PHYS 2001 -- Introduction to Physics (algebra based) -- Section 101

10 Jan 2017

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Class info & Homework on LONCAPA
Class info (including textbook) also at: http://inpp.ohiou.edu/~meisel/PHYS2001/phys2001_home.html

- Pick up Syllabus and personal questionnaire
- Make sure you have a TopHat account and have joined this course (Join code 254215)
- First Pre-class Assignment due Thursday morning 15 min before class
- Help Room on Thursday
  - Here – Walter 245 6-9PM
- Download OpenStax "College Physics" book

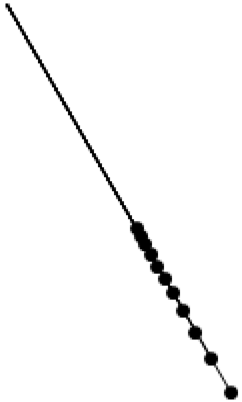
You need to be registered for a lab.
If you took 2001 previously and want to carry over lab score for part of the course, send me an email.

- Assignment 1 – Due Friday 11:59PM
- No labs first 2 weeks
- Online Diagnostic Math Quiz
  - Mon Jan. 16 11:59 PM

- Mechanics:
  - Motion, Forces, Energy
  - Momentum, Fluids
  - Harmonic Motion
- Thermal Physics:
  - Temperature
  - Heat
  - Law of Thermodynamics

Purpose of this class?

- Describe basic phenomena of the physical world
  - Key terminology and concepts
  - Represent a scenario with equations
  - Represent a scenario graphically
- Predict the behavior of basic systems
  - Motion (e.g. billiards)
  - Oscillations (e.g. pendulum, springs)
  - Fluid motion (e.g. air flow)
  - Heat transfer (e.g. air conditioner)



Sol Lederman

Who cares?

Major	Example
Aviation	How does an altimeter work? How is lift generated?
Engineering	How do you make a pendulum clock? …water clock? What do we have to change to make it work on Mars?
Communication Sciences & Disorders	How do changes in the vocal tract affect air flow and therefore create/prevent certain sounds?
Exercise Physiology	How do we quantify how much work it is to do 10 squats with 200lbs?
Chemistry	How can we measure how much energy is required for a phase change?
Geology	Why are certain gases harder to trap in rocks than others? How do we quantify the extra difficulty?
Molecular Biology	How do we construct a simple model for molecular vibrations? What equations describe these vibrations?


MPI -Biophysik

***science & math literacy are key to being an informed citizen!**

How are we going to achieve our class goals?

- Describe basic phenomena of the physical world
  - Key terminology and concepts
  - Represent a scenario with equations
  - Represent a scenario graphically
- Predict the behavior of basic systems
  - Motion (e.g. billiards)
  - Oscillations (e.g. pendulum, springs)
  - Fluid motion (e.g. air flow)
  - Heat transfer (e.g. air conditioner)

Textbook & pre-class assignments

- In-class questions & examples
- Homework
- Exams

“Clicker” Question: Have you had Physics before?

In-class question
using TopHat

A. High School Advanced Physics
B. High School Regular Physics
C. Physics 2001
D. Physics 201
E. Physics 251
F. 9th Grade Physics/Chemistry (physical science)
G. Have not had Physics before
H. None of the above

Things to do in the near future:

Pre-class Assignment – Due Thursday 15 minutes before class

Online Math Quiz – Due by Monday Evening 11:59PM

- You have 60 minutes following your first access
- Might do first 3 problems of Assignment 1 first
- Will not factor into grade. (This is just to help me find your current level)

Homework 1 – Due Friday by 11:59pm

Lab

- First lab two weeks from now - Density
- Complete pre-lab (available on LON-CAPA) before lab

Fundamentals: Standards and Units

📖 Sect 1.2

where to find this info in the OpenStax book

Measurements: Value, Units, Dimensions

- Need Standards - Reproduce measurements accurately
- SI - Système International (a.k.a. 'metric') - Meter, Second, Kilogram
- British Imperial System (a.k.a. 'standard') - Foot, Second, Pound
- Scientific notation: 300,000,000m/s = $3\text{x}10^8$ m/s
  - 0.0000000001 m = $1\text{x}10^{-10}$m
  - Forms: On anything written: $3.45\text{x}10^{-5}$, on LON-CAPA: 3.45e-5

Prefixes: (learn these common ones)

mega (M): 10^6
kilo (k): 10^3
centi (c): 10^{-2}
milli (m): 10^{-3}
micro (μ): 10^{-6}

📖 Table C4

If a log is 120 inches long, what is this in meters?

