Physics 113 - October 16, 2012

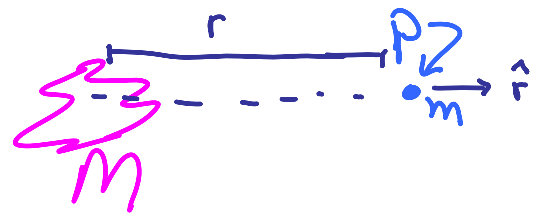
- Midterm class survey
- Exam 2 - Oct. 25, during regular lecture slot in Hoyt

  From Newton's laws w/ friction to start of Momentum Cons.
  9/25 lect to end of gravity in this lecture
  chapters 5, 6, 7, 8 → NOT sections 5-5, 5-6, 6-5, 6-7, 6-8
  Probsets 5, 6
  Workshops 4-6

- No lecture in Hoyt Tues., Oct. 23
  ↳ Slides + Audio will be posted

Gravitation

Last Time —

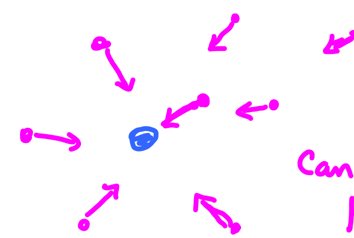


$$\vec{F}_{\text{of M on m}} = -\frac{GMm}{r^2}\hat{r}$$

gravitational field

$$\vec{g}(p) = \vec{F}/m = -\frac{GM}{r^2}\hat{r}$$

Vector

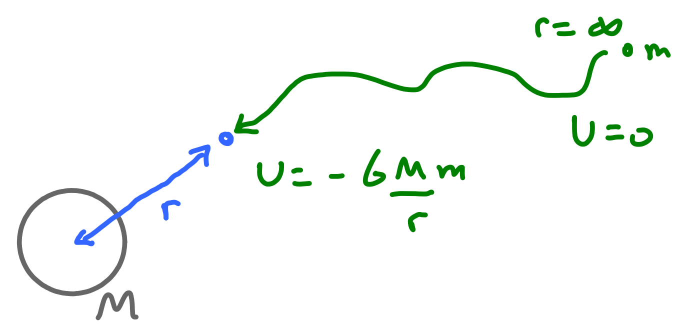


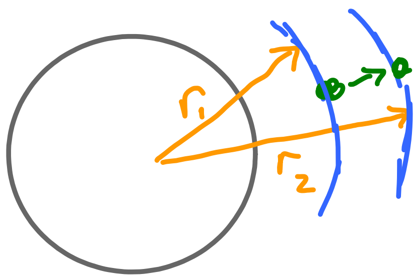
Can visualize Field

For mass brought in from ∞ to point P

