

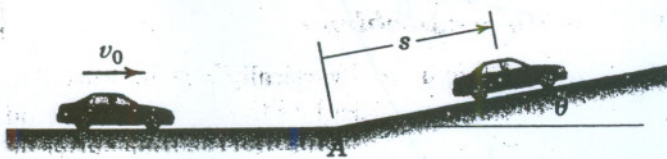
AE-231
ELEMENTS OF VIBRATIONS

Due date:
20-08-2009

Assignment No. 1

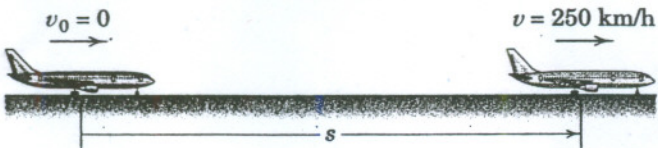
1. The car is traveling at a constant speed $v_0 = 100$ km/h on the level portion of the road. When the 6 percent ($\tan \theta = 6/100$) incline is encountered, the driver does not change the throttle setting and consequently the car decelerates at the constant rate $g \sin \theta$. Determine the speed of the car (a) 10 seconds after passing point A and (b) when $s = 100$ m.

Ans. (a) $v = 21.9$ m/s, (b) $v = 25.6$ m/s



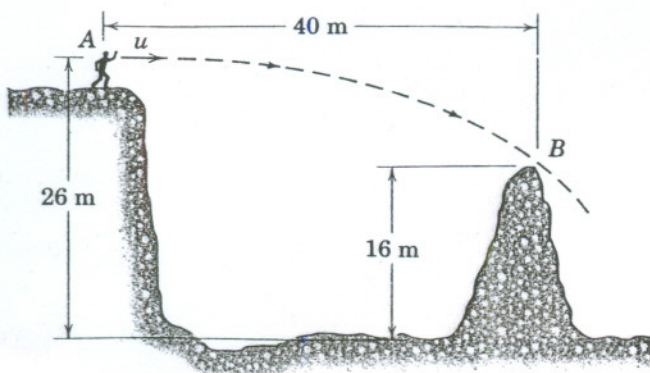
2. On its takeoff roll, the airplane starts from rest and accelerates according to $a = a_0 - kv^2$, where a_0 is the constant acceleration resulting from the engine thrust and $-kv^2$ is the acceleration due to aerodynamic drag. If $a_0 = 2$ m/s², $k = 0.00004$ m⁻¹, and v is in meters per second, determine the design length of runway required to reach the takeoff speed of 250 km/h if the drag term is (a) excluded and (b) included.

Ans. (a) $s = 1206$ m, (b) $s = 1268$ m



3. With what minimum horizontal velocity u can a boy throw a rock at A and have it just clear the obstruction at B?

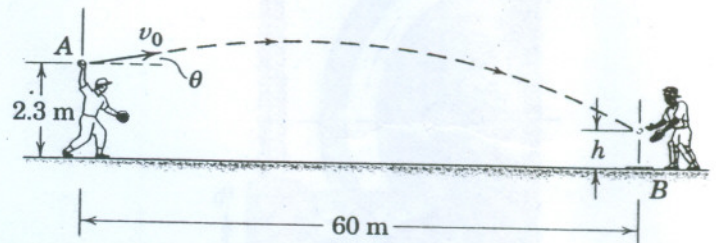
Ans. $u = 28.0$ m/s



4. An outfielder experiments with two different trajectories for throwing to home plate from the position shown: (a) $v_0 = 42$ m/s with $\theta = 8^\circ$ and (b) $v_0 = 36$ m/s with $\theta = 12^\circ$. For each set of initial conditions, determine the time t required for the baseball to reach home plate and the altitude h as the ball crosses the plate.

