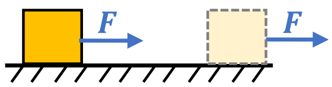
CONCEPT: WORK DONE BY A CONSTANT FORCE

● When you push an object (box) at rest with constant force along a smooth horizontal surface, it starts to move!

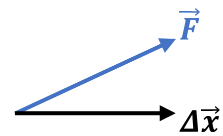


- It gains speed (v), so it gains ____________ Energy. This Energy comes from __________!

● **WORK (W)** is the __________ of Energy transferred between objects. You "______________" on the box. Unit: **[___]**

W_F = __________ = ___________ , where θ is *always* the angle between ___ & ___.

(Work done by Constant Force)



EXAMPLE: You pull a 2kg box initially at rest horizontally with 3N. Calculate the work you do on the box if you pull it a distance of 5m.

EXAMPLE: A 5kg cart is moving to the right at 10m/s when a 100N stopping force to the left acts on it over a distance of 2.5m. Calculate the work done by this stopping force.

● W is the amount of Energy any force **gives to** (__W) or **takes away** (__W) from the object.

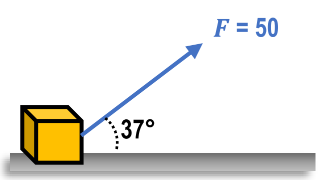
- If the force "helps", i.e goes *along with* the object's motion, the work done is **[POSITIVE | NEGATIVE]**
- If the force "hurts", i.e goes *against* the object's motion, the work done is **[POSITIVE | NEGATIVE]**

PROBLEM: You pull a 5kg box vertically up with a constant 100N force for 2m. How much work do you do?

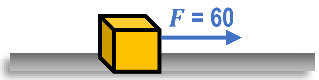
A) 51 J
B) 100 J
C) 102 J
D) 200 J
E) 500 J
F) 1000 J

WORK & ENERGY
$KE = \frac{1}{2}mv^2$
$W = Fd\cos\theta$

PROBLEM: You pull a 10kg suitcase with a 50 N force angled 37° above the floor. You pull the suitcase for 20m. **a)** Find the Work done by your pull $\boldsymbol{F}$. Decompose $\boldsymbol{F}$ into $\boldsymbol{F_x}$ and $\boldsymbol{F_y}$ and calculate the work done by **b)** $\boldsymbol{F_x}$ and **c)** $\boldsymbol{F_y}$.



PROBLEM: A box weighing 50N rests on a smooth, flat surface. The coefficient of kinetic friction $\mu_k = 0.7$. You pull the box horizontally with 60 N for 8m. Calculate the work done by **a)** Kinetic Friction; **b)** Weight; **c)** Normal.



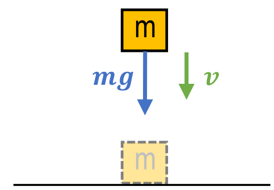
● Friction always ***opposes*** motion ($\vec{v}$) so it *ALWAYS* does ____________ WORK: W_{f_k} = $f_k d\cos(\_\_\_)$ = ______

CONCEPT: WORK DONE BY GRAVITY

- Because gravity is a FORCE (**mg**), gravity can also DO WORK**.**
  - Remember: Work is a *transfer* of energy → positive when ***F*** is along motion, negative when ***F*** is against motion**.**

Object Falling (Going *Down*)

EXAMPLE**:** A 5.1kg book falls from a 2m-tall bookshelf**.** The book has a speed of 6.26 m/s when it hits the ground**. a)** Calculate the work done on the book by gravity**. b)** Calculate the book's kinetic energy right before hitting the ground**.**

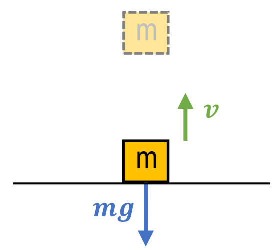


- W_g = **Fdcosθ** = (___)(____)cos(___) = _____
  - Gravity does **[+ | –]** Work

W_g **=** ______

Object Rising (Going *Up*)

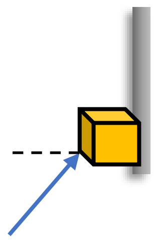
EXAMPLE**:** You throw a 2kg rock vertically upwards with an initial velocity of 15m/s**.** The rock rises to a max height of 11.5m**. a)** Calculate the initial kinetic energy of the rock**. b)** Calculate the work done on the rock by gravity**.**



- W_g = **Fdcosθ** = (___)(____)cos(___) = _____
  - Gravity does **[+ | –]** Work

PROBLEM: You push a 3k box against a wall for a distance of 2m with a force of 40N that makes a 53° angle with the horizontal, as shown. Calculate the work done by gravity.

A) 58.8 J
B) – 58.8 J
C) – 160 J
D) – 80 J



PROBLEM: A 75 kg hiker starts at the bottom of a 1,000 m mountain, and hikes up to the top. The hiker takes an irregular path with varying speeds & inclinations. How much work does gravity do on the hiker during the entire hike?

● Work done by Gravity depends *ONLY* on the change in ________, *not* the path taken. This is called **path independence.**