$$PE_{grav} = -\frac{GMm}{r}$$

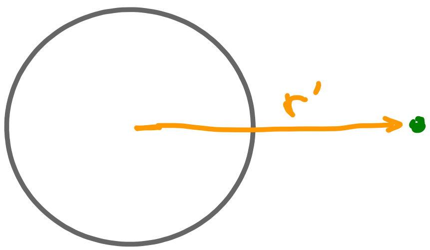
Scalar

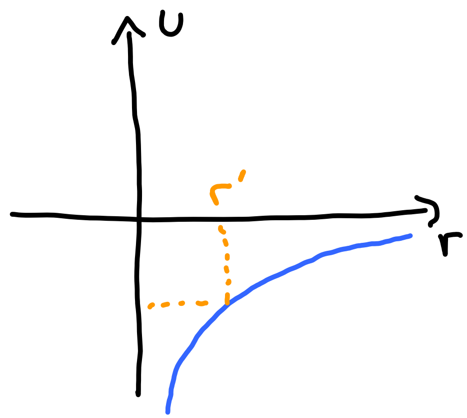




$$\Delta PE = -\frac{GMm}{r_2} - \left(-\frac{GMm}{r_1}\right)$$

$\approx mg\Delta r \approx mgh$ for small h near surf. of Earth

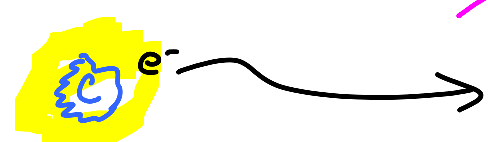


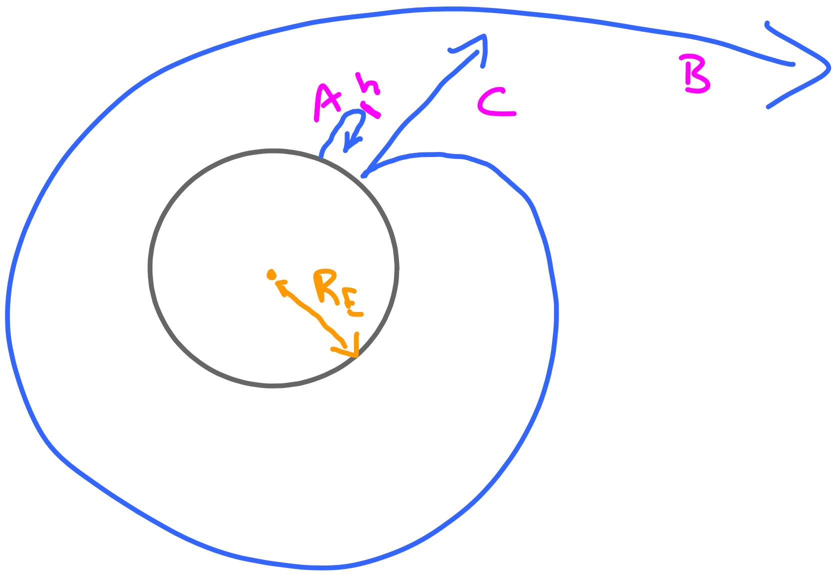


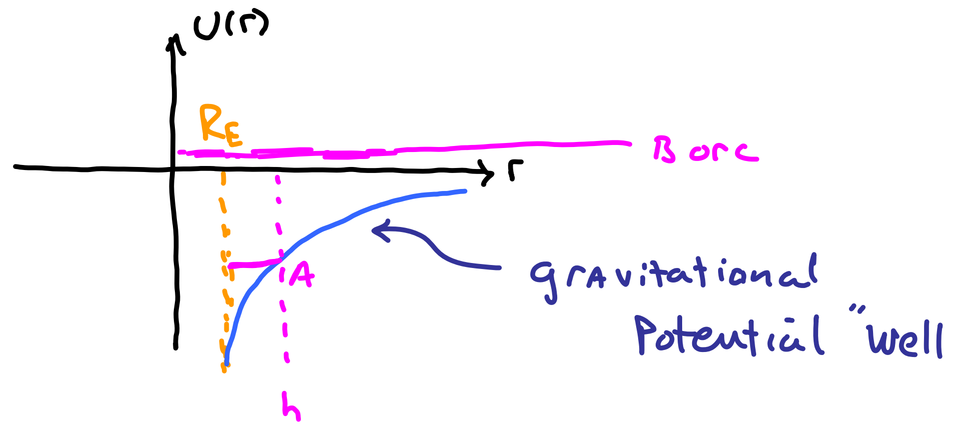
What does it mean that U is negative?

must put in $\frac{GMm}{r}$ of energy to free particle

Analogous to ionization energy in chemistry







Escape Velocity, V_{es}

KE PE of "bound" state

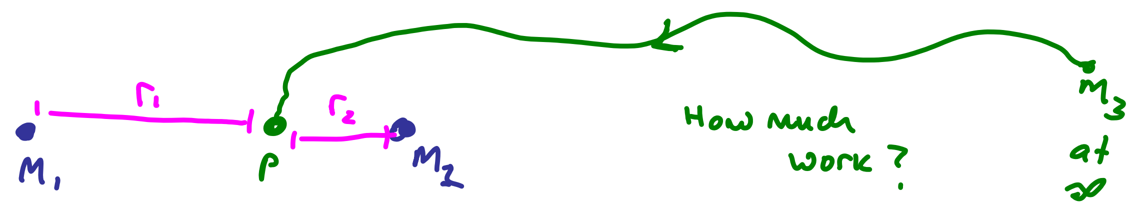
$$\frac{1}{2}mV_{es}^2 = \frac{GMm}{r}$$

From surface of Earth

$$\frac{1}{2}mV_{es}^2 = \frac{GM_E m}{R_E}$$

$$V_{es} = \sqrt{\frac{2GM_E}{R_E}}$$

Why potential?



