

EMIRATES AIRLINE

Pilot Aptitude Test

PHYSICS FORMULA GUIDE

COMPASS System • Formula Reference • No Calculator Preparation

Core equations, units, and quick-recall triangles

Prepared by AURA TUTORIAL

Contact: 0553220300

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How to use this guide. Learn the symbols and units first, memorise the boxed relationships, then practise rearranging each equation before substituting values.

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2 Mechanics and Newton's Laws

2.1 Core quantities

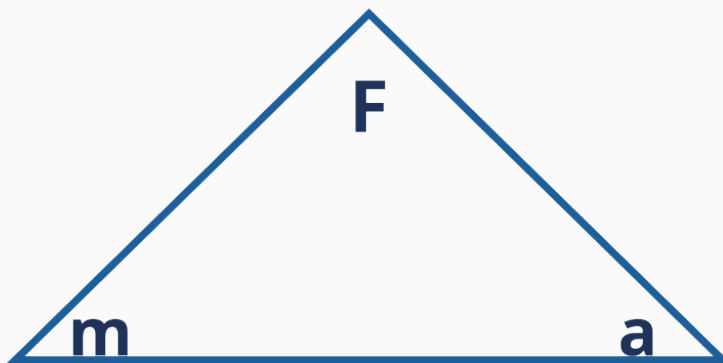
Quantity	Symbol	SI unit
Mass	m	kilogram (kg)
Displacement	s or d	metre (m)
Velocity	v	metre per second (m/s)
Acceleration	a	metre per second squared (m/s ²)
Force	F	newton (N)

Newton's Second Law

$$F = ma$$

Force = mass × acceleration

Force triangle



$$F = m a \quad | \quad m = F/a \quad | \quad a = F/m$$

Weight

$$W = mg$$

$g \approx 9.81$

$\frac{m}{s^2}$ near Earth's surface

Momentum

$$p = mv$$

Unit: kg·m/s

Impulse

$$J = F\Delta t = \Delta p$$

Impulse equals change in momentum.

Kinematic equation

$$v = u + at$$

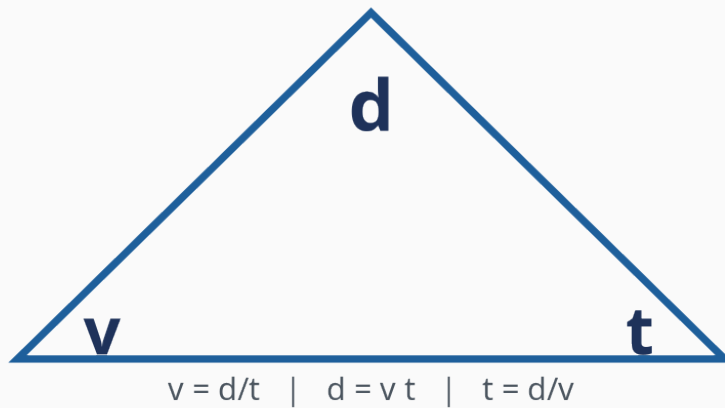
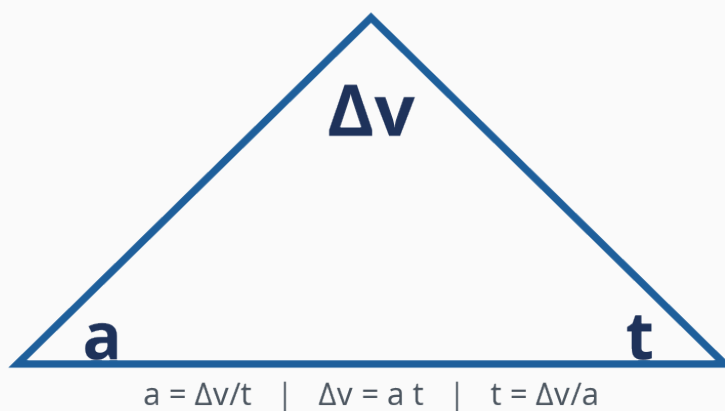
Displacement under constant acceleration

$$s = ut + \left(\frac{1}{2}\right)at^2$$

Velocity–displacement relation

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

3 Speed, Distance, Time, and Acceleration

Speed triangle**Acceleration triangle****Average speed**

$$v_{\text{avg}} = \frac{d_{\text{total}}}{t_{\text{total}}}$$

Unit conversions

$$1 \text{ knot} = 1.852 \text{ km/h}$$

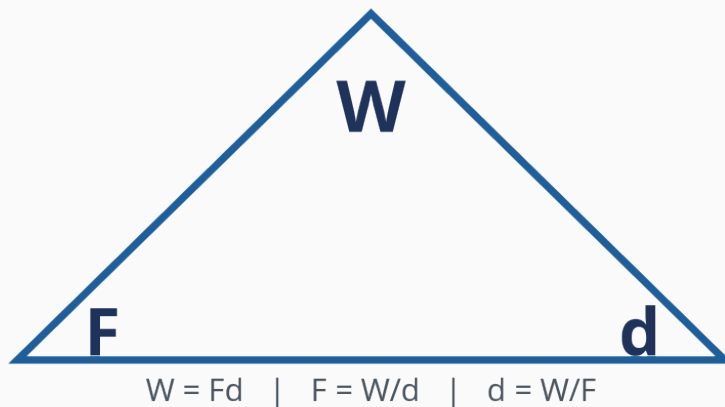
$$1 \text{ NM} = 1.852 \text{ km}$$

Uniform motion

$$d = vt$$

Keep time units consistent with the speed unit.

