

PHYSICS: Forces doing work and Forces and their Effects

Keywords	
Energy	Something that is needed to make things happen or change
Power	The amount of energy transferred per second. Units Watts (W)
Watts (W)	Unit of power. 1 Watt = 1 Joule per second
Work done	Energy transferred when a force acts through a distance
Action-reaction forces	Pairs of forces on interacting objects.
Force field	The space around something where a non-contact force affects things (e.g. a magnetic field or gravitational field)
Normal contact force	The force that acts at right angles to a surface as a reaction to a force on that surface
Non-contact force	A force between two objects that are not touching. Gravity, magnetism and electrostatic forces are all examples of non-contact forces.

Equations (You need to learn and be able to use these)

work done (J)
 = force (N) × distance moved in direction of force (m)

$$E = Fd$$

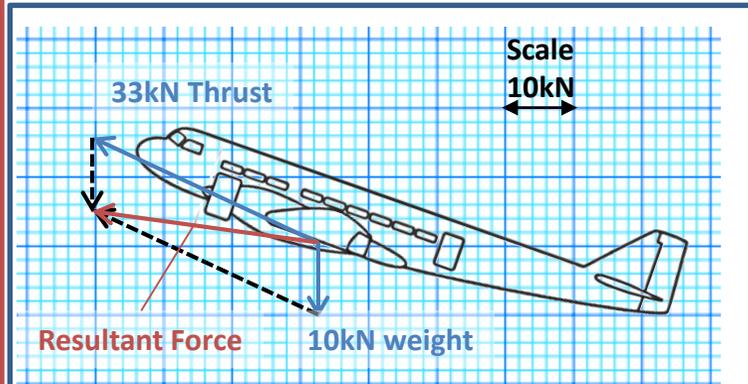
power (W) = $\frac{\text{work done (J)}}{\text{time taken (s)}}$ $P = \frac{E}{t}$

Check Your Understanding

6 mark question: Al walks directly up a hill and he takes 12 minutes to get to the top. Bev walks up the same hill on a shallower path that zig zags as it goes up. She takes 15 minutes to get to the top. Explain who has exerted the greater power, and who has transferred more energy while getting to the top of the hill. Include any assumptions you make in your answer.

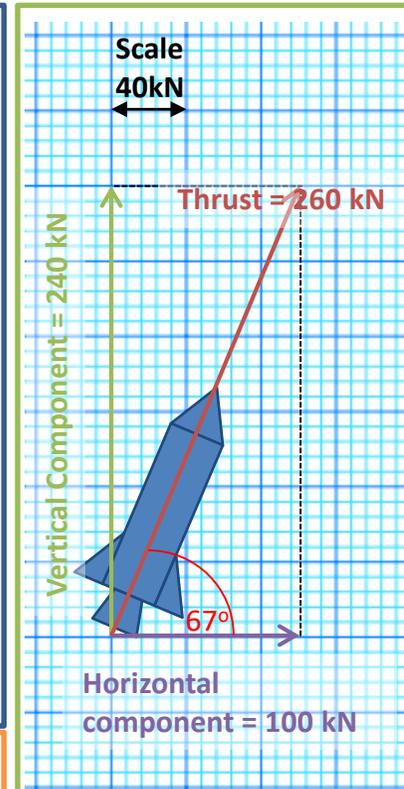
H

Higher Only



Drawing a scale diagram to find resultant force.

- 1) Draw arrows to represent the forces. The arrows should be at the correct angles and the length should represent the size of the force on the scale.
- 2) Draw lines to make a parallelogram.
- 3) Join the diagonal to show the resultant force. Measure this line and use the scale to work out the size of the resultant force.

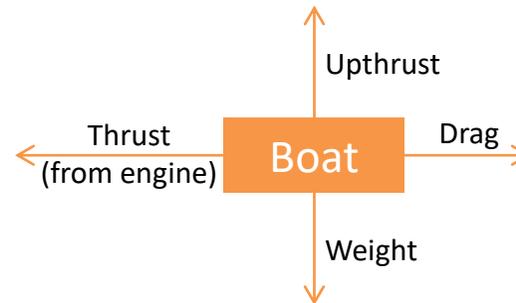


Drawing a scale diagram to resolve forces into components.

