AE 688 Dynamics And Vibration
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

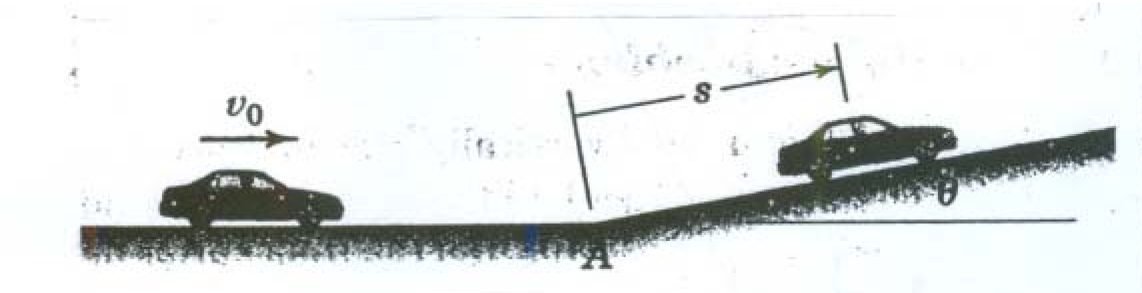


Figure 1

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 $a_0 = 2\,m/s^2, k = 0.00004\,m^{-1}$, 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

