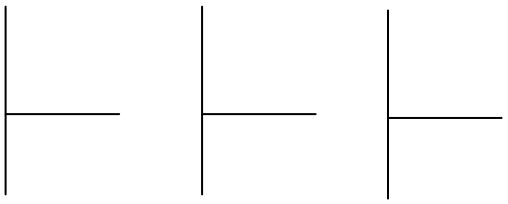
Projectile Motion
- An example of 2-dimensional motion.
- Something is fired, thrown, shot, or hurled near the earth's surface.
- Horizontal velocity is constant.
- Vertical velocity is accelerated.
- Air resistance is ignored.

Trajectory of Projectile
- The trajectory of a projectile is the path it follows.
- It is defined by a parabola.
- The RANGE of the projectile is how far it travels horizontally.
- The MAXIMUM HEIGHT of the projectile occurs halfway through its range, provided the projectile is fired over level ground.
- Acceleration points down at 9.8 m/s2 for the entire trajectory.
- Velocity is tangent to the path for the entire trajectory.
- The vertical velocity changes while the horizontal velocity remains constant.

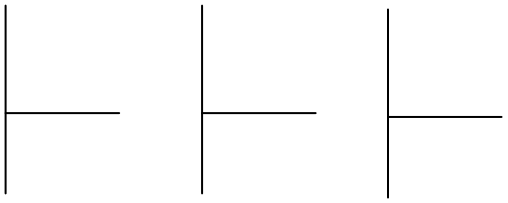
Problem: Graphs for 2D Projectiles

x-component of motion



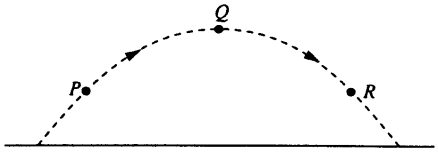
x vs t v vs t a vs t

y-component of motion



x vs t v vs t a vs t

Problems: Projectile Motion (1993)



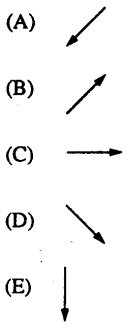
A ball is thrown and follows the parabolic path shown above. Air friction is negligible. Point Q is the highest point on the path. Points P and R are the same height above the ground.

64. How do the speeds of the ball at the three points compare?

(A) $v_P < v_Q < v_R$
(B) $v_R < v_Q < v_P$
(C) $v_Q < v_R < v_P$
(D) $v_Q < v_P = v_R$
(E) $v_P = v_R < v_Q$

Explain your choice:

65. Which of the following diagrams best shows the direction of the acceleration of the ball at point P ?



Explain your choice:

2D Motion problems
- Work as two one-dimensional problems.
- Each dimension can obey different equations of motion.
- Time is the same for each dimension.

Horizontal Component of Velocity
- Is constant, not accelerated
- Not influenced by gravity
- Follows constant motion equation:

$$\Delta x = v_x t$$

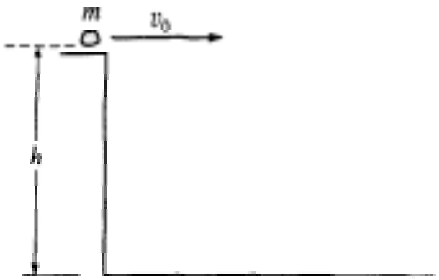
Vertical Component of Velocity
- Undergoes accelerated motion
- Accelerated by gravity (9.8 m/s2 down)
- Follows kinematic (star) equations:

$$v_y = v_{oy} + at$$

$$\Delta y = v_{oy} t + \frac{1}{2} a t^2$$

$$v_y{}^2 = v_{oy}{}^2 + 2a\Delta y$$

Problem: Initial horizontal velocity (most common)



A rock with mass m is thrown horizontally with speed v_o from a cliff of height h. How long is the rock in the air, and how far is the landing position is from the base of the cliff?

Vertical (a=g, star equations)	Horizontal (a=0, constant motion)
$\Delta y =$	$\Delta x =$
$v_{oy} =$	$v_x =$
$v_y =$	$t =$
$a_y =$	
$t =$	

Show your work:

Problem: Initial velocity angled

A broken pipe sends a jet of water shooting from the ground at and angle of 30 degrees from the horizontal. The water reaches a maximum height of 10 meters above the ground. What is the velocity of the water as it leaves the broken the pipe, and how far away from the pipe does it land?

Vertical (a=g, star equations)	Horizontal (a=0, constant motion)
$\Delta y =$	$\Delta x =$
$v_{oy} =$	$v_x =$
$v_y =$	$t =$
$a_y =$	
$t =$	

Show your work: