Chapter 41: Force, Work and Power.

Def: A Force is anything which causes an object to move or change its velocity.

Forces are measured in newtons (N)

Examples:

1. Push/Pull: Changes the velocity.

2. Weight: Moves objects towards the ground.

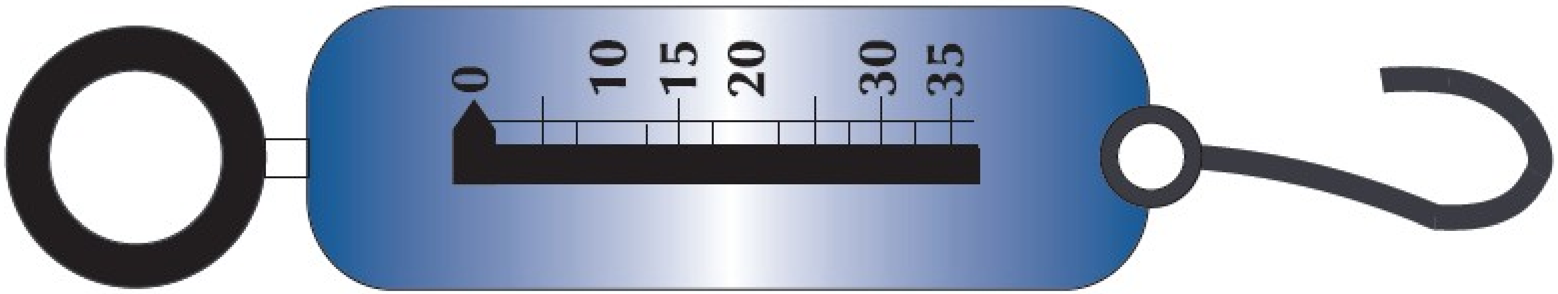
3. Friction: Slows down moving objects.

4. Electric: Causes charged particles to move.

5. Magnetic: Causes magnetic materials to move.

Measuring Forces.

Forces are measured using a spring balance.



The spring balance is used to measure the force of gravity on an object.

It can also be used to measure the force of friction.

Friction.

Def: Friction is the force which prevents easy movement between two objects in contact.

The rougher the surface the greater the friction.

High friction: Sand paper, car tyres.

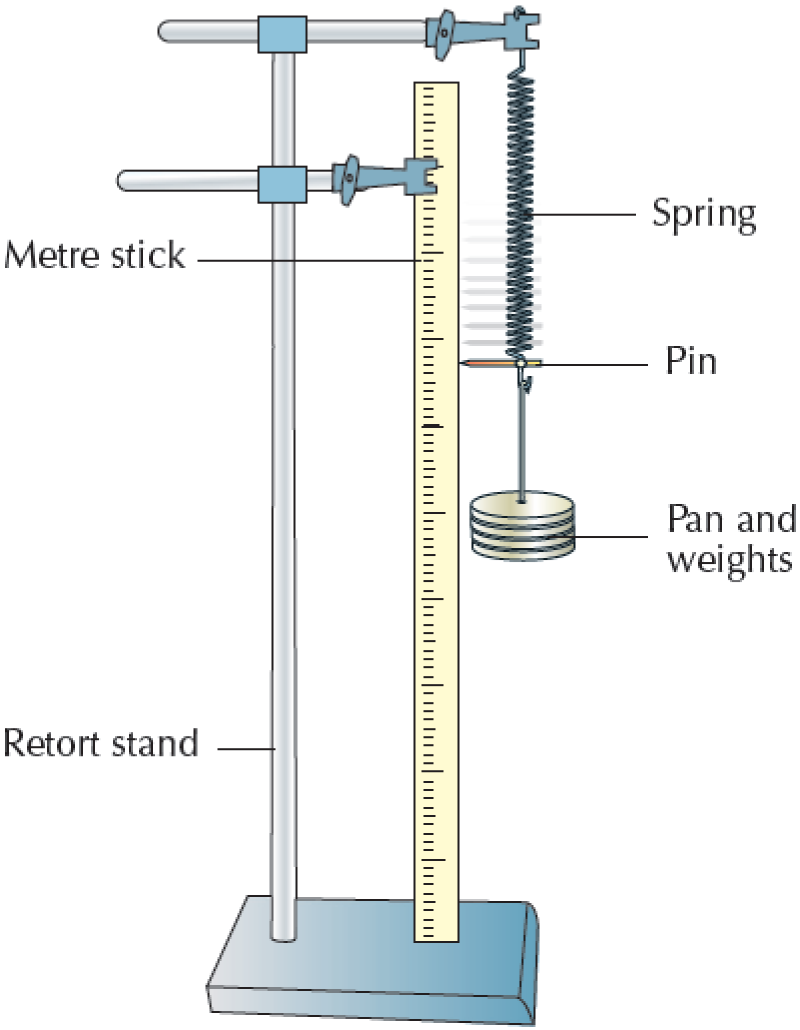
Low friction: Wet surfaces, soap, ice, glass

To reduce friction: Use a lubricant like oil, grease, soap.

