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

OR

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

The distance- speed- time equation.

d = distance travelled, in metres (m)

$\bar{v}$ = average speed, in metres per second (m/s)

t = time taken for trip, in seconds (s)

Distance is a scalar.

This equation is only used when the speed is ***constant***, or for an average velocity.

If the speed is changing, use the area under a speed – time graph to calculate distance.

This equation governs the horizontal component of projectile motion, since **a** is constant (0 ms^{-2}).

$$s = \overline{v}\, t$$

The displacement – velocity - time equation.

s = displacement travelled, in metres (m)

v = average velocity, in metres per second (m/s)

t = time taken for trip, in seconds (s)

Displacement is distance from beginning to end of journey in a ***straight line***. Since it is a vector, it also has direction eg right, north, or 53°.

This equation is only used when the velocity is ***constant***, or for an average velocity.

If the velocity is changing, use the area under a velocity – time graph to calculate displacement.

This equation governs the horizontal component of projectile motion, since **a** is constant (0 m/s).

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

To calculate constant or average acceleration.

a = acceleration of object, in metres per second per second (m/s^2)

Δv = change in velocity of object, in metres per second (m/s)

t = time for change in velocity to occur, in seconds (s)

Use this equation when the question gives you a change in velocity, rather than initial and final velocities.

$$a = \frac{v - u}{t}$$

$$v = u + at$$

The equation from National 5, rearranged.
Equation of motion without displacement **s**.

v = final velocity, in metres per second (m/s)
u = initial velocity, in metres per second (m/s)
a = average acceleration, in metres per second per second (m/s^2)
t = time taken for trip, in seconds (s)

v, **u**, and **a** are ***vector*** quantities. **t** is a ***scalar*** quantity.

For projectiles, the link between horizontal and vertical motion is time, **t**.

$$s = \frac{1}{2}(u + v)t$$

Equation of motion without acceleration **a**.

s = displacement, in metres (m)

u = initial velocity, in metres per second (m/s)

v = final velocity, in metres per second (m/s)

t = time taken for trip, in seconds (s)

$$W = mg$$

To calculate the weight of an object.

W = weight of object, in Newton (N)
m = mass of object, in kilograms (kg)
g = gravitational field strength, in newton per kilogram (N/kg)

Weight is a ***force***. The weight of an object is the force on it due to gravitational pull. If an object weighs 100 N on Earth, it weighs 0 N in space (no gravity) and 16 N on the moon.

Gravitational field strength is the weight per unit mass of an object in the field. The value of g on Earth is 9.8 N/kg.

The mass of an object is the amount of matter in the object. The mass remains constant anywhere in the universe. An object with mass 10 kg on earth will have a mass of 10 kg in space and a mass of 10 kg on the moon.

$$F = ma$$

The equation for Newton's Second Law.

F = unbalanced force acting on body, in newton (N)
m = mass of body, in kilograms (kg)
a = acceleration of body, in metres per second per second (m/s^2)

The unbalanced force is the resultant of all forces acting on a body.

Forces can change the shape, speed and direction of motion of an object.

When the force stays constant and the mass increases, the acceleration decreases.

When the mass stays constant and the force increases, the acceleration increases.

$$E_w = Fd$$

To calculate work done by a force.

E_w = work done, in joules (J) or newton metres (Nm)
F = force applied, in newton (N)
d = distance moved by force, in metres (m)

Work done is a measure of energy transferred.

$$E_p = mgh$$

To calculate change in gravitational potential energy.

E_p = change in gravitational potential energy, in joules (J)
m = mass, in kilograms (kg)
g = gravitational field strength, in newton per kilogram (N/kg)
h = vertical height moved, in metres (m)

Gravitational potential energy is the energy required to move a mass upwards through a height.

It is also the energy transferred when an object drops though a height. In this case, the energy is usually converted to kinetic energy.

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

To calculate kinetic energy.

