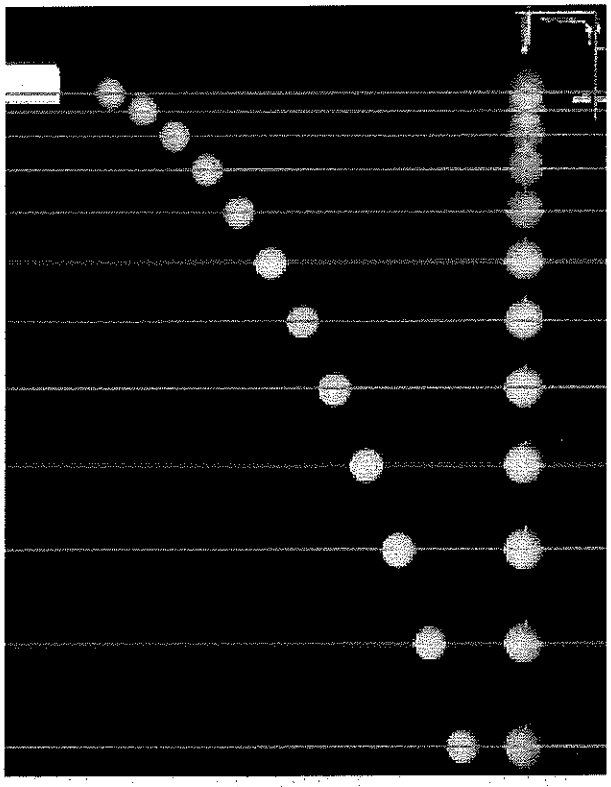
Question

Consider this projectile motion situation: Three balls are rreleased simultaneously from the same height above the floor. The first is dropped from rest and the other two ball are projected horizontally with speeds of 4 m/s and 6 m/s. Which ball hits the floor first?

a) First ball
b) Second ball
c) Third ball
d) All reach the floor at the same time
e) Not enough information to determine

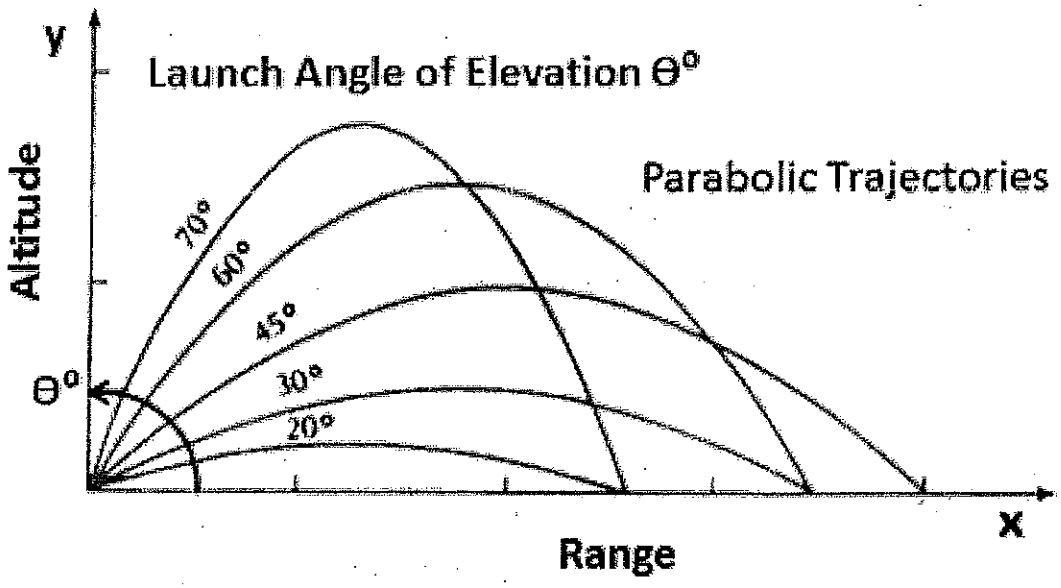
Answer

d



Carefully examine the following projectile motion diagram:

Range R vs Launch Angle Θ for a Given Initial Velocity V_0



What do you notice?

