

Grade 11 Physics: formula sheet

Kinematics, forces, energy, waves, electricity and heat · 43 formulas · metric edition 1

MODULE 1 · KINEMATICS

Physics 11-1 Speed, Distance & Time

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

Average speed from distance travelled and elapsed time.

Physics 11-2 Final Velocity (Uniform Acceleration)

$$v = v_0 + at$$

Final velocity after accelerating uniformly from an initial velocity for a given time.

Physics 11-3 Displacement (Uniform Acceleration)

$$d = v_0 t + \frac{1}{2} at^2$$

Distance travelled under constant acceleration, starting from an initial velocity, over a time t.

MODULE 2 · FORCES & NEWTON'S LAWS

Physics 11-4 Newton's Second Law

$$F = ma$$

Force equals mass times acceleration.

Physics 11-5 Weight ($W = mg$)

$$W = mg$$

Weight of a mass at Earth's surface, using standard gravity $g = 9.80665 \text{ m/s}^2$ (exact by definition).

Physics 11-6 Kinetic Friction Force ($f = \mu_k N$)

$$f_k = \mu_k N$$

Friction force resisting a sliding surface, equal to the coefficient of kinetic friction times the...

Physics 11-7 Maximum Static Friction ($f = \mu_s N$)

$$f_{s,\max} = \mu_s N$$

Largest static friction force available before an object breaks loose and slides, from the static...

Physics 11-8 Hooke's Law

$$F = kx$$

Restoring force of an ideal spring, proportional to its displacement from rest.

Physics 11-9 Rope Tension When Lifting a Mass

$$T = m(g + a)$$

Tension in a rope lifting a mass with an upward acceleration, exceeding the static weight by the...

MODULE 3 · ENERGY, WORK & POWER

Physics 11-10 Work ($W = Fd \cos \theta$)

$$W = Fd \cos \theta$$

Work done by a constant force acting at an angle to the displacement.

Physics 11-11 Kinetic Energy

$$E_k = \frac{1}{2}mv^2$$

Energy of a mass in motion.

Physics 11-12 Gravitational Potential Energy ($U = mgh$)

$$U = mgh$$

Energy stored by raising a mass to height h near Earth's surface, with $g = 9.80665 \text{ m/s}^2$.

Physics 11-13 Work–Energy Theorem

$$W = \frac{1}{2}m(v^2 - v_0^2)$$

Net work done on an object equals its change in kinetic energy, linking force and distance to a...

Physics 11-14 Power ($P = W/t$)

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

Average power as work or energy delivered per unit time.

Physics 11-15 Power from Force and Velocity ($P = Fv$)

$$P = Fv$$

Instantaneous power delivered by a force parallel to the velocity.

Physics 11-16 Machine Efficiency

$$\eta = \frac{W_{out}}{W_{in}}$$

Efficiency of a machine as useful work out divided by work in, with the shortfall lost to friction,...

MODULE 4 · WAVES & SOUND

Physics 11-17 Period-Frequency Relation

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

Period and frequency are reciprocals: seconds per cycle versus cycles per second.

Physics 11-18 Wave Speed ($v = f\lambda$)

$$v = f\lambda$$

The universal wave equation: a wave's speed equals its frequency times its wavelength.

Physics 11-19 Speed of Sound in Air

$$v = 331.3 + 0.606 T_C$$

The speed of sound in dry air grows about 0.6 m/s for every degree Celsius above freezing.

Physics 11-20 Fundamental Frequency of a String

$$f = \frac{v}{2L}$$

Lowest standing-wave frequency of a string fixed at both ends.

Physics 11-21 Wave Speed on a String

$$v = \sqrt{\frac{F}{\mu}}$$

Waves travel faster on a tighter, lighter string: speed is the square root of tension over linear...

Physics 11-22 Harmonic Frequencies

$$f_n = n f_1$$

The nth harmonic of a vibrating system is n times its fundamental frequency.

Physics 11-23 Fundamental of a Closed Pipe

$$f = \frac{v}{4L}$$

A pipe closed at one end resonates with a quarter wavelength inside, giving a fundamental of $v/4L$.

Physics 11-24 Decibel Sound Level

$$\beta = 10 \log_{10} \left(\frac{I}{I_0} \right)$$

Sound level in decibels compares an intensity to the threshold of hearing, $I_0 = 10^{-12} \text{ W/m}^2$.

Physics 11-25 Sound Intensity ($I = P/A$)

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

Sound intensity is the acoustic power passing through each square metre of surface.

Physics 11-26 Inverse-Square Law for Sound

$$I = \frac{P}{4\pi r^2}$$

A point source's intensity falls with the square of distance as its power spreads over an expanding...

Physics 11-27 Doppler Effect (Approaching Source)

$$f' = \frac{fv}{v - v_s}$$

Observed frequency rises when a sound source approaches, as each wavefront is emitted closer to the...

Physics 11-28 Doppler Effect (Approaching Observer)

$$f' = \frac{f(v + v_o)}{v}$$

A listener moving toward a stationary source meets wavefronts more often and hears a higher...

Physics 11-29 Beat Frequency

$$f_{\text{beat}} = f_1 - f_2$$

Two nearby tones interfere to produce a loudness pulse at their difference frequency, with f₁ the...

MODULE 5 · ELECTRICITY & MAGNETISM

Physics 11-30 Electric Charge (Q = It)

$$Q = It$$

Total charge transferred by a steady current flowing for a given time.

Physics 11-31 Ohm's Law

$$V = IR$$

Relates the voltage across a conductor to the current through it and its resistance.

Physics 11-32 Two Resistors in Series

$$R_t = R_1 + R_2$$

Total resistance of two resistors connected end to end is simply their sum.

Physics 11-33 Two Resistors in Parallel

$$R_t = \frac{R_1 R_2}{R_1 + R_2}$$

Total resistance of two resistors connected side by side: product over sum, always less than either...

Physics 11-34 Electrical Power (P = VI)

$$P = VI$$

Power delivered to a component as the product of the voltage across it and the current through it.

Physics 11-35 Electrical Power (P = I²R)

$$P = I^2 R$$

Power dissipated as heat in a resistance carrying a current (Joule heating).

Physics 11-36 Electrical Power (P = V²/R)

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

Power dissipated in a resistance held at a fixed voltage.

Physics 11-37 Electrical Energy (E = Pt)

$$E = Pt$$

Energy consumed by a device drawing constant power over a period of time.

Physics 11-38 Magnetic Force on a Current-Carrying Wire

$$F = BIL \sin \theta$$

Magnitude of the force on a straight current-carrying wire in a uniform magnetic field.

Physics 11-39 Transformer Voltage Ratio

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Relates the primary and secondary voltages of an ideal transformer to its turns ratio.

MODULE 6 · HEAT

Physics 11-40 Sensible Heat (Q = mcΔT)

$$Q = mc\Delta T$$

Heat needed to change a mass's temperature: mass times specific heat times the temperature change.

Physics 11-41 Latent Heat

$$Q = mL$$

Heat absorbed or released when a mass changes phase at constant temperature.

Physics 11-42 Heat Conduction Rate

$$P = \frac{kA\Delta T}{d}$$

Steady-state heat flow through a slab by Fourier's law of conduction.

Physics 11-43 Thermal Linear Expansion

$$\Delta L = \alpha L_0 \Delta T$$

Length change of a solid caused by a temperature change, via the linear expansion coefficient.