E_k = kinetic energy of the body, in joules (J)
m = mass of the body, in kilograms (kg)
v = velocity of the body, in metres per second (m/s)

Kinetic energy is the energy possessed by moving objects.

Note: only the velocity is squared – not the mass!

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

To calculate the power of both mechanical and electrical systems.

P = power, in watts (W)

E = energy transferred, in joules (J)

t = time taken, in seconds (s)

Power is the energy transferred in one second.

Power can also be expressed in joules per second (J/s).

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

To calculate pressure.

P = pressure, in pascals (Pa) or (N/m^2)
F = force normal to surface, in newton (N)
A = area over which force is exerted, in metres squared (m^2)

One pascal is a force of one newton per square metre, when the force acts normal to the surface.

$$\frac{PV}{T} = constant$$

The General Gas Law.

P = gas pressure, in pascals (Pa) or (N/m^2)
V = volume of gas, in metres cubed (m^3)
T = temperature of gas, in Kelvin (K)

The ***mass*** is kept constant.

K = °C + 273

At 0 K, or absolute zero, all particle motion stops. Particles have no energy, and this is the lowest possible temperature.

The kinetic theory of gas states that pressure is caused by very small particles bouncing elastically off surfaces.

Use the kinetic model to explain the change in pressure as the temperature of a gas increases.

As temperature increases, the kinetic energy of the gas particles increases. {½}

The particles hit the wall of the container more often {½}

And with greater force. {½}

So the pressure increases. {½}

$$Q = It$$

To calculate the amount of charge transferred in an electrical circuit.

Q = charge transferred, in coulombs (C)

I = current, in amperes (A)

t = time taken for charge to transfer, in seconds (s)

$$W = QV$$

OR

$$E=QV$$

To calculate work done by a potential difference on a charge.

W or E = work done, in joules (J).
Q = charge, in coulombs (C)
V = potential difference, or voltage, in volts (V)

Field lines start at the positive point or plate, and finish on the negative point or plate. The direction of the lines indicates the force on a positive "test" charge placed in the field.

The pd between 2 points is a measure of the work done in moving one coulomb of charge between 2 points.

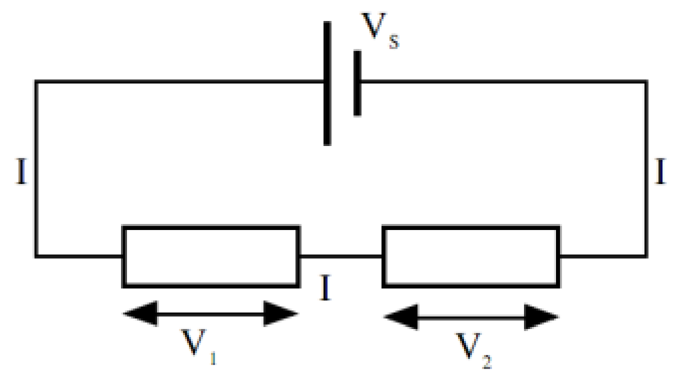
If 1 joule of work is done in moving 1 coulomb of charge between 2 points, then the pd between the points is 1 volt.

$$R_T = R_1 + R_2 + \dots$$

To calculate the total resistance of resistances in series.

R_T = total resistance of circuit, in ohms (Ω)
R_1 = resistance of first resistor, in ohms (Ω)
R_2 = resistance of second resistor, in ohms (Ω)

In a series circuit, the total resistance is the ***sum*** of the individual resistances.