4 Work, Energy, and Power

Work triangle**Work at an angle**

$$W = Fd \cos \theta$$

If force and displacement are parallel, $\cos \theta = 1$.

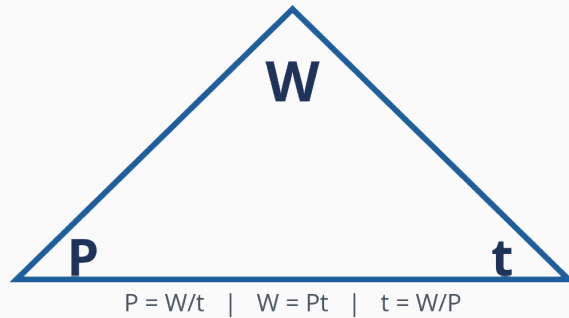
Kinetic energy

$$E_k = \left(\frac{1}{2}\right)mv^2$$

Gravitational potential energy

$$E_p = mgh$$

Power triangle



Mechanical power

$$P = Fv$$

Valid when force and velocity are parallel.

Efficiency

$$\eta = (\text{useful output} / \text{total input}) \times 100\%$$

5 Fluid Dynamics and Aerodynamics

Density

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

Unit: kg/m³

Pressure

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

Unit: pascal (Pa) = N/m²

Liquid pressure

$$p = \rho gh$$

Continuity equation

$$A_1 v_1 = A_2 v_2$$

For steady incompressible flow.

Bernoulli equation

$$p + (1/2) \rho v^2 + \rho g h = \text{constant}$$

Lift relationship

$$L = \left(\frac{1}{2}\right) \rho v^2 S C_L$$

S is wing area; C_L is the lift coefficient.

Drag relationship

$$D = \left(\frac{1}{2}\right) \rho v^2 S C_D$$

C_D is the drag coefficient.

6 Gas Laws and Thermodynamics

Boyle's Law

$$p_1 V_1 = p_2 V_2$$

Constant temperature and fixed mass of gas.

Charles's Law

$$V \frac{1}{T_1} = V \frac{2}{T_2}$$

Use absolute temperature in kelvin.

Gay-Lussac's Law

$$p \frac{1}{T_1} = p \frac{2}{T_2}$$

Constant volume and fixed mass.

Combined gas law

$$p_1 V \frac{1}{T_1} = p_2 V \frac{2}{T_2}$$

Ideal gas law

$$pV = nRT$$

R is the universal gas constant.

Heat energy

$$Q = mc\Delta T$$

c is specific heat capacity.

Latent heat

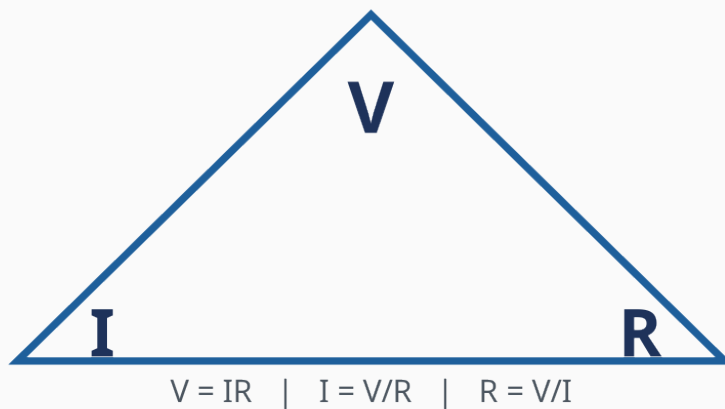
$$Q = mL$$

Applies during a change of state.

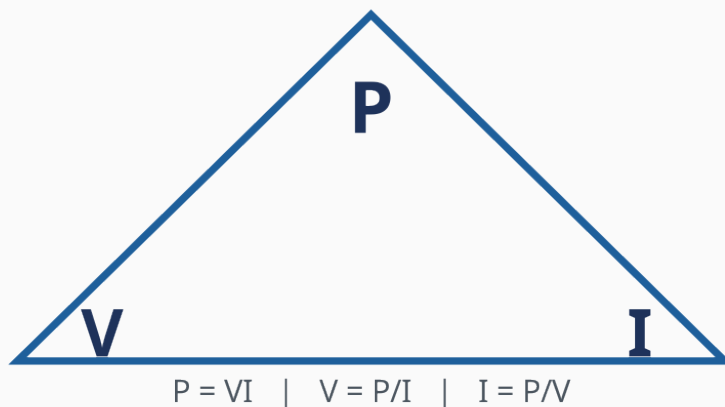
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7 Electricity and Magnetism

Ohm's Law triangle



Electrical power triangle



Electrical charge

$$Q = It$$

Unit: coulomb (C).

