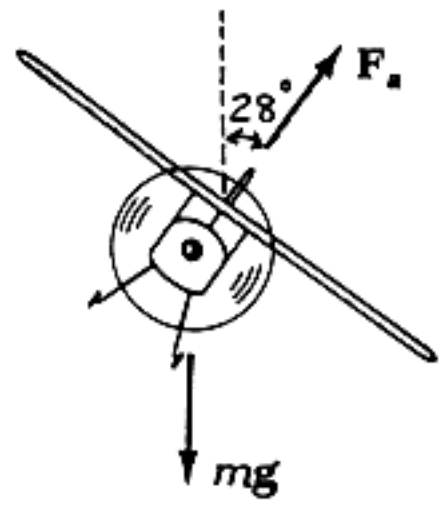
1 Problem 1 20%

If an aircraft is properly banked during a turn in level flight at constant speed, the force F_a exerted by the air on the aircraft is directed perpendicular to a plane which contains the aircraft's wings and fuselage (see Fig.1). Draw a free-body diagram for such an aircraft. An aircraft traveling at a speed v=75 m/sec makes a properly banked turn at a banking angle of 28°. What is the radius of curvature of the turn?

Fig. 1



2 Problem 2 20%

Two blocks, 1 and 2, are sliding down a plank (see Fig.2). Each block has the same mass m, but the coefficients of kinetic friction between the blocks and the surface are different, with $\mu_2 > \mu_1$. The system accelerates down the slope and the string between blocks remains tight.

(A) Show that the tension in the string is

$$F_T = \tfrac{1}{2}(\mu_2 - \mu_1) mg \cos\theta$$

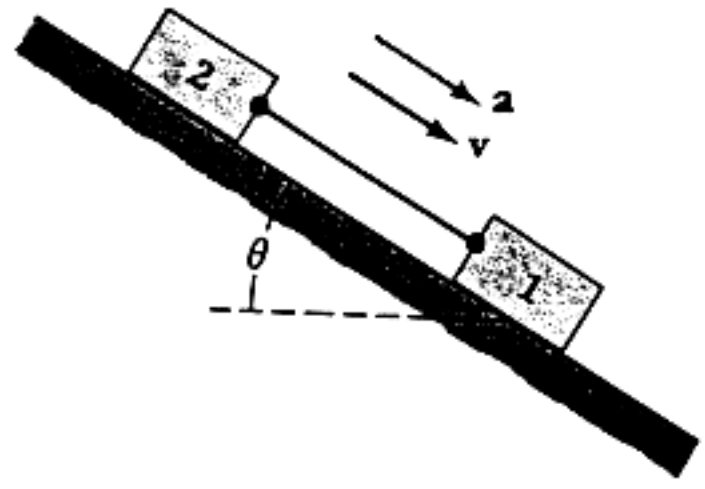
(B) Show that the magnitude a of the system's acceleration is

$$a = g\left(\sin\theta - \tfrac{1}{2}(\mu_2 + \mu_1)\cos\theta\right)$$

(C) Show that the system slides down the slope with constant velocity when $\theta = \theta_k$, where

$$\theta_k = \tan^{-1}\left[\tfrac{1}{2}(\mu_2 + \mu_1)\right]$$

Fig.2



3 Problem 3 20%

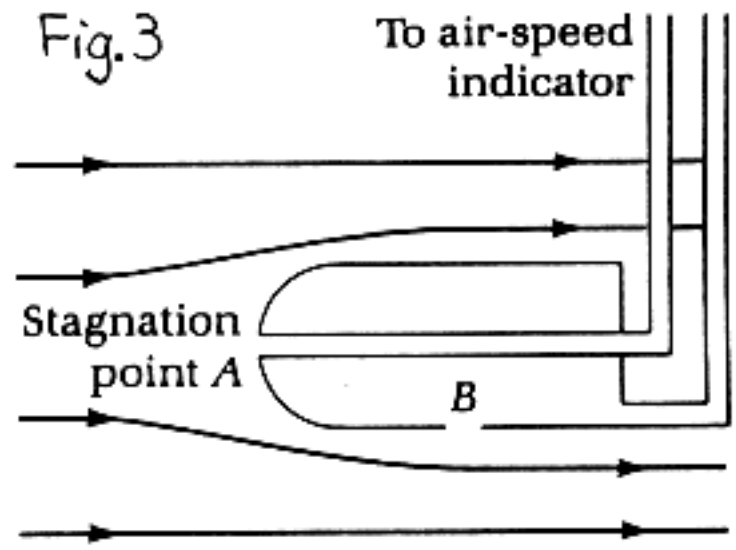
(A) An artificial satellite is placed in a circular orbit traveling eastward in the equatorial plane such that its height above the surface is 14000 km. What is the time interval the satellite remains above the horizon for an observer stationed at a point on the equator? (gravitational constant $G = 6.670 \times 10^{-11} N \cdot m^2/kg^2$)

(B) Repeat (A) except let the satellite be traveling westward.

4 Problem 4 20%

In the Pitot tube of Fig.3, the pressure at point A is higher than at point B. Why? How can this device be used to measure the airspeed of an airplane?

Fig. 3



5 Problem 5 20%

An inductance L and resistance R are in series with a battery of emf E_0 as shown in Fig.4. The witch S is closed at $t = 0$. Show the current in the circuit at time t is given by

$$i(t) = \tfrac{E_0}{R}\left(1 - e^{-t/\tau_L}\right)$$

and express the time constant τ_L in terms of R and L .

Fig.4