}}$$

3.2 Equilibrium

$$\Sigma\vec{\boldsymbol{F}} = 0$$

$$\Sigma\tau = 0$$

3.3 Moments

$$\tau = \vec{\boldsymbol{F}} \cdot d$$

$$\Sigma M_{cw} = \Sigma M_{acw}$$

3.4 Principle of Conservation of Momentum

$$\vec{\boldsymbol{p}}_f = \vec{\boldsymbol{p}}_i$$

3.5 Elastic Collision

$$m_1\vec{\boldsymbol{u}}_1 + m_2\vec{\boldsymbol{u}}_2 = m_1\vec{\boldsymbol{v}}_1 + m_2\vec{\boldsymbol{v}}_2$$

$$\frac{1}{2}m_1\vec{\boldsymbol{u}}_1^2 + \frac{1}{2}m_2\vec{\boldsymbol{u}}_2^2 = \frac{1}{2}m_1\vec{\boldsymbol{v}}_1^2 + \frac{1}{2}m_2\vec{\boldsymbol{v}}_2^2$$

3.6 Kinetic Energy and Momentum

$$E_k = \frac{\vec{\boldsymbol{p}}}{2m}$$

$$\frac{1}{2}m\vec{\boldsymbol{v}}^2 = \frac{\vec{\boldsymbol{p}}}{2m}$$

4 Work, Power, Energy

4.1 Gravitational Potential Energy

$$E = mgh$$

$$\Delta E = mg\Delta h$$

4.2 Kinetic Energy

$$E = \frac{1}{2}m\vec{\boldsymbol{v}}^2$$

4.3 Work

Note: if the object is not moving at an angle, $\theta = 0$ and $\cos\theta = 1$

$$W = \vec{\boldsymbol{F}} \cdot \vec{\boldsymbol{s}} \cos\theta$$

4.4 Power

$$P = \frac{W}{t} = \frac{E}{t}$$

$$P = \vec{\boldsymbol{F}} \cdot \vec{\boldsymbol{v}}$$

4.5 Efficiency

$$\eta = \frac{E_o}{E_i}$$

$$\eta = \frac{W_o}{W_i}$$

$$\eta = \frac{P_o}{P_i}$$

5 Fluid Dynamics

5.1 Density

$$\rho = \frac{m}{V}$$

5.2 Pressure

$$P = \frac{F}{A}$$

5.3 Hydrostatic Pressure

$$P = \rho g h$$

$$\Delta P = \rho g \Delta h$$

5.4 (*) Stoke's Law

Note: This is an extension of the CAIE 9702 Physics syllabus, we will only be using this equation to derive a relation.

$$\vec{\boldsymbol{F}}_v = 6\pi a \eta \vec{\boldsymbol{v}}$$

We can see that the force experienced due to the viscosity $\vec{\boldsymbol{F}}_v$, of the liquid is directly proportional to the speed $\vec{\boldsymbol{v}}$.

6 Deformation of Solids

6.1 Hooke's Law

$$\vec{\boldsymbol{F}} = kx$$

6.2 Combination of Springs (Series)

$$\Sigma x = x_1 + x_2 + ... + x_n$$

$$x_n = \frac{\vec{\boldsymbol{F}}}{k_n}$$

$$x_1 + x_2 + ... + x_n = \frac{\vec{\boldsymbol{F}}}{k_1} + \frac{\vec{\boldsymbol{F}}}{k_2} + ... + \frac{F}{k_n}$$

$$\vec{\boldsymbol{F}} = \left(\frac{1}{\Sigma K}\right) = \vec{\boldsymbol{F}}\left(\frac{1}{k_1} + \frac{1}{k_2} + ... + \frac{1}{k_n}\right)$$

$$\cancel{\vec{\boldsymbol{F}}}\left(\frac{1}{\Sigma K}\right) = \cancel{\vec{\boldsymbol{F}}}\left(\frac{1}{k_1} + \frac{1}{k_2} + ... + \frac{1}{k_n}\right)$$

$$\frac{1}{\Sigma K} = \frac{1}{k_1} + \frac{1}{k_2} + ... + \frac{1}{k_n}$$

6.3 Combination of Springs (Parallel)

$$\vec{\boldsymbol{F}} = kx$$
$$\Sigma\vec{\boldsymbol{F}} = \vec{\boldsymbol{F}}_1 + \vec{\boldsymbol{F}}_2 + ... + \vec{\boldsymbol{F}}_n$$
$$\Sigma\vec{\boldsymbol{F}} = k_1x + k_2x + ... + k_nx$$
$$\Sigma\vec{\boldsymbol{F}} = (k_1 + k_2 + ... + k_n)x$$

$$\Sigma k = k_1 + k_2 + ... + k_n$$

6.4 Elastic Potential Energy

$$E_p = \frac{1}{2}\vec{\boldsymbol{F}}x$$
$$E_p = \frac{1}{2}kx^2$$

6.5 Stress

Stress is essentially another word for pressure, however pressure is used when talking about fluids, and stress when talking about solids.

$$\sigma = \frac{F}{A}$$

6.6 Tensile Strain

Tensile Strain is the only type of strain in syllabus.

