

# Related Rates

While working in a group make sure you:

- Expect to make mistakes but be sure to reflect/learn from them!
- Are civil and are aware of your impact on others.
- Assume and engage with the strongest argument while assuming best intent.

1. A ladder 10 ft long rests vertically against a wall. If the base of the ladder slides from the wall at the rate of  $2\frac{\text{ft}}{\text{sec}}$ .

(a) Sketch pictures of the ladder after 1 second, 2 second, 3 second, and 4 seconds.

(b) Find the average speed that the top of the ladder is traveling from 1 sec to 2 sec, and from 3 sec to 4 sec. Are they the same?

(c) What is the (instantaneous) speed of the top of the ladder when the base is 4 feet away from the wall?

2. On April 20, 2010 the Deepwater Horizon drilling rig exploded initiating the worst oil spill in US history. It was important to estimate the volume of oil spewing out each day, but it is hard to measure such a high volume flow directly. Instead one can measure the area of the spill from the air and the thickness of the spill and compute backwards. Suppose that the spilled oil is cylindrical in shape and a uniform thickness of  $1\text{mm}^a$ . On day 9 of the spill the area of the spill was  $13,000\text{km}^2$ <sup>b</sup> and the radius of the spill was increasing at a rate of 10 meters per day<sup>c</sup> (Modified from Dr. Dawn's Blog)
- (a) At what rate was the volume of the spill increasing on the 9th day?
  - (b) How quickly was the oil spewing out on the 9th day?
  - (c) BP's original/official estimates of the flow rate were  $160$  to  $790\text{ m}^3/\text{day}^d$ , how accurate were their estimates? Be careful of units!

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<sup>a</sup>base on information from <https://www.amsa.gov.au/marine-environment/>

<sup>b</sup><https://content.time.com/time/health/article/0,8599,2012093,00.html>

<sup>c</sup>computed using data from <https://www.flickr.com/photos/skytruth/sets/72157623909364472/with/4559144956/>

<sup>d</sup>[https://en.wikipedia.org/wiki/Deepwater\\_Horizon\\_oil\\_spill](https://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill)