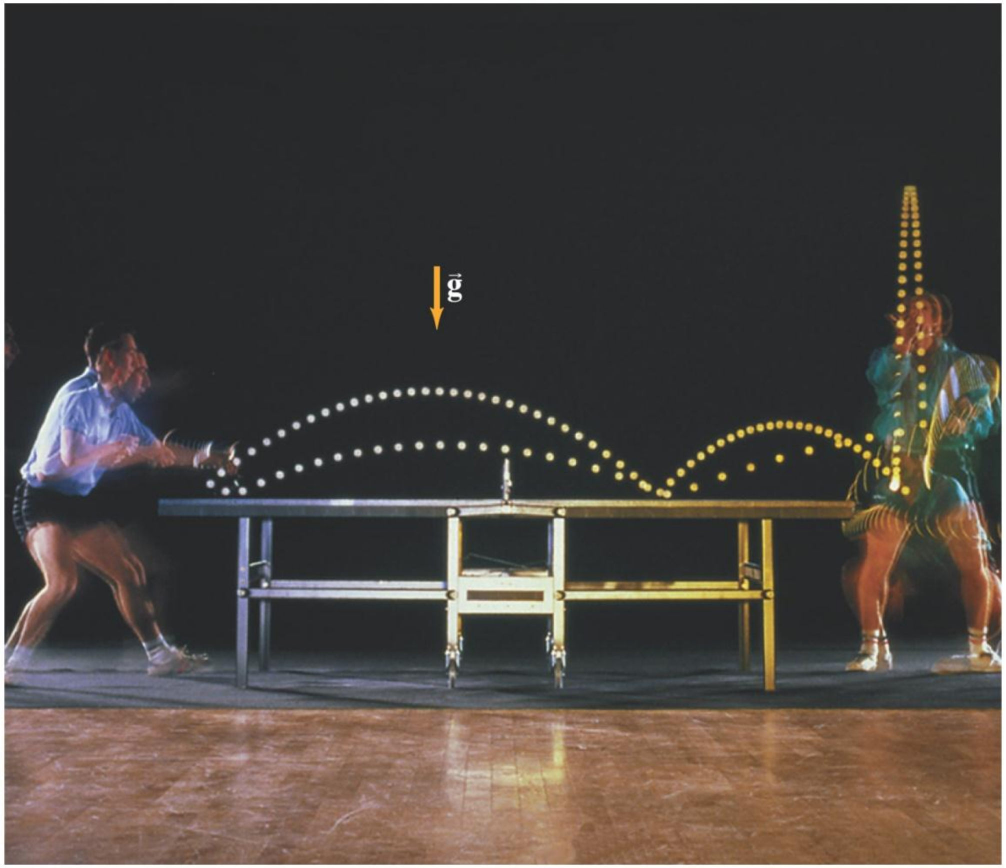
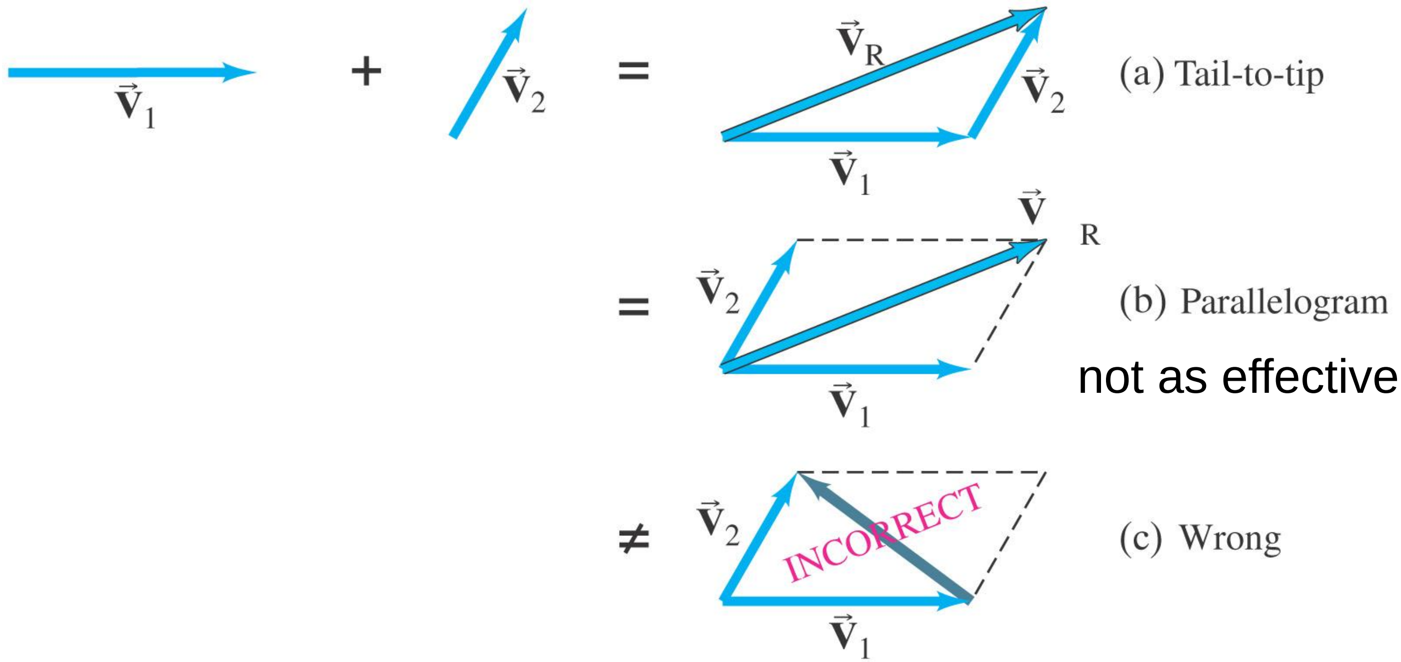
Chapter 3

