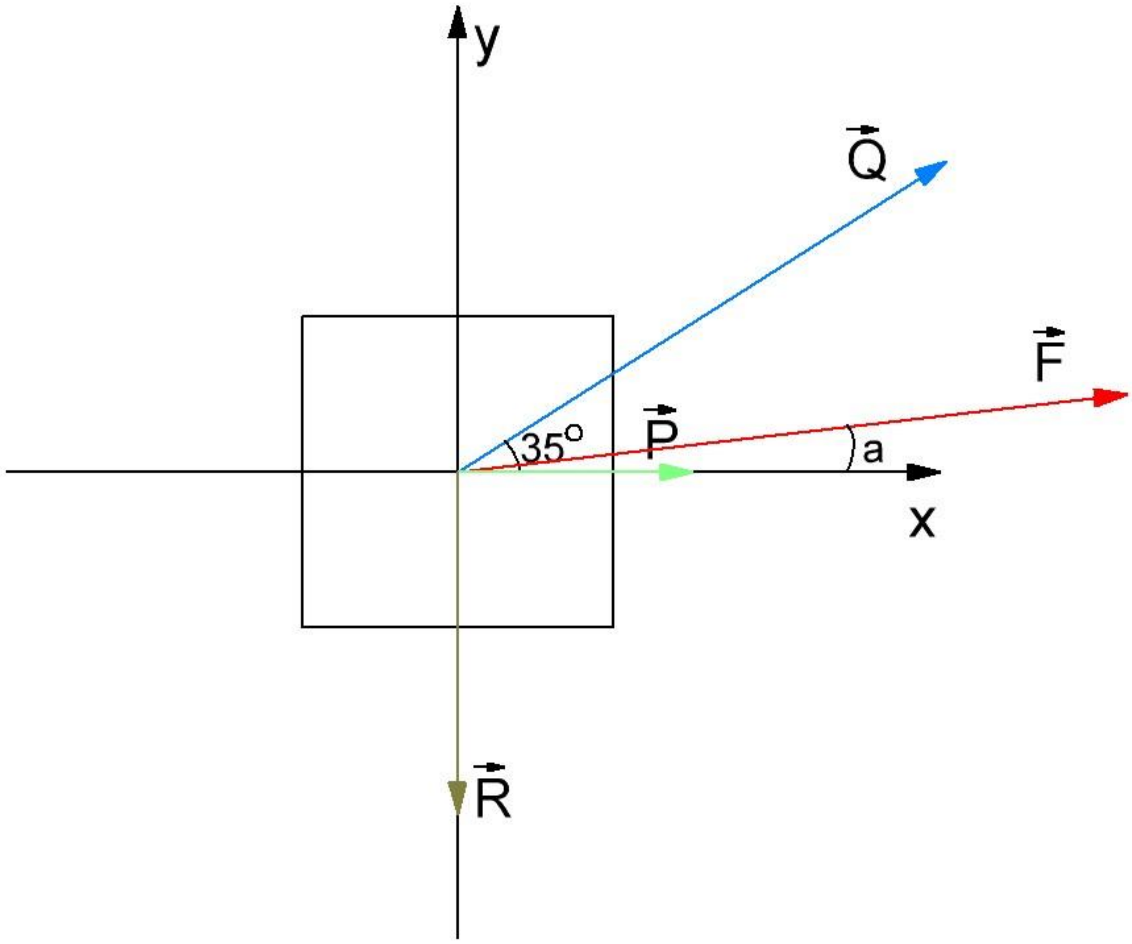
Condition of the problem: (a) An object is subjected to three different forces, P, Q and R. The magnitude of each force is: P = 5 N, Q = 30 N, R = 10 N. P is a horizontal force acting eastward; Q acts at an angle 35° above the horizontal plane; and R is acting downward. Draw a diagram to show the forces acting on the object and calculate the resultant force acting on the object.

Solution:



$$\vec{F} = \vec{P} + \vec{Q} + \vec{R}$$

$$Ox: \; F_x = P_x + Q_x + R_x = P + Q\cos 35° + 0 = P + Q\cos 35° \approx 29.6\ (N)$$

$$Oy: \; F_y = P_y + Q_y + R_y = 0 + Q\sin 35° - R = Q\sin 35° - R \approx 7.2\ (N)$$

$$F = \sqrt{{F_x}^2 + {F_y}^2} \approx 30.5\ (N)$$

$$\tan a = \frac{F_y}{F_x} \approx 0.24 \qquad a \approx 14°$$

Answer: $F = \sqrt{{F_x}^2 + {F_y}^2} \approx 30.5\ (N) \qquad a \approx 14°$

Condition of the problem: (b) Discuss an application of projectile motion by using an example. The mass, initial velocity and direction of the object must be described. Complete the discussion by deriving the equation to determine the location (x,y) of the object and drawing the path of the projectile motion on a graph paper.
Given the gravitational acceleration, g is 9.8 ms-2.

