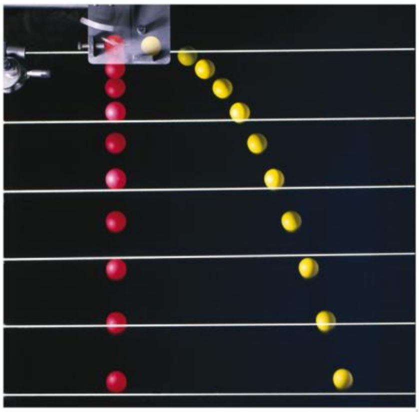


PHY131 F Fall 2020
Class 11

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

1

Poll

Have you tried the Module 2 Ch.4 Pre-Quiz yet? (It is due at 8:45pm tonight – about 9 hours from now.)

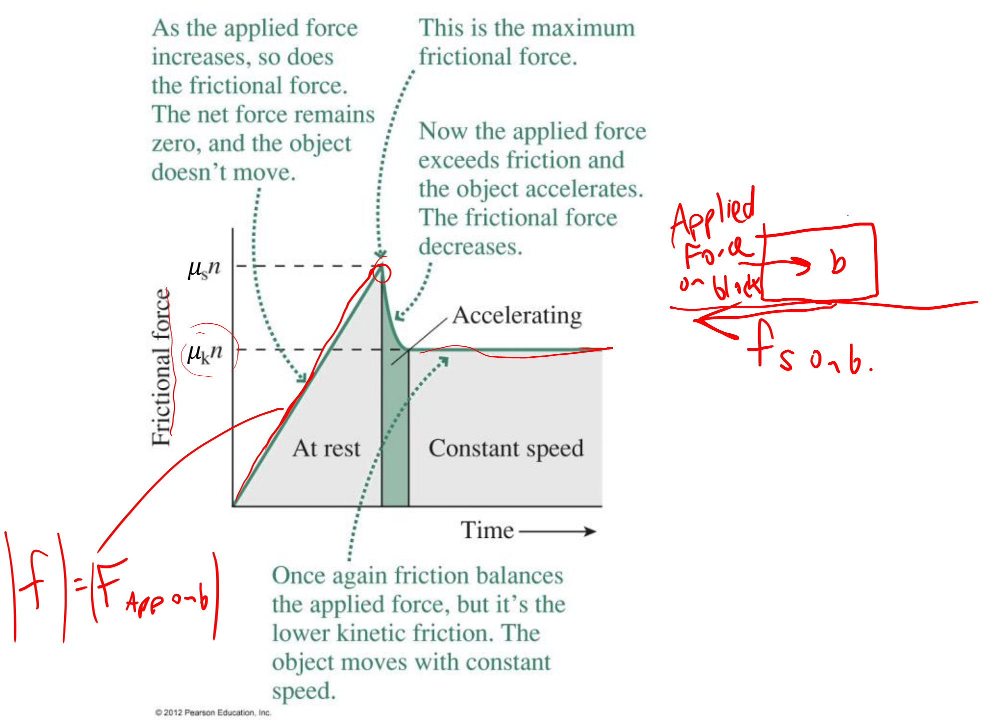
A. No, not yet
B. Yes, it went fine
C. Yes, but I had physics-related trouble
D. Yes, but I had technical trouble uploading my images

2

Midterm Assessment 2

- On Tuesday Oct. 13, 8:10-8:40pm Toronto Time, you will need to upload two solutions into a quiz very similar to the Ch.4 Practice Quiz.
- In case of weird Quercus-related glitchiness, I have set up a Google Drive folder:
- PHY131 Midterm Assessment 2 Last Resort Folder
- https://drive.google.com/drive/folders/1htRavsflpfVFVvm8b_QUqmTVfiohThHz?usp=sharing
- This link will be available in the instructions in case Quercus is really not allowing your upload. The Google drive will time-stamp your upload, so we can know you did it in time.

