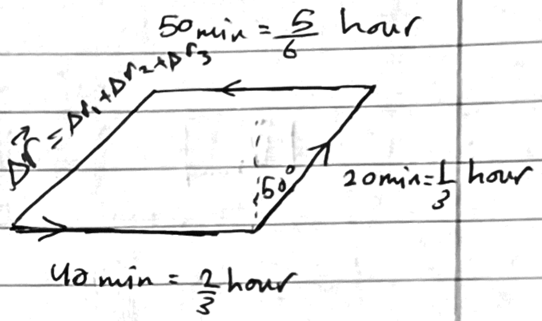
[illegible]

Principles of Physics (10th edition)
(Discussion)

Chapter 4: Motion in 2 and 3 dim
Problems: 5, 11, 15, 20, 27, 56, 67, 77

Problem 5: A train at a constant 60.0 km/h moves east for 40.0 min, then in a direction 50.0° east of due north for 20.0 min and then west for 50.0 min. What are the (a) magnitude (b) and angle of its avarge velocity during this trip?



$V_{constan} = 60 \text{ km/h}$

Sol: $1 h = 60 \text{ min}$

$\frac{40}{60} = \frac{2}{3} h$, $\frac{20}{60} = \frac{1}{3} h$, $\frac{50}{60} = \frac{5}{6} h$

$\Delta\vec{r}_1 = \vec{v} t$

$= \left(60 \times \frac{2}{3}\right) \hat{i}$

$\boxed{\Delta r_1 = (40 \text{ km}) \hat{i}}$

$\Delta\vec{r}_2 = v t$

$= \left(60 \times \frac{1}{3} \times \cos 40\right) \hat{i} + \left(60 \times \frac{1}{3} \times \sin 40\right) \hat{j}$

$= \cancel{\quad} \text{ km}$

$\boxed{\Delta\vec{r}_2 = (15.3 \hat{i} + 12.9 \hat{j}) \text{ km}}$

$\Delta\vec{r}_3 = 60 \times \frac{5}{6} \times \cos 180 \ \hat{i}$

$\boxed{\Delta\vec{r}_3 = (-50 \hat{i}) \text{ km}}$

$\Delta\vec{r} = \Delta\vec{r}_1 + \Delta\vec{r}_2 + \Delta\vec{r}_3$

$= \cancel{(40 + 15.3) \hat{i} + 12.9 \hat{j} + -50 \hat{k}}$

$$\Delta r = (40 + 15.3 - 50)\hat{i} + (12.9)\hat{j}$$

$$\boxed{\Delta r = (5.3\hat{i} + 12.9\hat{j})\ km}$$

$$\Delta t = \Delta t_1 + \Delta t_2 + \Delta t_3$$

$$= \frac{1}{3} + \frac{2}{3} + \frac{5}{6}$$

$$\boxed{\Delta t = 1.83\ h}$$

a) $$\vec{V}_{avg} = \frac{\Delta \vec{r}}{\Delta t} = \frac{5.3\hat{i} + 12.9\hat{j}}{1.83}$$

$$= (2.9\hat{i} + 7\hat{j})\ km/h$$

$$|\vec{V}_{avg}| = \sqrt{(2.9)^2 + 7^2}$$

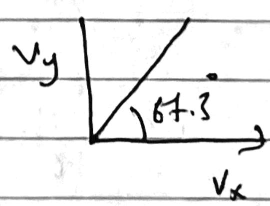
$$= 7.58\ km/h$$

b) $$\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right) = \tan^{-1}\left(\frac{7}{2.9}\right)$$

$$\theta = \tan^{-1}(2.4)$$

$$\boxed{\theta = 67.3^\circ}$$ ✓

67.3° north of east



سارة بكار

Problem 11: A particle that is moving in an xy plane has a position vector given by $\vec{r} = (3.00t^3 - 6.00t)\hat{i} + (7.00 - 8.00t^4)\hat{j}$ where $\vec{r}$ is measured in meters and t is measured in seconds. For $t = 3.00$ s, in unit vector notation find (a) $\vec{r}$ (b) $\vec{v}$ (c) $\vec{a}$ (d) Find the angle between the positive direction of the x-axis and a line that is tangent to the path of the particle at $t = 3.00$ s.

