Physics 101 Drop-In Hours for Fall Semester 2024

Note: You are welcome to attend ANY of these. You are not limited to your own instructors.

Day	Time	Person	Person	Office Location
Monday	10:00 AM - 11:00 AM	Anoj Khadka	Micky Holcomb	437 White Hall
	1:00 PM - 2:00 PM	Kehinde Akintola	Jason Ybarra	309 White Hall
Tuesday	11:00 AM - 12:00 PM	Micky Holcomb	Greg Riggs	215 White Hall
	12:30 PM - 1:30 PM	Robert Eissele	Kehinde Akintola	417 White Hall
	1:00 PM - 2:00 PM	Jason Ybarra	Eric Diaz	G03 White Hall
	2:00 PM - 3:00 PM	Roshiani Ghimire	Robert Eissele	413 White Hall
Wednesday	10:30 AM - 1:30 PM	Ashley Stone	Roshiani Ghimire	229 White Hall
	1:00 PM - 2:00 PM	Kehinde Akintola	Anoj Khadka	215 White Hall
Thursday	10:00 AM - 12:00 PM	Erick Diaz	Ashley Stone	G03 White Hall
	11:00 AM - 12:00 PM	Anoj Khadka		
	12:00 PM - 1:00 PM	Robert Eissele		

3:00 PM - 4:00 PM Roshiani Ghimire

For any suggested changes with this table, email Dr. Holcomb.

Last Modified: 12 Sep 2024

The Physics of Wile E. Coyote vs Roadrunner





http://www.youtube.com/w atch?v=_d8ROhH3_vs



Main Ideas in Class Today

- Wile E. Coyote
- Projectile Motion
- Formulas/Graphs
- X Relative Velocity (not tested)

Practice: 3.7, 3.9, 3.11, 3.13, 3.17, 3.33, 3.37, 3.41, 3.43, 3.47, 3.53

The Physics of Wile E. Coyote

- As Mr. Coyote runs off the cliff, he has horizontal velocity.
- A change in velocity is acceleration, in this case horizontal acceleration, which must come from a force in the horizontal direction. $v_{fx}=v_{ox}+a_{x}t$
- If we ignore air resistance (horizontal force = 0), then there is no horizontal force to slow him down horizontally.
- v_{fx}=v_{ox}
- Thus, Mr. Coyote will travel *horizontally at the same speed* the whole time until he hits the ground!



The Physics of Wile E. Coyote



- Vertical motion is treated separately.
- •As soon as the coyote leaves the cliff he will experience a vertical force due to gravity.
- •This force will cause him to start to accelerate in the vertical direction. As he falls he will be going faster and faster in the vertical direction.
- •The horizontal and vertical components of the motion of an object going off a cliff are separate from each other, and <u>can not affect each other</u>.

Watch: http://www.youtube.com/watch?v=bp0MuuR5Hqg



Projectile Motion



- Freely falling objects near surface of earth
- Object can have an initial velocity component parallel to the ground
 - Object will move in two dimensions
- Assumptions:
 - Neglects air resistance because small effect normally
 - Means that acceleration of gravity $g = 9.8 \text{ m/s}^2$ is the same for all objects (a_y)



Clicker Question

- Ignoring air resistance, an object dropped from a plane continuing to fly at constant speed in a straight line will
- A. quickly lag behind the plane.
- B. remain vertically under the plane.
- C. move ahead of the plane.
- D. not enough information to determine



<u>Common Strategy for Projectile</u> <u>Motion Problems</u>

The time will be the same for x and y parts of the question.

If you don't have enough information for x or y components, solve for time.



Throwing something off of a cliff (5 examples of possible questions with ~ increasing difficulty)

I throw a ball off the edge of a 15.0m tall cliff. I threw it at 16 m/s at an angle of 60 degrees from the horizontal.

- A. Determine how much time it takes to fall.
- **B. Determine how far from the base of the cliff** it hits the ground. (Need the time first)
- **C. Determine how fast** it is moving vertically when it hits the ground. (y component of final velocity)
- **D. Determine** what its magnitude of velocity is when it hits the ground.
- **E. Determine** the angle that it hits the ground from the horizontal.