3



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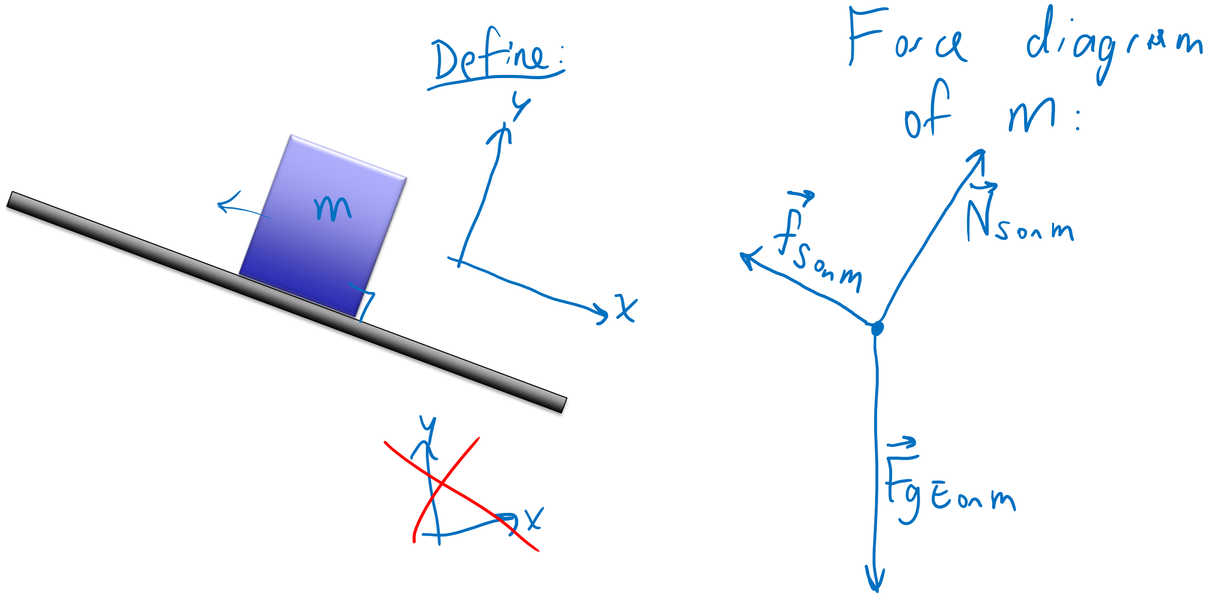
Mass on an incline



5

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.

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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 (Ch.2) or a force diagram (Ch.3 or 4).
  - Check for consistency of the diagrams—is the sum of the forces in the direction of the acceleration?

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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.

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4.4 Skills for Analyzing Processes Involving Forces in Two Dimensions

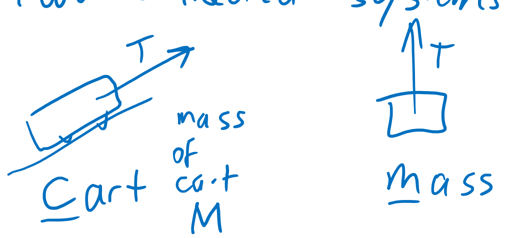
- Solve and evaluate
  - Substitute the given values into the mathematical expressions and solve for the unknowns.
  - Decide whether the assumptions that you made were reasonable.
  - Finally, evaluate your work to see if it is reasonable (check units, limiting cases, and whether the answer has a reasonable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

9

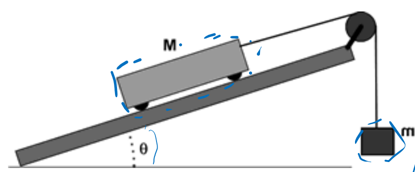
A cart of mass M is on a track which is at an angle of θ above the horizontal.
The cart is attached to a string which goes over a pulley; the other end of the string is attached to a hanging mass, m.
What is the acceleration of the cart?

SKETCH & TRANSLATE.

Two connected systems:

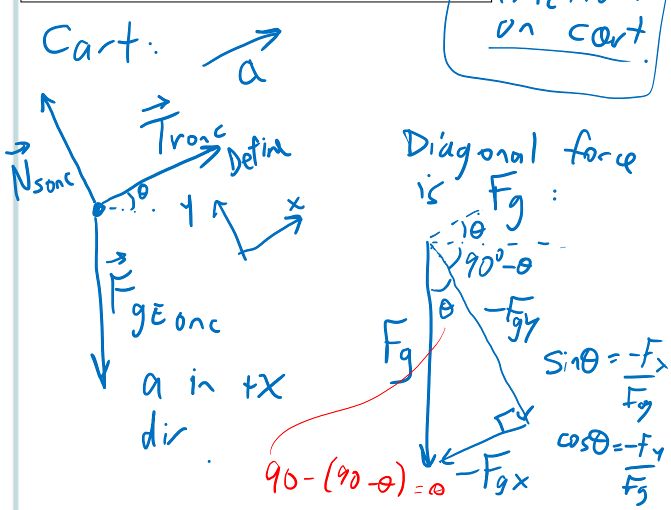


Acceleration magnitude is the same for both systems, as they are connected by a string



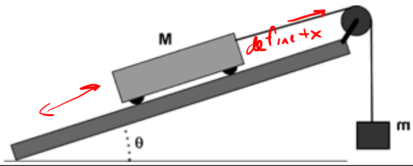
SIMPLIFY & DIAGRAM

Assume no friction on cart



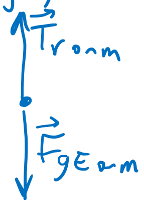
10

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?