- 1) Draw force arrow to scale at the correct angle
- 2) Draw a rectangle with the sides in the directions you are interested in
- 3) The resolved forces are the sides of the rectangle (e.g. vertical and horizontal)

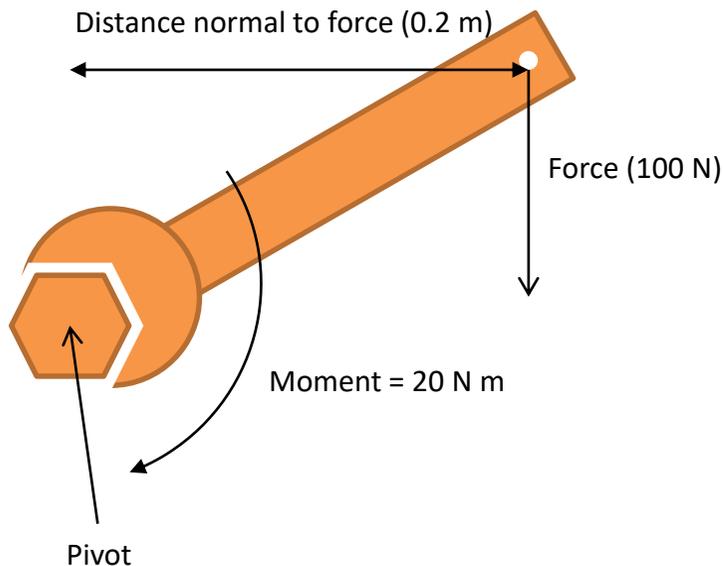
Free body force diagrams show all the forces acting on an object.

All the forces shown need to be acting on the same object.



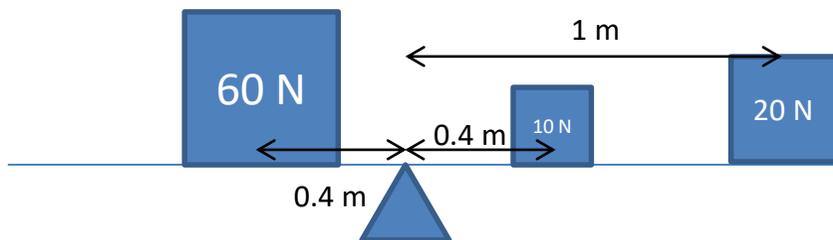
Rotational Forces

Moment of a force = force x distance normal (perpendicular)
 (N m) (N) to the direction of the force (m)



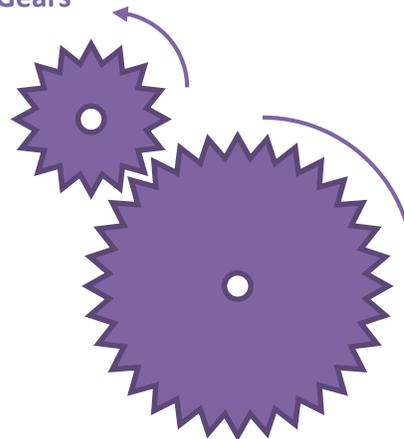
Law of moments:

When a system is in equilibrium the sum of the clockwise moments is equal to the sum of the anticlockwise moments



Clockwise moments: $(20 \times 1) + (10 \times 0.4) = 24 \text{ N m}$
 Anticlockwise moment: $60 \times 0.4 = 24 \text{ N m}$

Gears



The smaller gear has half the number of teeth of the larger gear and so must have half the diameter.

For every complete turn of the smaller gear, the larger gear will complete half a rotation.

If the small gear turns anti-clockwise the large gear will turn in the opposite direction (clockwise).

For any two gears the ratio of the diameters, or the ratio of the number of teeth, will tell you how many times the smaller gear will turn for each complete turn of the larger (or vice versa)

Example: If gear A has 48 teeth and gear B has 16 teeth then gear B will turn $48/16 = 3$ times for every complete turn of gear A.

Check Your Understanding

A man applies a force of 200 N on a spanner at a perpendicular distance of 0.7 m from the bolt. What is the size of the moment?

Some sacks are hanging from a point 0.1 m from a pivot. They are balanced by a weight of 200 N hanging 1 metre from the pivot and a weight of 10 N hanging 1.3 m from the pivot. Calculate the weight of the sacks.

A rock of weight 6 000 N is placed on a lever 0.3 m from the pivot. What force will someone need to apply on the other end of the lever, 2 m from the pivot, in order to lift the rock?

How could the person in the question above adjust the system so that they need to apply less force to move the rock?

Why is it easier to undo a stiff bolt with a longer spanner?

Gear X has 40 teeth and is connected to gear Y which has 10 teeth. How many times will gear Y turn if gear X completes 4 rotations?

If gear X is turned clockwise which way will gear Y turn?

Gear Z, with 20 teeth, is connected to gear Y. How many turns will it complete if gear X completes one turn?