How to optimise your model solar electric car for *SPEED*.

PART A - Design and build an energy efficient car

A solar car (like any machine or device) cannot create energy, but only transform energy from one form to another, and always with some energy losses. This is because it is impossible for energy to be transferred from one form to another with 100% efficiency, a universal law of physics (2nd law of thermodynamics). We can increase the car's overall efficiency by making energy transfer through the various working parts as efficient as possible. A more efficient solar car can run faster.

1. Maximise energy gains (useful energy) by maximising:

- light energy captured by the photovoltaic (PV) cell

  The collector side of a PV cell should face skywards and not be shaded.

  The cell will capture more light energy when the collecting surface is perpendicular to the direction of the sun.

  A simple reflector (e.g. aluminium foil) could be attached to direct more light onto the cell effectively increasing the collector area.

- electrical energy transferred to electric motor

  Use a PV cell with suitable specifications. The Plugging into the Sun® flexible cell has an output that is ideal for powering the motor of the solar car.

  A number of cells connected together will produce more power for the motor. Make sure electrical connections are good to avoid build up of electrical resistance.

- mechanical energy transferred to wheels

  Use a high-quality electric motor (such as the standard solar motor) that is matched to the PV cell.

2. Minimise energy losses (wasted energy) by minimising:

- friction in the working parts of the car

  Friction wastes moving energy, transferring it to heat.

  The force of friction between two surfaces depends on how hard they are pressed together.

  Reduce weight of the car to reduce pressure between the surfaces of axles and bearings

  Align all wheels to reduce friction in bearings.

  Avoid using an unnecessarily complicated transmission system between the motor shaft and wheels

- friction with the air (drag)

  Drag is more significant at higher speeds or if there is a head wind.

  Make the shape of the car smooth without unnecessary parts that may catch the wind; be careful with the shape of a reflector if you fit one.

- friction between wheels and running surface (rolling resistance)

  Reduce weight of car where possible to reduce rolling resistance caused by deformation of the wheel & running surface.

- inertial/mass resistance in the moving parts & in the car as a whole

  If parts of the car (e.g. wheels) and the car as a whole can be made with less mass then they will be lighter and will accelerate more easily. When the mass of a component is reduced it must still retain enough strength to perform it's function.

  Reducing weight also reduces the amount of work that must be done against gravity if car runs uphill.

PART B - Use the most favourable conditions available for high speed running and adapt the car to them.

1. lighting conditions

- Optimum performance is always achieved outside under natural lighting conditions.

  The cell will capture most light energy when sunlight is direct and there are no clouds or shading. When the sun is high in the sky then the light has less of the earth's atmosphere to travel through so more light energy reaches the earth's surface.

  The cell will capture the maximum amount of sunlight when it faces the sun directly. Position the cell & car so the collector side of the cell faces as near to the direction of the sun as possible.

  The flexible PV cell gains a significant amount of energy from the brightness of the rest of the sky. Let the cell 'see' as much of the sky as possible (speeds attained outside will be higher than speeds on a window sill for instance) by running the car in an open area away from large buildings.

2. running surface

- Run your car on a smooth, hard surface.

  This will reduce rolling resistance.

3. course

- The car will run faster in a straight line than in a curve, and faster on a flat course than up a gradient, all other things being equal.

  The car will run faster down a slope with the help of gravity, but go slower up a slope where energy is required to work against the force of gravity (energy of motion is transferred into gravitation potential energy).

4. gear ratio of the car

- <u>The optimum gear ratio for maximum speed depends on all of the previous factors.</u>

  It will give the best balance of wheel torque (rotation force) & wheel rotation speed.

  A higher ratio e.g. 3:1 (3 motor revs. per 1 wheel rev.) gives higher wheel speed but lower torque. If there is insufficient torque the car will not overcome the forces of friction described earlier. Neither will it be able to accelerate from a standstill or from a slow speed.

  A lower ratio e.g. 27:1 gives lower wheel speed but higher torque. The car requires high torque when moving up a gradient or over rough ground.

  The diameter of the driven wheels affects the overall gear ratio of the car. Larger diameter wheels raise the ratio and smaller diameter wheels lower the ratio. Try experimenting with different transmission ratios or by attaching discs of plastic or stiff card to the drive wheels to raise the overall gear ratio. Generally a higher ratio will make the car faster only until the amount of torque drops off too much.

<u>PART C - Evolve & improve the design of your solar car as you understand more of the physical processes involved in it's operation.</u>

Time the car as it runs over a known distance to calculate average speed.

Investigate all the parts of the car and how they work together. What changes can you make to help the car run faster?