SIMPLIFY & DIAGRAM

hanging mass:



Define $+x$ = down. So a for m is the same as a for cart.

REPRESENT MATHEMATICALLY

Cart:

	x-comp	y-comp
N	0	N
T	T	0
F_g	$-Mg\sin\theta$	$-Mg\cos\theta$

REPRESENT MATHEMATICALLY

No y-acceleration of cart:

$\Rightarrow \Sigma F_y = 0 = N - Mg\cos\theta$

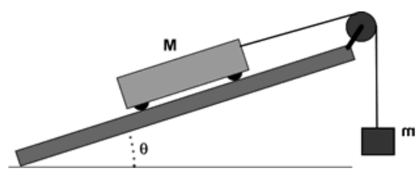
$N = Mg\cos\theta$.

$a_x = \frac{\Sigma F_x}{M} = \frac{T - Mg\sin\theta}{M}$ (1)

Hanging mass: $a_x = \frac{\Sigma F_x}{m} = \frac{mg - T}{m}$ (2).

2 unknowns: a & T.
Need a, don't care about T.
Solve for T in (1).

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?



SOLVE & EVALUATE

Use (1) to solve for T:

$a = \frac{T - Mg\sin\theta}{M}$

$Ma = T - Mg\sin\theta$

$T = M(a + g\sin\theta)$ ← plug into (2)

$a = \frac{mg - M(a + g\sin\theta)}{m}$

$a = g - \frac{M}{m}a - \frac{M}{m}g\sin\theta$

$a + \frac{M}{m}a = g\left[1 - \frac{M}{m}\sin\theta\right]$

$a\left(1 + \frac{M}{m}\right) =$

$$a = g\left[\frac{m - M\sin\theta}{m + M}\right]$$

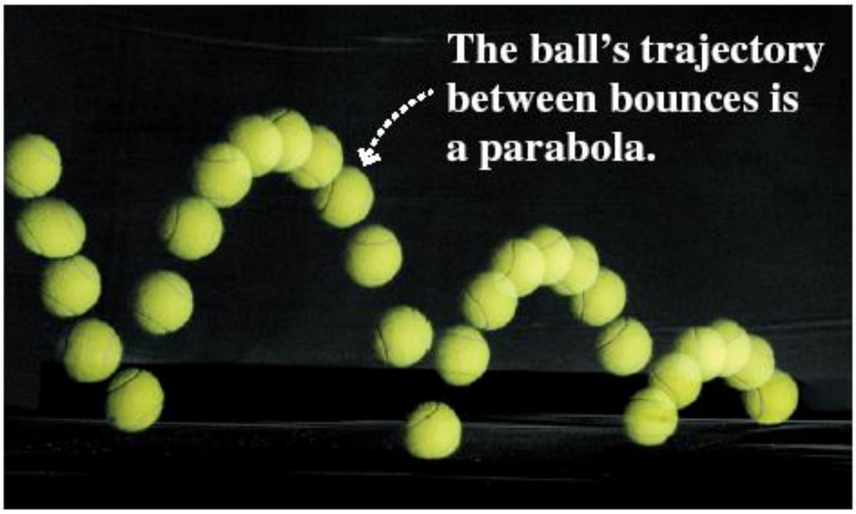
Limits: if $M \gg m$, $a = -g\sin\theta$ — a rolls backward

if $\theta = 0$, $a = g\left(\frac{m}{m+M}\right)$

if also $m \gg M$, $a = +g$

Projectile Motion

The parabolic trajectory of a bouncing ball.



