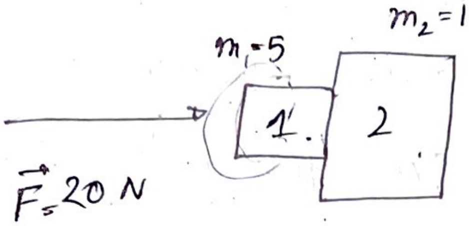
problem:

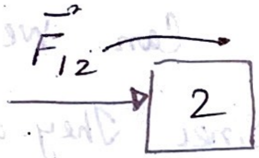


When you apply force $\vec{F}=20N$, two objects start moving together ~~with 1 m/sec² acceleration~~ with an acceleration. What is the acceleration of this?

$$\vec{F} = m\vec{a} = (m_1+m_2)\,\vec{a} = (5+15)\,\vec{a}$$

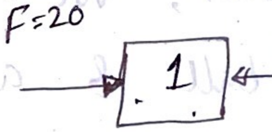
$$\text{or, } \vec{a} = \frac{F}{20} = 1 \text{ m/sec}^2$$

Now we will single out the object



object 1 is pushing object 2

$$\vec{F}_{12} = m_2\,\vec{a} \qquad \text{or, } F_{12} = 15 \text{ N}$$
$$= 15 \times 1 \text{ N}$$



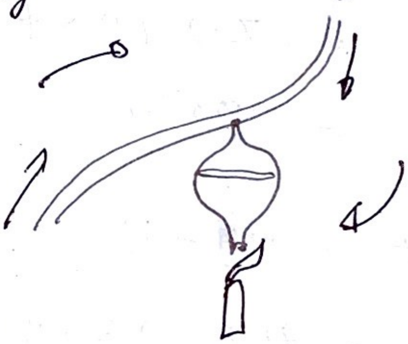
$\vec{F}_{21}$ → push from object 2

we know that Object 1 is beeing accelerated That's non negotiable

$$\vec{F} + \vec{F}_{21} = ma = 5 \text{ kg} \times 1 \text{ ms}^{-2}$$
$$\vec{F}_{21} = 5 - F = -15 \text{ N}$$

Therefore, One is pushing on two with 15 N in this direction. Two is pushing back in that direction & the whole system is being accelerated. 1 m/sec

Hero's Engine: Hero was Greek legend, was priestress of Aphrodite. Her lover Leander would swim across the Hellespont every night to be with her. One night poor guy drowned & Hero threw herself into the sea.



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problem "A passenger of mass = 72.2 kg stands on a platform scale in an elevator. We concerned with scale reading when the cab is stationary & when it is moving up or down with a constant .5 m/s / with acceleration 3.20 m/s².

① When the ~~cap~~ elevator is stationary,

$$F_N - F_g = ma$$

$$F_N = (mg + ma)$$

$$\boxed{F_N = F_g}$$

(ii) For any constant velocity, acceleration is zero,

$$F_N = m(g + a) = mg + 0$$

$$= 72.2 \times 9.8 = 708\ N$$

(iii) For $a = 3.2\ m/s^2$

upward,

$$F_N = m(g + a)$$

$$= 72.2\ (9.8 + 3.20)$$

$$= 939N$$

downward

$$F_N = m(g - a)$$

$$= 72.2\ (9.8 - 3.2) = 477\ N.$$

For an upward acceleration, the scale reading is greater than passenger's weight. This apparent weight. For downward acceleration, The scale reading is less than the passenger's weight.

PHY 107 14-12-2017 Lecture - 7

The concept of Energy: The transformation of energy is a powerful concept that enables us to describe a vast number of process.

Falling water releases stored gravitational potential energy which can become the kinetic energy associated with coherent motion of matter.

When you use electrical device, the electrical energy is transformed into other forms of energy. Like sound energy, heat energy.

Human being transform the stored chemical energy of food into various forms necessary for the maintenance of the functions of various organ system, tissue and cells in body.

