Work done by a force acting at an angle to the direction of motion

Starter

1. If no mechanical energy were lost, a skier descending a straight 40 m slope would arrive at the foot with speed 15 m/s. Calculate the angle the slope makes with the horizontal given that the skier set off from rest.

2. A cyclist climbs a hill of length 3 km which has an average gradient of $6\,\%$. At the bottom of the hill the cyclist is travelling at 30 km/h but at the top his speed has dropped to 12 km/h. Given that the cyclist's average driving force is 250 N and the combined mass of bike and rider is 80 kg, calculate the average resistive force.

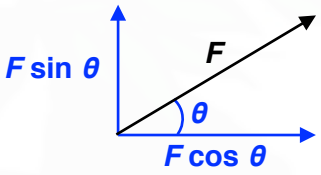
3. A force of 12 N acts at an angle of $30°$ to the horizontal. How much of this force acts:
   (a) in the horizontal direction (b) in the vertical direction.

4. A force of R N acts at an angle of θ to the horizontal. How much of this force acts:
   (a) in the horizontal direction (b) in the vertical direction.

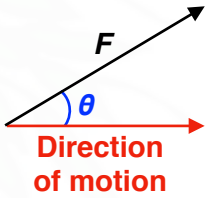
Notes

Resolving — sine or cosine

Turn through the angle ⇒ cos
Not turn through the angle ⇒ sin



E.g. 1 Work done = Force × Distance when the force is acting in the direction of motion i.e. $WD = Fs$. What is the work done when the force, F, is acting at an angle of θ to the direction of motion?



When the force, whether driving or resistive, acts at an angle to the direction of motion, ***resolve the force in the direction of motion*** before multiplying by the distance.

E.g. 2 A sledge is pulled along level ground by a rope inclined at $20°$ to the horizontal. Given that the tension in the rope is 30 N, calculate the work done, to the nearest J, in moving the sledge 40 m.

Video: Work done on rough inclined planes

Solutions to Starter and E.g.s

Exercise

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Summary

When the force, whether driving or resistive, acts at an angle to the direction of motion, ***resolve the force in the direction of motion*** before multiplying by the distance.