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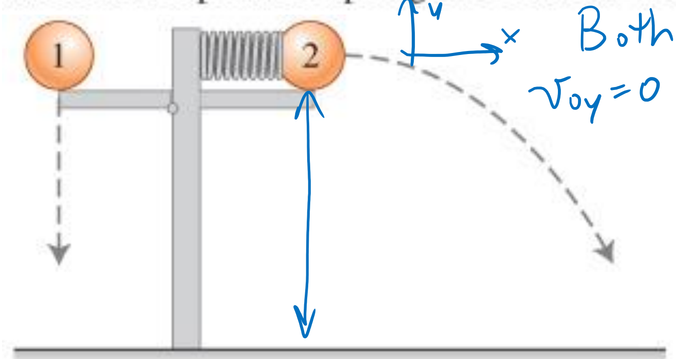
Poll

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?



Both balls travel same y-distance

$v_{0y} = 0$ for both balls

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

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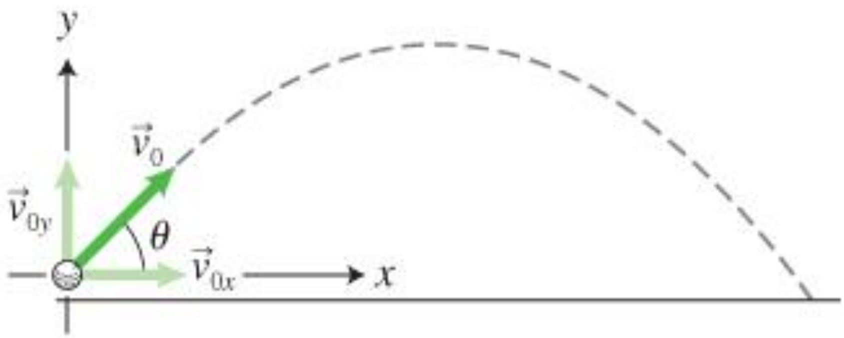
Projectile Motion

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.



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

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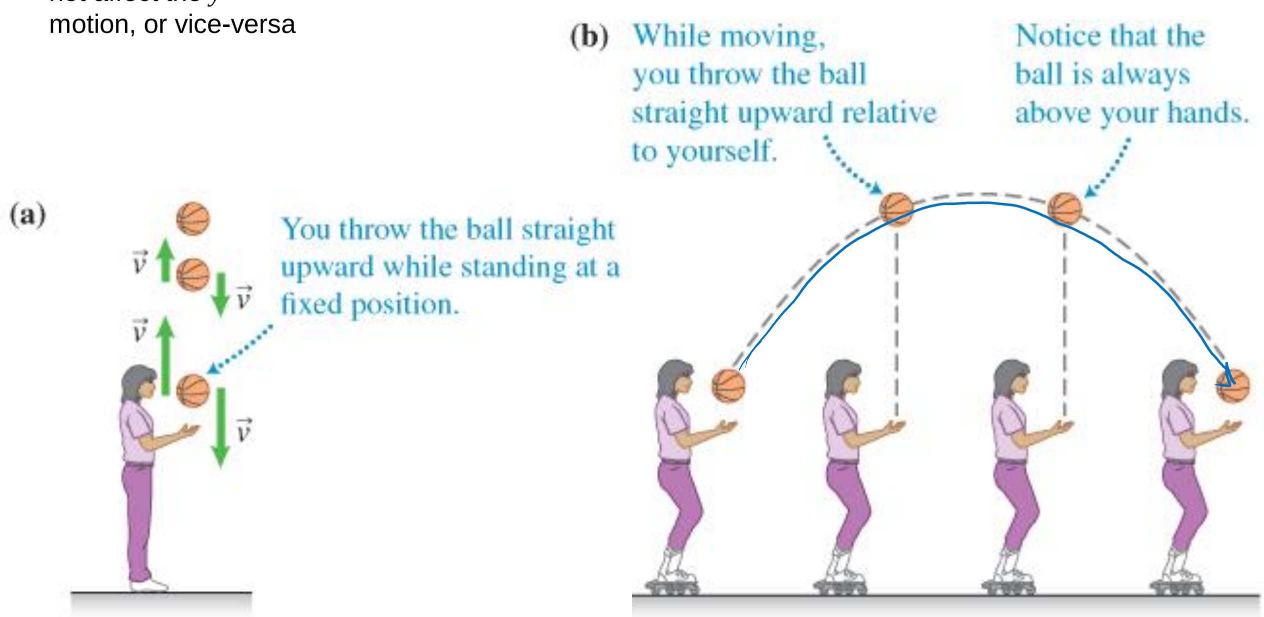
4.5 Projectile Motion

