Physics Revision Guide

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Contents

Energy & electricity

Energy

- Energy helps things move or work
- Energy comes in different forms (heat, light, sound, chemical, electrical, potential, kinetic and nuclear)
- Energy is measured in Joules (J).

Energy types

- Heat
- Light
- Sound
- Chemical
- Electrical
- Kinetic (movement)
- Potential (elastic or gravitational)
- Nuclear.

Energy changes

Understand that:

- Energy can be changed from one form to another.
- There are various devices that convert energy from one form to another, e.g. battery, microphone, bunsen burner, petrol engine.

Law of Conservation of Energy

This is a very important idea in Science:

- Energy cannot be created or destroyed, but only changed from one form to another.

It follows that:

- No machine can give out more energy than is put in
- Because of friction, no machine can be 100% efficient.

Electricity

- Electricity flows in an electrical circuit
- The flow of electricity is called current
- The current flows along metal wires called conductors
- The battery provides the energy to push the current.

Measuring electric current:

- Electric current is measured in Amperes (Amps, symbol A)
- Current is measured on an instrument called an Ammeter
- The ammeter is placed in series in a circuit to measure the current.

Voltage

- Voltage is the pushing force in a circuit
- Batteries have the voltage pushing force
- It is the voltage that pushes the current
- Voltage is measured on a Voltmeter
- Voltage is measured across components
- Voltmeters are placed in parallel across components.

Why is electrical energy so useful?

- Electricity can be made on a very large scale in power stations
- It is easily transmitted around the country using wires called the National Grid
- It is easily transformed into other useful types of energy such as heat, light, chemical and kinetic.

Making electricity

There are 3 ways to make electricity:

- A battery – converts chemical energy into electrical energy
- A photo-cell – converts light into electricity
- A generator – converts kinetic energy into electricity.

It is generators that are used in power stations.

Generators

- A generator is an electromagnetic device that turns movement into electricity
- The faster the movement, the more electricity produced
- Dynamos produce DC electricity
- Alternators produce AC electricity.

Mains electricity is AC (50 Hz).

How do we drive generators?

- Moving water such as hydroelectric (from mountain lakes), tidal and waves
- Moving steam made from burning coal, oil, gas, biofuels, geothermal, and also solar and nuclear.

Where heat is used we call them thermal power stations.

Thermal power stations

The main parts are:

- Boiler – where heat is used to produce steam
- Steam turbine – where heated steam produces movement
- Generator (alternator) – turns movement into electricity
- Cooling tower – where waste heat is removed.

Energy waste in electricity production:

- Not all the heat energy in burning fuels heats the water
- Not all the heat energy drives the turbines
- Friction in the turbine & generator produce waste heat
- Not all the movement is turned into electricity
- Heat is lost in the cooling towers.

Gravity & space

Mass

- Mass is the quantity of matter in an object
- Mass is measured in kilograms (kg) or grams (g)
- Mass is measured on an arm balance
- The mass of an object is the same anywhere in the Universe
- Mass does not change with gravity.

Weight

- The force of gravity on an object
- Weight is measured in Newtons (N)
- Weight is measured on a weighing machine (spring balance)
- Weight depends on the strength of gravity.

The Moon is a smaller body than the Earth so gravity is less and objects weigh less on the Moon.

What is gravity?

- All bodies have mass
- There is an attractive force between any 2 masses
- This attractive force is called gravity
- Gravity acts over the vast distances of space
- Gravity is the major force in the Universe
- Gravity, however, does get weaker with distance.

The strength of gravity

- Gravity can be measured from mass and weight
- We call this the gravitational field strength
- Gravitational field strength is given the symbol g

. g = weight/mass

Gravitational field strength is measured in Newtons per kilogram (N/kg).

Gravitational field strength

On the Moon:

- Every kilogram weighs 1.7 Newtons
- So g = 1.7 N/kg

On the Earth:

- Every kilogram weighs 10 Newtons
- So g = 10 N/kg

Jupiter is the largest planet:

- Every kilogram weighs 23.2 Newtons
- So g = 23.2 N/kg

Calculating weight from mass

- As g = weight/mass
- Then weight = mass x g

On Earth:

- Weight = mass x 10
- A 60 kg object weighs 600 Newtons.

Orbits in space

- A moving planet wants to go in a straight line
- The Sun's gravity puts a force on the planet
- This makes the planet move around the Sun
- The planet moves in a circular path
- This path is called an orbit.

Moons (satellites) orbit around planets for the same reason.

Satellites

Natural satellites:

- The Moon is our natural satellite
- It orbits the Earth in 28 days.

Artificial satellites:

- Geostationary satellites orbit the Earth in 24 hours
- Low Earth orbit satellites orbit in about 1.5 hours.