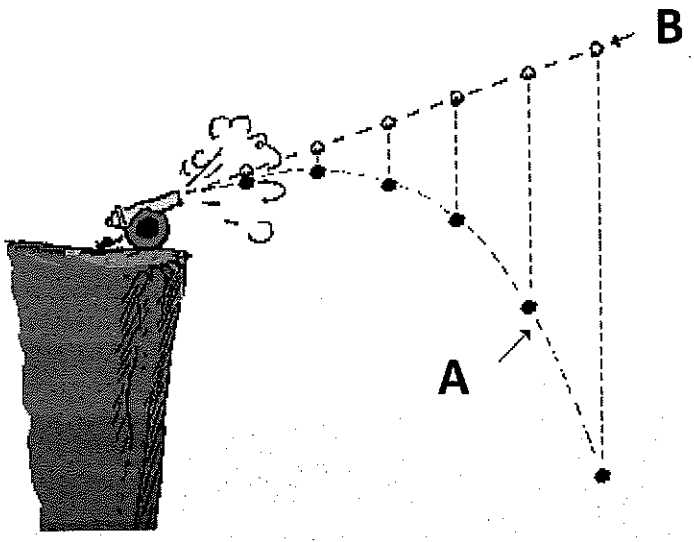
List three (3) relationships that stand out.

Answer:

1. Complimentary angles (angles that add to 90 degrees) yield the same horizontal range for a given initial velocity.
2. For a given initial velocity. 45 degrees yields the greatest range.
3. For a given initial velocity, the greater the launch angle, the greater vertical height.

Question:

In the figure below, two possible paths of a fired cannonball projectile are shown. Which statement regarding the paths is correct?



A) Path **A** is the projectile's parabolic inertial trajectory.
B) Path **B** represents the projectile's linear gravitational trajectory.
C) Path **A** corresponds to the projectile's linear gravitational trajectory.
D) Path **B** shows the projectile's parabolic inertial trajectory.
E) None of the above statements are correct

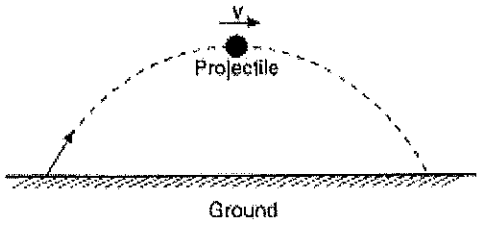
Provide an explanation which justifies your answer!

Answer:

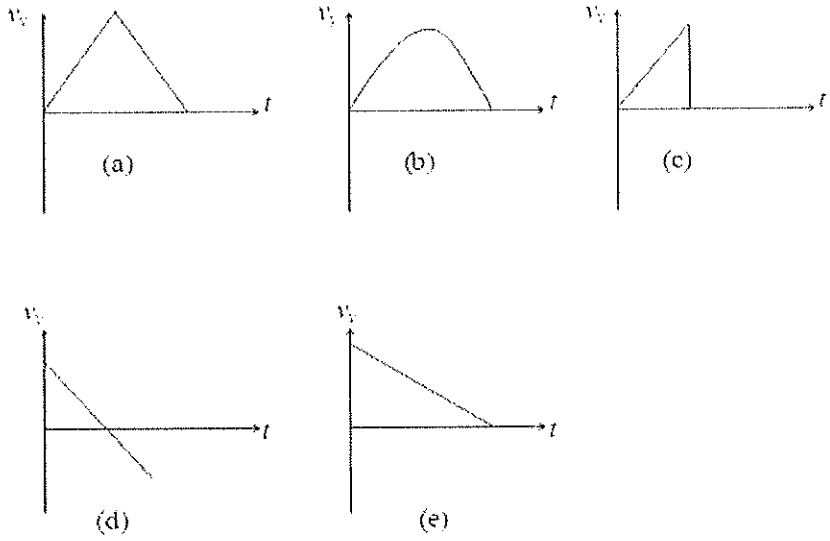
E > Path A shows the projectile's parabolic gravitational trajectory while path B corresponds to the projectile's linear inertial trajectory under the absence of a gravitational force.

Question:

A projectile is fired in the absence of air resistance and its path is shown below.



Which graph below shows the vertical velocity of the projectile as a function of time?



