Midterm 1 review

Day 7:
Review

Reminders:
No HW this week!
Lecture notes in full on website
Today's lecture on website after class

Additional Help Room hours

Wed: 3-4p
No Helproom Thurs (unless you really want :)

Thanks for the feedback

Question 3

What about the pace of this class... (5=Really fast 3=Just Right 1=Really slow)

1-really slow	0	(0 %)
2	6	(10.34 %)
3	30	(51.72 %)
4	19	(32.76 %)
5-way too fast	3	(5.17 %)

Number of Responses: 58

Reminder- exam Thursday … 11a. Here.
Like homework … part multiple choice, part essay/long answer.
Graphs and predictions for motion
- $F_{net} = ma$
- x, v, a, t relations.
- Springs

Bring 3 x 5 card with anything you want written on it
Bring calculator, pencil.
Can NOT use book.

Why exams? (not to inflict pain!)
1. You review material, reflect on what you do and do not understand, and why you think that.
2. Feedback to us on what you are (and are not) learning.
Is there anything we or you are missing by just looking at results on homework and in-class questions?

Mid term on Thursday

- Balcony areas will be CLOSED on Thursday
- 20 multiple choice questions, & 1 Long answer problems, total= worth 40 points.
-There will be no early or late exams given and no make-up exams.
-Accommodations please see me. Meet 11a G1b31.
- Exam will be closed book.
- ONE 3 by 5 inch formula card. You can WRITE anything on it BY HAND.
- Formula sheet / constants provided
- Calculator and pencil/eraser
  - Calculator cannot connect to outside world. No calculators on cell phones or laptops allowed.
  - No sharing of calculators.
  - No spare calculators available
- Exam grades and solutions will be posted after the exam on D2L.

Midterm preparation

- Prepare by applying the principles we have learned – practice.
- Do not seek to memorize answers to specific questions.
- Go over homeworks, class clicker questions, questions in the book.
- Today will be a review lecture

Not about memorization
Info will be on exam . . .

Each m/c question is worth 1.5 pts. The long answer 10 pts. Total points = 40.

Beware of grabbing at a numerical answer simply because you happen to see that number as you are calculating. We are sneaky and put in choices that are numbers you are likely to produce if you are not sure how to do the problem correctly. For many problems, it is good to make a simple sketch to picture the problem correctly.

For all of these problems, assume that air resistance is not important *unless* you are told otherwise.

Conversions you may or may not need:
1 pound = 4.45 N 1 slug = 14.594 kg, 1 mph = 0.447 m/s.

Formulas you may or may not need.

$x = x_0 + vt$
$v = v_0 + at$
$x = x_0 + v_0t + \frac{1}{2} at^2$
$v = (\Delta x / \Delta t) = (x_f - x_0) / (t_f - t_0)$
$a = (\Delta v / \Delta t) = (v_f - v_0) / (t_f - t_0)$
Force of Kinetic Friction = 0.3 x weight (for a moving object, like a book on a table)
$F_{net} = m a$
$F_{gravity} = m g$
$F_{spring} = -kx$

Midterm topics - Motion

- Position, velocity and acceleration
  - Definitions, Units
  - Scalars and vectors
  - Graphs of x, v, a vs time and relationships between graphs
  - Equations of motion and how to <u>use</u> them:
    - Constant velocity: $x = x_0 + vt$
    - Constant acceleration: $v = v_0 + at$
    - $x = x_0 + v_0 t + ½ at^2$
- Forces
  - Definition, units, vector
  - $\underline{F}_{gravity} = mg$ downwards
  - $\underline{F}_{friction} \approx 0.3 \times$ weight in direction opposing motion
  - $\underline{F}_{spring} = -k\underline{x}$ in direction opposing extension/compression
  - $\underline{F}_{net} = m\underline{a} \Rightarrow$ If $a = 0$, $F_{net} = 0$
  - Free body diagrams and finding F_{net}

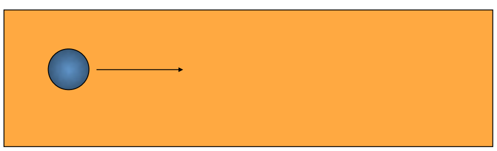
Basic relationships

$\underline{x}$ = position in space (distance and direction)

$\underline{v} = (\Delta\underline{x} / \Delta t) = (\underline{x}_f - \underline{x}_0) / (t_f - t_0)$

$\underline{a} = (\Delta\underline{v} / \Delta t) = (\underline{v}_f - \underline{v}_0) / (t_f - t_0)$

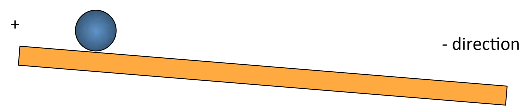
$\underline{F}_{net} = m\, \underline{a}$



Roll a steel ball on a clean level floor. If there is no net force on the ball it can?
a. go straight, b. turn to one side c. slow down,
d. either a. or b. e. either a, b, or c.

a. go straight. If nothing pushes on it, will continue in same direction and speed.

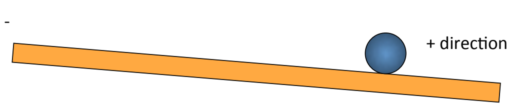
terminology questions.



rolling ball on floor that slopes down, positive direction is to the LEFT. So ball is speeding up.
a. velocity is positive (+), accel. is pos.
b. vel. is negative (-), accel. is pos.
c. vel. is positive, accel. is negative.
d. vel. is negative, accel. is negative.,
e. none of above, it is decelerating, so has no acceleration.

d. it is moving in negative direction, so velocity is negative.
the change in velocity also in negative direction- velocity becoming more negative (or remember that of force in negative direction), so acceleration also *negative*.

