Essential Physics Formulas: Grade 8

A concise school reference guide

Thermal phenomena, electric current and geometrical optics

1. Temperature

Change in temperature:

$$\Delta T = T_2 - T_1.$$

A temperature difference has the same numerical value in kelvins and degrees Celsius:

$$\Delta T\,[\mathrm{K}] = \Delta t\,[^\circ\mathrm{C}].$$

The relation between absolute temperature T and Celsius temperature t is:

$$T = t + 273.15,$$

where T is measured in kelvins and t in degrees Celsius.

2. Heating and cooling

The heat required to change the temperature of a body is:

$$Q = cm\Delta T.$$

Specific heat capacity:

$$c = \frac{Q}{m\Delta T}.$$

Unit of specific heat capacity:

$$[c] = \frac{\mathrm{J}}{\mathrm{kg}\cdot\mathrm{K}}.$$

Here c is the specific heat capacity of the substance and m is the mass.

3. Melting and solidification

At the melting temperature, the heat involved in a phase change is:

$$Q = \lambda m.$$

Here λ is the specific latent heat of fusion.
Its unit is:

$$[\lambda] = \frac{\mathrm{J}}{\mathrm{kg}}.$$

During melting, heat is absorbed.
During solidification, the same amount of heat is released.

4. Vaporization and condensation

For vaporization at constant temperature:

$$Q = Lm.$$

Some textbooks use the notation:

$$Q = rm.$$

L or r is the specific latent heat of vaporization.
Its unit is:

$$[L] = [r] = \frac{\mathrm{J}}{\mathrm{kg}}.$$

During vaporization, heat is absorbed, while during condensation it is released.

5. Combustion of fuel

The heat released by complete combustion of a fuel is:

$$Q = qm.$$

Here q is the specific heat of combustion.
Its unit is:

$$[q] = \frac{\mathrm{J}}{\mathrm{kg}}.$$

6. Heat balance

In a thermally isolated system, the heat released by some bodies equals the heat absorbed by others:

$$Q_{\text{released}} = Q_{\text{absorbed}}.$$

Using signed heat quantities:

$$\sum_i Q_i = 0.$$

For each stage of the process, choose the appropriate formula:

$$Q = cm\Delta T,$$

$$Q = \lambda m,$$

$$Q = Lm.$$

7. Efficiency of a heat engine

The efficiency of a heat engine is:

$$\eta = \frac{A}{Q_1} \cdot 100\%.$$

Since

$$A = Q_1 - Q_2,$$

we also have:

$$\eta = \frac{Q_1 - Q_2}{Q_1} \cdot 100\%.$$

Here Q_1 is the heat absorbed from the hot reservoir and Q_2 is the heat transferred to the cold reservoir.

8. Electric charge

Electric charge is quantized:

$$q = Ne.$$

The magnitude of the elementary charge is:

$$e = 1.6 \cdot 10^{-19}\ \text{C}.$$

Here N is an integer number of elementary charges.
Law of conservation of electric charge:

$$\sum q_{\text{before}} = \sum q_{\text{after}}.$$

9. Electric current

Electric current:

$$I = \frac{q}{t}.$$

Electric charge:

$$q = It.$$

The SI unit of electric current is the ampere:

$$[I] = \text{A}.$$

Therefore:

$$1\ \text{A} = 1\ \frac{\text{C}}{\text{s}}.$$

10. Voltage

Voltage:

$$U = \frac{A}{q}.$$

Work done by the electric field:

$$A = Uq.$$

Voltage shows how much work the electric field does per unit charge.
The SI unit of voltage is the volt:

$$[U] = \text{V}.$$

11. Electrical resistance

The resistance of a uniform conductor is:

$$R = \rho\frac{l}{S}.$$

Here:

$$\rho$$

is the electrical resistivity of the material,

$$l$$

is the length of the conductor,

$$S$$

is its cross-sectional area.
The SI unit of resistance is the ohm:

$$[R] = \Omega.$$

The SI unit of resistivity is:

$$[\rho] = \Omega \cdot \mathrm{m}.$$

Resistance increases with conductor length and decreases as its cross-sectional area increases.

12. Ohm's law

For a section of an electric circuit:

$$I = \frac{U}{R}.$$

Therefore:

$$U = IR,$$

$$R = \frac{U}{I}.$$

13. Series connection

In a series circuit, the current is the same through all components:

$$I = I_1 = I_2 = \dots$$

The total voltage is:

$$U = U_1 + U_2 + \dots$$

The total resistance is:

$$R = R_1 + R_2 + \dots$$

The voltages are proportional to the resistances:

$$\frac{U_1}{U_2} = \frac{R_1}{R_2}.$$

14. Parallel connection

In a parallel circuit, the voltage is the same across all branches:

$$U = U_1 = U_2 = \dots$$

The total current is:

$$I = I_1 + I_2 + \dots$$

For the equivalent resistance:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

For two resistors:

$$R = \frac{R_1 R_2}{R_1 + R_2}.$$

The equivalent resistance of a parallel connection is smaller than each individual branch resistance.

15. Electrical work and power

Electrical work:

$$A = UIt.$$

Using Ohm's law:

$$A = I^2 Rt,$$

$$A = \frac{U^2}{R} t.$$

Electrical power:

$$P = UI.$$

Also:

$$P = I^2 R,$$

$$P = \frac{U^2}{R}.$$

Units:

$$[A] = \mathrm{J}, \qquad [P] = \mathrm{W}.$$

16. Joule's law of heating

The heat produced by an electric current in a conductor is:

$$Q = I^2 Rt.$$

If all electrical energy is converted into internal energy of the conductor:

$$Q = A.$$

Therefore:

$$Q = UIt.$$

17. Reflection of light

Law of reflection:

$$\alpha = \beta.$$

Here α is the angle of incidence and β is the angle of reflection.
Both angles are measured from the normal to the surface at the point where the light ray strikes it.

18. Refraction of light

The absolute refractive index is:

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

where c is the speed of light in vacuum and v is the speed of light in the medium.
Snell's law:

$$n_1 \sin\alpha = n_2 \sin\beta.$$

Here α is the angle of incidence and β is the angle of refraction.
When light enters an optically denser medium, the ray bends toward the normal.

19. Thin lens

The thin-lens equation is:

$$\frac{1}{f} = \frac{1}{d} + \frac{1}{d'}.$$

Here:

$$f$$

is the focal length of the lens,

$$d$$

is the distance from the object to the lens,

$$d'$$

is the distance from the lens to the image.
The optical power of a lens is:

$$D = \frac{1}{f},$$

when f is measured in metres.
The unit of optical power is the dioptre:

$$[D] = \mathrm{D}.$$

Therefore:

$$1\ \mathrm{D} = 1\ \mathrm{m}^{-1}.$$

20. Lens magnification

Linear magnification:

$$\Gamma = \frac{H}{h}.$$

In terms of distances, using magnitudes:

$$|\Gamma| = \frac{|d'|}{|d|}.$$

Here h is the height of the object and H is the height of the image.
If

$$|\Gamma| > 1,$$

the image is enlarged.
If

$$|\Gamma| < 1,$$

the image is reduced.

Electric circuits

First determine the type of connection.
In a series connection, the current is the same through all components:

$$I = I_1 = I_2 = \dots$$

In a parallel connection, the voltage is the same across all branches:

$$U = U_1 = U_2 = \dots$$

Then choose the appropriate formulas for equivalent resistance, current and voltage.

This reference sheet is intended for quick review. Before using a formula, check the conditions under which it applies and the units of all quantities.