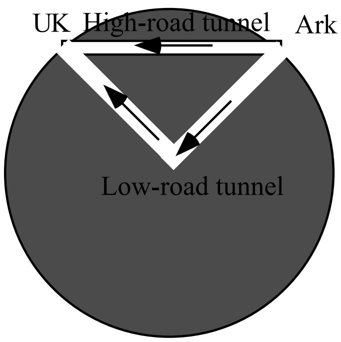
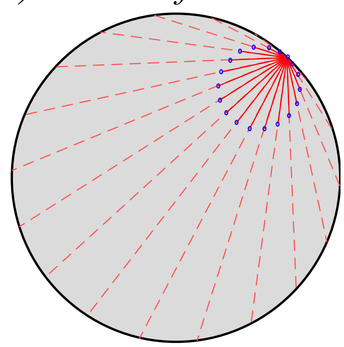
Assignment 5 Read Unit 1 Chapters 6 thru 9. Prepare for mid term exam based on some of the problems below. No class on Tue 9/29 but closed-notes mid-term will be given on Thur 10/1 when Assignment 5 is due.

1.9.3 Tunnels to UK (5600 miles as an earthworm crawls) are shown below. One high-road is a direct route. A low-road turns at the Earth center. (Travel and turn-around are assumed frictionless and survivable.) *(a)* What is the time for each trip? Discuss using geometry or algebra arguments. Thales geometry of circular chords may help.

(a) Hi-road & low-road



(b) Lots of roads



(b) Assume cars in subway tunnels depart Ark. at time $t=0$ as indicated above. Describe curve (thru dots shown) locating car positions at a later time t before arrival and at arrival. (Thales geometry helps here and in 1.9.4 below.)

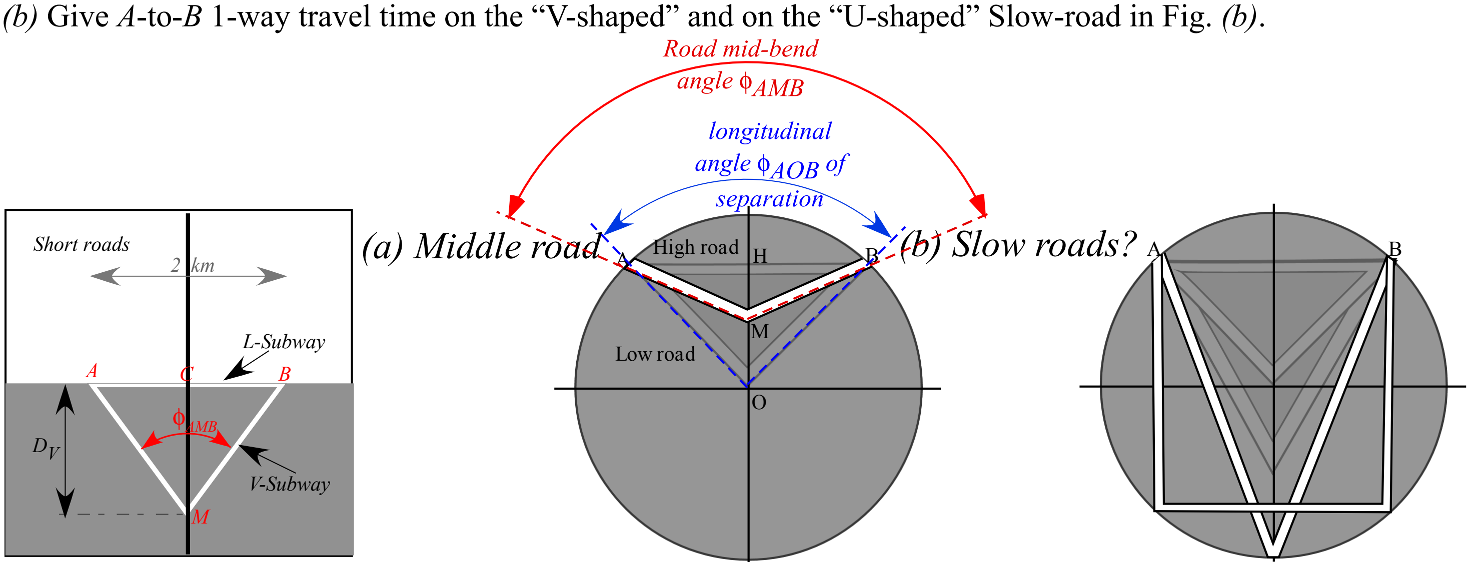
1.9.4. Ex. 1.9.3 compares high-road or direct-route to low-road or Earth-center-and-back-routes. Here we compare *Short-roads*, *Middle-road* routes in Fig *(a)* of fixed longitudinal angle ϕ_{AOB} and various road-bend angle ϕ_{AMB}, and "V-shaped" or "U-shaped" *Slow-Roads* in Fig. *(b)* below.

First consider a frictionless *2km L-subway ACB* that is laser-straight and 'level' (normal to Earth radius at *C*). A mag-lev car riding on it has a non-zero oscillation frequency? Discuss.

Next consider a frictionless *L-subway ACB* that is much faster. Derive the angle ϕ_{AMB} that gives maximum oscillation frequency, that is, shortest *A* to *B* travel time.

(a) Now for generally long trips find the fastest two-straight-section middle road *A*-to-*B* in Fig *(a)*. Derive optimal angle ϕ_{AMB} for $\phi_{AOB} = 90°$ (UK trips) and a general $\phi_{AMB}(\phi_{AOB})$ formula. Check formula for short road case. Compare optimal 1-way UK trip travel time to that for straight-and-level road *AHB*.

(b) Give *A*-to-*B* 1-way travel time on the "V-shaped" and on the "U-shaped" Slow-road in Fig. *(b)*.



1.9.5 Recall class constructions of neutron-starlet orbits inside a uniform asteroid that all have equal component oscillation amplitudes $A_x=1=A_y$ relative phase $\alpha_{xy}=\alpha_x-\alpha_y$ that are integer multiples of 15°. Let orbital Cartesian coordinates be given by $x=A_x\cos(\omega t-\alpha_x)$ and $y=A_y\cos(\omega t-\alpha_y)$ with angular frequency $\omega=2\pi/12$ *(radian/hr.)*.
Plot orbit at each *1/2*-hour of a 12-hour orbital period on phasor graph paper starting at $(\alpha_x=90°, \alpha_y=-15°)$ with fixed $\alpha_{xy}=105°$. Trace position **r**-path and velocity **v**-path for $t=0$ to $4.5hr$.(from 12:00PM to 4:30PM*(b)* Does a τ-period indicate an asteroid's mass?…or density? …compared to Earth. Give values or say why not?