

### ↻ Last Lecture

- ↻ Intro to Gravity

### ↻ Today

- ↻ More on Gravity

### ↻ Important Concepts

- ↻ Gravity depends on the product of the two masses and the inverse of the distance squared.
- ↻ In the standard convention, the PE of gravity is negative.
- ↻ "Escape velocity" is the speed needed to get very far away from something but with no speed left over.

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## Important Reminders

- ↻ Exam #3 is next Friday at 10am.
- ↻ Current MasteringPhysics due **tonight**.
- ↻ Pset #9 due this Friday.
- ↻ IAP class schedule is posted under "General Info".
- ↻ Next MasteringPhysics due next Monday.

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## Gravity far from the Surface

- ↻ Force depends on:

- ↻ the product of the two masses
- ↻ the inverse square of the distance
- ↻ a universal constant:  $G = 6.673 \times 10^{-11} \frac{Nm^2}{kg^2}$

- ↻ Force points along the line between the two objects in the direction to cause attraction

$$F_G = -\frac{GM_1M_2}{r^2} \hat{r}$$

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## Applications

- ↻ Circular orbits

- ↻ Straightforward  $F=ma$  problem

- ↻ Work & Energy

- ↻ Beware of the minus sign!

- ↻ Escape velocity

- ↻ The minimum speed needed to get very far away from some object

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## PE of Gravity

- ↻ A multitude of minus signs!

- ↻ Recall the general formula:  $PE(B) - PE(A) = -\int_A^B \vec{F} \cdot d\vec{s}$

- ↻ Since only the difference matters, we pick some point  $A$  and define  $PE(A)=0$ . For gravity, the standard convention is to define  $A = \infty$

- ↻ So:  $PE(r) = -\int_{\infty}^r \vec{F} \cdot d\vec{r} = -\int_{\infty}^r \left( -\frac{GM_1M_2}{r^2} \hat{r} \right) \cdot d\vec{r}$

- ↻ And the final result:  $PE(r) = -\frac{GM_1M_2}{r}$

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## Gravity Summary

- ↻ Force:  $F_G = -\frac{GM_1M_2}{r^2} \hat{r}$

- ↻ Energy:  $PE(r) = -\frac{GM_1M_2}{r}$

- ↻ Escape velocity:  $E_{Total} = KE + PE = 0$

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