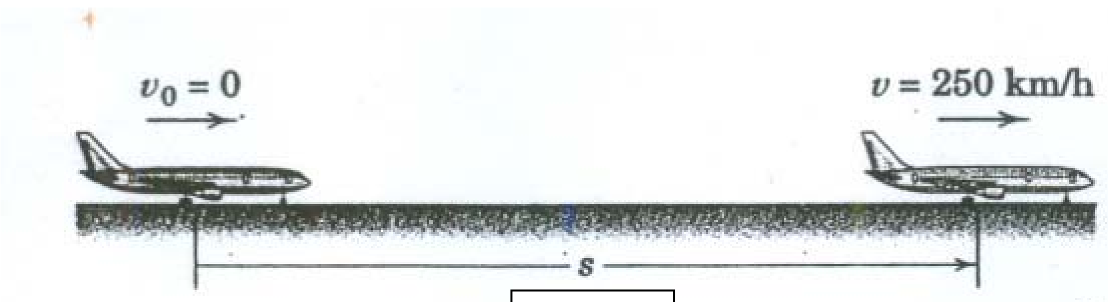


Figure 2

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. $u = 28.0\,m/s$

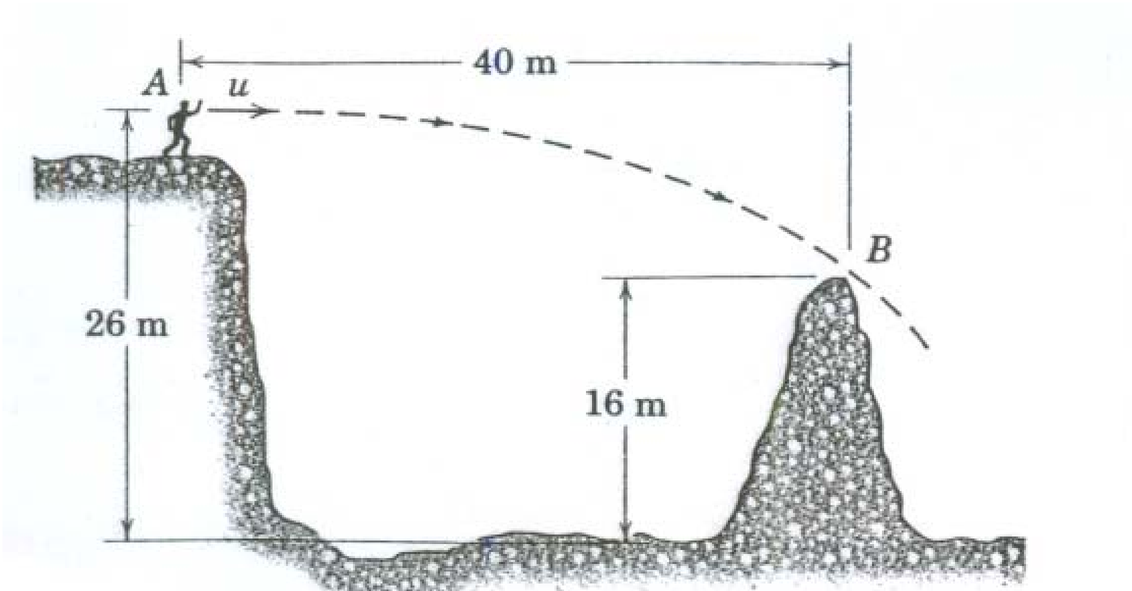


Figure 3

4. An outfielder experiments with two different trajectories for throwing to home plate from the position shown: (*a*) $v_0 = 42$ m/s with $\theta = 8°$ and (*b*) $v_0 = 36$ m/s with $\theta = 12°$. 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*) $t = 1.704\ s,\ h = 0.813\ m$

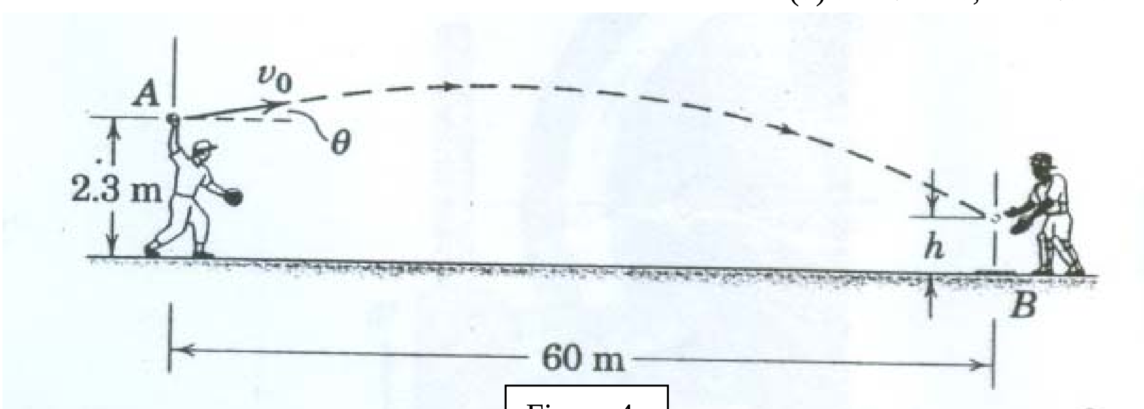
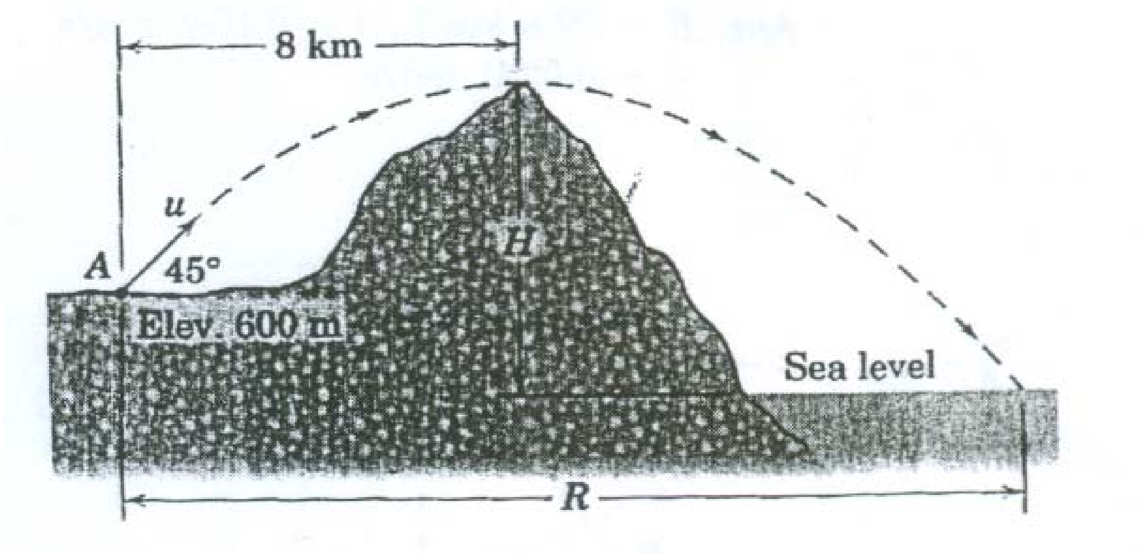


