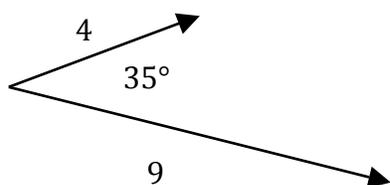# WORK

On Wednesday we introduced the concept of work as the term is used in physics, and on Thursday we went on to complete that definition using the scalar product of two vectors. Because of the symbol used for this type of multiplication we usually call it the "dot" product.

The dot product of two vectors is defined as follows:

Given two vectors such as $\vec{A}$ and $\vec{B}$ their dot product is defined as the product of their magnitudes (sizes) and the cosine of the angle between them. $\vec{A} \cdot \vec{B} = AB\cos\theta$.

For example given the two vectors shown here, what is the dot product?

Being sure your calculator is set in degree mode simply enter in 4×9cos35° to get 29.5

Now it is simple to use this definition to find the work done by any force on any object. The definition of work is then the dot product of the force and the displacement.

$$W = \vec{F} \cdot \vec{d}$$

Use this definition to find the work done by the forces and displacement in the following problems. Do the problems neatly one separate paper so they can be turned in at the end of the period. In each case show your work and clearly indicate your answers. Since this is a learning exercise you may seek help if you have trouble. In some cases the answers will be provided in brackets at the right in order to make sure you are on the right track.

1. A force of 500.N is applied horizontally to drag a 200. kg trunk 3.75 m across the floor.   [ans. 1880 J]

2. As a crate slides 5.0 meters across a floor a frictional force of 2.5 N opposes this motion. Calculate the work done by the frictional force.   [ans. -12.5J]

3. A 20.kg object is lifted 3.0 m at a constant velocity by a cable.
   a) How much work is done by the cable?   [ans. 590J using g = 9.8 m/s²]
   b) How much work is done by gravity? (remember to write out your equations and show your work.)   [ans – 590 J]

4. Gravity does 200.J of work pull a rock of mass 2.5 kg to the ground. How many meters did the rock move? [8.2 m using g = 9.8 m/s²]

5. A student pushes with a horizontal force on a large crate and does 250 J of work in moving it a horizontal distance of 4.5 m.
   a) How much force does the student exert? [56 N]
   b) If the crate moves at a constant speed how much force is friction exerting? [56 N]
   c) How much work is done by friction? [-250J]

6. A 0.20 kg shell is accelerated at a constant rate as it move down the 2.0 m barrel of a gun and it leaves the gun with a speed of 350 m/s.
   a) How much is the acceleration of the shell?
   b) How much is the net force on the shell?
   c) How much work is done on the shell?
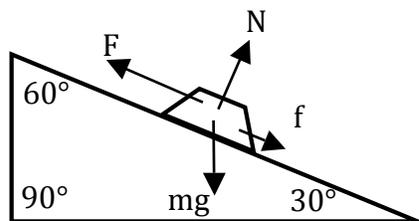
7. Shown above is an 4.0 kg object being pushed up a ramp. The total distance the object is moved along the slope of the ramp is 1.5 m.
   a) Calculate the weight, mg, of the object.
   b) Calculate the work done by the force F which is 25 N.
   c) Calculate the work done by the friction force which is 3.0 N
   d) Calculate the work done by gravitation.
   e) Calculate the work done by the normal force N.

Your copies of these solutions are to be turned in at then end of the period. Your homework is to read in the text pages 168 – 176.