Schools & Homes Energy Education Project

Glossary of Terms for

Working with Model Solar Powered Cars

acceleration - a change of *velocity*, the rate of change of *velocity* with respect to time

If the car speeds up or slows down or if it moves in a curve then we can say it is accelerating do to a force acting upon it.

aerodynamic drag - a force that resists the motion of a body through air

If the car's shape has less aerodynamic drag it can go faster.

amorphous - where the atoms of a solid exist in a random arrangement vibrating about a fixed position

Plugging into the Sun® flexible PV cells are made with amorphous silicon.

atom - the smallest particle of an element that has all of it's chemical properties

axle - a supporting component that carries a *wheel* and either rotates with the *wheel* to transmit mechanical *power* to or from it, or allows the *wheel* to rotate freely on it

Ideal properties: low friction, rigid, suitable diameter for bearing and wheel

Possible materials: steel shaft, nail, cocktail stick, coat-hanger wire, welding rod, wooden dowel, skewer

bearing - supports the *axle* while allowing rotation; a component that allows the relative motion of two parts

Reduce friction in bearings as far as possible.

Ideal properties: low friction, rigid, suitable size for axle

Possible materials: plastic credit type cards with holes drilled (as with Plugging into the Sun car), paper or plastic straw, pen body, hole in chassis, picture bracket with screw holes and brass tube

chassis - a frame for mounting the working parts of a vehicle or device

The Plugging into the Sun flexible PV cell can perform a dual function - generate electricity and form the car chassis.

Ideal properties: light weight and strong

Possible materials: flexible solar cell, toilet roll tube, toothpaste box, corrugated cardboard, balsa board, envelope stiffening corrugated plastic sheet and stiff insulating foam

crystalline - where the atoms are in a 3-dimensional orderly arrangement, a crystalline latticework of atoms

Some PV cells are made with crystalline silicon.

density - a measure of the compactness of a substance; expressed as its *mass* per unit *volume*

efficiency - the percent of *work* put into a machine that is converted into useful work output; the higher the efficiency of a machine, the lower the proportion of *energy* wasted as *heat*.

electric current - the rate of flow of electric charge; the net transfer of electric charge per unit time

electric motor - a machine that converts electrical *energy* into mechanical *energy*

electrical conduction - the transfer of electricity through a conductor; the passage of electric charge, such as passage of electrons

electricity - a form of energy associated with an electric current or charge; physical phenomenon involving electric charges and their effects when at rest and when in motion

electromagnetic radiation - the transfer of energy by the rapid oscillations of electromagnetic fields in space

electromagnetic spectrum - the range of frequencies over which electromagnetic radiation can be propagated; the lowest frequencies are associated with radio waves, then microwaves, infra-red waves, *light*, ultra-violet radiation, X-rays, and gamma rays, in sequence

electron - the negatively charged part of the *atom* that orbits the nucleus

electron/hole pair - when an *electron* escapes a bond it leaves a vacancy in the lattice; this vacancy is known as a hole; a region in which there is an excess of positive charge; the hole ceases to exist when an electron is captured; a hole is equivalent to a positive charge

A photon hitting a silicon atom can give an electron within the atom enough energy to leave it and move off through the structure. The negatively charged electron leaves a positively charged hole in its place; so the photon has created an electron/hole pair.

energy - the quantity that is a measure of the capacity for doing *work*

force - that influence on a body which causes it to accelerate; capable of altering the state of rest or motion in a body; the *force* F, required to produce an *acceleration* a, in a *mass* m, given by F=ma

friction - a *force* which opposes the relative motion of two bodies whenever such a motion exists or whenever there exists other forces which tend to produce such a motion

(rolling) friction - *force* resisting rolling of a body on a plane a due to fact that the rolling body is moving up the side of the hollow caused by the elastic deformation of the plane; is much smaller than *sliding friction* especially with *hard* surfaces hence use of *wheels* and ball bearings

(sliding) friction - *force* opposing the sliding of one surface over another

There will be sliding friction in the bearings of your car and also inside the motor.

gear - a toothed *wheel* that engages with another toothed *wheel*; a toothed machine element used to transmit motion between rotating shafts; an adjustment device of the transmission which determines *mechanical advantage*, relative *speed*, and direction

We use gear wheels (including those inside a gearbox) to transfer motion from the fast spinning motor spindle to the wheels spinning more slowly but with higher torque.

gear ratio - the *ratio* of the angular speed of the driving member of a *gear train* to that of the driven member, specifically the number of revolutions made by the engine per revolution of the drive wheels

A low gear ratio gives lower rpm but greater torque (better for climbing gradients), a high gear ratio gives higher rpm but lower torque (better for top speed runs).

