Problem Sheet No. 1

1. The velocity of a particle is given by $\nu = 20t^2 - 100t + 50$, where ν is in meters per second and t is in seconds. Plot the velocity ν and acceleration a versus time for the first 6 seconds of motion and evaluate the velocity when *a* is zero.
   Ans. ν = -75 m/s.

2. In the final stage of a moon landing, the lunar module descends under retrothrust of its descend engine to within *h* = 5 m of the lunar surface where it has a downward velocity of 2 m/s. If the descent engine is cut off abruptly at this point, compute the impact velocity of the landing gear with the moon. Lunar gravity is 1/6 of the earth's gravity.
   Ans. ν = 4.51 m/s.

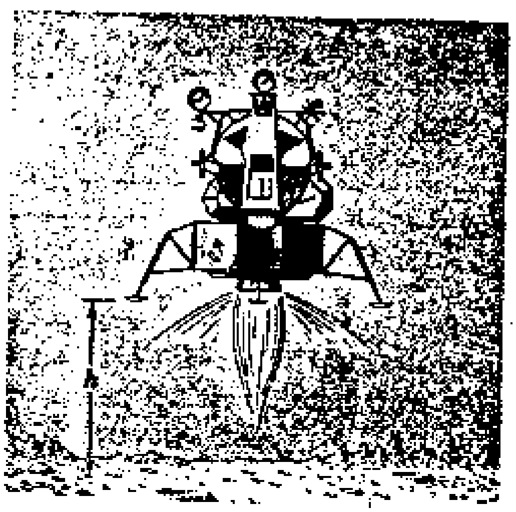

Figure P.2

3. The velocity of a particle along the s-axis is given by $\nu = 5s^{3/2}$, where s is in millimeters and ν is in millimeters per second. Determine the acceleration when s is 12 millimeters.
   Ans. $a = 150\ mm/s^2$

4. In travelling a distance of 3km between points A and D, a car is driven at 100 km/h from A to B for t seconds and at 60 km/h from C to D also for t seconds. If the brakes are applied for 4 s between B and C to give tie car a uniform deceleration, calculate t and the distance s between A and B.
   Ans. t = 65.5 s, s = 1.819 km.

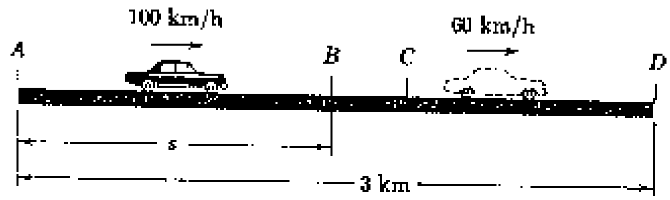

Figure P.4

5. A particle moves along the positive x – axis with an acceleration ax in m/s^2 which increases linearly with x expressed in millimeters, as shown on the graph for an interval of its motion. If the velocity of the particle at x = 40 mm is 0.4 m/s, determine the velocity x = 120 mm.
   Ans. ν = 0.8 m/s.

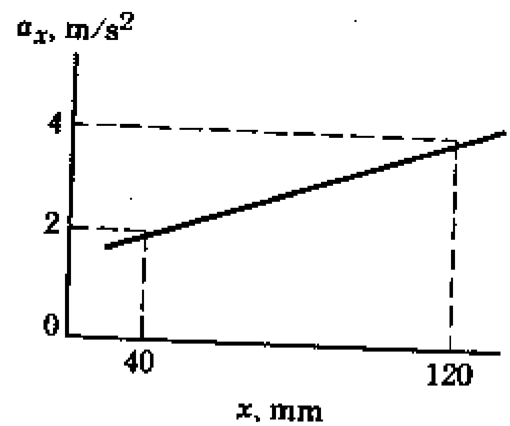

Figure P.5

6. The body falling with speed ν_0 strikes and maintains contact with the platform supported by a nest of springs. The acceleration of the body after impact is a = g-cy, where is a positive constant and y is measured from the original platform position. If the maximum compression of the springs is observed to be y_m, determine the constant c.
   Ans. $c = (v_0^2 + 2gy_m)/y_m^2$

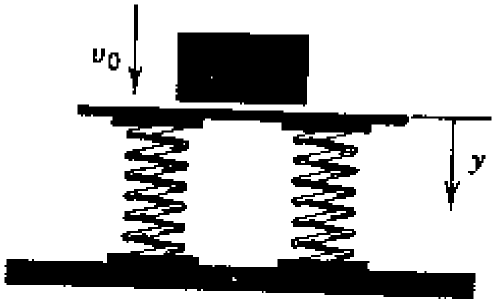

Figure P.6

7. A test projectile is fired horizontally into a viscous liquid with a velocity ν_0. The retarding force is proportional to the square of the velocity, so that the acceleration becomes $a = -k\nu^2$. Derive expressions for the distance D traveled in the liquid and the corresponding time t required to reduce the velocity to $\nu_0/2$. Neglect any vertical motion.

   Ans. $D = 0.693/k$, $t = 1/(k\nu_0)$.

Figure P.7

8. The preliminary design for a rapid transit system calls for the train velocity to vary with time as shown in the plot as the train runs the 3.2 km between stations A and B. The slopes of the cubic transition curves (which are form $a + bt + ct^2 + dt^3$) are zero at the end points. Determine the total run time t between the stations and the maximum acceleration.

   Ans. $T = 103.6$ s, $a_{max} = 3.61$ m/s^2

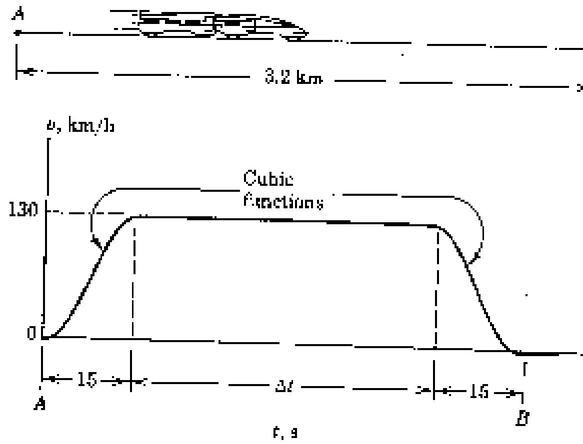

Figure P.8