Given that $\vec{\mathbf{F}}_{\text{grav, point masses}} = -G\dfrac{M_1 M_2}{r^2}\hat{r}$

What should we write for P.E.: $\mathrm{U(r)}_{\text{for point M2 near point M1}}$

A) $\mathrm{U(r)} = -G\dfrac{M_1 M_2}{r}$

B) $\mathrm{U(r)} = +G\dfrac{M_1 M_2}{r}$

C) $\mathrm{U(r)} = -G\dfrac{M_1 M_2}{r^3}$

D) $\mathrm{U(r)} = +G\dfrac{M_1 M_2}{r^3}$

E) Something totally different,
this is 3-D spherical coordinates!!

2- 1

Summary

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

$$\vec{\mathbf{F}}_{\text{grav, M2 a point}} = -GM_2\iiint_{V'}\frac{\rho(r')}{r^2}dV'\,\hat{r}$$

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

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

$$\text{Grav. potential} = \text{PE/m} = \Phi(\mathrm{r})_{\text{near point M1}} = -G\frac{M_1}{r}$$

$$\Phi = -G\iiint_{V'}\frac{\rho(r')}{r}dV'$$

2- 2

2.16

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

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

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-

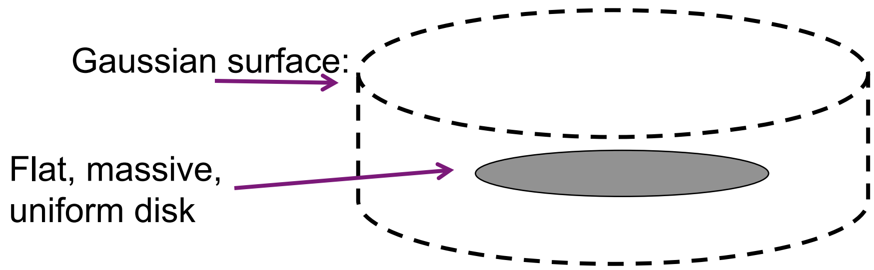
Gauss' law:

$$\text{For electricity: } \oiint \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}} = Q_{enclosed}/\varepsilon_0$$

$$\text{For gravity: } \oiint \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}} = -4\pi G M_{enclosed}$$

2- 5

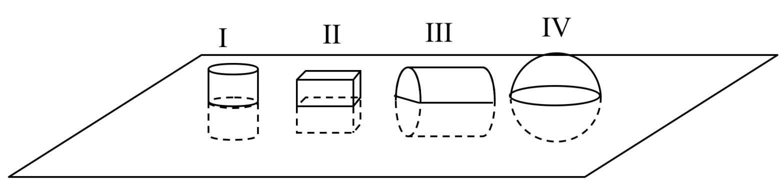
For the example of the uniform disk, could we have used Gauss' law with the Gaussian surface depicted below?



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- 6

Consider these four closed gaussian surfaces, each of which straddles an infinite sheet of constant areal mass density.
The four shapes are
I: cylinder II: cube III: cylinder IV: sphere
For which of these surfaces does gauss's law, $\oiint \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}} = -4\pi GM_{\text{enclosed}}$ hold ?

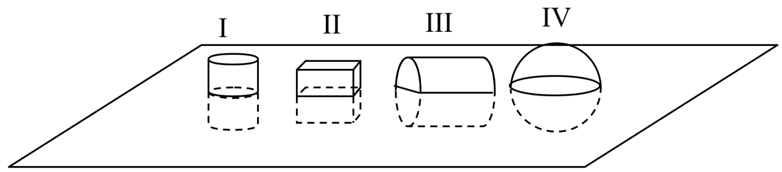


A) All B) I and II only C) I and IV only D) I, II and IV only
E) Some other combo

2- 7

Consider these four closed gaussian surfaces, each of which straddles an infinite sheet of constant areal mass density.
The four shapes are
I: cylinder   II: cube   III: cylinder   IV: sphere

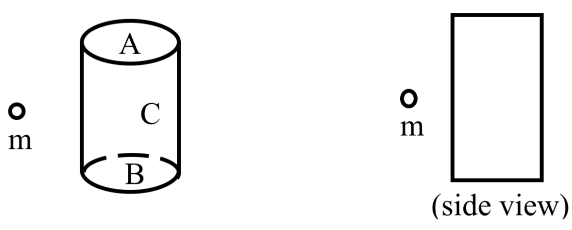
For which of these surfaces does gauss's law, $\oiint \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}} = -4\pi G M_{\text{enclosed}}$ help us find g near the surface??