Sol: $\vec{r} = (3t^3 - 6t)\hat{i} + (7 - 8t^4)\hat{j}$

a) $\vec{r}(3) = (3(3)^3 - 6(3))\hat{i} - (7 - 8(3)^4)\hat{j}$

$= 63\,m\,\hat{i} - 641\,m\,\hat{j}$

b) $\vec{v} = \frac{d\vec{r}}{dt} = (9t^2 - 6)\hat{i} - 32t^3\hat{j}$

$v(3) = (9(3)^2 - 6)\hat{i} - 32(3)^3\hat{j}$

$= 75\,m/s\,\hat{i} - 864\,m/s\,\hat{j}$

c) $\vec{a} = \frac{d\vec{v}}{dt} = 18t\,\hat{i} - 96t^2\,\hat{j}$

$a(3) = 18(3)\hat{i} - 96(3)^2\hat{j}$

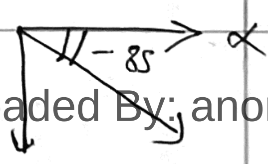
~~$= 54\,m\,\hat{i} - 864\,\hat{j}$~~

$a(3) = 54\,m/s^2\,\hat{i} - 864\,m/s^2\,\hat{j}$

d) slope $= \frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{-32t^3}{9t^2 - 6}$

at $t = 3 \Rightarrow m = \frac{-32(3)^3}{9(3)^2 - 6} = \frac{-864}{75} = -11.52$

$\theta = \tan^{-1} -11.52 = -85$



$\Rightarrow \theta = 360 - 85 = 275°$ with +x

~~= 275°~~ ~~with~~ +x

سهلة ،

Problem 15: From the origin, a particle starts at $t=0$, with a velocity $\vec{v} = 7.0\hat{i}$ m/s and moves in the xy plane with a constant acceleration of $\vec{a} = (-9\hat{i} + 3\hat{j})$ m/s^2. At the time the particle reaches the maximum x coordinate, what is its (a) velocity and (b) position vector?

sol: a) started from the origin then

$\vec{r} = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$, V_0: intial velocity

$\vec{V} = \vec{V}_0 + \vec{a}t$, a: constant acceleration

$x(t) = V_{ox}t + \frac{1}{2}a_x t^2$ | $\vec{V}_x = \vec{V}_{ox} + \vec{a}_x t$

$y(t) = V_{oy}t + \frac{1}{2}a_y t^2$ | $\vec{V}_y = \vec{V}_{oy} + \vec{a}_y t$

المعطيات

$V_0 = 7\hat{i}$ m/s , $\vec{a} = (-9\hat{i} + 3\hat{j})$ m/s^2

$\hookrightarrow V_{ox} = 7$ m/s , $a_x = -9$ m/s^2

$V_{oy} = 0$, $a_y = 3$ m/s^2

$V_x(t) = V_{ox} + a_x t = 7 + -9t$

$\Rightarrow \boxed{V_x(t) = 7 - 9t}$ —— (1)

$V_y(t) = V_{oy} + a_y t = 0 + 3t$

$\Rightarrow \boxed{V_y(t) = 3t}$ —— (2)

maximum x coordinate When $V_x = 0$ يتوقف الجسم

$V_x(t) = 7 - 9t$ عوض $V_x=0$ في معادلة (1)

$0 = 7 - 9t \Rightarrow \boxed{t = \frac{7}{9}}$ seconds [illegible] / من معادلة 2

$V_y(t) = 3t = 3 \times \frac{7}{9} = \cancel{12}\ \frac{21}{9} = 2.3\ m/s$

$\Rightarrow V = \sqrt{V_x^2 + V_y^2}$

$= \sqrt{zero + (2.3)^2}$

$\boxed{V = 2.3\ m/s}$

b) $x(t) = V_{0x} t + \frac{1}{2} a_x t^2$

$= 7 \times \frac{7}{9} + \frac{1}{2} \times -9 \times \left(\frac{7}{9}\right)^2$