Answer:

d

Question:

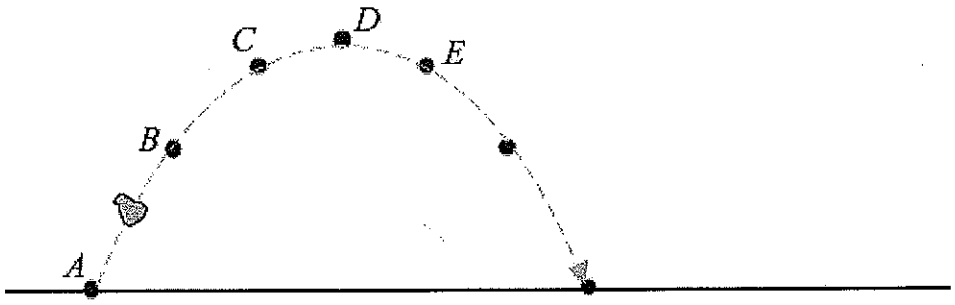
A projectile is launched at a 30° angle above the horizontal. Ignoring air resistance, the projectile's acceleration is

a. greatest at a point between the launch point and the high point of the trajectory.
b. greatest at the high point of the trajectory.
c. greatest at a point between the high point of the trajectory and where it hits the ground.
d. the same (but nonzero) at all points along the trajectory.
e. zero at all points along the trajectory.

Answer:

d.

Question:



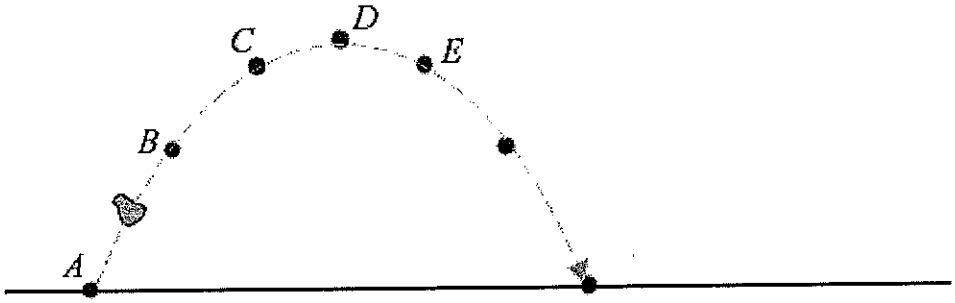
A rock is thrown into the air at an angle relative to the vertical, and follows the path shown here. Consider air friction to be negligible. At which position is the vertical velocity of the ball zero?

a. *A*
b. *B*
c. *C*
d. *D*
e. the vertical velocity of the rock is never zero.

Answer:

The correct answer is ***d***. The rock has a horizontal velocity throughout its entire path of travel, but its instantaneous vertical velocity is zero at the very top of its trajectory.

Question:



A rock is thrown into the air at an angle relative to the vertical, and follows the path shown here. Consider air friction to be negligible. What is the direction of the net acceleration of the rock at point *D*?

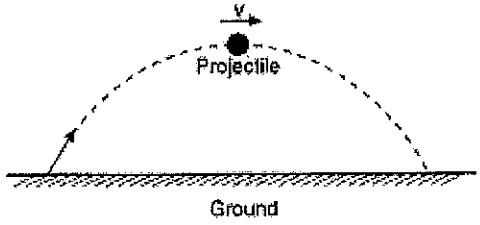
a. to the left
b. to the right
c. straight up
d. straight down
e. there is no net acceleration at point *D*

Answer:

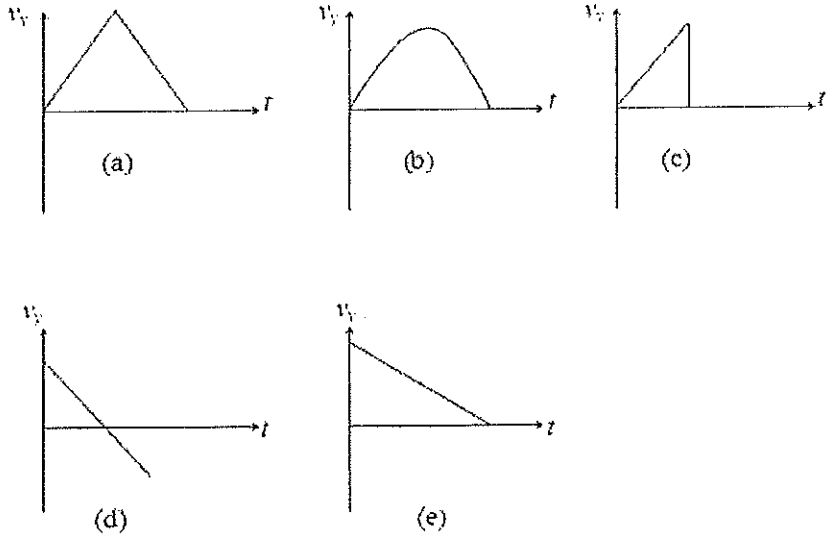
The correct answer is ***d***. The rock has constant horizontal velocity, and therefore no horizontal acceleration. Vertically, the rock's velocity is constantly changing, slowing down as it ascends, and speeding up as it falls. Its net acceleration, or change in velocity per unit time, is always in the downward direction.

Question:

A projectile is fired in the absence of air resistance and its path is shown below.



Which graph below shows the vertical velocity of the projectile as a function of time?



Answer:

d

Question:

If air resistance is neglected, which statement concerning projectiles and projectile motion is correct?

I. **The shape of a projectile's trajectory is a parabola.**
II. **For an object to be a projectile it must be in free-fall and have an initial *x* component of velocity.**
III. **A projectile is characterized by $a_x = 0$ and $a_y = -g$.**

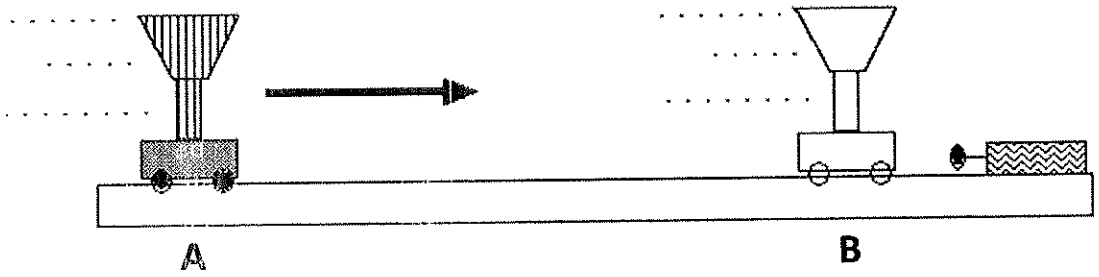
a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

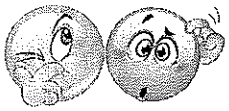
Answer:

e.

Question:

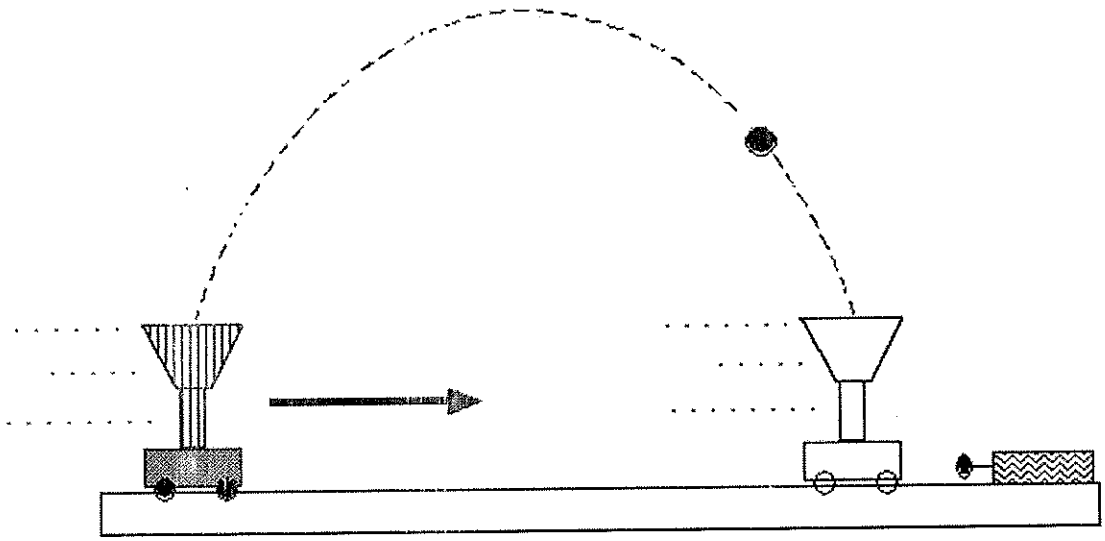
A small ball is placed in a spring-loaded cup attached to a cart that moves along a straight track. The ball is fired straight up when the cart reaches Point **A**. If the cart continues at a constant speed along the track, what will be the position of the ball relative to the cup when it returns to the same height from which it was fired?



