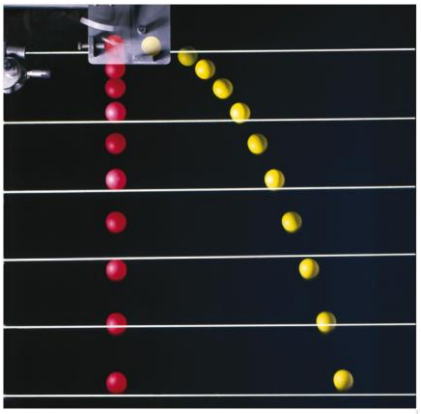
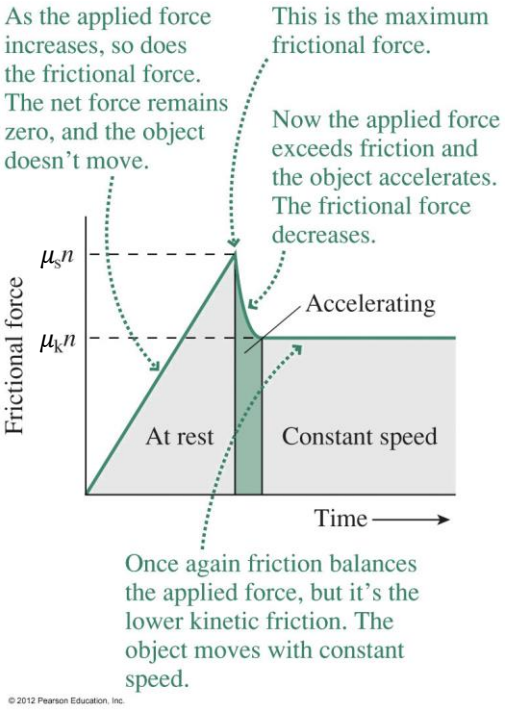


PHY131 F Fall 2020
Class 11

Today:

- 4.4 Solving Dynamics Problems in 2D
- 4.5 Projectile Motion

1



2

4.4 Skills for Analyzing Processes Involving Forces in Two Dimensions

- Sketch and translate
  - Make a sketch of the process.
  - Choose a system.
  - Choose coordinate axes with one axis in the direction of acceleration and the other axis perpendicular to that direction.
  - Indicate in the sketch everything you know about the process relative to these axes.
  - Identify the unknown quantity of interest.

3

4.4 Skills for Analyzing Processes Involving Forces in Two Dimensions

- Simplify and diagram
  - Simplify the process. For example, can you model the system as a point-like object? Can you ignore friction?
  - Represent the process diagrammatically with a motion diagram and a force diagram.
  - Check for consistency of the diagrams—is the sum of the forces in the direction of the acceleration?

4

4.4 Skills for Analyzing Processes Involving Forces in Two Dimensions

- Represent mathematically
  - Convert these qualitative representations into quantitative mathematical descriptions of the process using Newton's second law and kinematics equations.

5

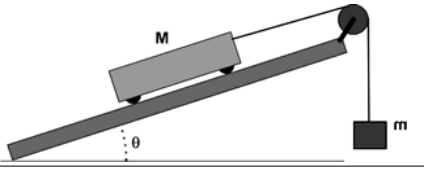
4.4 Skills for Analyzing Processes Involving Forces in Two Dimensions

- Solve and evaluate
  - Substitute the given values into the mathematical expressions and solve for the unknowns.
  - Decide whether the assumptions that you made were reasonable.
  - Finally, evaluate your work to see if it is reasonable (check units, limiting cases, and whether the answer has a reasonable magnitude).
  - Make sure the answer is consistent with other representations.

6

A cart of mass *M* is on a track which is at an angle of θ above the horizontal.
The cart is attached to a string which goes over a pulley; the other end of the string is attached to a hanging mass, *m*.
What is the acceleration of the cart?

SKETCH & TRANSLATE.



SIMPLIFY & DIAGRAM

7

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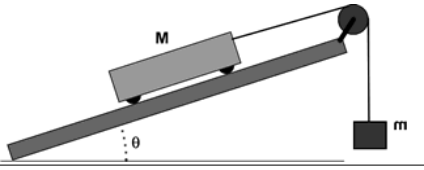
SIMPLIFY & DIAGRAM