$= \frac{49}{9} - \frac{\cancel{9} \times 49}{2 \times \cancel{9^2}}$

$= \frac{49}{9} - \frac{49}{18}$

$= \frac{98}{18} - \frac{49}{18}$

$\boxed{x(t) = \frac{49}{18}\ m = 2.7\ m}$

$y(t) = V_{0y} t + \frac{1}{2} a_y t^2$

$= 0 + \frac{1}{2} \times 3 \times \left(\frac{7}{9}\right)^2$

$= \frac{\cancel{3} \times 49}{2 \times \cancel{81}\ 27}$

$\boxed{y(t) = \frac{49}{54} = 0.91\ m}$

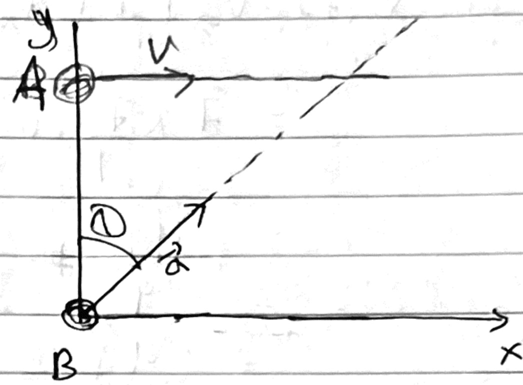
$\Rightarrow r = (2.7\,\hat{i} + 0.91\,\hat{j})\ m$

or $r = 2.7\,m\,\hat{i} + 0.91\,m\,\hat{j}$

$$⑥$$

سؤال مهم

Problem 20:- In Fig 4-23 Particle A moves alonge the line $y = 30m$ with a constant velocity $\vec{v}$ of magnitude 3 m/s and Parallel to the x-axis. At the instant particle A passes the y axis Particle B leaves the origin with a zero intial speed and a constant acceleration $\vec{a}$ of magnitude $0.40\ m/s^2$. What angle θ between $\vec{a}$ and the positive direction of the y-axis would result in a collision.



Sol:- for A

$\vec{v} = 3\ m/s\ \hat{i}$ constant

$\vec{r} = 30\ m\ \hat{j}$

$a = zero$

for B

$V_i = zero\ m/s$

$a = 0.4\ m/s^2 \Rightarrow a = 0.4 \sin\theta\ \hat{i} + 0.4 \cos\theta\ \hat{j}$

y: $y = \cancel{V_{oy} t} + \frac{1}{2} a_y t^2 \Rightarrow y = \frac{1}{2} a_y t^2$ (صفر)

$\Rightarrow 30 = \frac{1}{2} (0.4) \cos\theta\ t^2$

A عنده $V_y = 0$

$$\boxed{30 = 0.2 \cos\theta\ t^2} \rightarrow ①$$

x: $x = \cancel{V_{ox} t} + \frac{1}{2} a_x t^2$ (صفر)

B عنده $V_{ox} = zero$

$Vt = \frac{1}{2} a_x t^2$

لكن بما أنه سيحدث تصادم فإن X ستكون Vt

سرعة A

$3t = \frac{1}{2}\, 0.4 \sin\theta\ t^2$

$$\boxed{3t = 0.2 \sin\theta\ t^2}$$

$$\boxed{3 = 0.2 \sin\theta\ t} \rightarrow ②$$

سارة نجار

اقسم معادلة (2) على معادلة (1)

$$3 = 0.2 \sin\theta \, t$$
$$30 = 0.2 \cos\theta \, t^2$$

$$\frac{3}{30} = \cancel{\frac{0.2}{0.2}} \frac{\sin\theta}{\cos\theta} \frac{t}{t^2}$$

$$\frac{1}{10} = \frac{\sin\theta}{\cos\theta \, t}$$

$$\boxed{t = 10 \frac{\sin\theta}{\cos\theta}} \rightarrow (3)$$

عوض t في احدى المعادلتين لتكن (2)