Kinematics in Two Dimensions; Vectors



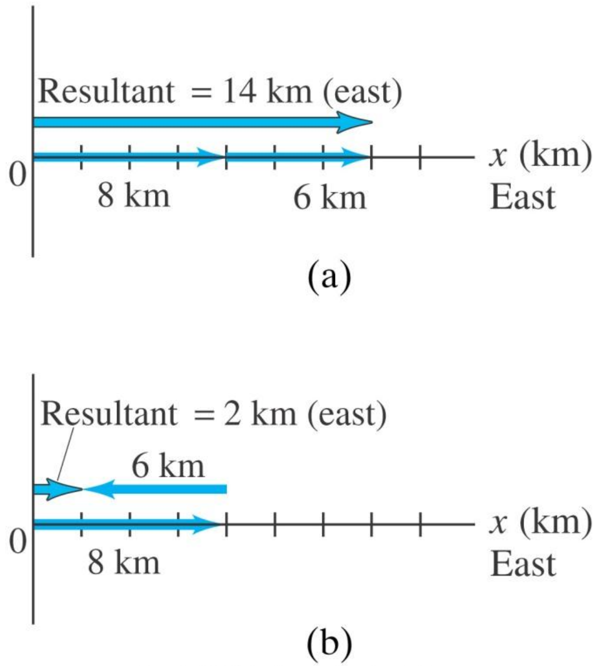
Resultant vector is the vector sum of two vectors