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



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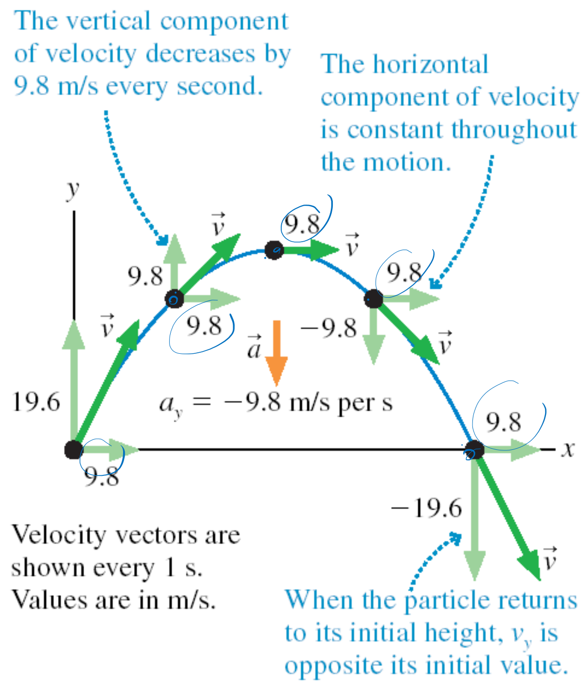

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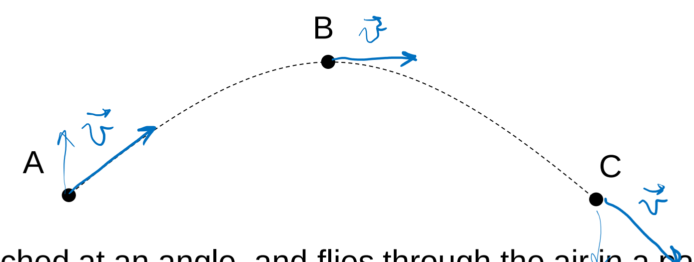
Poll Question



- 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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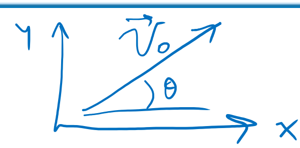
4.5 Projectile Motion

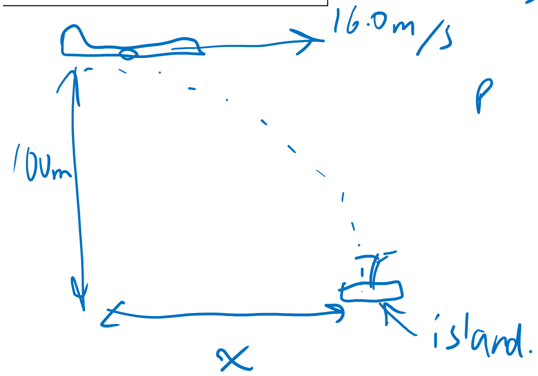
Projectile motion in the x-direction		Projectile motion in the y-direction	
$(a_x = 0)$		$(a_y = -g)$	
$v_x = v_{0x} = v_0 \cos\theta$	(4.7x)	$v_y = v_{0y} + a_y t = v_0 \sin\theta + (-g)t$	(4.7y)
$x = x_0 + v_{0x}t$		$y = y_0 + v_{0y}\,t + \frac{1}{2}a_y\,t^2$	
$= x_0 + (v_0 \cos\theta)t$	(4.8x)	$=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



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.

Define

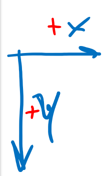


find x.

$v_{oy} = 0$ when released.

SIMPLIFY & DIAGRAM

parcel has same initial velocity as plane.



Neglect air resistance.

$a_y = +9.8\ m/s^2$

REPRESENT MATHEMATICALLY

$v_x = \frac{x}{t}$ (1)

$y = v_{oy}t + \frac{1}{2}g t^2$ (2)

Same t for both

Solve for x

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

$x = v_x t$ Need t.

(2) $y = \frac{1}{2} g t^2$

$\frac{2y}{g} = t^2$

$t = \sqrt{\frac{2y}{g}}$

$x = v_x \sqrt{\frac{2y}{g}} = 160 \sqrt{\frac{2(100)}{9.8}}$

$x = 722.8$

1 sig. dig

$x = 700 \text{ m}$

Drop the parcel when the plane is 700 m in front of island in x-direction.

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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. Most recent Facilitator must start the call in your Pod-chat during lecture.
- Monday Oct.12 there is no class, due to Thanksgiving

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