Energy to move M_3 to point P = $\sum U_i = -\frac{GM_1M_3}{r_1} - \frac{GM_2M_2}{r_2}$

Easier to calculate than $\vec{F}_g$

$$F_s = -\frac{dU_s}{ds}$$

Very impt in Electricity + Magnetism "Electrical potential" "potential difference"

End of Material for Exam 2

$$\vec{F} = m\vec{a} = m\frac{d\vec{v}}{dt} = \frac{d(m\vec{v})}{dt}$$

$$\frac{d(m\vec{v})}{dt} = m\frac{d\vec{v}}{dt} + \cancelto{0}{\frac{dm}{dt}}\,\vec{v}$$

Not zero if mass Δes

$$\frac{d(m\vec{v})}{dt}$$

$m\vec{v} \equiv \vec{p} \equiv$ momentum

$\longrightarrow$ Vector $\quad \vec{p} = m\vec{v} \longrightarrow$

$$p_x = mv_x$$

$$p_y = mv_y$$

$$p_z = mv_z$$

$$\vec{F} = \frac{d\vec{P}}{dt}$$

$$d\vec{p} = \vec{F}\,dt$$

$$\int d\vec{p} = \int \vec{F}\,dt$$

$$\Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = \int_{t_1}^{t_2} \vec{F}\,dt$$

Impulse

$$\Delta \vec{P}_1 = \int_{t_i}^{t_F} \vec{F}_{2\,on\,1}\,dt \qquad \Delta \vec{P}_2 = \int_{t_i}^{t_F} \vec{F}_{1\,on\,2}\,dt$$

$$\vec{F}_{2\,on\,1} = -\vec{F}_{1\,on\,2} \qquad \Delta \vec{P}_1 = -\Delta \vec{P}_2$$

$$\Delta\vec{p}_1 + \Delta\vec{p}_2 = 0$$

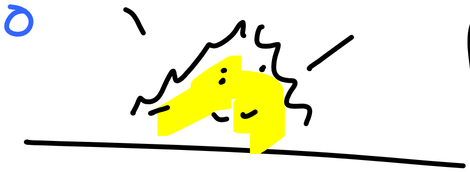
Sum of changes in $\vec{p} = 0$

MOMENTUM CONSERVATION

If there are no external forces acting on a system, the total momentum of the system is conserved

$$\sum \vec{p}_i = \sum \vec{p}_f$$

The discovery of the neutrino



β decay

$$n \to p + e^-$$

$$^{40}_{19}K \to {}^{40}_{20}Ca + e^-$$

$$e^- \longleftarrow n \longrightarrow p$$

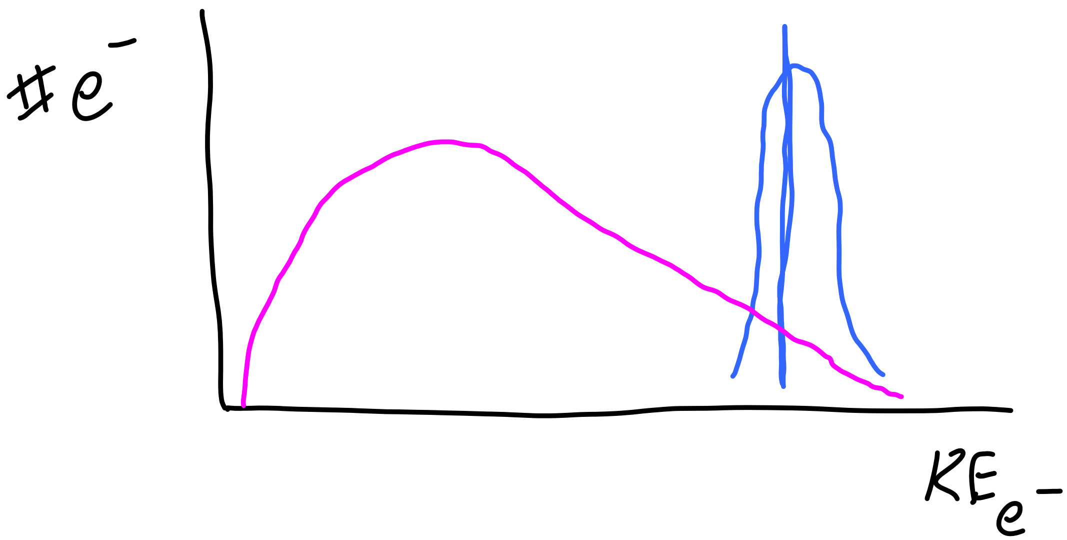
P cons $\quad m_e V_e = -M_p V_p \longrightarrow V_p = -\frac{m_e v_e}{M_p}$