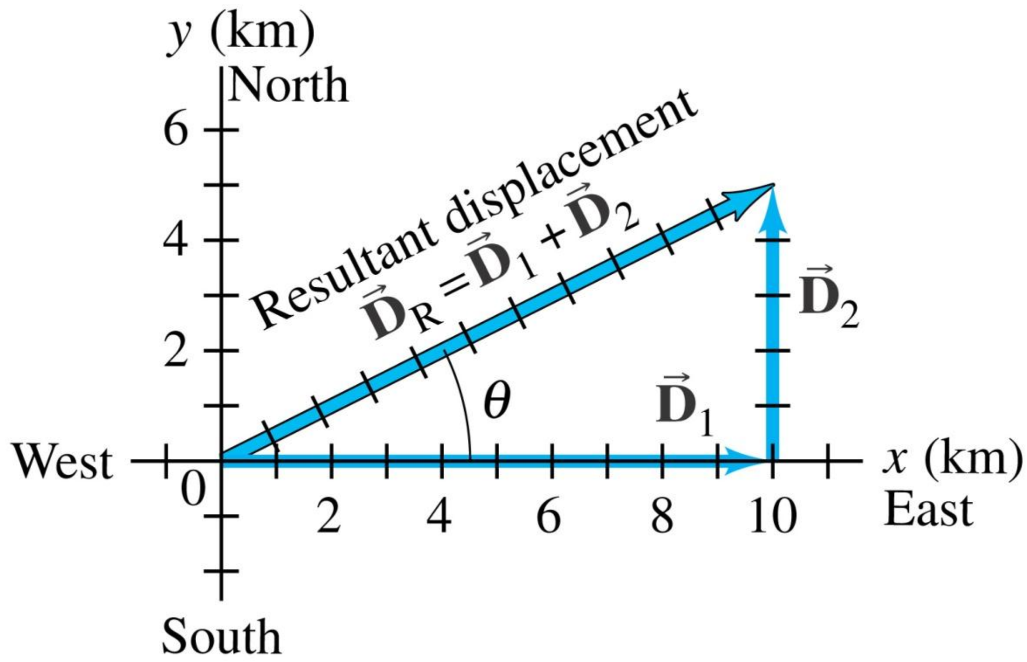
Tail – to – tip method for drawing vector diagrams



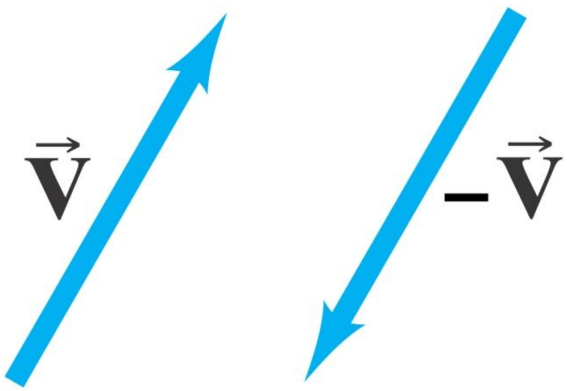
not as effective

Resultant vector has magnitude and direction





Vector subtraction



Perpendicular vector addition

A hiker walks 8 km east then turns and walks 2 km north.

Calculate a) the distance that the hiker walked and b) his resultant displacement.

a) Distance = scalar quantity

total distance walked = 8+ 2 = 10 km

b) Displacement = vector quantity

use Pythagorean Theorem to find magnitude of resultant

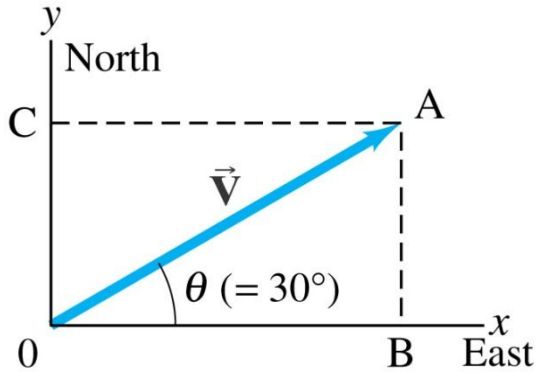
$$\sqrt{(64+4)} = 8.2$$

use inverse tangent to find direction – include compass directions

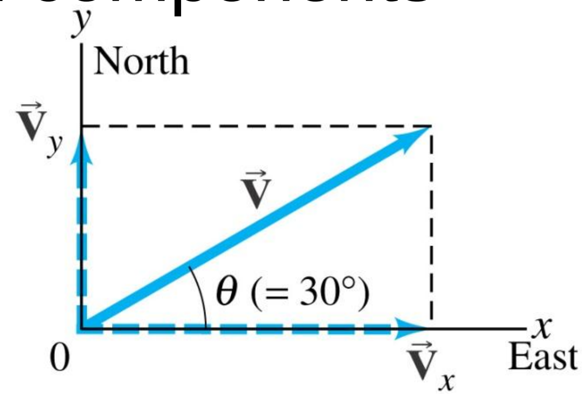
$$\tan^{-1}\left(\frac{2}{8}\right) = 14.0^{o} \quad North\, of\ East$$