$$3 = 0.2 \sin\theta \, t$$

$$3 = 0.2 \sin\theta \, 10 \frac{\sin\theta}{\cos\theta}$$

$$3 = 2 \frac{\sin^2\theta}{\cos\theta}$$

$$1.5 = \frac{\sin^2\theta}{\cos\theta}$$

لكن

$$\sin^2\theta = 1-\cos^2\theta$$

$$1.5 = \frac{1-\cos^2\theta}{\cos\theta}$$

$$1.5\cos\theta = 1-\cos^2\theta$$

$$\cos^2\theta + 1.5\cos\theta - 1 = 0$$

$a=1 \quad b=+1.5 \quad c=-1$

$$\cos\theta = \frac{-1.5 \pm \sqrt{(1.5)^2 - 4(1)(1)}}{2} = \frac{1}{2} \Rightarrow \boxed{\theta = 60}$$

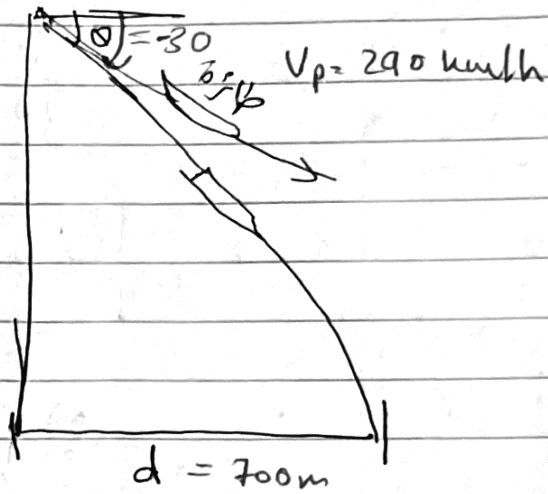
ريما /

Problem 27: A certain airplane has a speed of 290 km/h and is diving at an angle of $\theta = 30°$ below the horizontal when the pilot releases a radar decoy. The horizontal distance between the release point and the point where the decoy strikes the ground is $d = 700$ m. (a) How long is the decoy in the air? (b) How high was the release point?

Sol

$\theta = -30$

لانها عكس عقارب الساعة



$V_0 = 290 \text{ km/h}$

$= \dfrac{290 \times 1000}{3600}$

$\boxed{V_0 = 80.6 \text{ m/s}}$

a) $\Delta x = V_{0x} t$

$\Delta x = V_0 \cos\theta \, t$

$700 = 80.6 \cos(-30)\, t$

$\Rightarrow t = \dfrac{700}{80.6 \cos(-30)} \simeq 10.03 \text{ sec}$

b) $\Delta y = V_{0y} t - \frac{1}{2} g t^2$

$y_f - y_0 = V_{0y} t - \frac{1}{2} g t^2$

$0 - y_0 = (80.6 \sin(-30)) \times (10.03) - \frac{1}{2} \times 9.8 \times (10.03)^2$

$-y_0 = -40.3 \times (10.03) - 490$

$-y_0 = -897$ m

$\boxed{y_0 = 897 \text{ m}}$

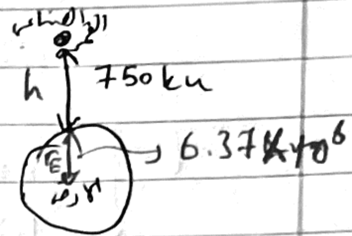
حل

Problem 56: An earth statellite moves in a circular orbit 750 km above Earth's surface with a period of 98 min What are the (a) speed and (b) magnitude of the centripetal acceleration of the satellite?