Light is an example of transforming electrical energy into light energy & heat energy. In nuclear power plant, the atomic energy ~~will~~ be is being converted to electrical energy.

If you rub your hand, heat will be produced due to the conversion mechanical energy to heat energy.

Kinetic energy: The first form of energy that we will study is an energy associated with the coherent motion of molecules that constitute a body of mass m, This energy is called the Kinetic energy (from the Greek "kinetikos" moving).

The faster the object moves, the greater is its kinetic, If the object is not ~~mol~~ changing its position, meaning no movement, the object's kinetic energy is zero.

For an object of mass m whose speed v is well below the speed of light

$$K = \frac{1}{2} m v^2$$ [Energy is a scalar quantity]

The SI unit of kinetic energy is Joule (J), named for James Prescott Joule, an English scientist

Defination of 1 joule

$$K \rightarrow 1 \text{ joule} = 1 J = 1 \, kg \cdot m^2 s^{-2}$$

problem: If a crow (25 kg) is flying with $4 \, ms^{-1}$ velocity. What would be its kinetic energy due to this motion?

$$E_k = \frac{1}{2} m v^2$$

$$= \frac{1}{2} \times .25 \times (4)^2$$

$$= \frac{1}{2} \times .25 \times 16 = 8 \times .25 = 2J \text{ Ans}$$

problem

Two cars crashed head to head from ~~an~~ opposite ends of 6.4 km long track. Each car weighed $1.2 \times 10^6 N$ and its acceleration was a constant $0.26 \, ms^{-2}$. what ~~was~~ the total kinetic energy of two cars just before the collission.

$$v^2 = v_0^2 + 2as \qquad v_0 = 0$$

$$v = 2 \times (.26) \times 3.2$$

$$v = 147 \text{ km/h} = \frac{147 \times 10\cancel{00}}{36\cancel{00}} = 40.8 \, ms^{-2}$$

$$m = \frac{W}{g} = \frac{1.2 \times 10^6 N}{9.8 \, ms^{-2}} = 1.22 \times 10^5 \text{ kg}$$

$$\text{so } K_E = 2 \cdot \left(\frac{1}{2} mv^2\right) = (1.22 \times 10^5 \text{ kg}) (147 \text{ km/h})$$

$$= 2 \times 10^8 J$$

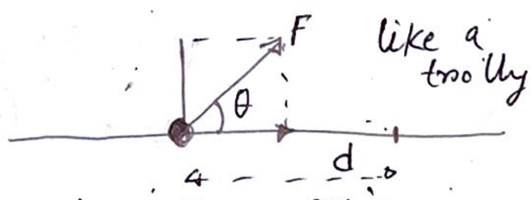
This collision was like an exploding bomb.

Work:

If you accelerate an object to a greater speed by applying a force to the object, you increase the kinetic energy K ($\frac{1}{2}mv^2$) of the object. Similarly you can also decelerate the object to lesser speed by applying force. Such a transfer of energy via force, is called Work.

- Work W is energy transferred to or from an object by means of a force acting on the object. Energy transferred to the object is positive work & energy transferred from the object is negative work.

- Lets consider a situation where you are pulling (F) a trolly bag by making an angle θ with a horizontal x axis.



The Force makes the acceleration of the object in x axis. Therefore

$$F_x = ma_x \quad \text{--- (i)}$$

If the V_0, V are the initial velocity, d is the displacement

$$V^2 = V_0^2 + 2a_x d$$

or, $2a_x d = V^2 - V_0^2$ or, $a_x = \dfrac{V^2 - V_0^2}{2d}$ — (ii) put the value of a_x (II) in equation (I)

$$F_x = m\left(\frac{v^2 - v_0^2}{2d}\right)$$

or $\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 = F_x \cdot d$ - - - (III)

The left term says about the change in kinetic energy. This change in kinetic energy is equal to the product of force & displacement.