cart video

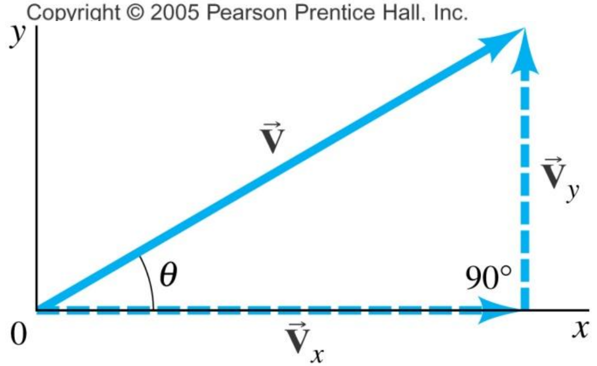
Vector resolution – breaking vector into its horizontal and vertical components



(a)



(b)

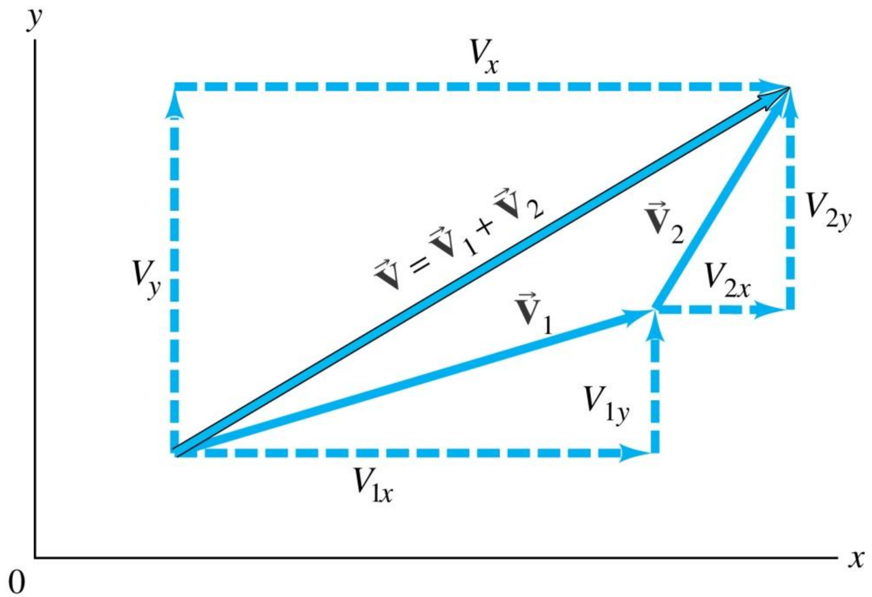


$$\sin\theta = \frac{V_y}{V}$$

$$\cos\theta = \frac{V_x}{V}$$

$$\tan\theta = \frac{V_y}{V_x}$$

$$V^2 = V_x^2 + V_y^2$$



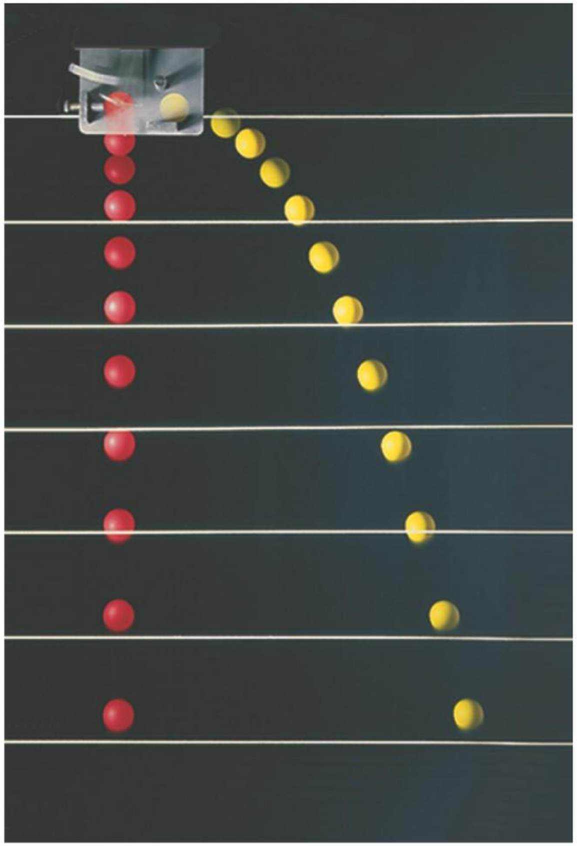
- resolve V_1, V_2 into x and y components
- add x components, add y components to yield V_x and V_y
- add 2 perpendicular vectors to find resultant magnitude and direction

