1.解：时间：2017 年 10 月 4 日　农历八月十五（中秋节）　22 时 52 分 40 秒

观测地点 1：Shanghai，China　N 31°13’19.99”　E 127°27’29.02”

方位角 1/高度角 1：+179°59’52.0”/+54°19’51.5”

观测地点 2：（我也不知道是哪里）　S 31°13’19.99”　E 127°27’29.02”

方位角 2/高度角 2：+0°00’08.5”/+62°14’15.2”

由地球半径为 6400km，且两处观测地点纬度差为　$31°13'19.99'' + 31°13'19.99'' = 62°26'39.98''$得

两处观测地点直线距离为　$d_{12} = 2 \times 6400\mathrm{km} \times \sin(62°26'39.98''/2) \approx 6635\mathrm{km}.$

由于两地经度相同，且此时观测地点 1 的方位角约为 180°，观测地点 2 的方位角约为 0 度，所以月球与两地连线的夹角为　θ=(180°-62°14’15.2”-54°19’51.5”)-(62°26’39.98”)=0° 59’13.32” ≈0.01722rad.

则地月距离为　$d_{地月} = d_{12}/\theta \approx 3.852 \times 10^5\mathrm{km}.$

2.（1）解：如图，设自然状态下两小球中心连线与水平线的夹角为α，碗中心与两小球切点连线和碗中心与任意小球中心连线所成角为β.

设碗口平面为零重力势能面.

由几何关系得　$\beta = \arcsin(a/(R-a)) = \pi/4.$

左边小球自然状态下重力势能为　$E_{左0} = -\mathrm{mg}(R-a)\cos(\alpha+\beta) = -\sqrt{2}\mathrm{mga}\cos(\alpha+\pi/4).$

左边小球在侧向偏转δ后重力势能为　$E_{左1} = -\mathrm{mg}(R-a)\cos(\alpha+\beta+\delta) = -\sqrt{2}\mathrm{mga}\cos(\alpha+\pi/4+\delta).$

左边小球在侧向偏转中重力势能变化为　$\Delta E_{左} = E_{左1} - E_{左0} = \sqrt{2}\mathrm{mga}[\cos(\alpha+\pi/4) - \cos(\alpha+\pi/4+\delta)] = \sqrt{2}\mathrm{mga}[\cos(\alpha+\pi/4) - \cos(\alpha+\pi/4)\cos\delta + \sin(\alpha+\pi/4)\sin\delta].$

同理，右边小球自然状态下重力势能为　$E_{右0} = -2\mathrm{mg}(R-a)\cos(\beta-\alpha) = -2\sqrt{2}\mathrm{mga}\cos(\pi/4-\alpha).$

右边小球在侧向偏转δ后重力势能为　$E_{右1} = -2\mathrm{mg}(R-a)\cos(\beta-\alpha-\delta) =$

$-2\sqrt{2}\mathrm{mgacos}(\pi/4-\alpha-\delta)$.

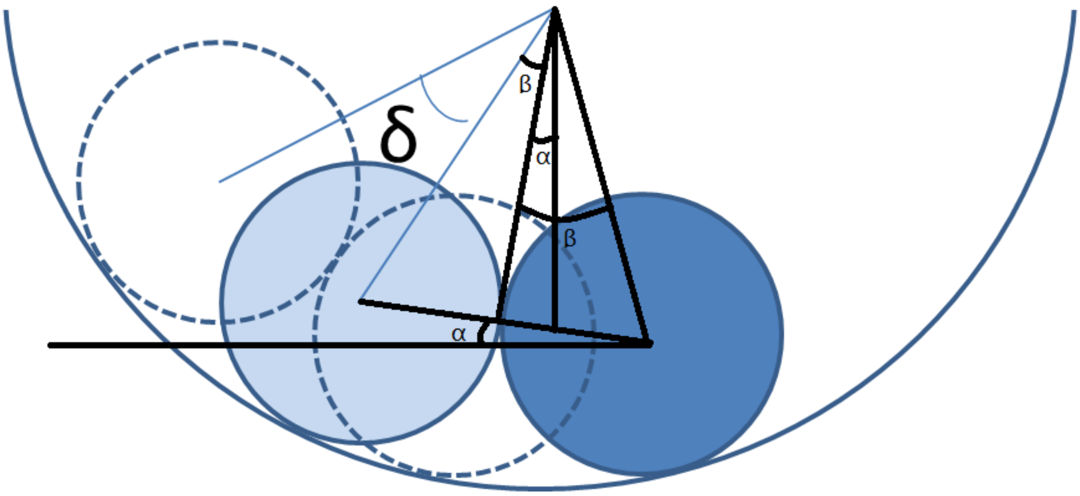
右边小球在侧向偏转中重力势能变化为 $\Delta E_{右}=E_{右1}-E_{右0}=2\sqrt{2}\mathrm{mga}[\cos(\pi/4-\alpha)-\cos(\pi/4-\alpha-\delta)]=2\sqrt{2}\mathrm{mga}[\cos(\pi/4-\alpha)-\cos(\pi/4-\alpha)\cos\delta-\sin(\pi/4-\alpha)\sin\delta]$.

（2）解：为了使两小球平衡，当α→0 时，应使$\Delta E_{左}+\Delta E_{右}=0$.

且此时$\Delta E_{左}=\sqrt{2}\mathrm{mgasin}\delta(\alpha+\pi/4)$，$\Delta E_{右}=2\sqrt{2}\mathrm{mga}\delta[-\sin(\pi/4-\alpha)]$

所以$\Delta E_{左}+\Delta E_{右}=\sqrt{2}\mathrm{mga}\delta[\sin(\alpha+\pi/4)-2\sin(\pi/4-\alpha)]=\mathrm{mga}\delta(3\sin\alpha-\cos\alpha)=0$.

由此得两小球中心连线与水平线之间的夹角　$\alpha=\arctan(1/3)$.



3.1：Beta decay has three types:

(1)Beta minus decay:$n\rightarrow p+e^{-}+\bar{\nu}_e$　A neutron is converted into a proton and an electron and　an electron　antineutrino.　OR　${}_{Z}^{A}X\rightarrow {}_{Z+1}^{\ \ A}X+e^{-}+\bar{\nu}_e$　A atomic nucleus was convert into a nucleus with atomic number increased by one, while emitting an electron and an electron antineutrino.

(2) Beta plus decay:$\mathrm{p}\rightarrow \mathrm{n}+e^{+}+\bar{\nu}_e$　A proton is converted into a neutron and an positron an electron neutrino.　OR　${}_{Z}^{A}X\rightarrow {}_{Z-1}^{\ \ A}X+e^{+}+\nu_e$　A atomic nucleus was convert into a nucleus with atomic number subtracted by one, while emitting an electron and an electron antineutrino.

(3)Electron capture: ${}_{Z}^{A}X+e^{-}={}_{Z-1}^{\ \ A}X+\nu_e$　A nucleus captures one of its atomic electrons, resulting in the emission of a neutrino.

2. Wolfgang Pauli. Neutron(renamed to neutrino by Enrico Fermi later).