physics cheat sheet

unit 3 : Energy

Energy = the ability to do damage (measured in Joules)

- Potential Energy
  - → symbol ⇒ U
  - → $U = mgh$
- E_{lost}
  - → $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2 + E_{lost}$
- Kinetic Energy
  - → Symbol ⇒ KE
  - → $KE = \frac{1}{2}m(v^2)$

example:

mass x2: 20kg car hits a wall at 5mph → 40kg car hits a wall at 5mph ⇓ double (x2)

mph x2: 20kg car hits a wall at 5mph → 40kg car hits a wall at 5mph ⇓ quadruple (x4)

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example problems:

Romin (mass unknown) is on a flying toad at a velocity of 12m/s such that it has a KE of 4Q.

a) if he accelerates to a speed of 18m/s, how much KE will he have?

$$\left(\frac{V_f}{V_i}\right)^2 = \left(\frac{18}{12}\right)^2 = 4 \times KE_i$$

$$2.25 = 4 \times KE_i$$

$$2.25 \times 4Q = 9Q \Rightarrow 162m \times \frac{4Q}{72m} = 9Q$$

b) if he slows down to a speed of 6 m/s, how much KE does he have?

$$\left(\frac{V_f}{V_i}\right)^2 = \left(\frac{6}{12}\right)^2 = \frac{1}{2}^2 = \frac{1}{4} \times KE_i = \frac{1}{4} \times 4Q = Q$$

If you go from a velocity V and have KE of Q, and go to velocity 3V, your KE will then be 9Q.

A TIE bomber of mass 3M is flying at velocity V_i and KE of 200Q.

a. it slows down and now has KE of 5Q. What is its new V? (write in terms of V_i)

$$KE_f = 5Q = \frac{1}{2}mv^2$$

$$KE_i = 2Q = \frac{1}{2}3mv_i^2$$

$$20 = 4(5) = 4\left(\frac{1}{2}3m(v_i^2)\right)$$

$$\frac{1}{2}3m(v_f^2) = 4\left(\frac{1}{2}3m(v_i^2)\right)$$

$$\frac{1}{2}3m(v_f^2) = 2(3m(v_i^2))$$

$$\cancel{3m}(v_f^2) = \cancel{3m}(v_i^2)$$

$$V_f = \frac{1}{2}V_i$$

b. it launches its missiles, changing its mass to 2M and simultaneously accelerating to velocity of 2V. Find its new KE in terms of Q.

velocity v, mass 3m : $KE = 5Q = \frac{1}{2}3m(v^2) = \frac{3}{2}mv^2$

$$mv^2 = \frac{10Q}{3}$$

plug in.

velocity 2v, mass 2M : $KE = \frac{1}{2}(2m)(2v^2) = 4mv^2$

$$= 4\left(\frac{10}{3}Q\right) = \frac{40}{3}Q$$

TOTAL ENERGY IS ALWAYS CONSERVED. $\Rightarrow E_i = E_f$

Power & Work :

- Power $= \frac{\text{work}}{\text{time}}$

  $\downarrow$

  $P = \frac{dw}{dt}$

  or

  $= \frac{dw}{dx}$

- Work
  - measured in watts
  - $\int F(x)\,dx$
  - force × distance
  - $E_{final} - E_{initial}$

- Force = mass × acceleration

  $F = -\frac{du}{dx}$

$W(t) = \int P(t)\,dt$ or $P = \frac{dw}{dt}$

$W(t) = P(t)\,dt$ or $F = \frac{dw}{dx}$

example:

For a particular nonlinear spring, the relationship between the applied force F and resultant displacement x from equilibrium is given by the equation $F = kx^2$. What is the amount of work done by stretching the spring a distance x_0?

answer: $\frac{1}{3}kx_0$

$$F = \frac{dW}{dx}$$

$$W = \int F\,d(x)$$

$$= \int kx^2(dx) = \frac{1}{3}kV_0^3$$

A starship with engine A takes 10 sec. to get to full speed. Engine B has 1/4 the power of engine A. How long would it take for engine B to get the same ship to full speed.

$$F = \frac{-du}{dx} = 40\,\text{sec}$$

Two characters are sliding down identical ramps. If the surface is frictionless, what velocity will they hit the bottom with?

$PE_i + KE_i = PE_f + KE_f$

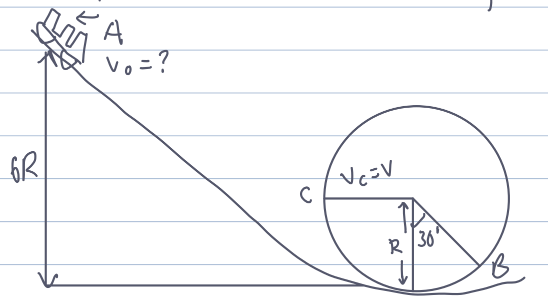
$PE_i + 0 = 0 + KE_f$

$mgh = \frac{1}{2}mv^2$

$-9.8(10) = \frac{1}{2}v^2$

$v = 14\ m/s$

) At point A the cart of mass M is thrown down with an unknown velocity V_0. It goes over the loop that has a radius R.
) A point C it has a velocity of V.



$h = R$

$E_c = KE_c + V_c$

$E_c = \frac{1}{2}mv^2 + mgR$

$E_A = E_c$

$KE_A + V_A = \frac{1}{2}mv^2 + mgR$

$\frac{1}{2}mv^2 + mg6R = \frac{1}{2}mv^2 + mgR$

$\frac{1}{2}V_0^2 + 6gR = \frac{1}{2}V^2 + gR$

$V_0^2 = V^2 - 10gR$

$V_0 = \sqrt{V^2 - 10gR}$