A) All   B) I and II only   C) I and IV only   D) I, II and IV only
E) Some other combo

A point mass m is near a closed cylindrical gaussian surface. The closed surface consists of the flat end caps (labeled A and B) and the curved barrel surface (C). What is the sign of $\oiint_C \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}}$ through surface C?

A) +   B) -   C) zero   D) ????

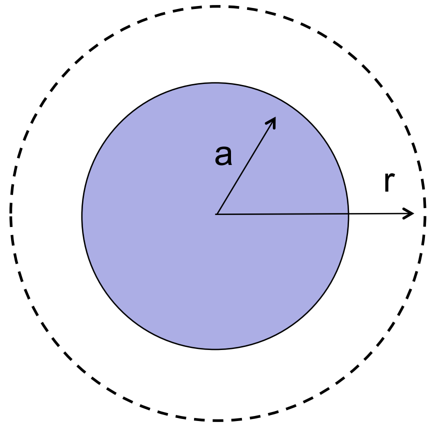


(for closed surfaces, the direction of the surface vector is the direction of the *outward* normal.)

The uniform solid sphere has mass density ρ, and radius a.

What is Menclosed, for r>a?

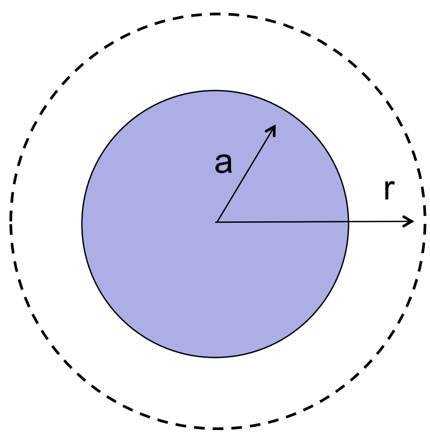
A) $4\pi r^2 \rho$
B) $4\pi a^2 \rho$
C) $(4/3)\ \pi r^3 \rho$
D) $(4/3)\ \pi a^3 \rho$
E) Something else entirely!



2- 10

The uniform solid sphere has mass density ρ, and radius a.

What is $\oiint_{\substack{Gaussian \\ surface}} \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}}$?



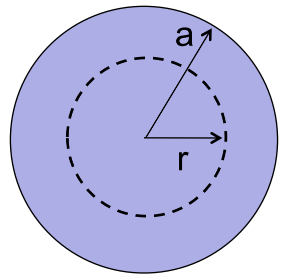
A) $-g\ 4\pi r^2$
B) $-g\ 4\pi a^2$
C) $-g\ (4/3)\ \pi r^3$
D) $-g\ (4/3)\ \pi a^3$
E) Something else entirely! (e.g, signs!)

2- 11

The uniform solid sphere has
mass density ρ,
and radius a.

What is Menclosed, for r<a?

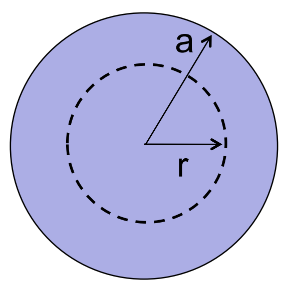
A) $4\pi r^2\rho$
B) $4\pi a^2\rho$
C) $(4/3)\,\pi r^3\rho$
D) $(4/3)\,\pi a^3\rho$
E) Something else entirely!



2- 12

The uniform solid sphere has
mass density ρ,
and radius a.

What is $\underset{\text{Gaussian surface}}{\oiint} \vec{\mathbf{g}} \cdot d\vec{\mathbf{A}}$?