Part A: Time to Fall (more than one way to approach)

Use either vertical or horizontal depending on which has more info. Here, we will only use vertical numbers.

$$\Delta y = v_{oy}t + 1/2 \text{ at}^2$$

$$\Delta y = (16 \sin 60) t + 1/2 (-9.8) t^2$$

Quadratic eq. (at²+bt+c=0): a=-4.9, b=13.85, c=- $\Delta y =15$ m
t=[-b ± (b²-4(a)(c))^{-1/2}]/(2a)
=-13.85±(191.8-4(-4.9)(15))^{-1/2}]/(-9.8)
t= 1.41 ± 2.25= -0.84 s or 3.66 s

Part B: How far from cliff base (Think Horizontal)

Well, we know it was in the air for 3.66s (from the previous question), and it was moving at a constant speed in the x-direction the whole time $(a_x=0)$, so...

 $v = \Delta x/t$ or $\Delta x = v_{ox}t + \frac{1}{2}a_x t^2$ where ax=0 $\Delta x = v_x t = (16 \cos 60^{\circ})(3.66s)$ $\Delta x = 29m$ It will move 29m horizontally, so it hits the ground 29m away from the base of the cliff.

Part C: Vertical speed at the bottom (Think Vertical)

It has been accelerating down the whole time. We know that gravity is causing this acceleration, so we can figure out how fast it is going (vertically) when it hits the ground. (This is one other equation you could use. This one is easier.)

$$v_{fy} = v_{iy} + a t$$

 $v_{fy} = 16 \sin 60^{\circ} - 9.8 x3.66$
 $v_{fy} = -22 m/s$
Should be negative since moving opposite from positive y
direction

Part D/E: Velocity when hits (Combination of x and y directions)

It's total velocity is found by adding the horizontal and final vertical components of the velocity to find the resultant.

$$c^{2} = a^{2} + b^{2}$$

= (8.0m/s)² + (-22m/s)²
c = 23.4 m/s

 $tan\Theta = opp/adj$ = (-22 m/s) / (8m/s) $\Theta = tan^{-1}(-22/8) = -70^{\circ}$

The object is moving at 23m/s at an angle of 70° with respect to the horizontal.



<u>"Money Hunter" Demo</u> <u>https://www.youtube.com/watch?v=TbWiMsfr_DQ</u> <u>Follow ups:</u> <u>https://www.youtube.com/watch?v=0jGZnMf3rPo</u> <u>https://www.youtube.com/watch?v=3ECZRejB5d4</u>

Show pForce (first) video.

Probably some of these problems will be on the problem solving day unless other questions are asked



The Long Jump

A long jumper leaves the ground at an angle of 20 degrees to the horizontal at a speed of 11 m/s.

- (a) How long does it take for him to reach maximum height?
- (b) What is the maximum height?
- (c) How far does he jump?

At an altitude of 1000 m, you drop something from a plane traveling at 60 m/s.



- How long does it take to reach the ground?
- Horizontally, how far is the object displaced from the position the plane was above when the object was dropped?

Motion in Two Dimensions With Constant Acceleration

• Separation of vectors into components allows separation of equations into components:

$$v_x = v_{xo} + a_x t$$
$$\Delta x = v_{xo} t + \frac{1}{2} a_x t^2$$

$$v_{y} = v_{yo} + a_{y}t$$
$$\Delta y = v_{yo}t + \frac{1}{2}a_{y}t^{2}$$

• For projectile motion: $a_x = 0$ $a_y = -g = -9.8 \text{ m/s}^2$

$$v_x = v_{xo}$$
$$\Delta x = v_{xo}t$$

$$v_{y} = v_{yo} - gt$$
$$\Delta y = v_{yo}t - \frac{1}{2}gt^{2}$$

Projectile motion means right after it leaves your hand, and right before it hits the ground (when only gravity acts on the object!)



- $v_y = 0$ at top of trajectory
- $v_x = v_{xo}$ remains the same throughout trajectory because there is no acceleration along the *x*-direction

Physics for Pilots Similar formulas even if not in freefall!

An airplane is approaching a runway. The pilot measures her horizontal speed to be 400 mph. The altimeter indicates that the plane is dropping at a constant speed of 10 feet/s. If the plane is at a height of 3000 feet and the start of the runway is 28 miles away (horizontally), does the pilot need to make any adjustments to her descent?



Similar strategy, but not projectile motion (this case a_y=0 because plane not accelerating)



(Harder) A battleship simultaneously fires two shells at enemy ships. If the shells follow the parabolic trajectories shown, which ship gets hit first? (The speed of the shots is not the same.)



- A. *A*
- B. *B*
- C. Both at the same time
- D. need more information