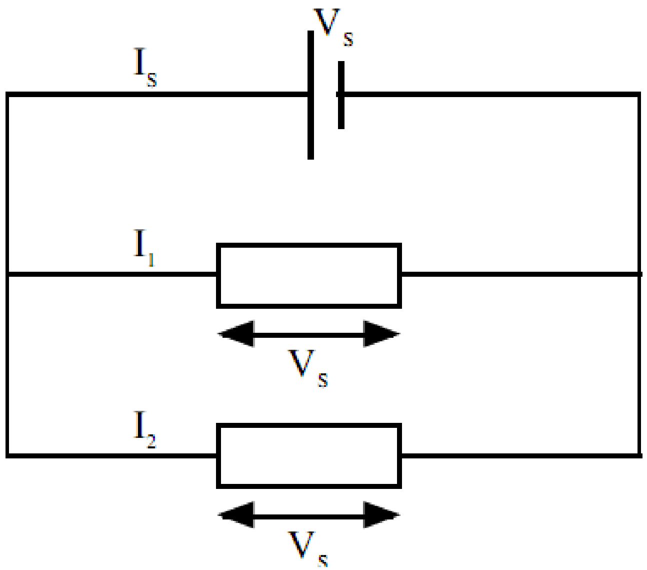
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

To calculate the total resistance of resistors in parallel.

R_T = total resistance of circuit, in ohms (Ω)

R_1 = resistance of first resistor, in ohms (Ω)

R_2 = resistance of second resistor, in ohms (Ω)



$$V = IR$$

Also known as “Ohm’s Law” equation.

V = voltage across resistance, in volts (V)

I = current through resistance, in amperes (A)

R = resistance, in ohms (Ω)

In a resistor V/I remains constant as the resistance of the resistor is not affected by Voltage. In a light bulb the value V/I is not constant as the resistance changes with temperature. However, V/I still represents the resistance at that voltage

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

To calculate electrical power.

P = power, in watts (W)

V = pd across resistance, in volts (V)

I = current through resistance, in amperes (A)

R = resistance, in ohms (Ω)

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

The Period equation.

T = period of wave, in seconds (s)

f = frequency of wave, in hertz (Hz)

T is the time taken for 1 complete wave to pass a point, in seconds (s).

$$\text{Frequency} = \frac{\text{no of waves}}{\text{time taken}}$$

$$A = \frac{N}{t}$$

To calculate radioactive activity.

A = radioactive activity, in becquerels (Bq)

N = number of decays (counts) (no units)

t = time taken, in seconds (s)

One becquerel is an activity of 1 decay per second.

Radiation	Nature	Symbol
Alpha particle	Helium nucleus	${}^{4}_{2}He$ α
Beta particle	Fast electron	${}^{0}_{-1}e$ β
Gamma ray	High frequency electromagnetic wave	γ

$$D = \frac{E}{m}$$

To calculate absorbed dose.

D = absorbed dose, in grays (Gy)
E = absorbed energy, in joules (J)
m = mass of matter absorbing the dose, in kilograms (kg)

One gray = 1 J/kg.

The absorbed dose is the energy absorbed per unit mass.

The absorption of energy by a substance depends on:
- the nature and thickness of the substance
- the type of radiation
- the energy of the particles or photons of the radiation.

$$H = Dw_R$$

Equivalent, or effective, dose.

H = equivalent dose, in sieverts (Sv)

D = absorbed dose, in grays (Gy).

$\mathbf{w_R}$ = radiation weighting factor (no units). This is a measure of radiation's biological effect.

Kind of radiation	w_r (no units)
x and γ rays	1
β particles	1
α particles	20
Neutrons: slow (thermal) fast	 2.3 10

$$\dot{H} = \frac{H}{t}$$

Equivalent dose rate.

$\dot{H}$ = equivalent dose rate, in sieverts per unit time

H = equivalent dose, in sieverts (Sv)

t = time over which dose is absorbed (units vary: usually days or years).

We have to take into account the time of exposure when considering the damage done by radiation. If the dose is concentrated in a short period of time it can lead to radiation sickness or even death.

The average annual background radiation in the UK is **2.2 mSv**

The average annual effective dose limit for a member of the public in the UK is **1 mSv** (ie 1 mSv/y)

The average annual effective dose limit for radiation workers is **20 mSv** (ie 20 mSv/y)