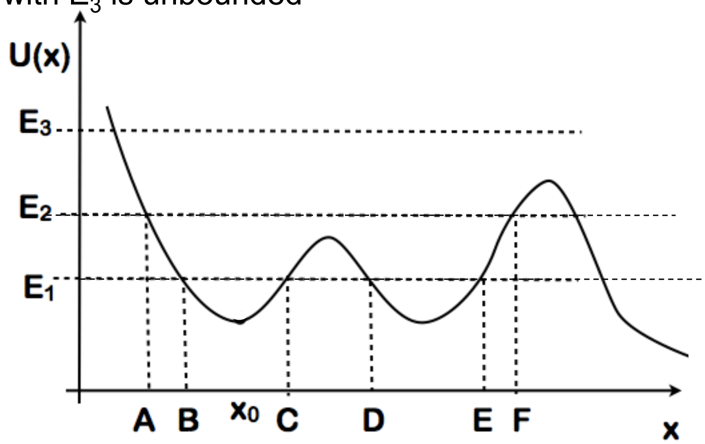
Which statements are true about a particle located at x_o?
I- If it has energy E_1, it can move between B and E
II- If it has energy E_2 it is bounded between A&F, it cannot escape
III- A particle with E_3 is unbounded

A) All
B) II only
C) III only
D) I&II
E) II&III



2- 1

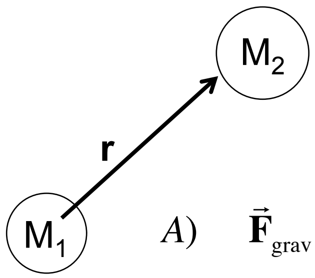
Summary from last class:

- 1-D systems, U(x) yields F(x)=-dU/dx

- Equilibrium when U'(x)=0
- Stable Equilibrium if U''(x)>0

-Plots of U(x) vs x give us immediate information (about binding, motion, v(x), v(t), equilibrium, ...)

2- 2



What is the force of gravity on (pointlike) M_2 caused by (pointlike) M_1 ?

$A)\quad \vec{\mathbf{F}}_{\text{grav}} = -G\dfrac{M_1 M_2}{r^2}\hat{r}$

$B)\quad \vec{\mathbf{F}}_{\text{grav}} = +G\dfrac{M_1 M_2}{r^2}\hat{r}$

$C)\quad \vec{\mathbf{F}}_{\text{grav}} = -G\dfrac{M_1 M_2}{r^3}\vec{r}$

$D)\quad \vec{\mathbf{F}}_{\text{grav}} = +G\dfrac{M_1 M_2}{r^3}\vec{r}$

$E)$ None of these or MORE than one of these!!

GRAVITY

- Newton’s law of gravity
- Gravitational force (direct integration)
- gravitational field
- Symmetry and Invariance arguments
- gravitational potential, and PE

A "little man" is standing a height z above the origin. There is an infinite line of mass (uniform density) lying along the x-axis.

Which *components* of the local **g** field can little man argue against *just by symmetry alone?*

A. ONLY that there is no g_x
B. ONLY that there is no g_y
C. ONLY that there is no g_z
D. ONLY that there is neither g_x nor g_y
E. That there is neither g_x, g_y, nor g_z

2- 5

A "little man" is standing a height z above the origin. There is an infinite line of mass (uniform density) lying along the x-axis.

He has already decided $\vec{\mathbf{g}}(x,y,z) = g_z(x,y,z)\,\hat{\mathbf{k}}$

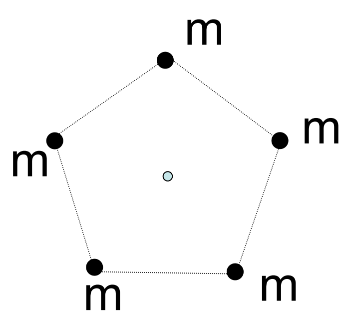
Which *dependences* of the local g_z(x,y,z) field can he argue against, *just by symmetry alone!*

A. ONLY that there is no x dependence,
i.e. only that $\vec{\mathbf{g}}(x,y,z) = g_z(y,z)\,\hat{\mathbf{k}}$
B. ONLY that there is no y dependence
C. ONLY that there is no z dependence
D. ONLY that there is neither x nor y dependence
E. That there is neither x, y, nor z dependence.

2- 6

2.5 5 masses, m, are arranged in a regular pentagon, as shown.

What is the g field at the center?