A. 3.05 m
B. 5.24 m
C. 10.0 m
D. 32.8 m
E. 36.6 m
F. 439 m
G. 586 m
H. 4720 m

1 mi = 5280 ft

1 mi = 1.609 km

1 m = 3.281 ft

$$120\text{in}\left(\frac{1\text{ft}}{12\text{in}}\right)\left(\frac{1\text{m}}{3.281\text{ft}}\right) = 3.05\text{m}$$

Check Answer: Does it make sense?

1m is about one yard. 10 ft is about 3 yards

Fundamentals: Unit Conversion

Sect 1.2

- Can't mix units when adding or subtracting - Need to convert

  18 km + 5 mi is not 23
- Can always multiply by conversion factor with same thing in numerator and denominator
  - 1 km =1000 m   “1” = (1 km/1000m)
- Can cancel units algebraically

Example:

You throw a baseball and it is 'clocked' at 30m/s by a radar gun. Is this a reasonable number? Convert to mi/hr (mph).

$$30\frac{\cancel{m}}{\cancel{s}}\left(\frac{1\cancel{km}}{1000\cancel{m}}\right)\left(\frac{1mi}{1.609\cancel{km}}\right)\left(\frac{60\cancel{s}}{1\ \cancel{min}}\right)\left(\frac{60\cancel{min}}{1\ hr}\right)= 67.1mi/hr$$

67mph   A little bit more than two times the value in m/s.

Convert 1000. ft/min into meters per second.

A. 0.0847 m/s

B. 0.197 m/s

C. 5.08 m/s

D. 24.5 m/s

E. 54.7 m/s

F. 169 m/s

G. 1540 m/s

H. 18300 m/s

1 mi = 5280 ft

1 mi = 1.609 km

1 m = 3.281 ft

$$1000\,\frac{\text{ft}}{\text{min}}\left(\frac{1\,\text{min}}{60\text{s}}\right)\left(\frac{1\text{m}}{3.281\text{ft}}\right)=5.08\text{m/s}$$

A bucket has a volume of 1560 cm^3. What is its volume in m^3? 

(A) 1.56×10^{-6} m^3
(B) 1.56×10^{-4} m^3
(C) 1.56×10^{-3} m^3
(D) 1.56×10^{-2} m^3
(E) 1.56×10^{-1} m^3
(F) 1.56 m^3
(G) 15.6 m^3
(H) 1.56×10^{3} m^3
(I) 1.56×10^{6} m^3
(J) 1.56×10^{9} m^3

1560cm^3 = 1560 cm*cm*cm, so need to do single conversion three times:

$$1560\ \mathrm{cm}^3\left(\frac{1\,\mathrm{m}}{100\ \mathrm{cm}}\right)\left(\frac{1\,\mathrm{m}}{100\ \mathrm{cm}}\right)\left(\frac{1\,\mathrm{m}}{100\ \mathrm{cm}}\right)=1.56\times10^{-3}\ \mathrm{m}^3$$

How do you interpret cm^{-3} ? $\frac{1}{\mathrm{cm}^3}$

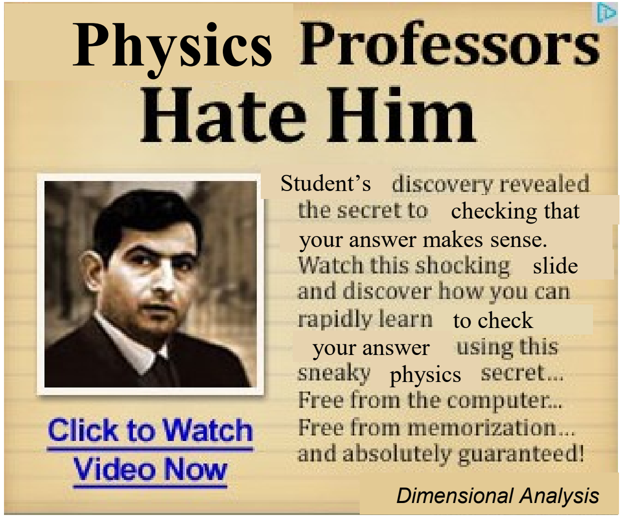
Negative exponent – inverse – place in denominator