gear train - a combination of two or more gears used to transmit motion between two rotating shafts; e.g. pinion gear on motor shaft & larger gear on axle

gradient - an upward or downward slope; the rate of decent or ascent (steepness of slope) of any surface

When the car runs down a gradient the force of gravity is assisting the work of the motor making the car faster; when running up a gradient the car must work against gravity which means more work for the motor.

gravitational attraction - the mutual attraction between all masses in the universe

gravity - the force of *gravitational attraction* at the surface of the earth

It is gravity that forces the car against the ground, (more so if the mass of the car and hence it's weight is high).

heat - a form of *energy* that is transferred by a difference in temperature; other types of *energy* in transit are called *work*

inertia - the tendency of a body to preserve its state of rest or uniform motion in a straight line; the property of mater which manifests itself as resistance to any change of the *momentum* of a body

If the mass (i.e. weight) of the car is made as low as possible then it's inertia is lower and it will be easier to accelerate.

light - the visible part of the *electromagnetic spectrum*

Our eyes have evolved to respond to the light emitted by the sun.

light intensity - the energy transmitted by light; the *power* transmitted by light across a unit area *perpendicular* to the wave

Positioning the PV perpendicular to the wave gives highest gains.

mass - a quantitative measure of a bodies resistance to being accelerated; a measure of a body's resistance to changes in *velocity*; a measure of the *force* experienced in a gravitational field

A car with lower mass will be easier to accelerate and will have less friction in the bearings.

mechanical advantage - the *ratio* of the *force* produced by a machine such as a *lever*, *gear train* or pulley to the *force* applied to it, also known as force ratio; a machine that multiplies force does so at the expense of distance, likewise, a machine that multiplies distance does so at the expense of force.

mesh - engagement or working contact of teeth of *gears*

molecule - the smallest unit of a particular substance; atoms combine to form molecules

momentum - the *strength* of a body's motion; the product of the *mass* and *velocity* of a body (non-relativistic)

motor mount - structure supporting the *electric motor* e.g. self-adhesive grey plastic mount

photovoltaic (PV) effect - the production of a voltage by the absorption of light or other electromagnetic radiation

pinion - the smaller of a pair of *gear* wheels or the smallest wheel of a *gear train*

power - the time rate of doing *work* or expending *energy*; the ability to perform *work*

PV - see photovoltaic

ratio - the *ratio* of two qualities A and B is the fraction A/B

resistance (electrical) - the opposition to a flow of electric current

If electrical connections are not sound then a high electrical resistance may waste energy.

resistance (mechanical) - any force that tends to oppose motion

Mechanical resistance occurs when the car is working against friction and gravity.

rpm - revolutions per minute; a unit of angular velocity; in one revolution a body rotates through 360^{O}

A motor or wheel with higher rpm is spinning faster.

semiconductor - a normally insulating material such as crystalline silicon or germanium that becomes conducting when made with certain impurities or when energy is added

PV cells are made with semiconductors.

solar cell (PV cell) - a device which converts the radiant energy of sunlight directly into electrical energy

solar energy - the *energy* transmitted from the sun in the form of electromagnetic radiation

solar power - the conversion of the *energy* of the suns radiation to useful *work*

solar radiation - the electromagnetic radiation emitted by the sun

speed - the rate at which something moves (or is done)

thermal energy - the energy in a substance due to the random motion of it's molecules

torque - any force that causes rotation

A lower gear ratio creates a higher turning force at the wheels.

traction - adhesive *friction* of a moving body on the surface on which it moves, e.g. a *wheel* on a road

velocity - the time rate of change of position of a body; a vector quantity having direction and magnitude; the *speed* of a body expressed as the rate of change of its position in a particular direction with time

voltage - the 'pressure' of electricity; potential difference or electromagnetic force

weight - a measure of the heaviness (vertical force towards the earth) of an object; the gravitational *force* with which the earth attracts a body; equal to *mass* of body times *acceleration* due to *gravity*; the *force* exerted by the body on the support; the force exerted by the support on the body.

wheel - a circular component with a hub at the centre for attachment to an *axle*, about which it may revolve and bear a load

Ideal properties: light weight, suitable diameter and width, rigid

Possible materials: plastic toothed *gear,* plastic bottle top, thin disc stuck to plastic toothed gear, card or plastic or wood disc cut out with a pair of compasses, cotton reel, model car wheel

work - the transference of *energy* that occurs when a *force* is applied to a body in such a way that the *force* has a component in the direction of the bodies motion

worm gear - a threaded shaft (worm) that meshes with a *gear* wheel so transferring motion between two *perpendicular* shafts