Total KE $\to$ $Q = KE_e + KE_p = \frac{1}{2} M_e V_e^2 + \frac{1}{2} M_p V_p^2$

$$Q = KE_e \left[\frac{M_e}{M_p} + 1 \right]$$

$$KE_e = \frac{Q M_p}{M_p + M_e}$$

fixed #



1930-31

Pauli

$$n \rightarrow p + e^- + \nu$$

neutrino

1959 Reines

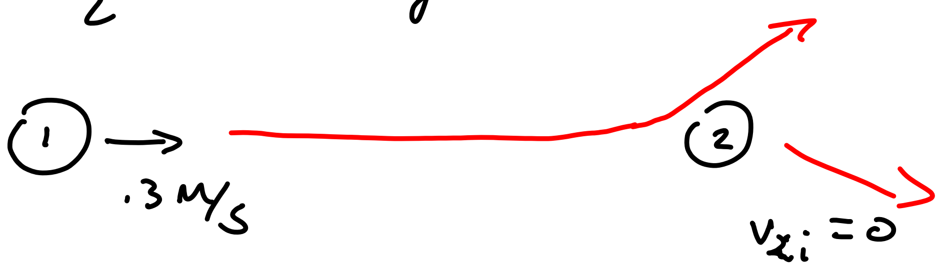
Elastic collision $\longrightarrow$ $\vec{P}$ conserved, KE conserved

inelastic collision $\longrightarrow$ $\vec{P}$ conserved

KE <u>NOT</u> conserved

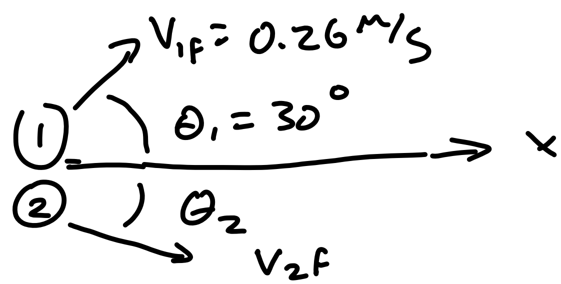
$M_1 = M_2 = 0.1\ kg$

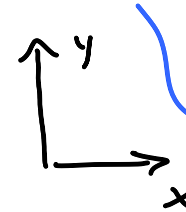
initial



Find V_{2f} θ_2

final state





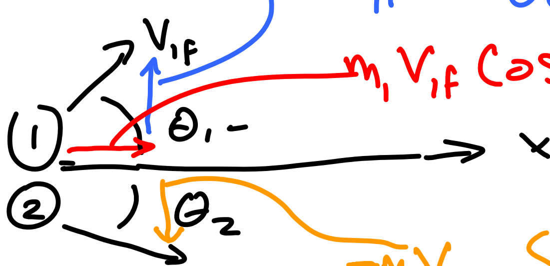
$$\sum \vec{P}_i = \sum \vec{P}_f \longrightarrow \sum P_{ix} = \sum P_{fx}$$

$$\sum P_{iy} = \sum P_{fy}$$

x eqn

$$m_1 V_{1f} \sin\theta_1 = P_{1fy}$$

$$m_1 V_{1f} \cos\theta_1 = P_{1fx}$$



$$-m_2 V_{2f} \sin\theta_2 = P_{2fy}$$

$$P_{1xi} + \cancelto{0}{P_{2xi}} = P_{1xf} + P_{2xf} \qquad m_2 V_{2f} \cos\theta_2 = P_{2fx}$$

$$\boxed{m_1 V_{1i} = m_1 V_{1f} \cos\theta_1 + m_2 V_{2f} \cos\theta_2}$$

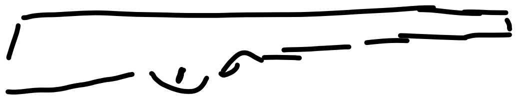
y eqn

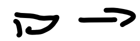
2 eqns
2 unknowns

$$0 = m_1 v_{1f} \sin\theta_1 - m_2 v_{2f} \sin\theta_2$$

$|v_{2f}| = 0.15 \, m/s$

$\theta_2 = 60^\circ$ down from $+x$ axis





V_b = bullet

Block of wood

V_{Bb} = Block + bullet

inelastic collision

$$\cancel{\frac{1}{2} m_b V_b^2 = \frac{1}{2} (M_b + M_B) V_{Bb}^2}$$

$\vec{p}$ conservation is useful

$$m_b V_b = (m_b + M_B) V_{bB}$$