Fundamentals: Dimensional Analysis

- Dimension - physical nature of quantity (length, mass, time)
- Can be derived dimensions or units: acceleration is length/time^2

- All terms in an equation must have same dimension! Otherwise it can't be right.
  - speed = distance^2/time
    …doesn't make sense: ([L]/[T] =? [L]^2/[T])

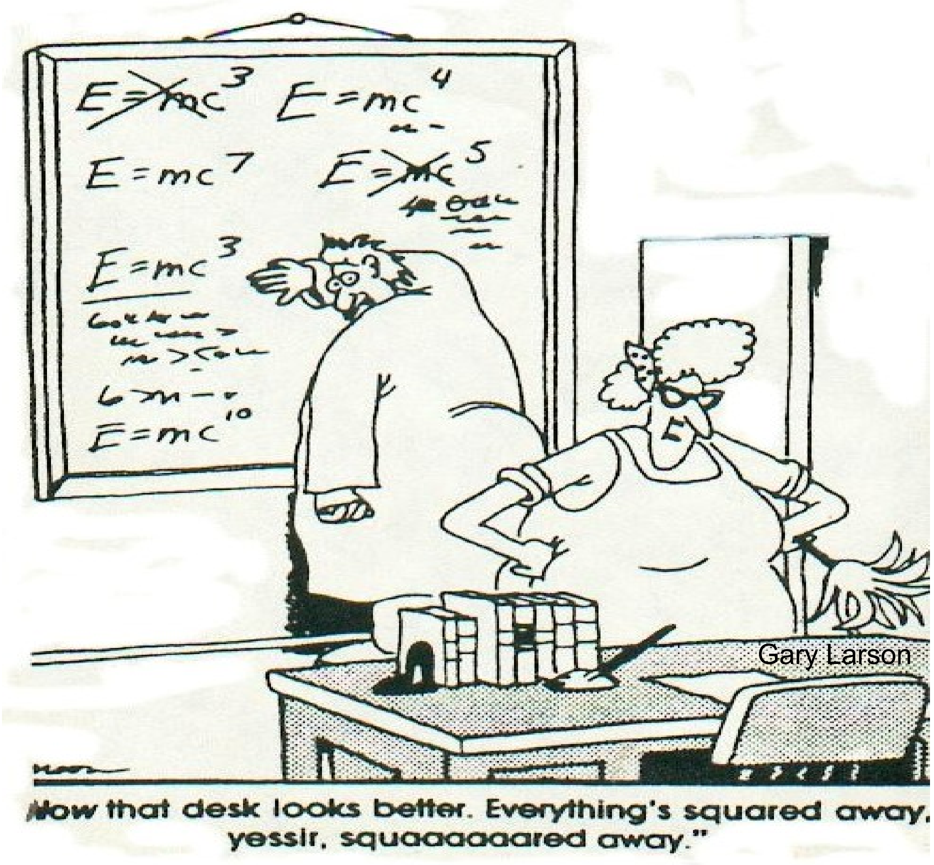
- Can use algebra to figure out dimensions and units
  - Force = (mass) x (acceleration)
  - [Force] = mass x (length/time^2)
  - SI Units of Force: kg m/s^2 (or Newtons - N)



Dimensional Analysis: Example

- Mass-Energy Equivalence:
  - $E = mc^2$?
  - ~~$E = mc^3$?~~
  - ~~$E = mc^7$?~~
- c is speed of light (m/s)
- m is mass (kg)
- Units of Energy are:

  kg m^2/s^2

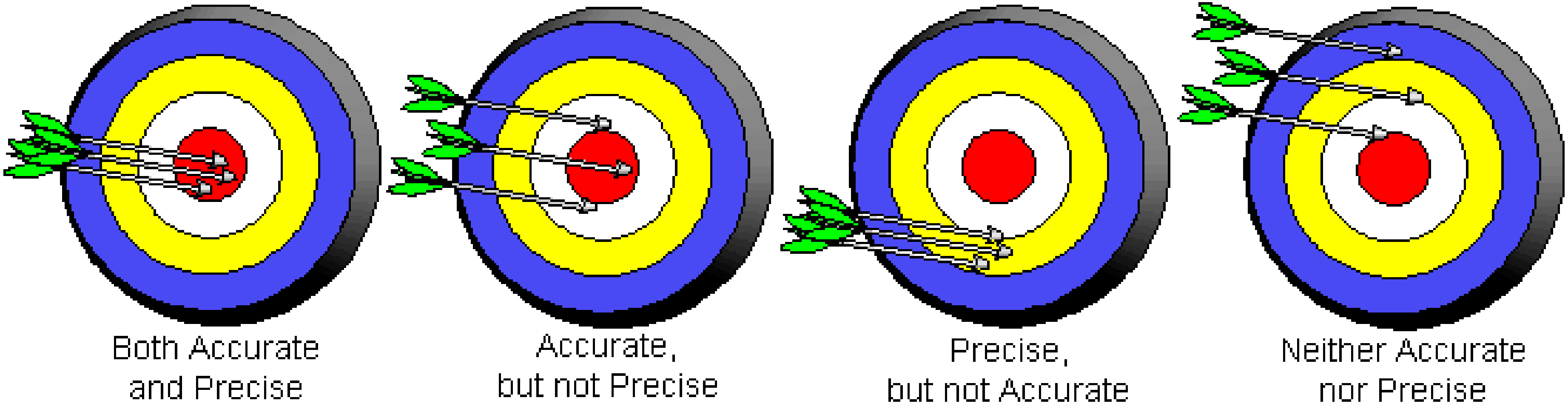


Always check your answer for units & sensibility

Fundamentals: Accuracy and Precision

📖 Section 1.3

- Accurate: Close to known or accepted value
- Precise: Repeated measurements are close to each other



Fundamentals: Significant Figures

📖 Section 1.3

- Way of handling precision
  - 3.5621 cm from a meter stick?
- Ignore leading zeros
- Ignore trailing zeros if no decimal point
- Safest way: scientific notation
- Homework: 3-5 typically accepted

Value	# of Sig Figs
15.6	3
0.0016	2
16000	2
16000.	5
$1.60\text{x}10^4$	3

If the answer is 3 meters, you may need to enter 3.00 m if more digits are required.

You are not penalized tries.

Ratios/ Scaling Laws

Example:

Acceleration = Force/Mass

$$a = \frac{F}{m}$$

If you double the force while keeping the mass constant, the new acceleration will be ______ times the original acceleration.

(A) ¼ (B) ½ (C) 1 (D) 2 (E) 4

$$a_2 = \frac{F_2}{m} = \frac{2F_1}{m} = (2)\left(\frac{F_1}{m_1}\right) = 2a_1$$

Ratios/ Scaling Laws

Example:

Acceleration = Force/Mass

$$a = \frac{F}{m}$$

If you double the mass while keeping the force constant, the new acceleration will be ______ times the original acceleration.

(A) ¼ (B) ½ (C) 1 (D) 2 (E) 4

$$a_2 = \frac{F}{m_2} = \frac{F}{2m_1} = \left(\frac{1}{2}\right)\left(\frac{F}{m_1}\right) = \frac{1}{2}a_1$$

Ratios/ Scaling Laws

Example:

Acceleration = Force/Mass

$$a = \frac{F}{m}$$

So now lets increase the force by a factor of 2 while quadrupling the mass. The new acceleration will be ______ times the original acceleration.

(A) ¼ (B) ½ (C) 1 (D) 2 (E) 4

$$a_2 = \frac{F_2}{m_2} = \frac{2F_1}{4m_1} = \left(\frac{2}{4}\right)\left(\frac{F_1}{m_1}\right) = \frac{1}{2}a_1$$

You are examining two circles.
Circle 2 has a radius 1.7 times bigger than circle 1. 
What is the ratio of the areas?
Express this as the value of the fraction A_2/A_1.

$$A = \pi r^2$$

(A) 1/1.7 (B) 1.7 (C) $(1/1.7)^2$ (D) 1.7^2

(E) $\sqrt{1/1.7}$ (F) $\sqrt{1.7}$

$$\frac{A_2}{A_1} = \frac{\pi r_2^2}{\pi r_1^2} = \frac{\pi (1.7 r_1)^2}{\pi r_1^2} = (1.7)^2$$