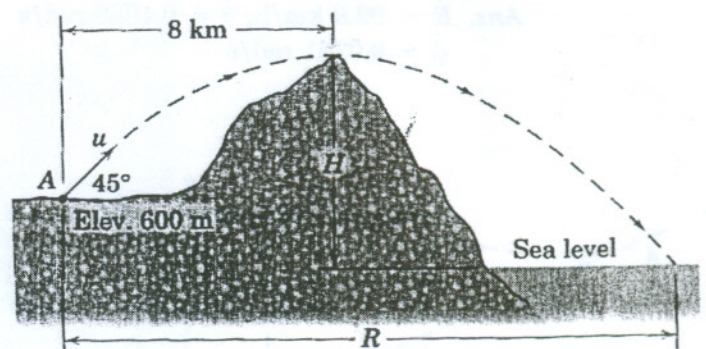
Ans. (a) $t = 1.443$ s, $h = 0.525$ m

(b) $t = 1.704$ s, $h = 0.813$ m



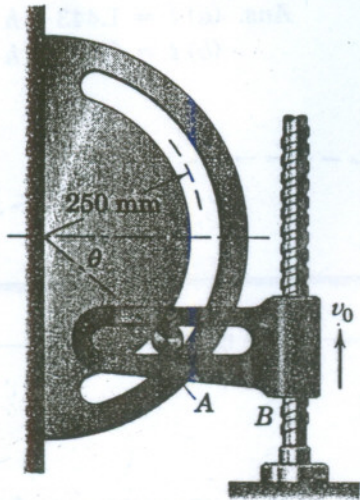
5. A long-range artillery rifle at A is aimed at an angle of 45° with the horizontal, and its shell is just able to clear the mountain peak at the top of its trajectory. Determine the magnitude u of the muzzle velocity, the height H of the mountain above sea level, and the range R to the sea.

Ans. $u = 396$ m/s, $H = 4600$ m, $R = 16.58$ km



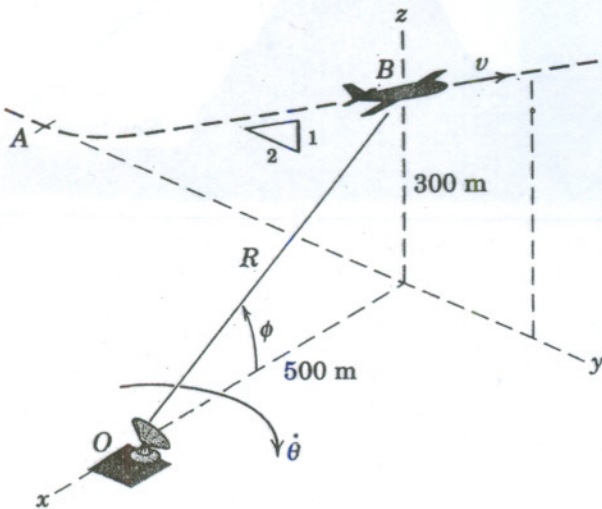
6. In the design of a timing mechanism, the motion of the pin A in the fixed circular slot is controlled by the guide B , which is being elevated by its lead screw with a constant upward velocity $v_0 = 2$ m/s for an interval of its motion. Calculate both the normal and tangential components of acceleration of pin A as it passes the position for which $\theta = 30^\circ$.

Ans. $a_n = 21.3 \text{ m/s}^2, a_t = -12.32 \text{ m/s}^2$



7. An aircraft takes off at A and climbs at a steady angle with slope of 1 to 2 in the vertical $y-z$ plane at a constant speed $v = 400$ km/h. The aircraft is tracked by radar at O . For the position B , determine the value of $\dot{R}, \dot{\theta},$ and $\dot{\phi}$.

Ans. $\dot{R} = 92.0 \text{ km/h}, \dot{\theta} = 0.1988 \text{ rad/s}$
 $\dot{\phi} = 0.0731 \text{ rad/s}$



8. An aircraft flying in a straight line at a climb angle β to the horizontal is tracked by radar located directly below the line of flight. At a certain instant, the following data are recorded: $r = 3600$ m, $\dot{r} = 110$ m/s, $\ddot{r} = 6$ m/s², $\theta = 30^\circ$, and $\dot{\theta} = 2.20$ deg/s. For this instant determine the aircraft altitude h , velocity v , angle of climb β , $\ddot{\theta}$, and acceleration a .

Ans. $h = 3120$ m, $v = 176.7$ m/s, $\beta = 8.5^\circ$
 $\ddot{\theta} = -2.10(10^{-3}) \text{ rad/s}^2, a = 1.112 \text{ m/s}^2$