Fig. 5 Low friction occurs when smooth surfaces are in contact.

Hooke's Law.

Def: The extension of a spring is in direct proportion to the force that is stretching it.



A force on the end of a spring will cause it to stretch. The greater the force, the more the spring will be stretched.

However, if too much force is applied, the spring will pass it's "elastic limit" and will not return to it's original position.

Work.

Def: Work is done when a force moves an object.

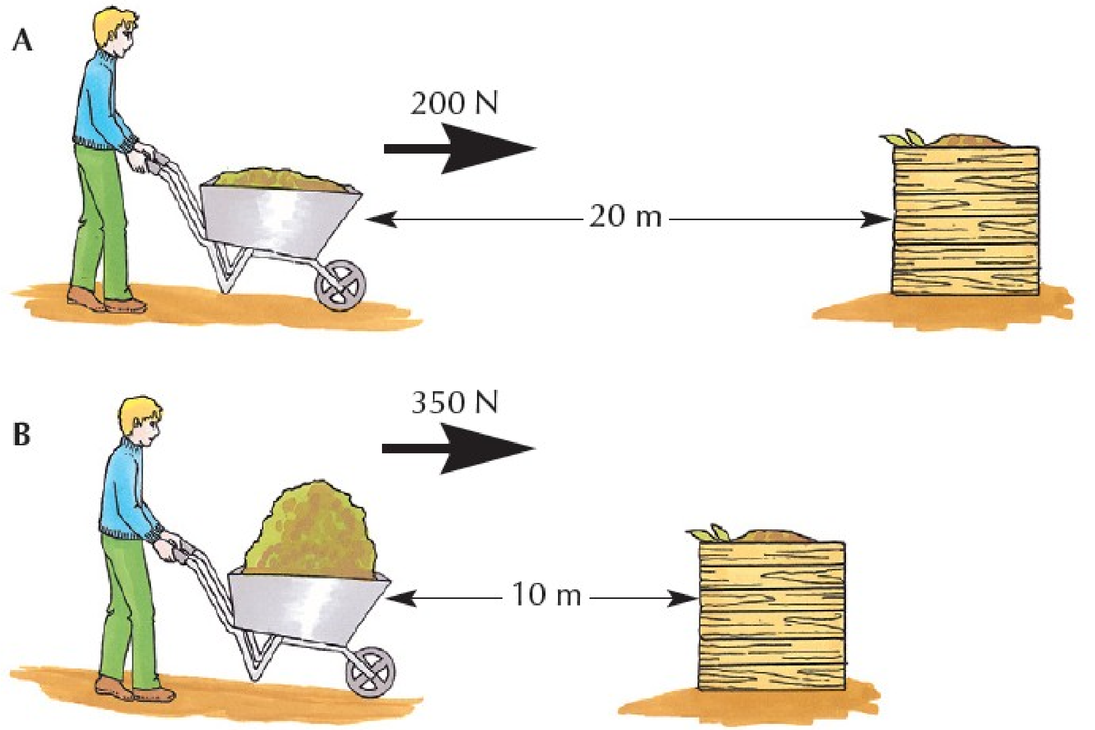
Formula:

$$\text{Work} = \text{Force(N)} \times \text{Distance(m)}$$

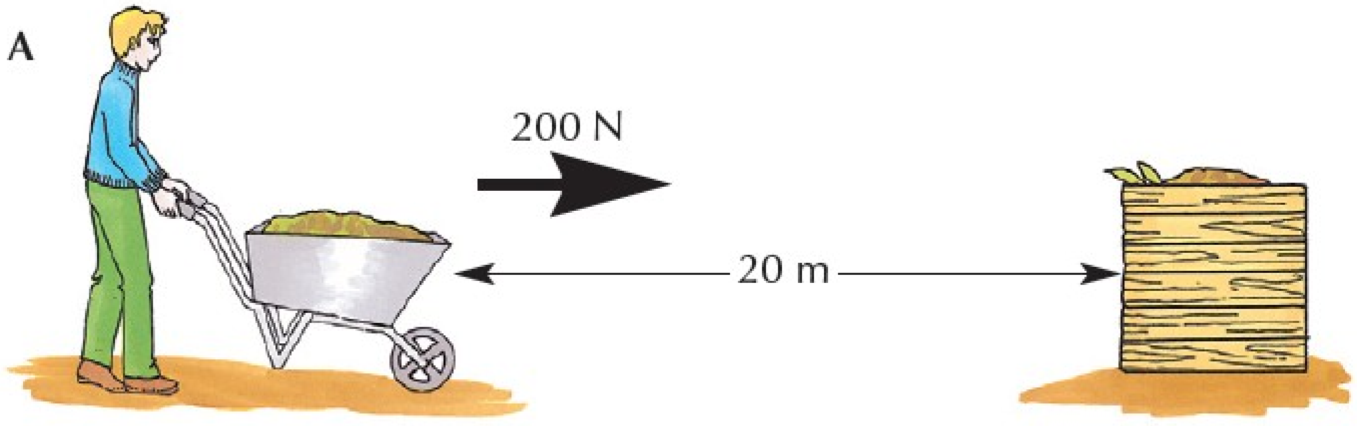
Example:
The gardener in figure A exerts a force of 200N over a distance of 20m.