If you double the radius of a pizza, you get 4 times as much pizza

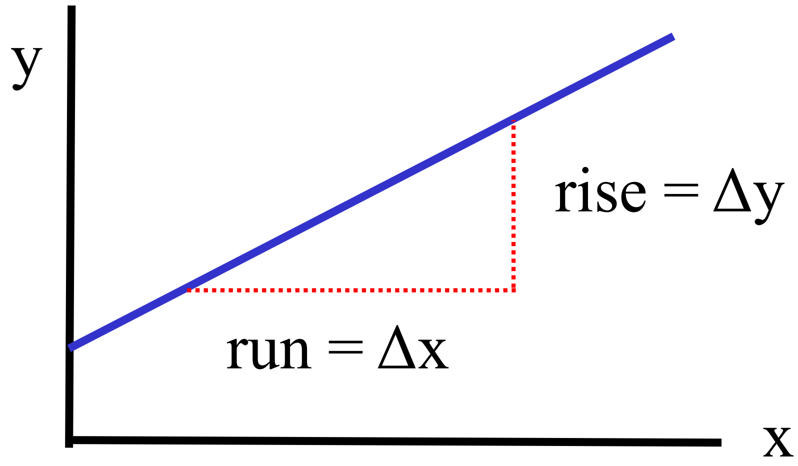
1.7 times the radius, gives 2.9 times as much area.

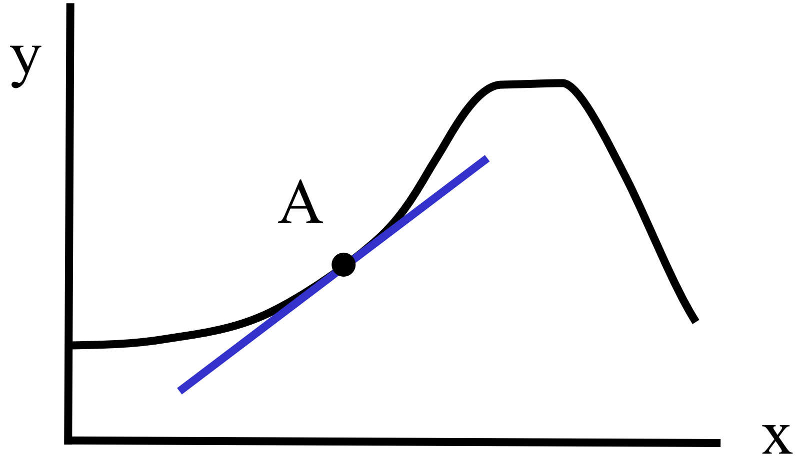
Graphs: Slope of Function on Graph

- Slope = rise/run
- Up to right is positive
- Down to right is negative

- Slope of curve at a point
  - slope of tangent line
- Slope of straight line same at any point

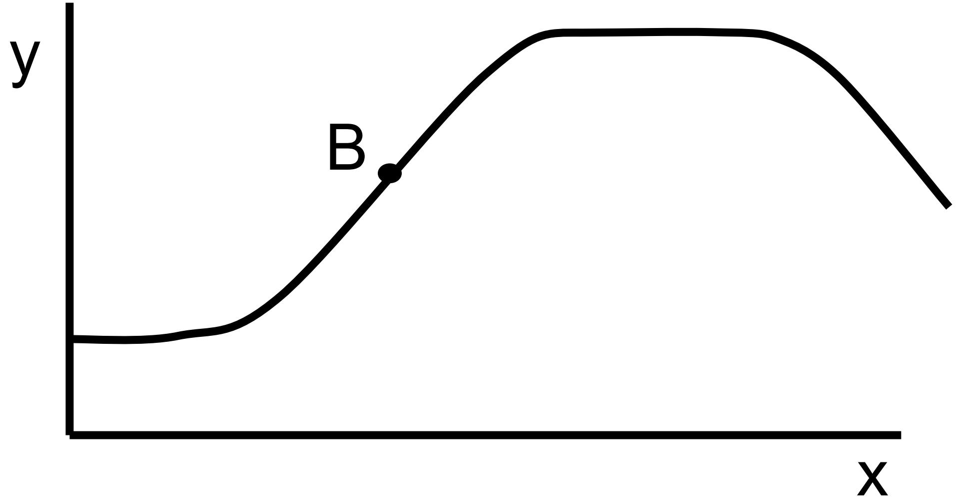
- When finding slope off a graph, use the longest part of the line possible.





