Tutorial sheet 5

1. The position of a particle which moves along a straight line is defined by the relation $x = t^3 - 6t^2 - 15t + 40$, where *x* is expressed in feet and *t* in seconds. Determine (*a*) the time at which the velocity will be zero, (*b*) the position and distance traveled by the particle at that time, (*c*) the acceleration of the particle at that time, (*d*) the distance traveled by the particle from t = 4 s to t = 6 s. **[a) t=5 sec, b) x=-60 m, distance= 100 m, c) a= 18 m/sec^2, d) x= 18 m]**

2. The motion of a particle is defined by the relation $x = 6t^4 - 2t^3 - 12t^2 + 3t + 3$, where x and t are expressed in meters and seconds, respectively. Determine the time, the position, and the velocity when a = 0. **[t=0.667 sec, $x_{2/3}$=0.259 m and $v_{2/3}$=-8.56 m/sec]**

3. The motion of a particle is defined by the relation $x = 2t^3 - 15t^2 + 24t + 4$, where *x* is expressed in meters and *t* in seconds. Determine (*a*) when the velocity is zero, (*b*) the position and the total distance traveled when the acceleration is zero. **[(a) t=4 sec, (b) t=2.5 sec, $x_{2.5}$= 1.5 m and distance traveled= 24.5 m]**

4. The motion of a particle is defined by the relation $x = 6t^2 - 8 + 40\cos\pi t$, where *x* and *t* are expressed in meters and seconds, respectively. Determine the position, the velocity, and the acceleration when *t* = 6 s **[x_6= 248 m, v=72 m/s and a=-383 m/sec^2]**

5. The acceleration of a particle is defined by the relation $a = kt^2$. (*a*) Knowing that *v* = -32 ft/s when *t* = 0 and that *v* = 32 ft/s when *t* = 4 s, determine the constant k. (*b*) Write the equations of motion, knowing also that *x* = 0 when *t* = 4. **[k=3, v= t^3- 32, x=t^4/4 -32t+ 64]**

6. A ball is tossed with a velocity of 10 m/s directed vertically upward from a window located 20 m above the ground. Knowing that the acceleration of the ball is constant and equal to 9.81 m/s^2 downward, determine (*a*) the velocity *v* and elevation *y* of the ball above the ground at any time *t*, (*b*) the highest elevation reached by the ball and the corresponding value of *t*, (*c*) the time when the ball will hit the ground and the corresponding velocity. **[t= 1.012 sec, y=25.1m]**

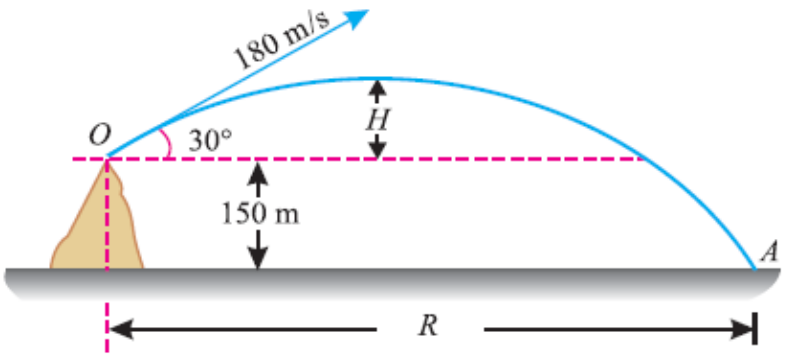
7. A stone is thrown vertically upwards, from the ground, with a velocity 49 m/sec. after 2 seconds, another stone is thrown vertically upwards from the same place. If both the stone strike the ground at the same time, find the velocity, with which the second stone was thrown upwards **[velocity=39.2 m/sec]**

8. A stone, dropped into well, is heard to strike the water after 4 seconds. Find the depth of well, if the velocity of sound is 350 m/sec. **[s=70.8 m]**

9. A driver is driving his car at 60 km/hr when he observes that a traffic light 250 m ahead turns red. The traffic light is timed to remain red for 20 seconds before it turns green. The driver wishes to pass the traffic lights without stopping to wait for it turns green. Calculate (a) the required uniform acceleration of the car, (b) the speed of the car as it passes the traffic light. **[a= -0.417 m/sec2, v= 8.33 m/sec]**

