Class 1: Baserunning

Outline

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Good Webpages

Dave Kagan’s Publications: <https://physics.csuchico.edu/baseball/Pubs/>

Alan Nathan’s Webpage: <http://baseball.physics.illinois.edu/>

Dan Flanagan’s Simulator: <http://dandecrosswords.com/baseball>

MLB Data: [https://baseballsavant.mlb.com/](https://baseballsavant.mlb.com/visuals/pitch3d?player_id=518553#v=1&mainView=tracking&pov=umpire&g1=566645&g2=490675&hitterSide=all&marks=none&plays1=52&plays2=all)

**Example: Outfielder**

An outfielder starts from rest and chases a flyball which she assesses will land a distance away from where she started.

* 1. If the fielder has an acceleration , how long will it take her to get to where the ball will land?
  2. What is her speed when she reaches the landing spot?
  3. If ft and , what are and ?

**Handout #1**

Concept Questions

1. Consider the situation where a batter has just hit the ball and they take off for first base which is 60 feet away. We will say the time they start running is and the time they reach first base is sec.
   1. On the plots below, sketch what you expect the position and speed of the of the player as a function of time.

time,

speed,

1.5 sec

time,

position,

1.5 sec

* 1. Looking at your sketches, do you see any relationship between them?

Problems

1. There is a pop up that will land between the second baseman and the right fielder. Both fielders start from rest and sprint toward the landing spot (and toward each other) trying to get there before the ball. The right fielder has an acceleration of 15 ft/s2 and the second baseman at 10 ft/s2. The fielders start a distance apart and the landing spot is a distance from where the second baseman starts running.
   1. Find an expression for the time it takes each runner to reach the landing spot.
   2. The fielders start 40 ft apart. The ball lands 15 ft from where the second baseman started, 1.8 sec after they started running. Will either fielder catch the ball?
   3. Assuming they keep running at with these accelerations, when will they collide? First find an expression for this time, and then plug in the given values.

**Measurement #1**

**Task:** Answer the question, should Kasey slide into first base?

**Learning Goals**

1. *Video analysis in Logger Pro*
2. *Some principles of measurement*
3. *Principles of 1-D motion*

**Measurement 1: Reaching 1st Base**

Kasey has given you three videos of himself running from home plate to first base. One video shows him running though the base, on sliding head-first, one sliding feet-first.

* Use the *Video Physics* app on to analyze Kasey’s motion for each video.
* How do the plots compare to what you made on the conceptual question in Handout 1?
* Use this analysis complete the “Measurement 1 Synthesis Question”.
* Now analyze the video of Carl Crawford you were given. You don’t need to answer any questions about this, just check it out.

**Measurement 2: Time Measurements**

Kasey repeated each of these attacks on first base while someone else recorded the time it took him for each sprint, the times are recorded below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | No slide/dive | Head-first slide | Feet-first slide |
| Time 1 [s] | 3.19 | 3.17 | 3.73 |
| Time 2 [s] | 3.27 | 3.28 | 3.38 |
| Time 3 [s] | 3.18 | 3.65 | 3.20 |
| Time 4 [s] | 3.22 | 3.53 | 3.43 |

* Use the data above to assess how long it takes Kasey to reach first base for each of the approaches.
* Use this analysis to complete the “Measurement 2 Synthesis Question”.

**Measurement #1 Synthesis Questions**

Names:

[Measurement 1 Synthesis Question]: Should Kasey slide into first base?

Your answer should include plots and descriptions of the physics, inferred from the plots, that supports your answer.

*Your answer here.*

[Measurement 2 Synthesis Question]: Should Kasey slide into first base?

Your answer should include a clear description of how your analysis of provided data supports your answer.

*Your answer here.*

**Homework #1**

1. A baserunner is caught in a pickle where she is being chased by a defender. The runner has 25 ft to go before reaching the base. The baserunner is running at 10 ft/s and the defender is running at 15 ft/s. The defender is 10 ft behind the baserunner. Does the baserunner reach the base safely?
2. Sketch the problem and define your coordinate system.
3. Draw a graphical representation for this situation.
4. Write down the equations of motion for the baserunner and the defender, consistent with parts (a) & (b).
5. Use equations to solve, and then determine if your answer makes sense.

![A close up of a logo

Description automatically generated]()

1. An 85.0 kg baserunner tries to steal second base. When he is 6 ft from the base, he begins his slide at a speed of 30 ft/s. He comes to rest just as he touches the base.
   1. Sketch the problem and define your coordinate system.
   2. Find his acceleration while sliding.
   3. Find the time it takes him to complete the slide.
2. In celebration of a victory, a player those a ball upward with a speed of 80 ft/s. During its flight the ball has an acceleration of 32 ft/s2 in the downward direction.
   1. Find the maximum height the ball gets to.
   2. Find the time it takes to get to its max height.

Kasey’s Notes

Qualitative discussion questions

1. What “variables” are needed to describe motion?

[x, v, a, t]

1. The most basic of these is x, but how is it defined? It must be relative to something…

[Define a coordinate system]

1. How do these variables relate to one another?

[They are changes of one another]

1. We will often talk about a runner “speeding up” or “slowing down”, what does that mean in the context of these variables?

[Speeding up: speed is increasing, so a in same direction as v

Slowing down: speed is decreasing, so a in opposite direction of v]

1. What causes a runner (or a ball or bat) to speed up or slow down?

[Force: something pushing or pulling on the runner (or ball or bat). We will talk more formally about forces later.]

Quantitative discussion questions

1. What are the equations that relate the variables we discussed?
2. [Example] A baseball is thrown upward with a speed, v.
   1. Show that the time it takes to reach maximum height is equal to the time it takes to fall back down.
   2. Find the velocity when it gets there.
3. [Example] An outfielder starts from rest and chases a flyball which she assesses will land a distance d away from where she started.
   1. If the fielder has an acceleration , how long will it take her to get to where the ball will land?
   2. What is her speed when she reaches the landing spot?
   3. If d=20 ft and , what are t and v?