NAME: KEY

Work

A. What is the definition of work?

$W = Fd$

B. How is work related to energy?

Work is the transfer of energy from one object to another

C. What are the units for work?

J "Joules" → it is energy!

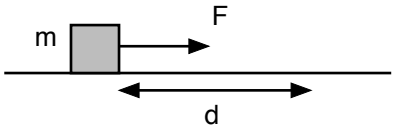
D. Can a force do negative work?

Yes! If a force is trying to slow down an object, it does negative work

E. If a force is perpendicular to the distance an object moves, how much work would the force do on the object?

None. A force only does work when it is trying to change the speed of an object. (speed up = + work & slow down = − work)

Calculations



The diagram above shows a block being pulled across a floor or table by a horizontal force F.

1. If the force was a constant 20 N, how much work was done by the force pulling the object 5 m?

F = 20 N
d = 5 m

$W = Fd$ $W = (20)(5)$ **$W = 100\ J$**

2. If the force was a constant 20 N, how much work was done by the force pulling the object 15 m?

F = 20N
d = 15 m

$W = Fd$ $W = (20)(15)$ **$W = 300\ J$**

3. How far would a force of 15 N have to pull the object to do 100 J of work?

F = 15N
W = 100J

$W = Fd$ $100 = (15)\,d$ **$d = 6.7\ m$**

Work

4. If the distance pulled was 8 meters and the total work done was 90 J, what was the force?

$d = 8\text{ m}$, $W = 90\text{ J}$ $\quad W = Fd \quad 90 = F(8) \quad F = 11.25\text{ m}$

5. If there was a friction force of 5 N, and the object was still pulled to the right 7 meters, how much work did friction do?

$F = -5\text{ N}$, $d = 7\text{ m}$ $\quad W = Fd \quad W = (-5)(7) \quad W = -35\text{ J}$

friction tries to SLOW DOWN things...

6. If friction did –75 J of work, and the object was pulled 8 meters, what was the force of friction?

$W = -75\text{ J}$, $d = 8\text{ m}$ $\quad W = Fd \quad -75 = F(8) \quad F = -9.4\text{ N}$

7. Can friction ever do positive work? Explain.

No! Friction ALWAYS tries to slow things down, so it ALWAYS does negative work.

8. A 35 N force is pulling a box to the right. There is also a frictional force of 15 N acting on the box. The box is pulled a total of 5 meters.
   a. How much work did the 35 N force do?

$F_1 = 35\text{ N}$, $F_2 = -15\text{ N}$, $d = 5\text{ m}$ $\quad W_1 = Fd \quad W_1 = (35)(5) \quad W_1 = 175\text{ J}$

   b. How much work did friction do?

$W_2 = Fd \quad W_2 = (-15)(5) \quad W_2 = -75\text{ J}$

   c. How much total work was done on the box?

$\text{Total Work} = W_1 + W_2 = 175 + (-75) = 100\text{ J}$ ($\uparrow \Sigma W$)

9. A 50 N force is pulling a box to the right a distance of 12 meters. Friction does –200 J of work on the box.
   a. How much work did the 50 N force do?

$F_1 = 50\text{ N}$, $d = 12\text{ m}$, $W_2 = -200\text{ J}$ $\quad W_1 = F_1 d \quad W_1 = (50)(12) \quad W_1 = 600\text{ J}$

   b. What was the force of friction?

$W_2 = F_2 d \quad -200 = F_2(12) \quad F_2 = -16.7\text{ N}$

Work

c. How much total work was done on the box?

$\Sigma W = W_1 + W_2 = 600 + (-200) =$ **400 J**

Now Involving Energy!

10. Starting from rest, a 2000 kg car accelerates to 30 m/s.
    a. How much kinetic energy does the car end up with?

$v_i = 0$ m/s
$m = 2000$ kg
$v_f = 30$ m/s

$KE = \frac{1}{2}mv^2$ $KE = \frac{1}{2}(2000)(30)^2$ **$KE = 900{,}000$ J**

    b. How much work was done on the car?

Since the car gained 900,000 J of energy, that is the work done on it. So **900,000 J**

    c. How much work would it take to stop the car?

To stop the car, we need to take away ALL its energy, so we need to do **−900,000 J** of work to stop it.

11. A 4 kg box is lifted 3 meters.
    a. How much potential energy does the box gain?

$m = 4$ kg
$h = 3$ m

$PE = mgh$ $PE = (4)(10)(3)$ **$PE = 120$ J**

    b. How much work was done on the box?

Since the box gained 120J, that is how much work was done on it. **120 J**

12. A 3 kg box has an initial speed of 4 m/s. It slides to a stop in a distance of 1.5 meters.
    a. How much kinetic energy does the box have at the start?

$m = 3$kg
$v_i = 4$ m/s
$d = 1.5$ m
$v_f = 0$ m/s

$KE = \frac{1}{2}mv^2$ $KE = \frac{1}{2}(3)(4)^2$ **$KE = 24$ J**

    b. How much work does friction have to do to stop the box?

Friction will have to take away all the energy, so it will need **−24 J** of work.

    c. What was the force of friction while sliding to a stop?

$W = Fd$ $-24 = F(1.5)$ **$F = -16$ N**