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

$$\tan\theta = \frac{V_y}{V_x}$$

Projectile Motion

- Scooter – where does the ball land?
- Which ball hits the table first?

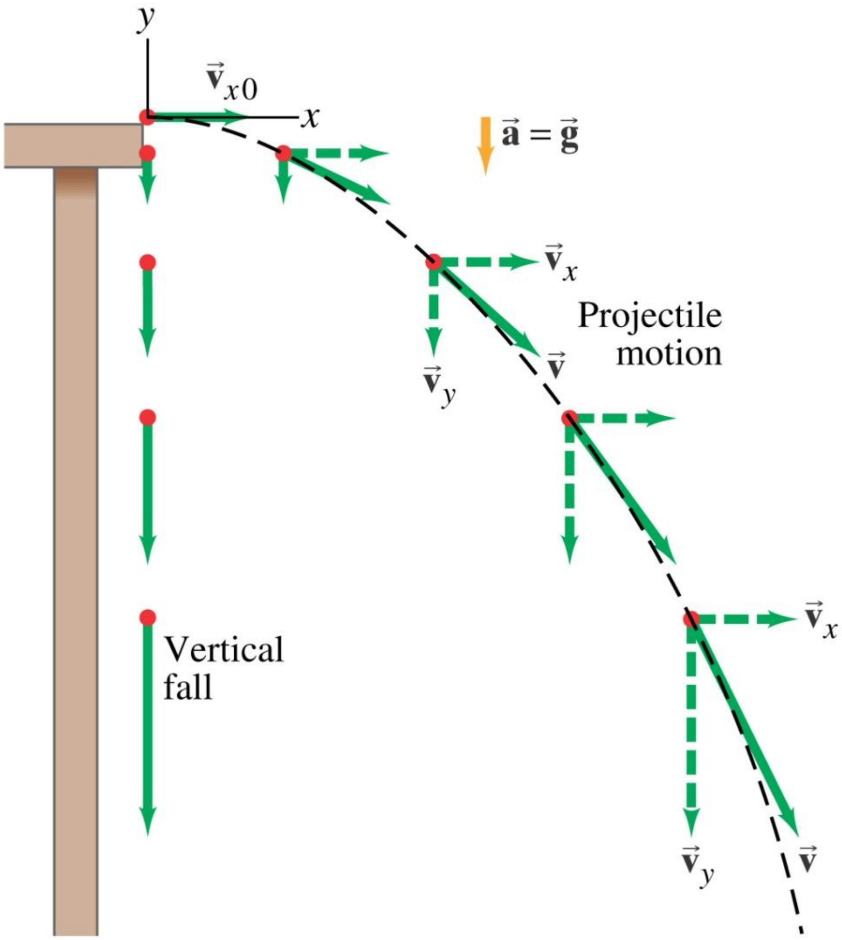


• motion in x and y directions are independent of each other

• both balls are accelerating in free fall at same rate

animation 6-1

3-5 Projectile Motion



- It can be understood by analyzing the **horizontal** and **vertical** motions separately.
- **Constant velocity in x direction**
- **Free fall in y direction**