A) Zero

B) Non-zero

C) Really need trig and a calculator to decide

2-

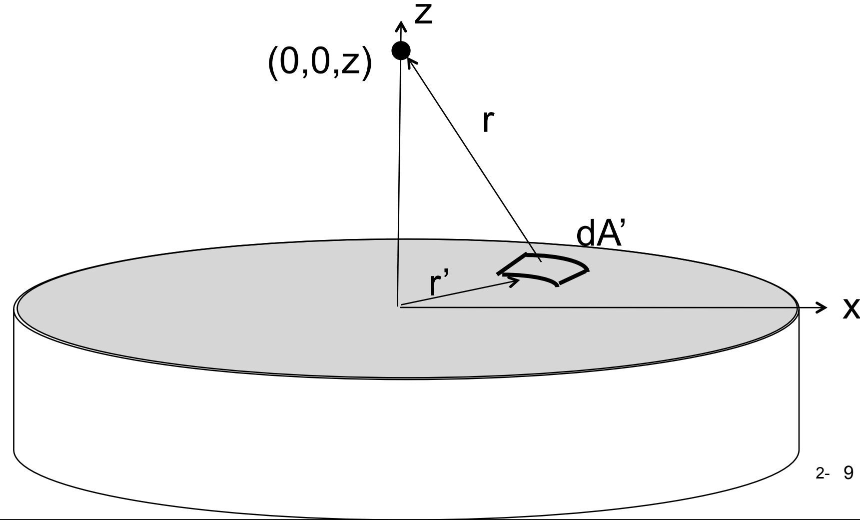
Force, potential energy, gravitational potential, gravitational acceleration

- What is the practical difference between $\vec{F}, U, \vec{g}$, and Φ ?
  A. U and Φ are fields while $\vec{F}$ and $\vec{g}$ are not.
  B. They have different masses.
  C. $\vec{F}, U$ depend on both masses, while $\vec{g}$, and Φ depend on only one mass.
  D. $\vec{F}$ and $\vec{g}$ are easier to calculate.
  E. U and Φ are energies, while $\vec{F}$ and $\vec{g}$ are forces.

2-

For **g** along the z-axis above a massive disk, we need

$$(\vec{\mathbf{g}})_z = -G\iiint \frac{\rho(r')}{r^2}(\hat{\mathbf{r}})_z\, dV' \qquad = -G\iint_{disk} \frac{1}{r^2}(\hat{\mathbf{r}})_z\, \sigma\, dA'$$



2- 9

$$(\vec{\mathbf{g}})_z = -G\iint_{disk} \frac{1}{r^2}(\hat{\mathbf{r}})_z\, \sigma\, dA'$$ What is $(\hat{\mathbf{r}})_z = ?$

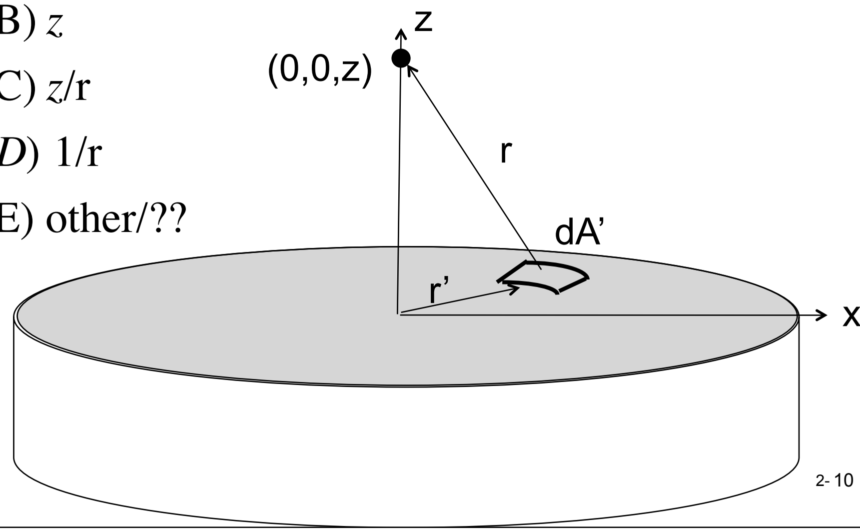
A) 1

B) z

C) z/r

D) 1/r

E) other/??



