Sheet 3

1.1 A car starts from rest and reaches a speed of 24 m/s after traveling 150 m along a straight road. Determine its constant acceleration and the time of travel.

1.2 Traveling with an initial speed of 70 km/h, a car accelerates at 6000 km/h^2 along a straight road. How long will it take to reach a speed of 120km/h? Also, through what distance does the car travel during this time?

1.3 A sphere is fired downward into a medium with an initial speed of 27 m/s. If it experiences a deceleration $\mathbf{a = (-6t)\ m/s^2}$, where **t** is in seconds, determine the distance traveled before it stops.

1.6 When a train is traveling along a straight track at 2 m/s, it begins to accelerate at $\mathbf{a = (60\, v^{-4})\ m/s^2}$, where *v* is in m/s. Determine its velocity **v** and the position 3 s after the acceleration.

1.7 A particle moves to the right along a straight line with a velocity $\mathbf{v = \frac{5}{4+s}\ m/s}$, where *s* is in meters. Determine its deceleration when **s** = 2 m.

1.8 A particle travels in a straight line with accelerated motion such that $\mathbf{a = -ks}$, where **s** is the distance from the starting point and **k** is a proportionality constant which is to be determined. For s = 2 m the velocity is 4 m/s, and for **s** = 3.5 m the velocity is 10 m/s. What is **s** when **v** = 0?

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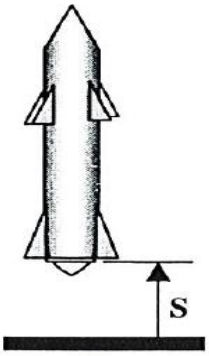
and $s = 0$ when $t = 0$.



Problem 9 &10

1.10 The acceleration of a rocket traveling upward is given by $a = (6 + 0.02s)\ m/s^2$, where s is in meters.

Determine the time needed for the rocket to reach an altitude of $s = 100$ m. Initially, $v = 0$ and $s = 0$ when $t = 0$.

1.12 The displacement time equations of a particle is given as :

$x = 10t^2 + 2t$, $y = t^3 + 5$ and $z = 0$ (m,s)

Determine the velocity and acceleration of the particle at $t = 2$ s.

1.13 The position vector of a particle moving in a plane is

$$\vec{r}(t) = 4(2t - \sin 2t)\vec{i} + 4(1 - \cos 2t)\vec{j}$$

Find the velocity and acceleration vectors at any time instant and verify that $v^2 = 2ay$.

1.14 A particle travels along a path such that its position is

$$\vec{r} = (5\sin t + 3)\vec{i} + (5\cos t)\vec{j} \quad m,$$

where t in seconds and the arguments for the sine and cosine are in radians Find the equation $y = f(x)$ which describes the path, and show that the magnitudes of the particle's velocity and acceleration are constant. What are these magnitudes, and what is the magnitude of the particle's displacement from t=1 s to t=3 s?

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1.15 The motion of particle A and B is described by the position vectors $\vec{r}_A = (2t)\vec{i} + (t^2 - 1)\vec{j}$ (m) and $\vec{r}_B = (t + 2)\vec{i} + (2t^2 - 5)\vec{j}$ (m) respectively, where t is in seconds. Determine the point where the particles collide and their speeds just before the collision.

1.16 A particle moves along the path $\vec{r} = (4t^4)\vec{i} + (3t + 8t^3)\vec{j}$ (m), where t is in seconds. Determine the magnitudes of the particle's velocity and acceleration when t = 2 s. Also determine the equation **y=f(x)** of the path.

1.17 The position of a particle is defined by

$$\vec{r} = \theta^3\vec{i} + (\sin 2\theta)\vec{j} + (\cos 2\theta)\vec{k} \quad \text{(m)},$$

where θ is in radians. If $\theta = 2t^2$ rad, where t is in seconds, determine the velocity and acceleration vectors when **t = 1 s.**

1.18 If the velocity of a particle is defined as

$$\vec{v}(t) = (1.5t^2)\vec{i} + (1.8t)\vec{j} + (t^3)\vec{k} \quad \text{(m/s)},$$

where t is in seconds, determine the displacement of the particle from t = 1 to t = 3 s.

1.19 A particle is subjected to an acceleration

$$\vec{a} = (9t^2)\vec{i} + (12t^3)\vec{j} - (6t)\vec{k} \quad (\text{m/s}^2).$$

Determine the particle's position (x,y,z) when t = 2 s. When t = 0, the particle is located at point $\vec{r}_0 = 2\vec{i} - \vec{j} + 2\vec{k}$ (m) and has a velocity of $\vec{v}_0 = 2\vec{i} - 6\vec{j} + 5\vec{k}$ (m/s).

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1.20 A particle travels along the path $y = x^2$, where x and y are in meters. If the particle's component of velocity in the y direction is always $v_y = 3$ m/s, determine the magnitude of the particle's velocity when t = 2 s. When t = 0 the particle is at point (1 , 1)m. How far from the origin is the particle when t = 2 s ?

1.22 The position of a particle is defined by

$\vec{r} = (5\cos 2t)\vec{i} + (4\sin 2t)\vec{j}$ (m) , where t is in seconds and the arguments for the sine and cosine are given in radians. Determine the magnitudes of the velocity and acceleration of the particle when t = 1 s. Also, prove that the path of the particle is elliptical.