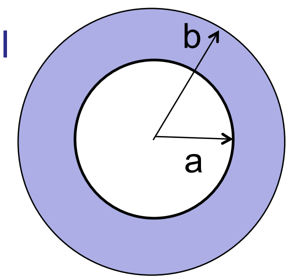


A) $-g\,4\pi r^2$
B) $-g\,4\pi a^2$
C) $-g\,(4/3)\,\pi r^3$
D) $-g\,(4/3)\,\pi a^3$
E) Something else entirely! (e.g, signs!)

2- 13

The spherical *shell* has mass density ρ, inner radius a, outer radius b.

How does the gravitational potential ϕ depend on r, for r>b?

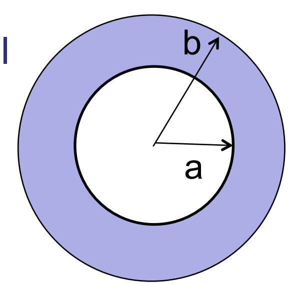


A) ~r
B) ~r^2
C) ~r^{-1}
D) ~r^{-2}
E) Something else entirely!

2- 14

The spherical *shell* has mass density ρ, inner radius a, outer radius b.

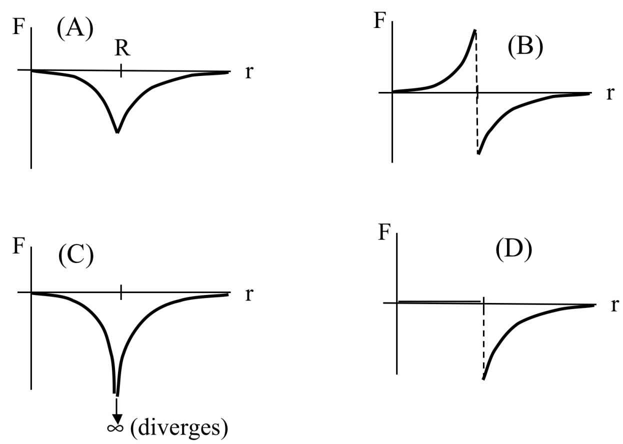
How does the gravitational potential ϕ depend on r, for r>a?

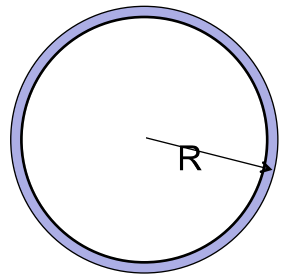


A) ~r
B) ~r^2
C) ~r^{-1}
D) ~r^{-2}
E) Something else entirely!

2- 15

A test mass m moves along a straight line toward the origin, passing through a THIN spherical mass shell of radius R, centered on the origin.
Which graph correctly shows the force F on the test mass vs. position r ?

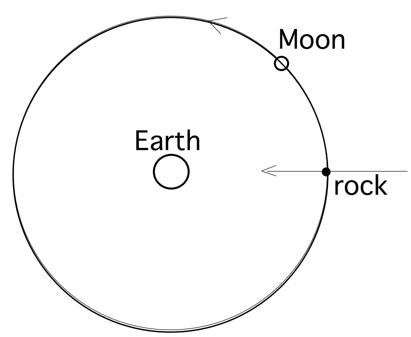




A rock is released from rest at a point in space far beyond the orbit of the Moon. It falls toward the Earth and crosses the orbit of the Moon.
When the rock is the same distance from the Earth as the Moon, the acceleration of the rock is:
(Ignore the gravitational force between the rock and the Moon.)

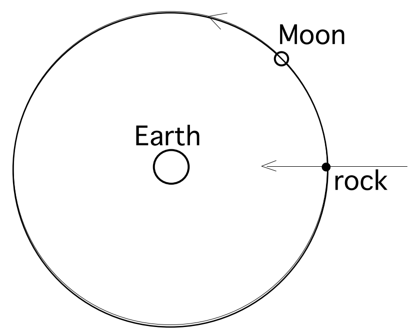
A) greater than
B) smaller than
C) the same as

the acceleration of the Moon.



As the rock falls toward the Earth, its acceleration is:

A) constant. B) not constant.



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