Solution:

$$\vec{r} = \vec{r_0} + \int_0^t \vec{v}dt, \quad \vec{r} - poisiton$$

$$\begin{cases} Ox: \quad x = x_0 + \int_0^t v_x dt \\ Oy: \quad y = y_0 + \int_0^t v_y dt \end{cases}$$

As $v_x = const$ and $v_y = v_{y0} - gt$

$$\begin{cases} Ox: \quad x = x_0 + v_x t \\ Oy: \quad y = y_0 + v_{y0}t - \frac{gt^2}{2} \end{cases}$$

From $x = x_0 + v_x t \quad t = \frac{x - x_0}{v_x}$, so

$$y = y_0 + v_{y0}t - \frac{gt^2}{2} = y_0 + v_{y0}\frac{x - x_0}{v_x} - \frac{g\left(\frac{x - x_0}{v_x}\right)^2}{2} = y_0 + \frac{v_{y0}}{v_x}(x - x_0) - \frac{g}{2{v_x}^2}(x - x_0)^2$$

So, that is parabola.

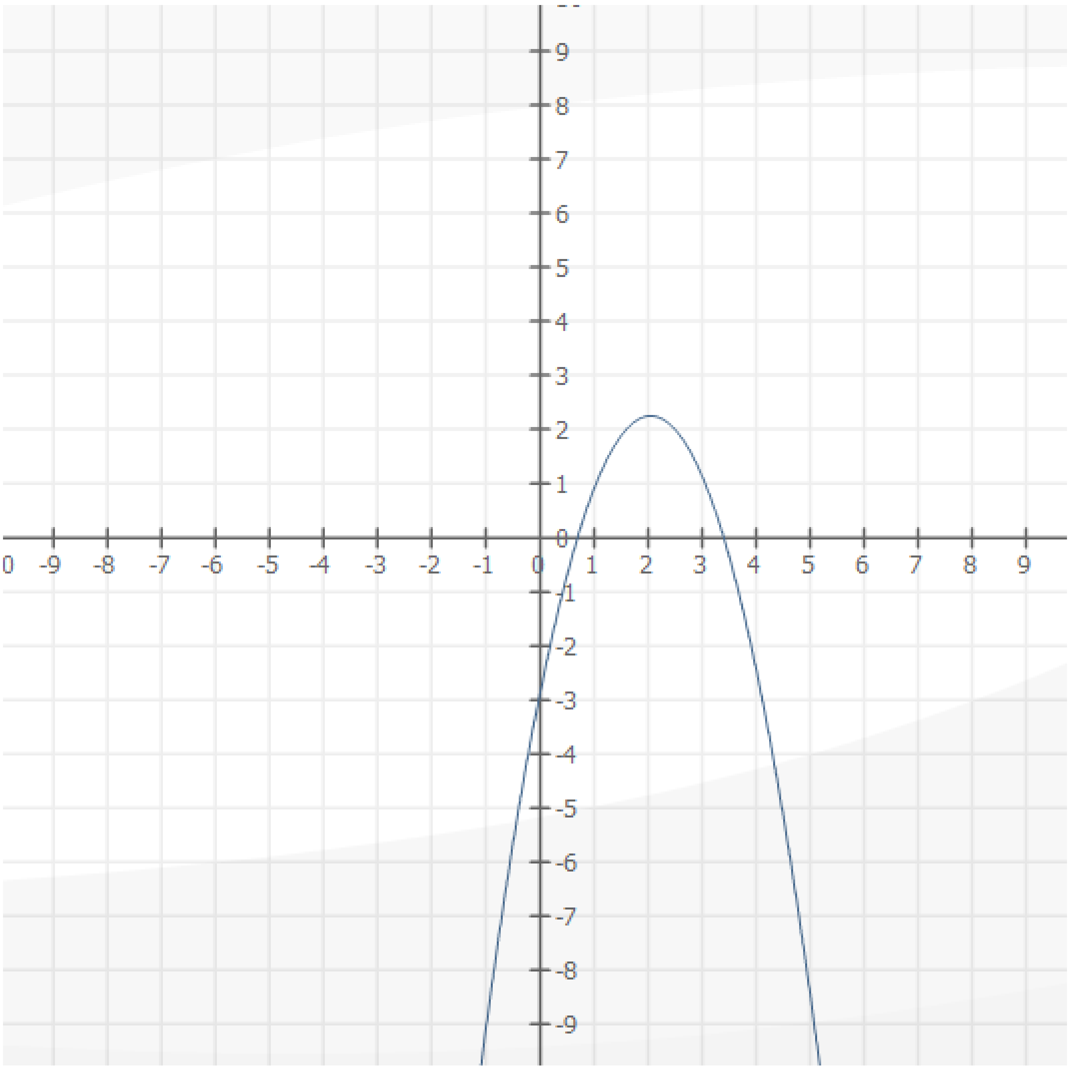
$$v = \sqrt{{v_x}^2 + {v_y}^2} = \sqrt{{v_x}^2 + \left(v_{y0} - gt\right)^2}$$

The direction of v is determined by the angle to the horizon (a).

$$\tan a = \frac{v_y}{v_x} = \frac{v_{y0} - gt}{v_x}$$

For example assume that $v_x = 2\frac{m}{s}, v_{y0} = 5\frac{m}{s}, x_0 = 1, y_0 = 1, g = 9.8\, m/s^2$

$$y = 1 + 2.5(x - 1) - 1.23(x - 1)^2 = -1.23x^2 + 4.96x - 2.73$$



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