REPRESENT MATHEMATICALLY

REPRESENT MATHEMATICALLY

8

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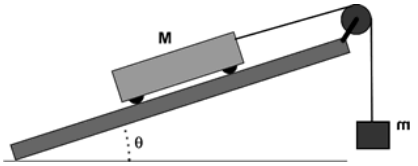
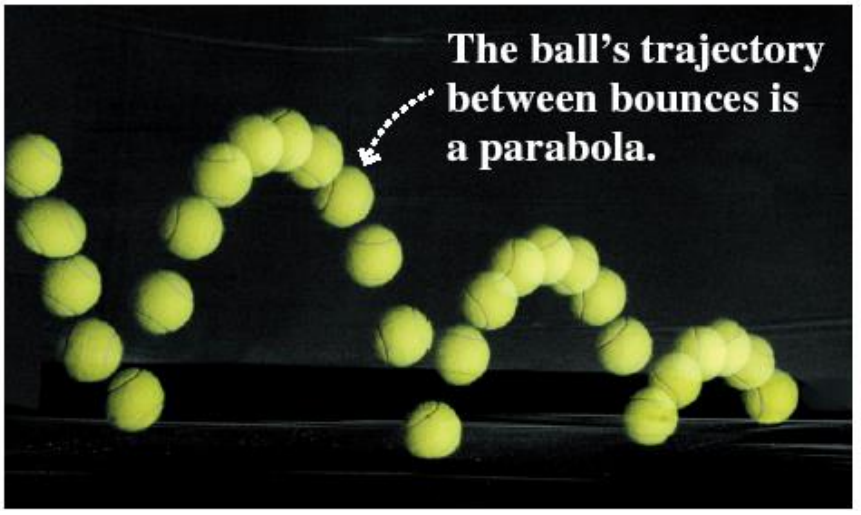
SOLVE & EVALUATE



9

Projectile Motion

The parabolic trajectory of a bouncing ball.

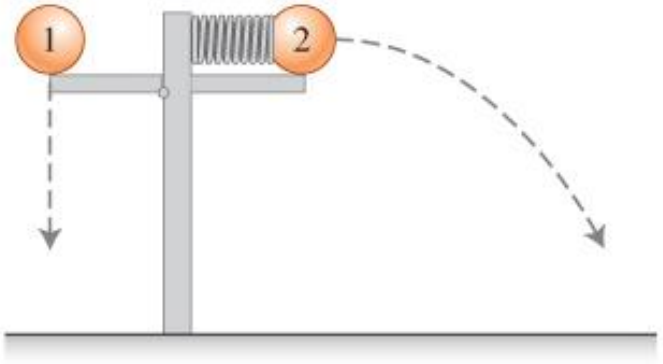


10

Poll

4.5 Projectile Motion

At time zero, ball 1 is dropped. Simultaneously, ball 2 is shot horizontally when a compressed spring is released. Which ball hits the surface first?



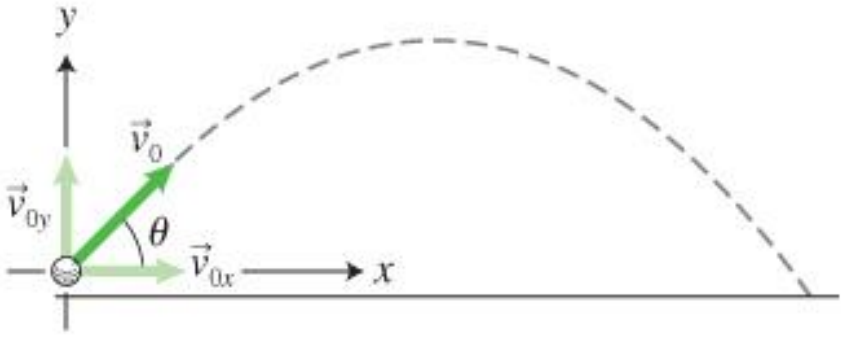
A. Ball 1
B. Ball 2
C. Both will hit the surface at the same time

11

Projectile Motion

Projectile motion is made up of two **independent** motions:

- uniform motion at constant velocity in the horizontal direction and
- free-fall motion in the vertical direction.

