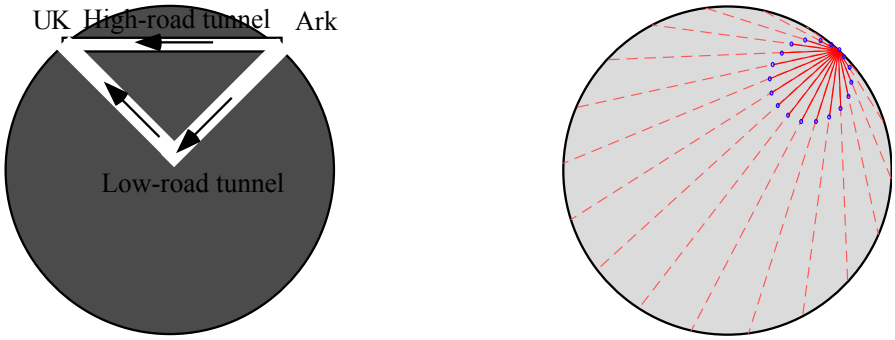
Assignment 4 Read Unit 1 Chapters 6 thru 9. Due Tue 9/27.

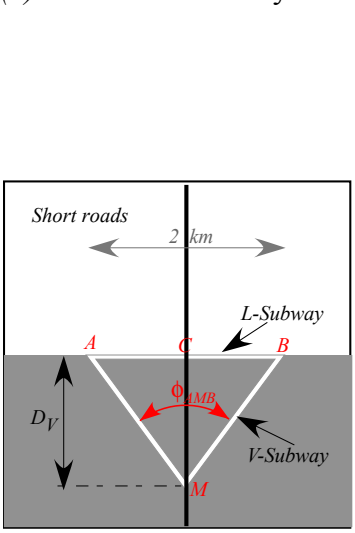
1.9.3 Tunnels to UK (5600 miles as an earthworm crawls) are shown below. One high-road is a direct route. A low-road turns at the Earth center. (Travel and turn-around are assumed frictionless and survivable.) *(a)* What is the time for each trip? Discuss using geometry or algebra arguments.

(a) Hi-road & low-road *(b) Lots of roads*

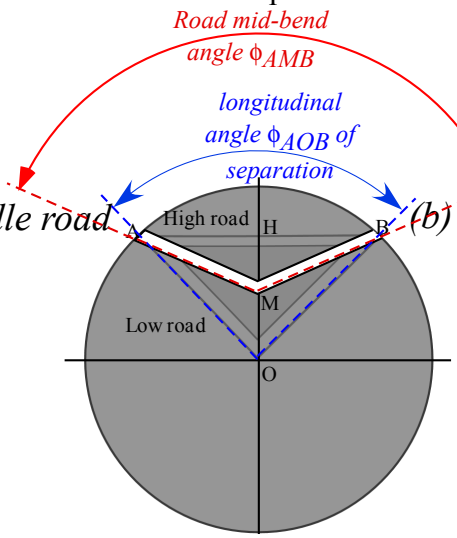


(b) Assume cars in subway tunnels depart Ark. at time *t=0* as indicated above. Describe curve (thru dots shown) locating car positions at a later time *t* before arrival and at arrival. (Thales geometry helps here and in 1.9.4 below.)

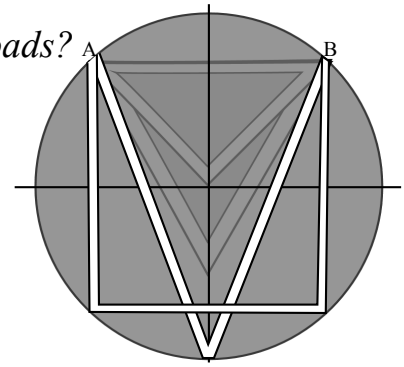
1.9.4. Ex. 1.9.3 compares high-road or direct-route to low-road or Earth-center-and-back-routes. Here we compare *Short-roads*, *Middle-road* routes in Fig *(a)* of fixed longitudinal angle ϕ_{AOB} and various road-bend angle ϕ_{AMB}, and "V-shaped" or "U-shaped" *Slow-Roads* in Fig. *(b)* below. Believe-it-or-not, *(a_3)* is elegantly solvable by geometry.
(a_1) 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.
(a_2) Next consider a frictionless *L-subway AMB* that is much faster. Derive the angle ϕ_{AMB} that gives maximum oscillation frequency, that is, shortest *A* to *B* travel time.
(a_3) 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 low ϕ_{AOB} case.) Compare optimal 1-way UK trip travel time to that for straight-thru road *AHB*.
(b) Give *A*-to-*B* 1-way *Slow-road* travel time on the "V-shaped" tunnel and on the "U-shaped" tunnel in Fig. *(b)*.



(a) Middle road



(b) Slow roads?



(c)Xtra credit Later we will discuss the very-very-quickest A-to-B roads. You're free to comment or speculate on what these results might be.