In figure B, he exerts a force of 350N over a distance of 10m.

In which case did he do more work?



Answer. In A



Force = 200N

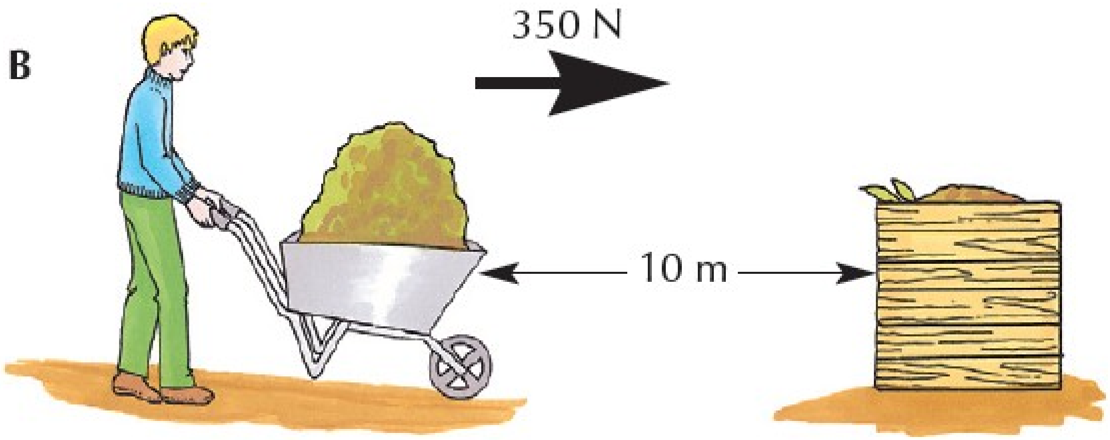
Distance = 20m

Work = force x Distance

= 200 x 20

= 4000J (joules)

In B



Force = 350N

Distance = 10m

Work = force x Distance

= 350 x 10

= 3500J (joules)

So he did more work in figure A

Power.

Def: Power is the rate at which work is done.

Formula: $$\text{Average Power} = \frac{\text{Work done (J)}}{\text{Time taken (s)}}$$

Example:

A crane lifts a tub of concrete that weighs 60,000N from the ground up to a platform 40 m from the ground in 20 seconds.

(i) Calculate the work done by the crane.

(ii) What is the power of the crane?

Answer. (i)

Work = Force x Distance

= 60,000N x 40m

= 2,400,000J

Answer. (i)

$$\text{Average Power} = \frac{\text{Work done (J)}}{\text{Time taken (s)}} = \frac{2,400,000}{20}$$

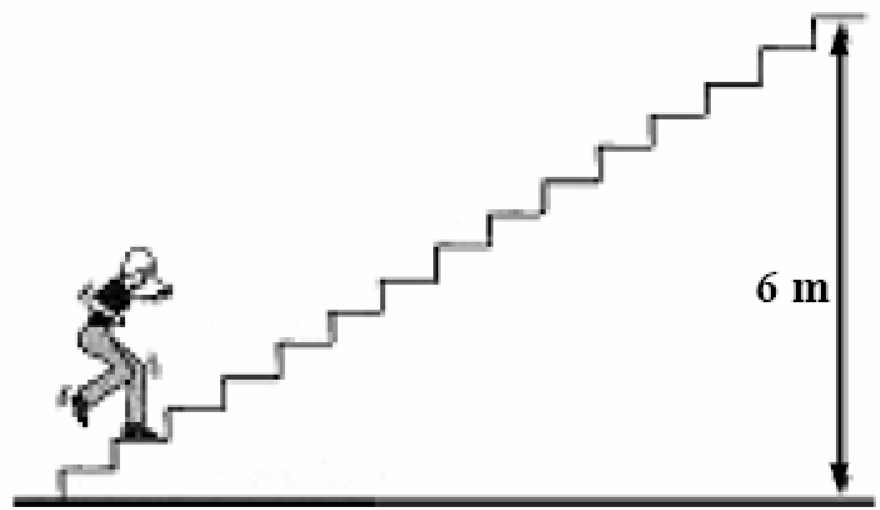
= 120,000J/s or 120,000W or 120kW

The driver of a moving car applied the brakes. The brakes produced an average stopping force of 8 kN (8000 N) and the car stopped having travelled 20 m after the brakes were applied. Calculate the ***work done*** in stopping the car.