Force & acceleration

Speed, distance & time

- Speed is distance travelled in a given time
- In science we measure speeds in metres per second (m/s)
- On roads in the UK we measure speed in miles per hour(mph)
- In Europe speeds are measured in kilometres per hour (km/h).

Speed = distance/time

Calculating distance from speed & time

- Distance = speed x time

Calculating time from distance & speed

- Time = distance/speed

Acceleration

- Acceleration means getting faster
- Acceleration is the rate of change of speed

Acceleration = (change of speed)/(time taken)

Acceleration is measured in m/s^2.

Force, mass & acceleration

- Force makes an object accelerate
- The bigger the force the bigger the acceleration
- A large mass is difficult to accelerate
- Force, mass and acceleration are related in Newton's Laws of Motion.

Newton's Laws of Motion

- A body remains at rest or continues with steady speed in the same direction unless acted upon by a force
- Force = mass x acceleration
- For every action (force) there is an equal and opposite reaction (the rocket principle).

Friction

- Friction is the rubbing force between 2 surfaces
- Friction always tries to slow objects down (decelerate)

Lubricants, such as oil, reduce friction.

Air resistance

- The force on an object moving through the air
- Air resistance always tries to slow an object down
- Air resistance increases with speed
- Streamlined shapes have less air resistance.

Skydiving & terminal velocity

- As you fall, you accelerate
- As you get faster, air resistance increases
- Finally, air resistance = weight
- You stop accelerating and fall with constant speed
- This speed is called the Terminal Speed.

Pressure

Force, area and pressure

Pressure measures how concentrated a force is.

- Pressure = Force/Area
- Force is measured in Newtons (N)
- Area is measured in square metres (m^2)
- Pressure has the units N/m^2 (also called Pascals –Pa).

Examples where pressure is important

- Knife – blade has small area therefore large pressure for cutting
- Tank – has caterpillar tracks to spread weight and not sink in mud/sand
- Snow shoes – large area, small pressure, won't sink in snow.

Atmospheric pressure

- Although we don't feel it, the atmosphere has pressure
- This pressure is created by a column of air 50 km above our heads
- This produces a pressure of 100,000 N/m^2
- This is also called 1 Atmosphere (1 At).

Divers under pressure

- The deeper the dive the greater the pressure
- Every 10 m you dive down increases the pressure by 1 At.

The mains water in your home comes from a water tank high up outside. This gives water pressure in your home.

Different units for pressure

- 1 N/m^2 = 1 Pa (1 Pascal)
- 100,000 N/m^2 = 1 At (1 Atmosphere)
- 1 At = 1 Bar (1 B) = 1000 mB (1000 milliBars)
- milliBars are used in weather forecasting.

Hydraulic brakes

- Driver puts foot on brake pedal
- This pushes a fluid in a piston (master)
- This puts a pressure in the piston fluid
- This pressure is transmitted along a tube
- The tube is connected to a second piston
- This second (slave) piston pushes the brakes.

Moments & levers

Levers

- A lever is a simple machine that turns about a pivot
- With a lever you can amplify a force.

Simple examples:

- Claw hammer to remove nails
- Using a screwdriver to remove paint lid.

Levers and turning forces

- A lever produces a turning force
- A turning force depends on the size of the force
- It also depends on the distance from the pivot
- A turning force is also called a Moment.

Moments

- Moment = force x distance from pivot
- Force is measured in Newtons (N)
- Distance is measured in metres (m)
- Moments are measured in Newton-metres (Nm).

Balancing a seesaw

- If Weight W_1 is distance d_1 from the pivot
- If Weight W_2 is distance d_2 from the pivot
- Then $W_1 \times d_1 = W_2 \times d_2$

Machines

Work

- Machines do work
- Work is a form of energy measured in Joules
- Work is sometimes called Mechanical Work
- Work is done when a force is moved through a distance.

Work = force (N) x distance moved (m)

- 1 J = 1 Nm

Load & effort

- A machine does useful work moving a force called the Load
- The load is moved through a distance (load distance)
- Work must be put into the machine
- The work put in depends on the force or Effort put in and the effort distance.

Mechanical Advantage

- Mechanical Advantage (MA) is a measure of the usefulness of a machine
- MA = Load/Effort
- Some machines are force amplifiers

Machines

- A machine is any device that does useful work
- Work or energy must be put into the machine
- No machine can give out more energy than is put in
- This is the Law of Conservation of Energy.

Efficiency of machines

- Efficiency tells you how good a machine is
- Efficiency = Work out/Work in
- Work out = Load (N) x load distance (m)
- Work in = Effort (N) x effort distance (m).

Because of friction, no machine can be 100% efficient.