a. The ball will land in the cup when the cart reaches Point **B**.
b. The ball will be fired at a forward angle and land at a position on the track ahead of the cup when the cart reaches Point **B**.
c. The ball will go straight up and land on the track at Point **A**.
d. The ball will be fired at a backward angle and land at a position on the track behind Point **A**.
e. Something else will happen 

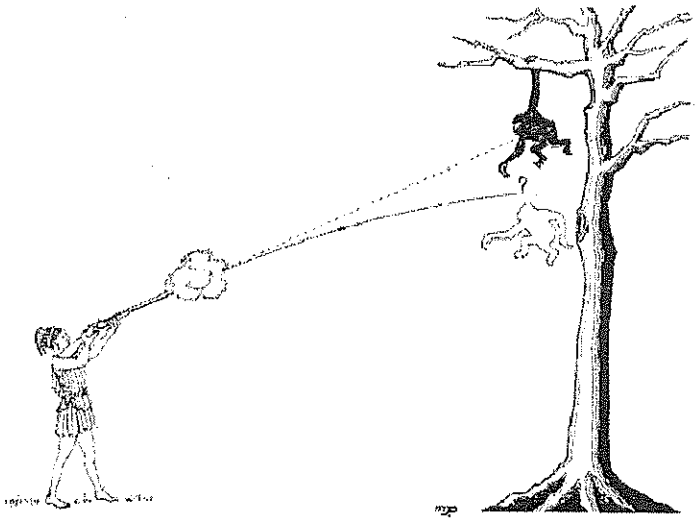
Answer:

a



Question:

Where should the vet aim to hit the monkey with a tranquilizer dart?

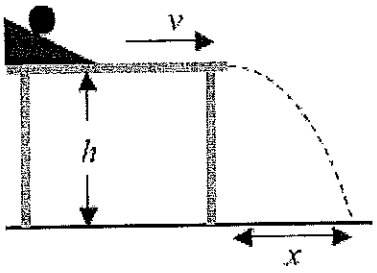


a. Aim just above the monkey
b. Aim directly at the monkey
c. Aim just below the monkey
d. Aim the gun horizontally
e. Can't be determined without knowing the speed of the dart

Answer:

b.

Question:



In a lab experiment, a ball is rolled down a ramp so that it leaves the edge of the table with a horizontal velocity v. If the table has a height h above the ground, how far away from the edge of the table, a distance x, does the ball land? You may neglect air friction in this problem.

a. $\frac{2v^2}{g}$

b. $v\sqrt{\frac{2h}{g}}$

c. $\frac{2vh}{g}$

d. $\frac{2h}{g}$

e. none of these

Answer:

The correct answer is *b*. The ball takes a time t to fall from the table, as determined here:

$\Delta y = v_0 t + \frac{1}{2} a t^2$

$$t = \sqrt{\frac{2\Delta y}{-g}} = \sqrt{\frac{2h}{g}}$$

Horizontally, during that time the ball travels at constant velocity:

$\Delta x = vt$

$$x = v\sqrt{\frac{2h}{g}}$$

Question:

Consider a ball thrown up from the surface of the earth into the air at an angle of 30° above the horizontal. Air friction is negligible. Just *after* the ball is released, its acceleration is:

a. Upwards at 9.8 m/s^2
b. Upwards at 4.9 m/s^2
c. Downwards at 9.8 m/s^2
d. 0 m/s^2
e. None of these

Answer:

The correct answer is *c*. The ball, even as it moves upwards and sideways through the air, experiences a force of gravity acting on it, which causes it to accelerate downwards at **g**.