The slope at point B on this curve is __________ as you move to the right on the graph. Think about slope just a 'smidgen' to the left and right of Point B.

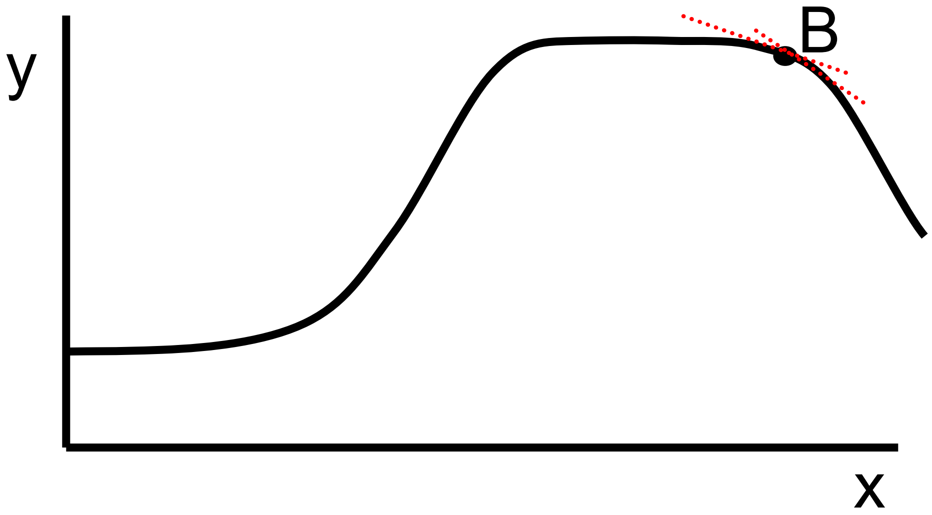
1. increasing
2. decreasing
3. staying the same



Slope of a straight line is the same anywhere along that line.
Along the straight portion of the curve, the slope is not changing.

The slope at point B on this curve is __________ as you move to the right on the graph.

1. increasing
2. decreasing
3. staying the same



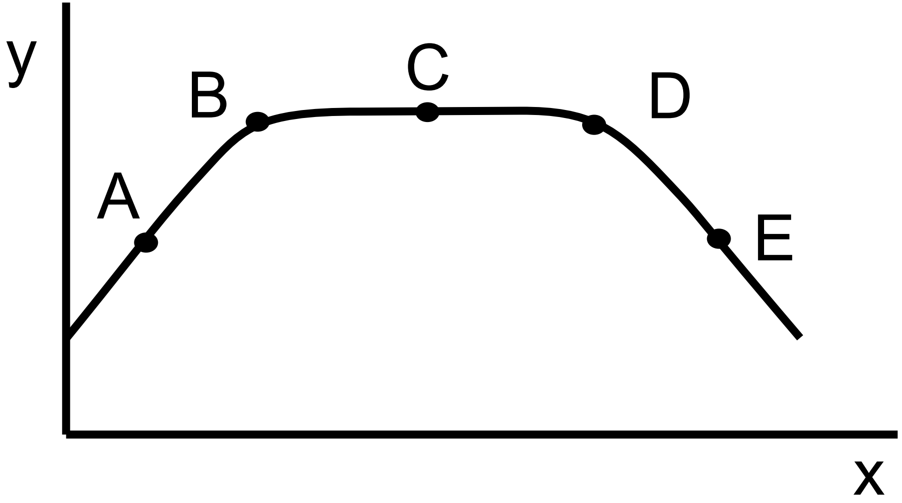
Think about slope just a 'smidgen' to the left and right of the point.

As slope gets more negative, it is decreasing.

If we asked about the magnitude of the slope (absolute value in this case), the magnitude of the slope is increasing.

At what point or points is the slope of the function decreasing as you move to the right on the graph?

(1) A
(2) B
(3) C
(4) D
(5) E
(6) D, E
(7) B, D, E
$\boxed{\text{(8) B, D}}$
(9) B, C, D
(0) A, B



Think about slope just a 'smidgen' to the left and right of the point.

On the straight line segments the slope is constant, the same, not changing.

At B the slope is less steep as you move to the right.

At D the slope is becoming more negative (so decreasing)