Electrical energy

$$E = Pt = Vit$$

Series resistance

$$R_{\text{total}} = R_1 + R_2 + \dots$$

Parallel resistance

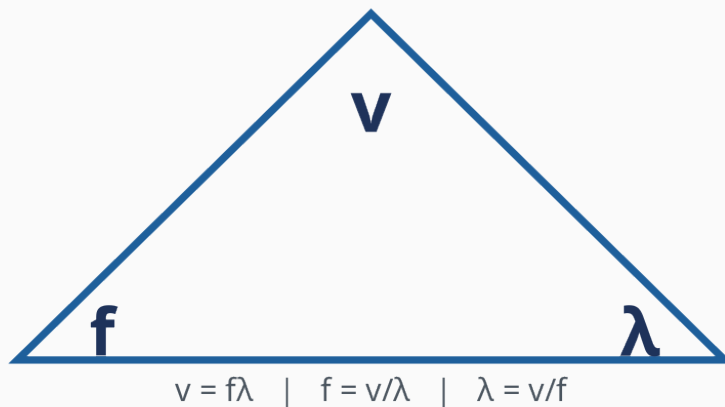
$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

Electrical force

$$F = qE$$

8 Waves, Sound, and Optics

Wave-speed triangle



Wave period and frequency

$$f = \frac{1}{T}$$

Frequency in hertz (Hz); period in seconds (s).

Echo distance

$$d = v \frac{t}{2}$$

Divide by two because the sound travels out and back.

Refraction law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Refractive index

$$n = \frac{c}{v}$$

Lens equation

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

9 Circular Motion, Torque, and Gravitation

Centripetal acceleration

$$a_c = v \frac{v}{r} = \omega^2 r$$

Centripetal force

$$F_c = mv \frac{v}{r}$$

Angular speed

$$\omega = \frac{\theta}{t} = 2\pi f$$

Torque

$$\tau = Fr \sin \theta$$

Maximum torque occurs when the force is perpendicular.

Gravitational force

$$F = Gm_1 m_2 \frac{1}{r^2}$$

Orbital speed

$$v = \sqrt{G \frac{M}{r}}$$

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10 Properties of Matter and Simple Machines

Pressure in a fluid

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

Hooke's Law

$$F = kx$$

k is the spring constant.

Elastic potential energy

$$E_e = \left(\frac{1}{2}\right)kx^2$$

Mechanical advantage

$$\text{MA} = \text{load} / \text{effort}$$

Moments balance

$$F_1 d_1 = F_2 d_2$$

Hydraulic principle

$$F \frac{1}{A_1} = F \frac{2}{A_2}$$

11 Aviation Applications and Constants

Constant or reference	Symbol	Useful value
Gravitational acceleration	g	9.81 m/s ²
Speed of light in vacuum	c	3.00×10^8 m/s
Speed of sound in air at sea level	a	approximately 340 m/s
Standard atmospheric pressure	p_0	101,325 Pa
Absolute zero		-273.15 °C = 0 K
One knot		1.852 km/h
One nautical mile		1,852 m

Mach number

$$M = \frac{v}{a}$$

Aircraft speed divided by local speed of sound.

Takeoff kinetic energy

$$E_k = \left(\frac{1}{2}\right)mv^2$$

Increasing speed has a squared effect on kinetic energy.

Fuel burn

$$\text{Fuel used} = \text{burn rate} \times \text{time}$$

Descent time

$$\text{Time} = \text{altitude lost} / \text{descent rate}$$

12 Exam Method and Unit Checklist

1. Write the known quantities and convert them to compatible units.
2. Select the equation that contains the unknown and the known values.
3. Rearrange the equation before substituting numbers.
4. Check the dimensions: force should end in newtons, energy in joules, power in watts, and pressure in pascals.

5. Estimate the answer to detect an incorrect option or a misplaced decimal.
6. For aviation calculations, distinguish knots from kilometres per hour and nautical miles from kilometres.

Quick reminder. Do not confuse mass (kg) with weight (N), speed (m/s) with acceleration (m/s²), or power (W) with energy (J).

13 Formula Index

Topic	Main symbol	Key relationship
Motion	v, a, d, t	$v = \frac{d}{t}, a = \Delta \frac{v}{t}$
Forces	F, m, a	$F = ma, W = mg$
Energy and power	E, W, P	$E_k = (\frac{1}{2})mv^2, P = \frac{W}{t}$
Fluids	p, ρ, A, v	$p = \frac{F}{A}, A_1 v_1 = A_2 v_2$
Thermodynamics	p, V, T	$pV = nRT$
Electricity	V, I, R	$V = IR, P = VI$
Waves	v, f, λ	$v = f\lambda$
Circular motion	F_c, a_c, r	$F_c = mv_r^2$
Materials	ρ, p, k	$\rho = \frac{m}{V}, F = kx$

AURA TUTORIAL

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