PHY 105 – Introduction – Exercises

Exercise 1

At $t = 0$, a particle moving in the xy plane with constant acceleration has a velocity of $\vec{\mathbf{v}}_i = (3.00\,\hat{\mathbf{i}} - 2.00\,\hat{\mathbf{j}})$ m/s when it is at the origin. At $t = 3.00$ s, the particle's velocity is $\vec{\mathbf{v}} = (9.00\,\hat{\mathbf{i}} + 7.00\,\hat{\mathbf{j}})$ m/s Find

(a) the acceleration of the particle at any time t.

(b) its coordinates (x_f, y_f) at any time t.

$v_i = 3i - 2j \Longrightarrow t = 0\ s$

$v_f = 9i + 7j \Longrightarrow t = 3s$

a) $v_f = v_i + at$

$at = v_f - v_i$

$a = \dfrac{v_f - v_i}{t}$

$\bar{a} = \dfrac{(9i + 7j) - (3i - 2j)}{3}$

$\bar{a} = \dfrac{9i + 7j - 3i + 2j}{3} = \dfrac{6i + 9j}{3}$

$\bar{a} = \dfrac{6i}{3} + \dfrac{9j}{3} = \boxed{2i + 3j\ m/s^2}$

magnitude

✓ $|\bar{a}| = \sqrt{2^2 + 3^2} = \sqrt{13}\ m/s^2$

b) The coordinates at any time

$$\Delta\vec{r} = v_i t + \frac{1}{2}at^2$$

$$r_f - r_i = v_i t + \frac{1}{2}at^2 \quad (r_i \to \text{zero})$$

$$r_f = (3i - 2j)t + \frac{1}{2}(2i + 3j)t^2$$

$$\vec{r}_f = 3ti - 2tj + \frac{1}{2}2t^2 i + \frac{1}{2}3t^2 j$$

$$r_f = 3ti + t^2 i + -2tj + \frac{3}{2}t^2 j$$

$$\vec{r}_f = (3t + t^2)i + (\frac{3}{2}t^2 - 2t)j$$

x y

$$x = 3t + t^2 \ (m) \qquad y = \frac{3}{2}t^2 - 2t \ (m)$$

Exercise 2

The vector position of a particle varies in time according to the expression $\vec{\mathbf{r}} = (3.00\,\hat{\mathbf{i}} - 6.00t^2\,\hat{\mathbf{j}})$ m.

(a) Find expressions for the velocity and acceleration as functions of time.

(b) Determine the particle's position and velocity at $t = 1.00$ s.

$$\vec{r} = 3i - 6t^2 j$$

a) $$\vec{v} = \frac{d\vec{r}}{dt} = 0i - 12t\,j$$ سرعة

$$\vec{v} = -12t\,j \quad m/s$$

$$\vec{a} = \frac{d\vec{v}}{dt} = -12\hat{j} \quad m/s^2$$ تسارع

b) 1s اوجد موقع الجسم والسرعة عندما يكون الزمن

→ $$\vec{r} = 3\hat{i} - 6t^2\hat{j} \quad \text{at} \quad 1s$$

$$\vec{r} = 3i - 6(1^2)\hat{j} = 3\hat{i} - 6\hat{j}$$

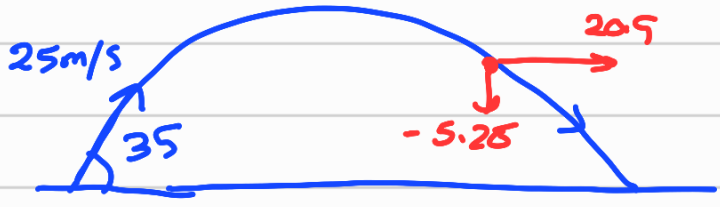
$$|\vec{r}| = \sqrt{3^2 + 6^2} = \sqrt{45} \quad m$$

→ $$\vec{v} = -12t\,j = -12\hat{j} \quad m/s$$

$$|\vec{v}| = \sqrt{(-12)^2} = 12 \quad m/s$$

Exercise 3

A football player kicked a ball with a speed of 25.0 m/s at a 35°. 0 angle. What is the speed of the ball at $t = 2.00$ s.



$V_{ox} = 25\cos 35$

$V_{ox} = 20.5\ m/s$

After 2s

$V_x = 20.5\ m/s$ ✓

$V_y = V_{oy} - gt$

$V_y = 14.34 - 9.8(2)$

$V_y = -5.26\ m/s$ ✓

$\bar{V} = 20.5i - 5.26j \quad m/s$

magnitude

$|\bar{V}| = \sqrt{(20.5)^2 + (-5.26)^2} = 21.16\ m/s$

direction $\theta = \tan^{-1}\left(\frac{-5.26}{20.5}\right) = -14.4^\circ$