There the work done on the trolly is

$$\boxed{W = F_x d}$$

* To calculate the work, we use the force compo-
-nent along the object's displacement. & the displacement.

$$W = Fd \cos\theta$$

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

Causion

* Force must be constant
* object must be particle like. (move togetho)
object must be rigid.

② Alternatively, we can first find the net force $\vec{F}_{net}$ of those forces. then calculate the work.

problem

If you apply force, $\vec{F}$, $1N$ on an object with 60° degree angle & the displace is $2m$. Calculate the work done.

$$W = F d \cos\theta$$

$$= 1 \times 2m \cos 60^{\circ}$$

$$= 1 \quad J \text{ Ans.}$$

Work Energy theorem:

We saw the change of kinetic energy of the trolly. ($K_i = \frac{1}{2} m v_0^2, K_f = \frac{1}{2} m v^2$) to the work done on the bead.

$$\frac{1}{2} m v^2 - \frac{1}{2} m v_0^2 = F.d = W$$

$$\Delta K = K_f - K_i = W$$

Change in kinetic energy of trolly = net work done on the particle

$$K_f = K_i + W$$

kinetic energy after the net work is done = kinetic energy before the net work + The net work done.

This is known a "Work energy theorem".

Check point 1: A particle moves along an x axis. Does the kinetic energy of the particle increase, decrease or remain same if the particle's velocity changes

(a) from $-3\,m/s$ to $-2\,m/s$ (b) from $-2\,m/s$ to $2\,m/s$.

(c) In each situation, is the work done on the particle positive, negative or zero

(a) $K_f - K_i = W$

$\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 = W$

$\frac{1}{2}m(-2)^2 - \frac{1}{2}m(-3)^2 = W$ or $\frac{4m}{2} - \frac{9m}{2} = W$

or, $\frac{-5}{2}m = W$ $-$

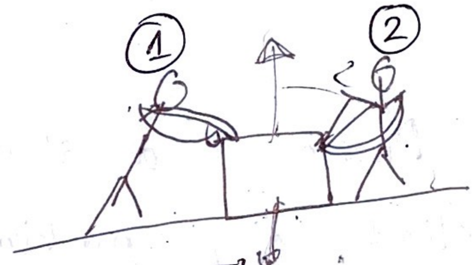
$\boxed{\text{decreases}}$ / work done negative

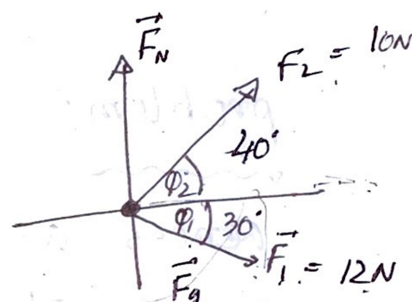
(b) $\frac{1}{2}mv^2 - \frac{1}{2}mv_0 = W$

or $\frac{1}{2}m(2)^2 - \frac{1}{2}m(-2)^2 = W$

or $2m - 2m = W$ $\boxed{W = 0}$ no change in kinetic energy, work done zero

problem





(A) What is the net work done on the safe by forces $\vec{F}_1$ & $\vec{F}_2$ during displacement 8.5 m.

Workdone by F_1 $W_1 = F_1 d \cos\phi_1 = 12N \times 8.5m \times \cos 30^\circ$

$= 88.33 J$

by F_2, $W_2 = F_2 d \cos\phi_2 = 10N \times 8.5m \cos 40^\circ = 65.11 J$

$W = W_1 + W_2 = 88.33 J + 65.11 J = 153.4 J$

(m) Work done by F_g, $W_g = mg\, d \cos 90^\circ = 0$

Normal force F_n, $W_N = F_N \cos 90^\circ = 0$

We should have know this result. Since these forces are perpendicular to the displacement. They do zero work on the box. & do no transfer energy to/from it.