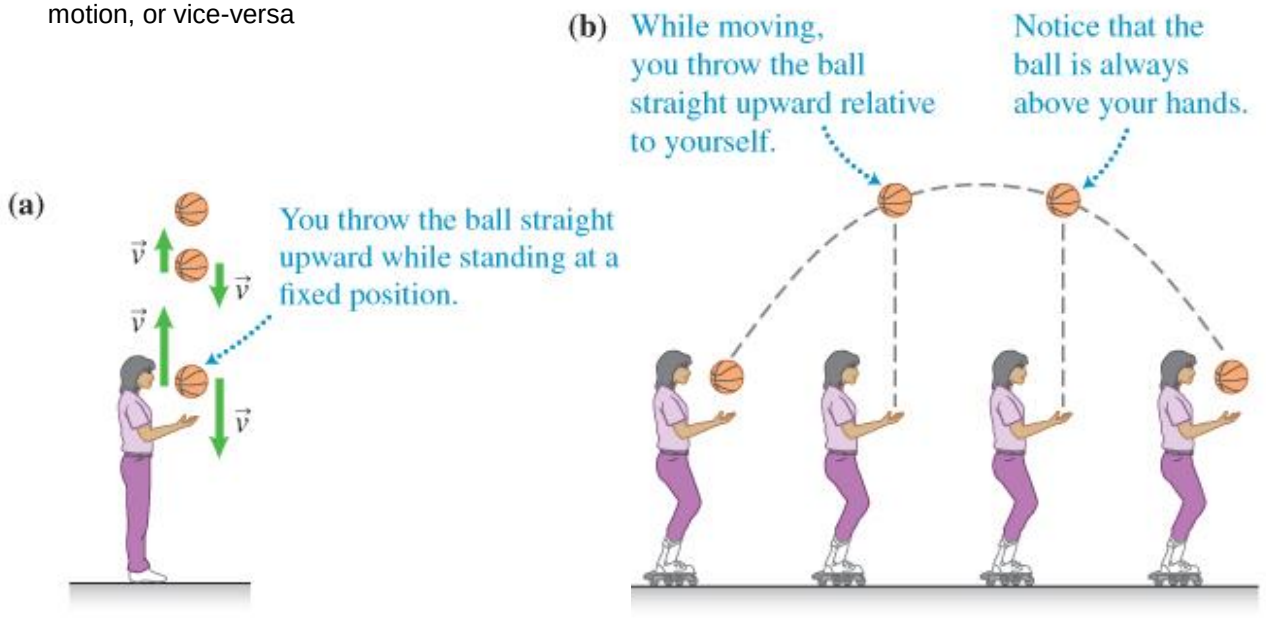


$$v_{0x} = v_0 \cos\theta$$
$$v_{0y} = v_0 \sin\theta$$

12

The x-motion does not affect the y-motion, or vice-versa

4.5 Projectile Motion



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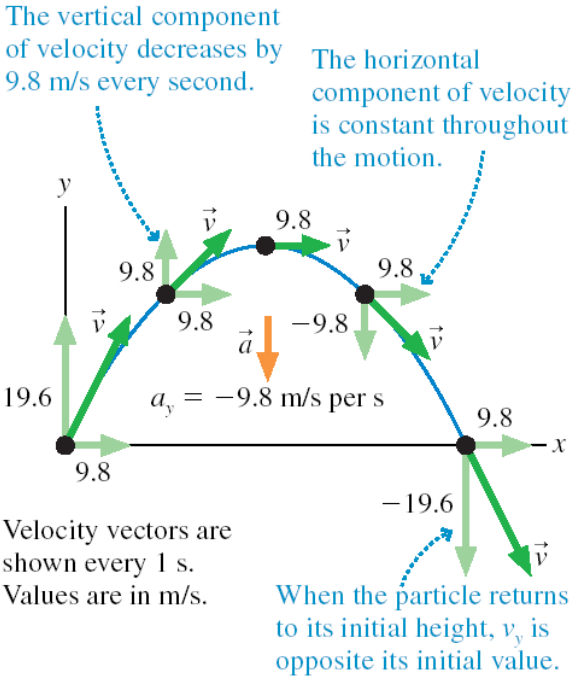
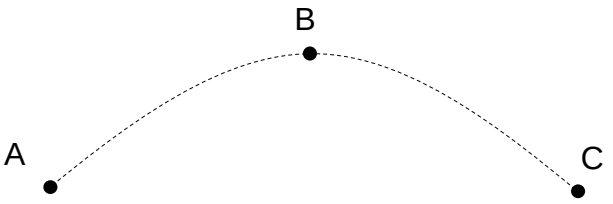


14

Poll Question



- A tennis ball is launched at an angle, and flies through the air in a parabolic path, as shown, A→ B → C.
- At point B:

A. the velocity is horizontal, and the speed is maximum.
B. the velocity is horizontal, and the speed is minimum.
C. the velocity is horizontal, but the speed is neither a maximum nor a minimum.
D. the velocity is not horizontal, but the speed is minimum.
E. the velocity is not horizontal, and the speed is neither a maximum or minimum.

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4.5 Projectile Motion

Projectile motion in the x-direction		Projectile motion in the y-direction	
$(a_x = 0)$		$(a_y = -g)$	
$v_x = v_{0x} = v_0 \cos\theta$	(4.7x)	$v_y = v_{0y} + a_y t = v_0 \sin\theta + (-g)t$	(4.7y)
$x = x_0 + v_{0x}t$		$y = y_0 + v_{0y}\,t + \frac{1}{2}a_y\,t^2$	
$= x_0 + (v_0 \cos\theta)t$	(4.8x)	$= y_0 + (v_0 \sin\theta)t - \frac{1}{2}gt^2$	(4.8y)

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Problem 4.60. An airplane is delivering food to a small island. It flies 100 m above the ground at a speed of 160 m/s. Where should the parcel be released so it lands on the island?

SKETCH & TRANSLATE.

SIMPLIFY & DIAGRAM

REPRESENT MATHEMATICALLY

17

Problem 4.60. An airplane is delivering food to a small island. It flies 100 m above the ground at a speed of 160 m/s. Where should the parcel be released so it lands on the island?

SOLVE & EVALUATE

18

Before Class 12 on Wednesday

- Please finish reading Ch.4
- We will be discussing rolling without slipping, and taking up problems in Chapter 4 to prepare you for the Oct.13 Midterm Assessment
- On Friday we will be starting Chapter 5, even though Chapter 5 material will **not** be on the Oct. 13 Midterm Assessment
- Also on Friday we will be doing a group quiz during class. You should be able to work with your Practicals Partners in Microsoft Teams *during* the Class.
- Monday Oct.12 there is no class, due to Thanksgiving

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