Sol: $R = H + r_E$

$= 750 \times 10^3 + 6.37 \times 10^6$

$= 7.12 \times 10^6 \, m$



The speed of satallite

a) $v = \frac{2\pi r}{T} = \frac{2\pi (7.12 \times 10^6)}{98 \times 60}$

$= \frac{4.47 \times 10^7}{5880}$

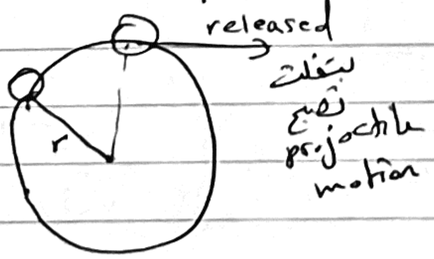
$= 7.6 \times 10^3 \, m/s$

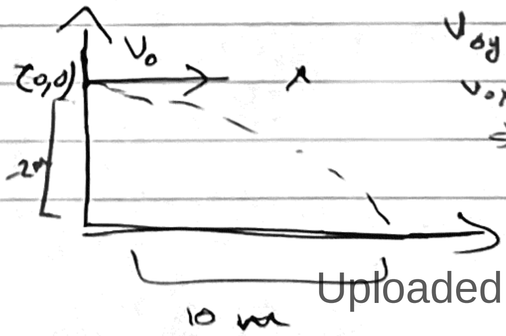
b) $a = \frac{v^2}{r} = \frac{(7.6 \times 10^3)^2}{7.12 \times 10^6}$

$= 8.11 \, m/s^2$

Problem 67: A boy whirls a stone in a horizantal circle of radius 1.5 m and at height 2 m above level ground. The string breaks, and the stone flies off horizontally and strikes the ground after traveling a horizantal distance of 10 m. What is the magnitude of the centripeted acceleration of the stone during the circular motion?

(يدور ; حركة دائرية افقية ; ينقطع)





$V_{0y} = $ zero

$V_{0x} = $ constant

$\Rightarrow x = vt$

سابقاً ،

$a = \frac{v^2}{r}$ من نستطيع معرفة تسارعه المركزي يجب معرفة سرعته خلال الحركه الاثريه والتي تشكل v_0

$X = v_0 t$, $y = \cancel{v_{0y} t}^{\text{صفر}} - \frac{1}{2} g t^2$

$y = -\frac{1}{2} g t^2 \Rightarrow t = \sqrt{\frac{-2y}{g}}$

$t = \sqrt{\frac{-2 \times 2}{9.8}} = 0.64 \text{ sec}$

$v_0 = \frac{X}{t} = \frac{10}{0.64} = 16.625 \text{ m/s}$

$a = \frac{v_0^2}{r} = \frac{(15.625)^2}{1.5} = 162.8 \text{ m/s}^2$

~~Problem 77: snow is falling vertically at a constant airspeed of 8 km/h. The pilot sets out for a destination 900 km due north but discovers that the plane must be headed 20 east of due north to fly there directly. The plane arrives in 2 h. What were the (a) magnitude and (b) direction of the wind velocity~~

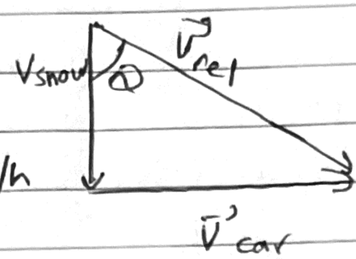
هام جداً

Problem 77: Snow is falling vertically at a constant speed of 8 m/s. At what angle from the vertical do the snowflakes appear to be falling as viewed by the driver of a car traveling on a straight, level road with speed of 50 km/h?

تتساقط الثلوج عمودياً بسرعة ثابتة مقدارها 8m/s . في أي زاوية من العمودي يبدو أن رقائق الثلج تتساقط كما يراها سائق يسير على خط مستقيم مستوى بسرعة 50km/h

sol : relative motion in two dimension.

Relative to the car the velocity of the snowflakes has a vertical componant of $v_y = 8$ m/s and horizantal componant $V_x = 50$ km/h



$$v_x = \frac{50 \times 1000}{3600} = 13.9 \text{ m/s}$$

$$\tan\theta = \frac{v_{car}}{v_{snow}} = \frac{v_x}{v_y} = \frac{13.9}{8} = 1.7375$$

$$\Rightarrow \theta = \tan^{-1}(1.7375) = 60^\circ$$

$$\boxed{\vec{V}_{rel} = \vec{V}_{snow} + \vec{V}_{car}}$$

لو طلب