Question:

A zookeeper fires a tranquilizer dart directly at a monkey. The monkey lets go at the same instant that the dart leaves the gun barrel. The dart reaches a maximum height P before striking the monkey. Ignore air resistance.

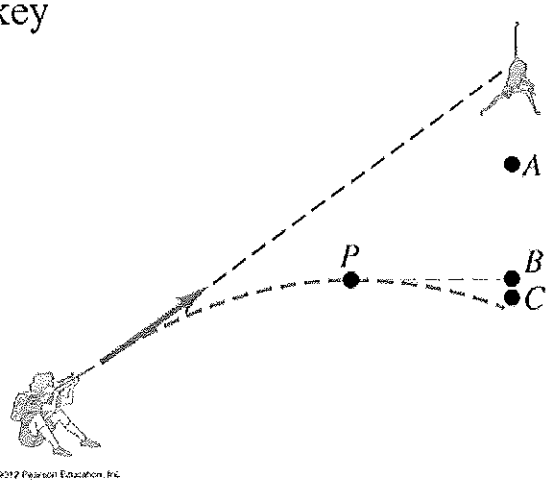
When the dart is at P, the monkey

A. is at A (higher than P).

B. is at B (at the same height as P).

C. is at C (lower than P).

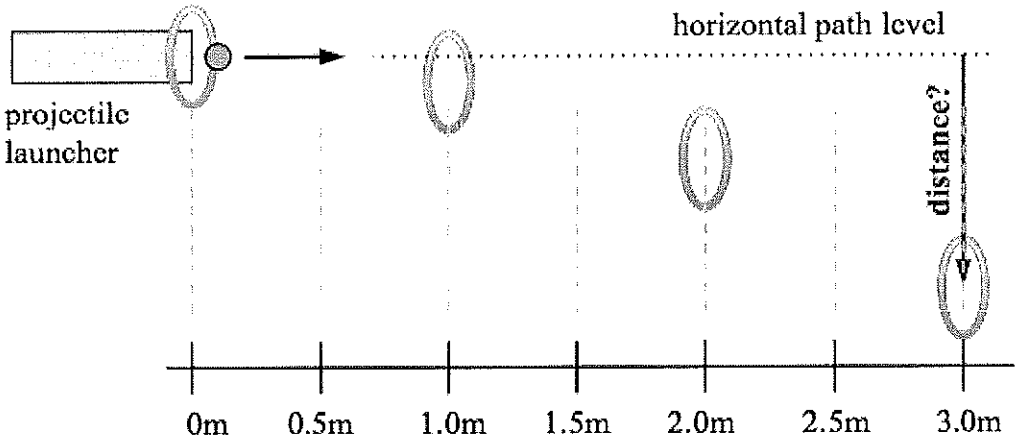
D. not enough information given to decide



Answer:

A.

Question:



A physics teacher wants to prepare a demonstration on projectile motion for her students. A launcher, placed at the top of a building, will fire a ball horizontally, and the ball will pass through a series of elevated rings that have been set up as shown above. The ball is fired with an initial horizontal velocity of 2.0 m/s; air friction is negligible. At what distance below the horizontal path level should the fourth ring be placed if the ball is to pass through it?

a. 1.5 m
b. 3.0 m
c. 4.5 m
d. 6.0 m
e. 11 m

Answer:

The correct answer is *e*. A horizontal analysis of the ball reveals that it will reach ring 4 in 1.5 seconds:

$$\Delta x = v_x t$$

$$t = \frac{\Delta x}{v_x} = \frac{3.0m}{2.0m/s} = 1.5s$$

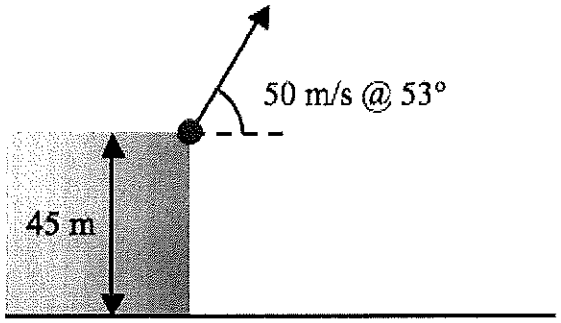
During that time, the vertical distance that the ball falls can be determined:

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

$$\Delta y = 0t + \frac{1}{2}(-10m/s^2)(1.5s)^2 = 5 \bullet 2.25 = -11.0m$$

You can also estimate the distance that the ball has traveled during the 1.5 seconds by using average velocity: the accelerating ball has an average velocity of 5m/s during its first second of travel. After one second of falling the ball will have dropped 5.0 meters. In the additional half-second of travel the ball will be moving even faster, making the 11 meter answer the logical result.