$$\text{strain} = \frac{\Delta l}{l}$$

6.7 Young's Modulus

$$E = \frac{\vec{\boldsymbol{F}}L}{Ax}$$

7 Electricity

7.1 Electric Current

$$I = \frac{Q}{t}$$
$$I = \frac{ne}{t}$$

7.2 Drift Velocity

$$I = nA\vec{\boldsymbol{v}}_d e$$

$$\vec{\boldsymbol{v}}_d = \frac{1}{nAe}$$

7.3 Potential Difference

$$V = \frac{E}{Q}$$

$$V = \frac{W}{Q}$$

7.4 Electrical Resistance

$$R = \frac{V}{I}$$

7.5 Electric Power

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

7.6 Electric Energy

$$E = I^2 Rt$$

$$E = \frac{V^2 t}{R}$$

7.7 Resistivity

$$\rho = \frac{RA}{L}$$

7.8 Internal Resistance

$$E = IR + Ir$$

$$E = I(R + r)$$

7.9 Kirchhoff's Current Law (KCL)

$$\Sigma I = 0$$

$$I_{in} = I_{out}$$

7.10 Kirchhoff's Voltage Law (KVL)

$$\Sigma E = \Sigma V$$

$$\Sigma E = \Sigma(IR)$$

7.11 Combined Resistance (Series)

$$\Sigma R = R_1 + R_2 + ... + R_n$$

7.12 Combined Resistance (Parallel)

$$\frac{1}{\Sigma R} = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_n}$$

7.13 Potential Dividers

Note: Here V_1 is the voltage of the top resistor, and V_2 is the voltage of the bottom resistor.

$$V_1 = \left(\frac{V}{R_1 + R_2}\right) \cdot R_1$$

$$V_2 = \left(\frac{V}{R_1 + R_2}\right) \cdot R_2$$

8 Waves

8.1 Wave Equation

$$\vec{\boldsymbol{v}} = f\lambda$$

8.2 Doppler Effect of Sound Waves

$$f = f_o\left(\frac{v}{v \pm v_s}\right)$$

8.3 Malu's Law

$$I = I_o \cos^2\theta$$

8.4 (*) Intensity of a Wave

This is not a required formula to know, only the relation we can derive from it.

$$I = 2\pi^2 f^2 A^2 \rho \vec{\boldsymbol{v}}$$

We can see that intensity is directly proportional to amplitude squared (A^2) as well as a few other relations.

8.5 Relation of Phase and Path Difference

Here Δx is the path difference

$$\phi = \frac{2\pi}{\lambda} \cdot \Delta x$$

8.6 Constructive Interference

$$\phi = 2n\pi$$

8.7 Destructive Interference

$$\phi = (2n+1)\pi$$

8.8 Young's Double-Slit Experiment

$$\lambda = \frac{ax}{D}$$

8.9 Diffraction at an angle

$$\lambda = \frac{d \sin\theta}{n}$$

$$d = \frac{1}{c}$$

8.10 Stationary Waves: Closed Pipe

For n = 0, 1, 2, 3, ...

$$L = \frac{(2n+1)\lambda}{4}$$

8.11 Stationary Waves: Open Pipe

For n = 1, 2, 3, ...

$$L = \frac{n\lambda}{2}$$

9 Particle Physics

9.1 α Decay

Note: Here ${}^{0}_{0}\gamma$ is the energy released, you will learn about this in A2.

$${}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} \longrightarrow {}^{4}_{2}\mathrm{He} + {}^{\mathrm{A}-4}_{\mathrm{Z}-2}\mathrm{Y} + {}^{0}_{0}\gamma$$

$${}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} \longrightarrow {}^{4}_{2}\alpha + {}^{\mathrm{A}-4}_{\mathrm{Z}-2}\mathrm{Y} + {}^{0}_{0}\gamma$$

9.2 β^- Decay

$$
\begin{aligned}
{}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} &\longrightarrow {}^{0}_{-1}\mathrm{e} + {}^{\mathrm{A}}_{\mathrm{Z}+1}\mathrm{Y} + {}^{0}_{0}\bar{\nu} + {}^{0}_{0}\gamma \\
{}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} &\longrightarrow {}^{0}_{-1}\beta^- + {}^{\mathrm{A}}_{\mathrm{Z}+1}\mathrm{Y} + {}^{0}_{0}\bar{\nu} + {}^{0}_{0}\gamma
\end{aligned}
$$

$$
{}^{1}_{0}\mathrm{n} \longrightarrow {}^{0}_{-1}\mathrm{e} + {}^{1}_{1}\mathrm{p}
$$

9.3 β^+ Decay

$$
\begin{aligned}
{}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} &\longrightarrow {}^{0}_{1}\mathrm{e} + {}^{\mathrm{A}}_{\mathrm{Z}-1}\mathrm{Y} + {}^{0}_{0}\nu^{+}\,{}^{0}_{0}\gamma \\
{}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X} &\longrightarrow {}^{0}_{1}\beta^{+} + {}^{\mathrm{A}}_{\mathrm{Z}-1}\mathrm{Y} + {}^{0}_{0}\nu^{+}\,{}^{0}_{0}\gamma
\end{aligned}
$$

$$
{}^{1}_{1}\mathrm{p} \longrightarrow {}^{0}_{1}\mathrm{e} + {}^{1}_{0}\mathrm{n}
$$

9.4 γ Decay

$$
{}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{Y}^{*} \longrightarrow {}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{Y} + {}^{0}_{0}\gamma
$$