Figure 4

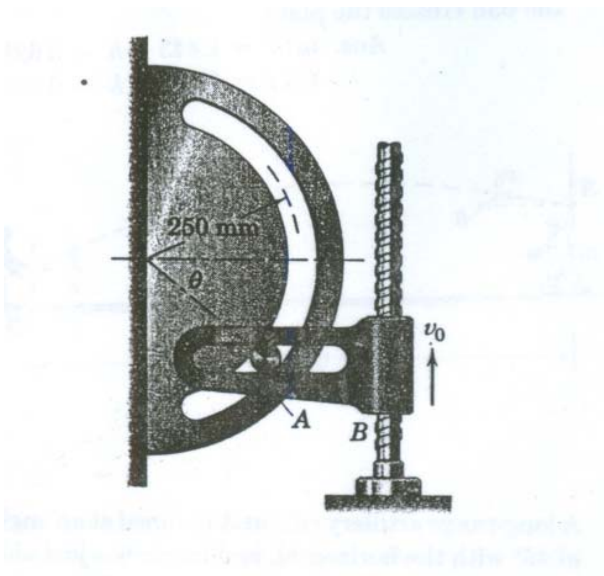
5. A long-range artillery rifle at A is aimed at an angle of $45°$ with the horizontal, and its shell is just able to clear the mountain peak at the top of its trajectory. Determine the magnitude u of the muzzle velocity, the height H of the mountain above sea level, and the range R to the sea.

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 $\theta = 30°$.

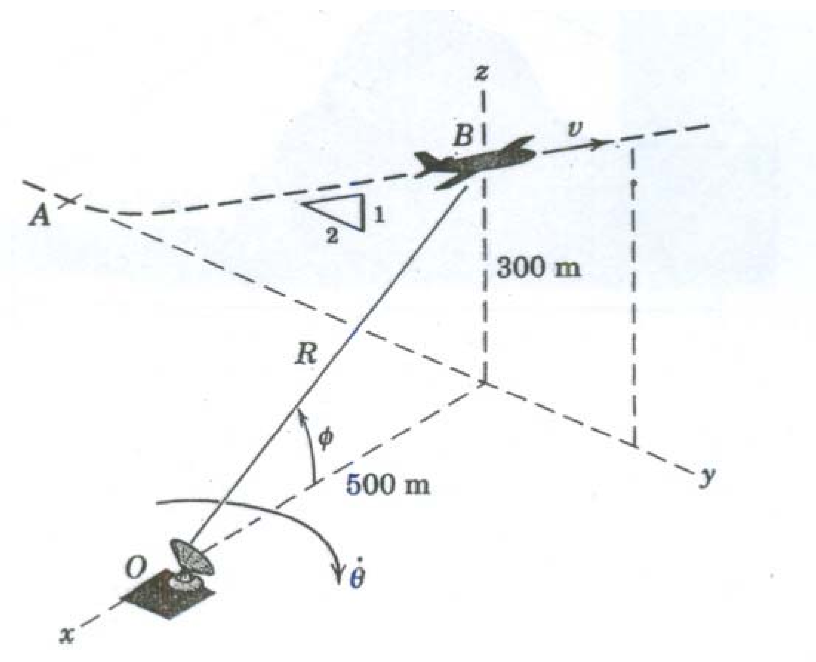
Ans. $a_n = 21.3 m/s^2$, $a_t = -12.32 m/s^2$



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

$\dot{\phi} = 0.0731$ rad/s



8. An aircraft flying in a strength 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: $r = 3600\,m,\ \dot{r} = 110\,m/s,\ \ddot{r} = 6\,m/s^2,\ \theta = 30°,$ and $\dot{\theta} = 2.20\,\text{deg}/s.$ For this instant determine the aircraft altitude h, velocity v, angle of climb β, $\ddot{\theta}$, and acceleration a.

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