2- 10

$$(\vec{\mathbf{g}})_z = -G\sigma \iint_{disc} \sigma \frac{z}{r^3}\, dA' \qquad \text{What is } \frac{1}{r^3} = ?$$

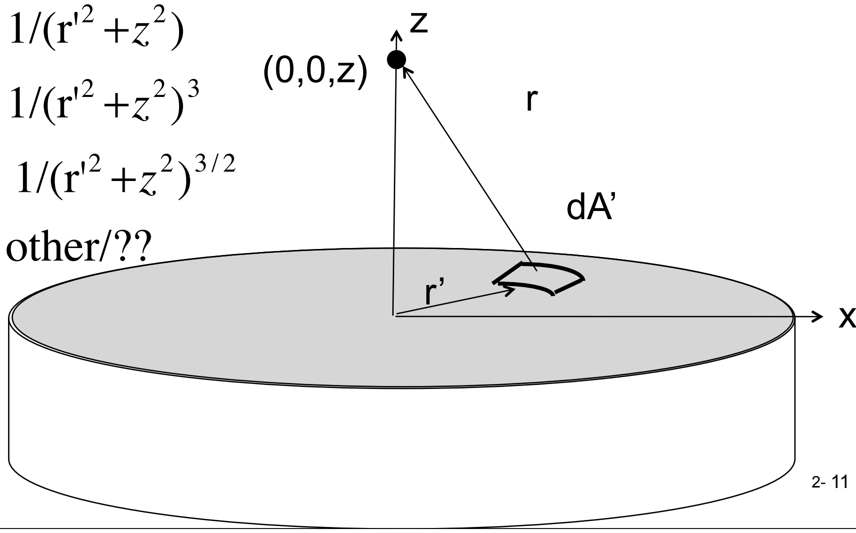
A) $1/(r'^3 + z^3)$

B) $1/(r'^2 + z^2)$

C) $1/(r'^2 + z^2)^3$

D) $1/(r'^2 + z^2)^{3/2}$

E) other/??



2- 11

2.16

Above the disk, $g_z(0,0,z)$=

$$(\vec{\mathbf{g}})_z = +2\pi G\sigma\, z \left[\frac{1}{\sqrt{a^2+z^2}} - \frac{1}{z} \right] \text{ (if } z > 0)$$

If z>>a, let's Taylor expand. What should we do first?

2-

2.16

Above the disk, $g_z(0,0,z)$=

$$(\vec{\mathbf{g}})_z = +2\pi G\sigma\, z\left[\frac{1}{\sqrt{a^2+z^2}} - \frac{1}{z}\right] \quad (\text{if } z>0)$$

If z>>a, let's Taylor expand. What should we do first?

A) Find d/dz of this whole expression, and evaluate it at z=0

B) Rewrite $\frac{1}{\sqrt{a^2+z^2}} = \frac{1}{a\sqrt{1+(z/a)^2}}$ and then use the "binomial" expansion $(1+\varepsilon)^n \approx (1+n\varepsilon+\ldots)$

C) Rewrite $\frac{1}{\sqrt{a^2+z^2}} = \frac{1}{z\sqrt{1+(a/z)^2}}$ and then use the "binomial" expansion.

D) Just expand $(a^2+z^2)^{-1/2} \approx a^2 - (1/2)z^2 + \ldots$

2-

Summary

$$\vec{\mathbf{F}}_{\text{grav, points}} = -G\frac{M_1 M_2}{r^2}\hat{r}$$

$$\vec{\mathbf{F}}_{\text{grav, M2 a point}} = -G\iiint_{V'}\frac{\rho(r')}{r^2}dV'\,\hat{r}$$

$$\vec{\mathbf{g}} = \vec{\mathbf{F}}_{\text{grav, on point m}}/m$$

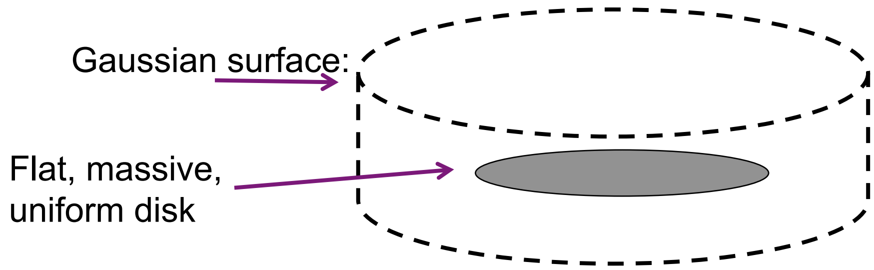
$$\text{PE:}\quad \text{U(r)}_{\text{for point M2 near point M1}} = -G\frac{M_1 M_2}{r}$$

$$\text{Grav. potential:}\quad \Phi(\text{r})_{\text{near point M1}} = -G\frac{M_1}{r}$$

$$\text{Gauss' law:}\quad \oint\!\!\oint \vec{\mathbf{g}}\cdot d\vec{\mathbf{A}} = -4\pi G M_{enclosed}$$

2-14

For the example of the uniform disk, could we have used Gauss' law with the Gaussian surface depicted below?



A) Yes, and it would have made the problem much easier!!!
B) Gauss' law applies, but it would not have been *useful* to compute "g"
C) Gauss' law would not even apply in this case

2-15