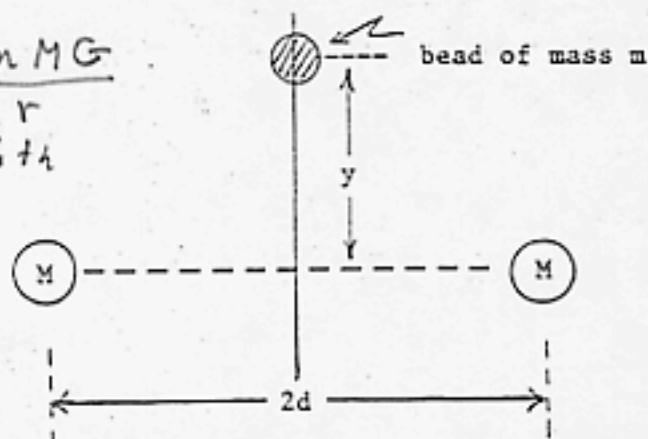11. (15 pts) A small bead of mass m is constrained to move without friction on a rod situated halfway between two spheres each having mass M as shown below:

For gravity, $V = -\dfrac{m\,M\,G}{r}$.

for each sphere with

$r = \sqrt{d^2 + y^2}$.

bead of mass m

y

M — — — — — — — — — M

2d

The rod intersects and is perpendicular to the line joining the centers of the spheres. The bead suffers a gravitational force under the action of the two spheres.

(a) (5 pts) Find the gravitational potential energy $V(y)$ of the bead as a function of y. Set $V(\infty) = 0$. [Recall that if two masses m_1 and m_2 are separated by a distance ℓ, the *force* between them is attractive and has magnitude $m_1 m_2 G \ell^{-2}$ where G is the gravitational constant.] Make sure you get your signs rights. Also sketch $V(y)$.

$V(y) = \dfrac{-2\,M\,m\,G}{\sqrt{d^2 + y^2}}$

Sketch

$V(y)$

y

7