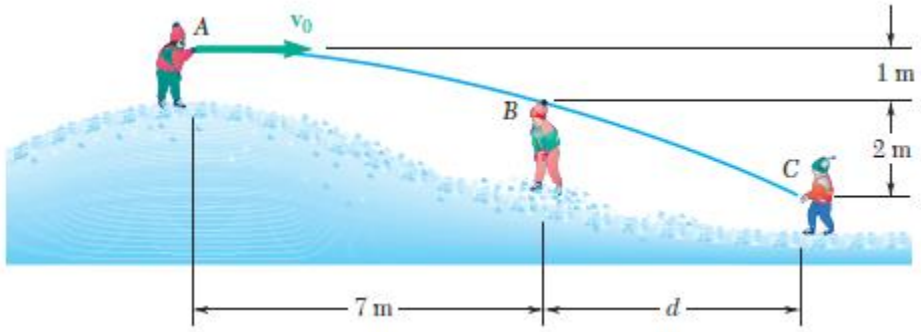
10. A projectile is fired from the edge of a 150-m cliff with an initial velocity of 180 m/s at an angle of 30° with the horizontal. Neglecting air resistance, find (*a*) the horizontal distance from the gun to the point

where the projectile strikes the ground, (*b*) the greatest elevation above the ground reached by the projectile **[(a)s=563.3 m, (b)horizontal distance=3102 m]**

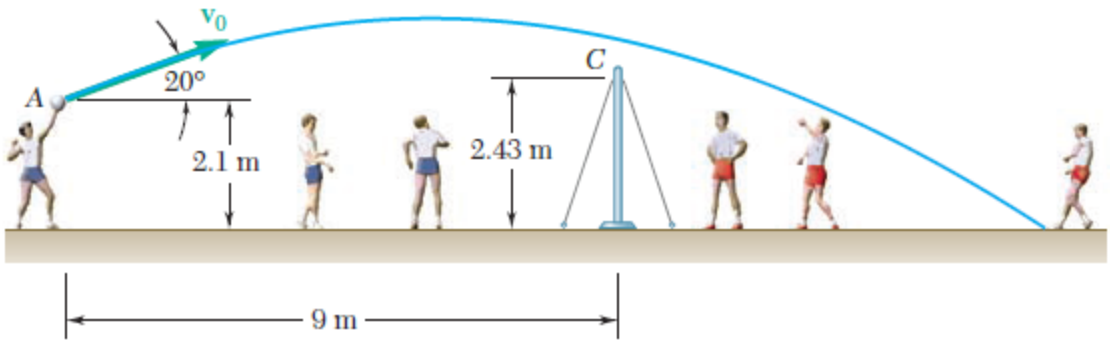


11. A projectile is fired with an initial velocity of 800 ft/s at a target *B* located 2000 ft above the gun *A* and at a horizontal distance of 12,000 ft. Neglecting air resistance, calculate the value of the firing angle α **[α=29.5° and α=70°]**

12. Three children are throwing snow-balls at each other. Child *A* throws a snowball with a horizontal velocity $\mathbf{V}_0$. If the snowball just passes over the head of child *B* and hits child *C*, determine (*a*) the value of $\mathbf{V}_0$, (*b*) the distance *d*. **[V_0=15.5 m/s and d=5.12 m]**



13. A volleyball player serves the ball with an initial velocity $\mathbf{V}_0$ of magnitude 13.40 m/s at an angle of 20° with the horizontal. Determine (*a*) if the ball will clear the top of the net, (*b*) how far from the net the ball will land.**[(a) yes, the ball will clear the net; y_c>2.43 m (b) 7.01 m from the net]**



14. The motion of a cam is defined by the relation $\theta = 2t^3+0.5$, where θ is expressed in radians and t in seconds. Determine the displacement, the angular velocity, and the angular acceleration of the cam when $t = 2$ s. **[θ=16.5 rad, $\dot{\omega}$=24 rad/sec and α=24 rad/s^2]**

15. Load B is connected to a double pulley by one of the two inextensible cables shown in fig 1. The motion of the pulley is controlled by cable C, which has a constant acceleration of 9 in/s^2 and an initial velocity of 12 in/s, both directed to the right. Determine (a) the number of revolutions executed by the pulley in 2s, (b) the velocity and change in position of the load B after 2 s, and (c) the acceleration of point D on the rim of the inner pulley at t = 0. **[(a) n=2.23 rev. (b) v=50 in/s and Δy= 70 in (c) a=48.8 in/sec^2]**