(6)

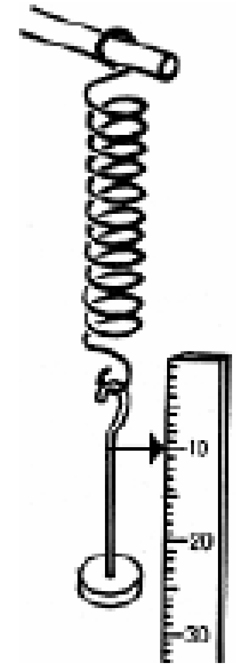
A girl of mass 60 kg (weight 600 N) climbed a 6 m high stairs in 15 seconds.

Calculate the ***work*** she did and the average ***power*** she developed while climbing the stairs.



Question 9 (39)

(*a*) Robert Hooke (1635-1703) made a number of discoveries including the effect of force on elastic bodies now known as Hooke's law. ***State Hooke's law***. (6)



Hooke's law ____________________________________

____

A student was given a box of identical springs and asked to analyse them so that they could be used as newton meters.

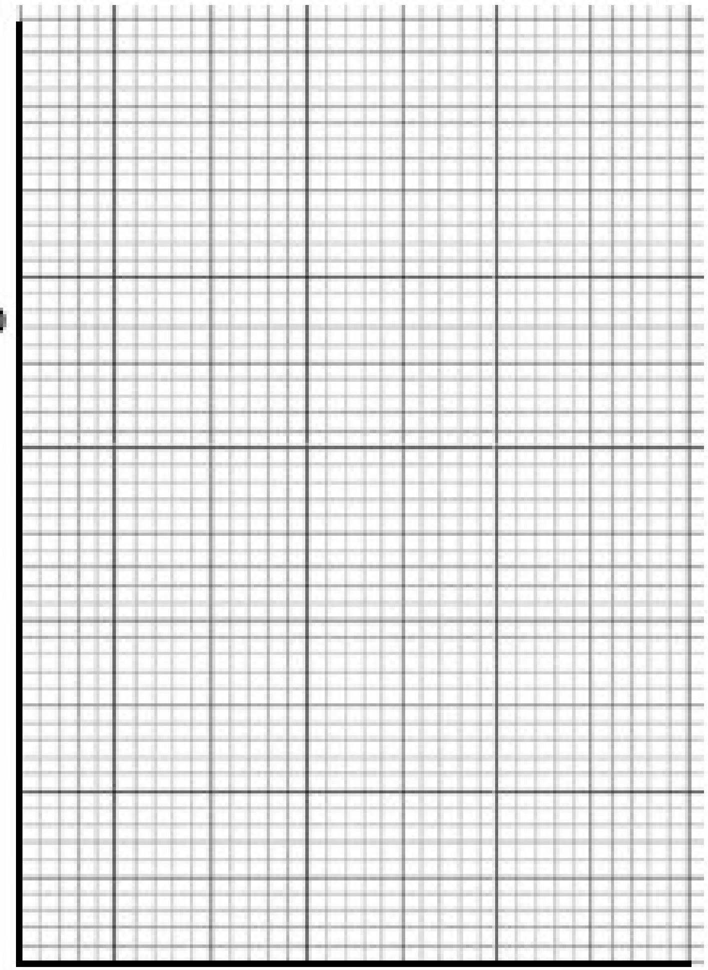
The student performed an experiment, using the apparatus shown in the diagram, on one of the springs.

In the experiment the student measured the increase in length of the spring caused by a number of weights. The spring was tested to destruction (that is weights were added until the spring was damaged).

The data from the experiment is given in the table.

Weight (N)	0.0	0.4	0.8	1.2	1.6	2.0	2.4
Extension (cm)	0.0	2.0	4.0	6.0	8.0	8.5	8.6

(*i*) Plot a ***graph of extension*** (increase in length) ***against weight*** (x-axis). in the grid provided on the right. (9)



(*ii*) Use the graph to find the ***weight*** that would produce an ***extension*** of 5 cm in the spring. (3)

Weight ____________

(*iii*) Study your graph carefully. The spring obeys Hooke's law for the earlier extensions and then when the spring becomes damaged it does not appear to do so. Estimate, from your graph, ***the weight after the addition of which the law seems no longer to apply.*** (3)

Force	Distance	Distance Moved
0N		
1N		
2N		
3N		
4N		
5N		
6N		