Machines – How They Work Essay, Research Paper

A machine is any device used to change the magnitude or direction of an applied force. It is used to make tasks easier and less force-needing for humans, by transferring energy from one point to another. It?s main advantage is that it enables a person to exert a force greater than could be exerted by using muscles alone, or to apply a force more efficiently, as with the pulley.

Machines don?t always have to be complicated and intricate technological equipment, as we first think of them- a simple lever is a machine. The human skeleton is also a machine. The four most basic and simple machines are the lever, the pulley, the wheel and axle, and the inclined plane or ramp. Simple and basic machine combinations are many times used inside more complex machines, like a watch for example, which makes of use or different wheels turning each other.

The force increase is usually at the expense of speed, as the smaller force has to be sustained for longer to complete the same amount of work done. For example:

We know that WORK DONE= force x distance. Keeping this formula in mind, we can see that to perform the same amount of work, with a decrease in the force, a longer distance has to be covered, thus increasing the time taken. We can see this put into practice by looking at a simple block being pulled up a slope and directly upwards from the lowest point.

We can see that pushing the block up the slope uses a smaller force, but covers a larger distance, while the lifting of the block straight upwards uses a larger force, but covers a smaller distance. In both cases, the total amount of work done or energy used is the same.

This shows that levers don?t actually save any energy, but do make the job significantly easier, because of the diminished force requirement.

The mechanical advantage that the machine brings ? or the ratio between the force applied and the resistance offered by the load against which the force is acting upon ? can be calculated by a simple formula,, but it must be kept in mind that this is the theoretical value of the machine?s advantage, as friction is always responsible for a small decrease in this efficiency. By looking at the formula (and not taking into account friction), we get:

distance moved by effort x effort force = distance moved by load x load force

\*or after its rearrangement\*

distance moved by effort = load force

distance moved by load effort force

By looking once again at the ramp example, we can see that its mechanical advantage is 4/2 (the distance moved by the effort ? 4m ? divided by the distance moved by the load ? 2m ? or the load force – 100N divided by the effort force ? 50N.) , or 2, meaning that the use of the ramp makes the task of pulling the block uphill twice as easy.

This efficiency of a machine can also be calculated, by looking at the ratio between the amount of energy produced (the output) and the amount of energy expended (the input). Because once again, some extra work must be done against friction, thus ?losing? some energy to the surrounding in the form of heat, the efficiency of a machine will never be 100%.

Again, we can apply this formula to the ramp example:

If the Efficiency of a machine = output energy ,

input energy

and supposing that the ramp is 75% efficient (due to friction) the efficiency of the ramp would be

75 = 200 and after its rearrangement input energy = 200 x 100

100 input energy 75

This would result in a 266.7 J energy expenditure, transferred over a total distance of 4 metres, meaning that a force of 66.7 N would be the force you would need to use. We can see that this is a much smaller force then the force that would be needed to lift the block straight up, though not experiencing friction:

Output energy = (100N x 2m) = 200 = 200

Input energy Input energy 1 (efficiency is 100%

- no friction)

These 200Nm would then have to be divided by 2M, which is the distance that the force need to be applied over, ,meaning that a force of 100N would be needed to pull this block straight up, a larger force then the 66.7N needed with the use of the slope.

Another type of machine, serving the same function of transferring energy from one point to another is also very important to our world. They are known as Hydraulic machines, and they transport power by means of working fluid, such as oil, and they are used in situations or in machines for the transfer of forces over distances where mechanical linkages would be less appropriate. A good example is the braking system of a car, where the force exerted on the brake pedal is transmitted through a hydraulic line to work the brake at the wheel.

Machines such as the wheel date all the way back to prehistoric times, when man first began to make its attempts at this shape.

LeverThe lever is a simple machine made with a bar free to move about a fixed point called a fulcrum. Any tool that pries something loose is a lever. They are extremely useful, as depending on the distance from the fulcrum, meaning the further you go, the less effort you need to move something. It is even possible for a single child to lift and entire elephant depending on their distance from the pivot point. This principle is based on the moments principle and the formula moment = force (N) x distance from pivot point (m), showing that the further you are from the pivot point, the bigger the moment is, even with the same force exerted. You can find levers everywhere – the claw end of a hammer that you use to pry nails loose, the hand shovel which you use to remove weeds from your flowerbed, your elbow ? all levers. There are three types of levers:A first class lever, or a force multiplier is when the pivot is nearer to the load, because the effort is less then the load. I the pivot is nearer to the effort, the lever is a distance multiplier, meaning the load moves more then the effort. A good example for this type of lever is a see-saw- one end will lift an object (child) up just as far as the other end is pushed down.A second class lever is a lever where the effort always moves more then the load, and it is a force multiplier. The effort is less then the load, but it moves through a larger distance. A good example is a like a wheel barrow. The long handles of a wheel barrow are really the long arms of a lever, helping to carry then weight.A third class lever, is a distance multiplier, where the load always moves more then the effort. In this lever, the load force is less then the effort force. Take a fishing pole for example – when the pole is given a tug, one end stays still but the other end flips in the air catching the fish.

A lot of levers can be found in ?our? machine, in the human body. At first glance, the human body seems to be built wrong, as the levers are all backwards. Consider the elbow- when you hold a can of soda in your hand with your elbow bent at a right angle, the weight of the can pulls the lower arm down, pivoting it about the elbow joint. The bicep muscle pulls up on the lower arm, fighting gravity and holding the arm in place, but as anyone who has used a lever knows, the farther the force is from the pivot, the greater the twisting force, or torque, it exerts. If you push on a door at the knob, it pivots easily on its hinges, but if you try to push a door open with your hand placed only a few inches from the hinge, the closer your hand is to the hinge, the more difficult it is to open the door. Similarly, the can is five times further from the elbow than the bicep attachment. For example, to hold up a one-pound can, the bicep muscle must pull up with five pounds of force.

The whole human body is designed this way. Almost every muscle, including those of the hand, works at a mechanical disadvantage. The muscle must exert more force than the weight opposing it. This happens because the muscles cannot move very far. Looking at out body right now as it stands, the muscle must exert five pounds of force to lift a one-pound can, but if the can is lifted one foot, the muscle only needs to contract one-fifth of a foot, a little over two inches. If the body were designed with a mechanical advantage of five, then the muscle would only have to pull with one-fifth of a pound of force, but it would have to contract five feet, and our elbows would drag across the ground.