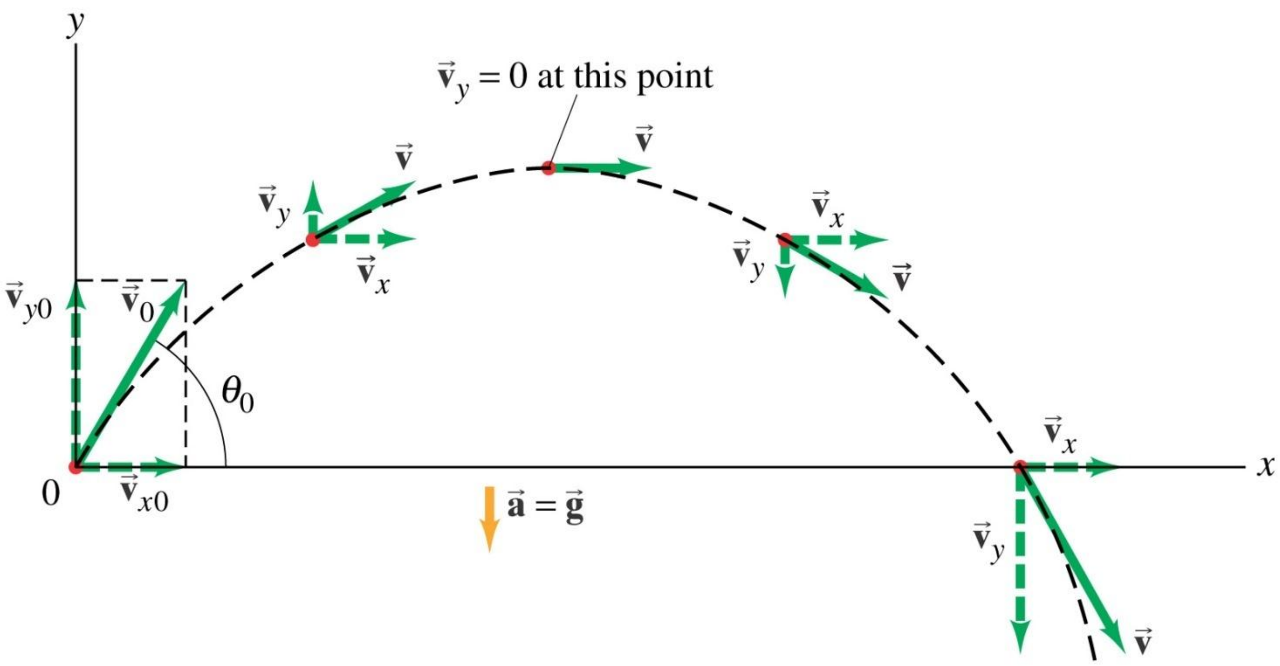
3-6 Solving Problems Involving Projectile Motion

Projectile motion is motion with constant acceleration in two dimensions, where the acceleration is *g* and is down.

TABLE 3–2 Kinematic Equations for Projectile Motion
(y positive upward; $a_x = 0$, $a_y = -g = -9.80\ \mathrm{m/s^2}$)

Horizontal Motion ($a_x = 0$, $v_x =$ constant)		Vertical Motion† ($a_y = -g =$ constant)
$v_x = v_{x0}$	(Eq. 2–11a)	$v_y = v_{y0} - gt$
$x = x_0 + v_{x0}t$	(Eq. 2–11b)	$y = y_0 + v_{y0}t - \frac{1}{2}gt^2$
	(Eq. 2–11c)	$v_y^2 = v_{y0}^2 - 2g(y - y_0)$

† If y is taken positive downward, the minus (−) signs in front of g become + signs.



Resolve initial velocity V_0 at angle θ into V_{0x}, V_{0y} and then use projectile motion kinematic equations to solve problems