Question:



A projectile is launched at 50 m/s, at an angle of 53 degrees above the horizontal, from the top of a 45 meter high vertical cliff. If air resistance is negligible, the projectile lands:

a. about 120 m from the base of the cliff
b. about 90 m from the base of the cliff
c. about 135 m from the base of the cliff
d. about 450 m from the base of the cliff
e. about 270 m from the base of the cliff

Answer:

The correct answer is *e*. The projectile begins its motion at an angle of 53° above the horizontal, which indicates that its components are part of a 3-4-5 triangle:

$$v_x = v\cos\theta = 50\cos 53° = 50(3/5) = 30 m/s$$

$$v_y = v\sin\theta = 50\sin 53° = 50(4/5) = 40 m/s$$

Kinematics can be applied to the vertical motion to determine the time that the projectile is in the air:

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

$$-45 = 40t + \frac{1}{2}(-10)t^2$$

$$-9 = 8t - t^2$$

$$t^2 - 8t - 9 = 0$$

$$(t-9)(t+1) = 0$$

$$t = \{9, -1\}$$

The particle is in the air for 9 seconds, so we can determine how far it travels horizontally in that time:

$$\Delta x = vt = (30 m/s)(9 s) = 270 m$$

Question:

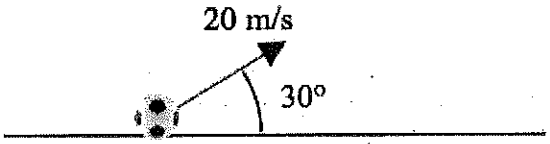
A projectile is launched at a 30° angle above the horizontal. Ignoring air resistance, the projectile's acceleration is

a. greatest at a point between the launch point and the high point of the trajectory.
b. greatest at the high point of the trajectory.
c. greatest at a point between the high point of the trajectory and where it hits the ground.
d. the same (but nonzero) at all points along the trajectory.
e. zero at all points along the trajectory.

Answer:

d.

Question:



A soccer ball is kicked to give it an initial velocity of 20 m/s at 30° relative to the ground, as shown. The maximum height reached by the ball will be about

a. 10 m
b. 1.0 m
c. 5.0 m
d. 20 m
e. 15 m

Answer:

The correct answer is *c*. To determine the vertical height reached by the ball, we focus only on the vertical aspects of the ball's motion.

The ball has an initial vertical velocity of 20 sin 30, or 10 m/s. The ball's final vertical velocity at the top of its path is 0 m/s. Using kinematics, the maximum height of the ball y can be determined:

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\Delta y = \frac{v_f^2 - v_i^2}{2a} = \frac{0^2 - (10m/s)^2}{2(-10m/s^2)} = 5m$$

The ball has a horizontal aspect to its motion as well, of course—a horizontal velocity of 20 cos 30 = 17.3 m/s, and no acceleration—but these qualities are independent of the ball's vertical motion.

Question:

A ball rolling across a flat, horizontal table has a velocity of v_1. After it leaves the edge of the table, the ball continues to travel with a constant horizontal velocity as it begins to fall. Just before the ball hits the ground, it has a net velocity of v_2. What is the ball's vertical speed at this moment?

a. v_2

b. $v_1 + v_2$

c. $v_2 - v_1$

d. $\sqrt{v_1^2 + v_2^2}$

e. $\sqrt{v_2^2 - v_1^2}$

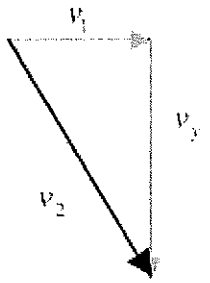
Answer:

The correct answer is *e*. This is a projectile problem in which the ball has a constant horizontal velocity v_1 and an unknown vertical velocity. The given *net* velocity v_2 can be used to find the unknown vertical velocity v_y by applying the Pythagorean theorem:

$$v_1^2 + v_y^2 = v_2^2$$

$$v_y^2 = v_2^2 - v_1^2$$

$$v_y = \sqrt{v_2^2 - v_1^2}$$



Question:

A projectile is fired horizontally from a height of 20 meters above the ground, with an initial velocity of 7.0 m/s. How far does the projectile travel horizontally before it reaches the ground?

a. 7m
b. 14m
c. 140m
d. 3.5m
e. 20m

Answer:

The correct answer is *b*. We begin by finding how much time it takes the object to fall the 20m:

$$\Delta y = v_i t + \tfrac{1}{2} a t^2$$

$$-20m = 0t + \tfrac{1}{2}(-10)t^2$$

$$t = \sqrt{4} = 2 \ s$$

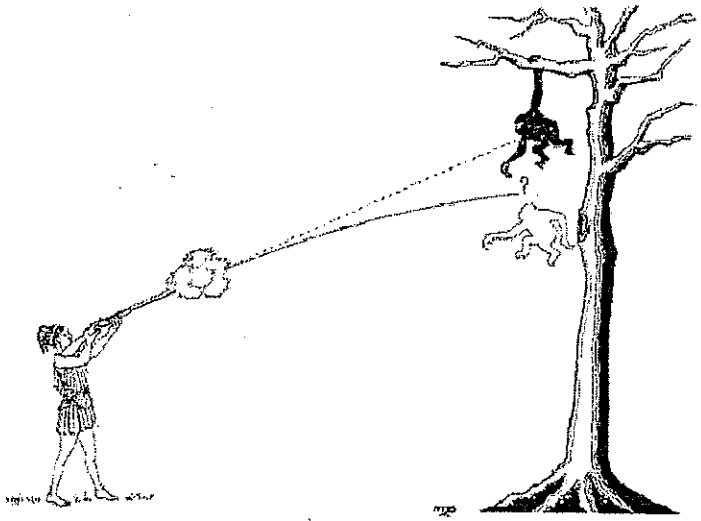
Then, determine how far the ball travels horizontally during that time:

$$\Delta x = v_x t$$

$$\Delta x = (7m/s)(2s) = 14m$$

Question:

Where should the vet aim to hit the monkey with a tranquilizer dart?



a. Aim just above the monkey
b. Aim directly at the monkey
c. Aim just below the monkey
d. Aim the gun horizontally
e. Can't be determined without knowing the speed of the dart

Answer:

b.

Question:

A 2.00 kg mass is dropped from the top of an 80.0 m high vertical cliff at the same time that a 1.00 kg mass is launched horizontally from the top of the cliff with an initial velocity of 8.00 m/s. If air resistance is negligible:

a. the 2 kg mass lands first, with the 1 kg mass landing about 32 m from the base of the cliff
b. the 1 kg mass lands first, about 24 m from the base of the cliff
c. the two masses land at the same time, the 1 kg mass landing about 80 m from the base of the cliff
d. the 2 kg mass lands first, with the 1 kg mass landing about 80 m from the base of the cliff
e. none of the above

Answer:

The correct answer is *e*. Because air resistance is negligible, both masses are going to accelerate at approximately 10 m/s^2 down. It takes about 4 seconds for both masses to reach the ground:

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

$$-80 = 0t + \frac{1}{2}(-10)t^2$$

$$t = 4s$$

During that time, the 1 kg projectile has been traveling at a constant 8 m/s horizontally, so it lands 32 m from the base of the cliff.

$$\Delta x = vt$$

$$\Delta x = (8m/s)(4s)$$

$$\Delta x = 32m$$

Question:

Consider a ball thrown up from the surface of the earth into the air at an angle of 30° above the horizontal. Air friction is negligible. Just *after* the ball is released, its acceleration is:

a. Upwards at 9.8 m/s^2
b. Upwards at 4.9 m/s^2
c. Downwards at 9.8 m/s^2
d. 0 m/s^2
e. None of these

Answer:

The correct answer is *c*. The ball, even as it moves upwards and sideways through the air, experiences a force of gravity acting on it, which causes it to accelerate downwards at g.