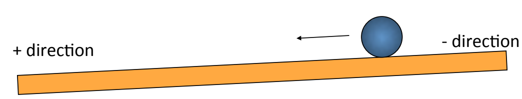
Now starts out rolling to left, definition reversed so left is negative direction.



started rolling ball to left, so ball is slowing down,
a. velocity is positive (+), accel. is pos.
b. vel. is negative (-), accel. is pos.
c. vel. is positive, accel. is negative.
d. vel. is negative, accel. is negative.,
e. none of above, it is decelerating, so has no acceleration.

velocity is negative (moving in - direction)
acceleration is positive (force is in + direction)

terminology question (if time).

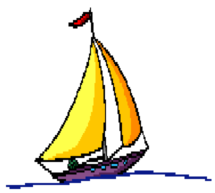


floor slopes other direction.
a. velocity is positive (+), accel. is pos.
b. vel. is negative (-), accel. is pos.
c. vel. is positive, accel. is negative.
d. vel. is negative, accel. is negative.,
e. none of above, it is decelerating, so has no acceleration.

a. it is moving in + direction, so velocity is +.
the change in velocity also in +direction, velocity becoming more positive (or remember that of force in + direction), so acceleration also positive.

The wind is providing a nice steady breeze, and the sail boat is sailing directly towards the shore at a constant speed of 2 knots. What do we know about the forces on the boat?

A. There must be a net force in the direction of the shore.
B. There is a force on the boat exerted by the wind.
C. The net force is zero.
D. A and B
E. B and C



The wind is providing a nice steady breeze, and the sail boat is sailing directly towards the shore at a constant speed of 2 knots. What do we know about the forces on the boat?

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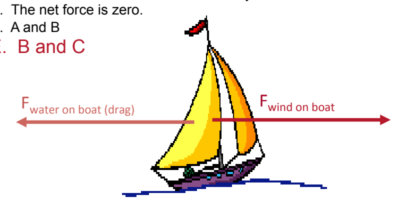
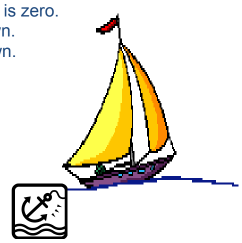


Speed and direction of motion are constant.
Velocity is constant.
Acceleration is 0, so net force must be 0.
Force of wind on boat and force (drag) of water on boat exactly balance.

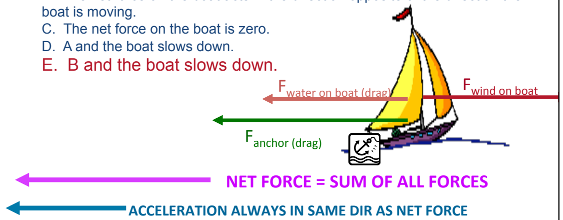
What happens right after we drop in an anchor in the water that drags along the sandy bottom?

A. The net force on the boat acts in the direction the boat is moving.
B. The net force on the boat acts in the direction opposite of the direction the boat is moving.
C. The net force on the boat is zero.
D. A and the boat slows down.
E. B and the boat slows down.



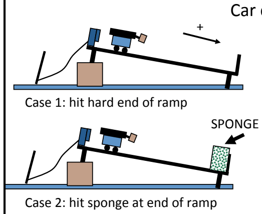
What happens right after when we drop in an anchor in the water that starts dragging along the sandy bottom?

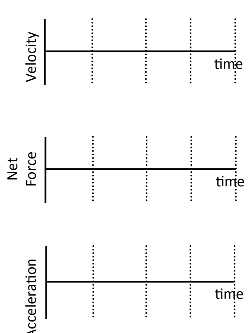
A. The net force on the boat acts in the direction the boat is moving.
B. The net force on the boat acts in the direction opposite of the direction the boat is moving.
C. The net force on the boat is zero.
D. A and the boat slows down.
E. B and the boat slows down.



Added a force on the boat from the dragging anchor.
So now net force is NOT 0 N.
Net force is opposing the motion.
Since F_{net} = mass x acceleration, acceleration is opposing the motion.
So boat is slowing down….
Acceleration is acting in the direction opposite to the velocity.

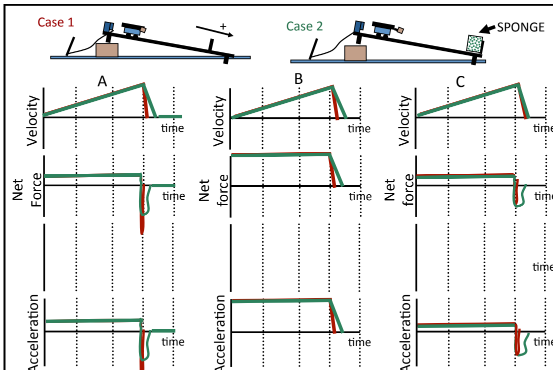
Car crashes



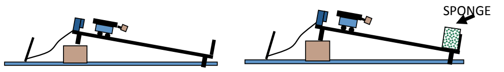


Sketch your predictions of the velocity, acceleration, net force, and measured force (by probe) vs time for this motion. Starting when we let go and ending after crash.
Plot CASE 1 AND 2 on same graph.

HINT: Consider the time that it takes to crash



D. Same as a, but with all curves on negative side of 0 instead of positive.
E. None of these choices.



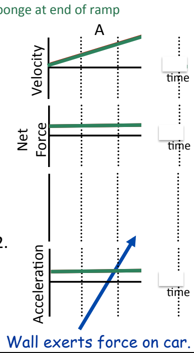
Just before crash:
All conditions for car 1 and 2 are identical
After crash:
Both car in 1 and 2 are at rest. Velocity = 0 m/s

During crash:

Same in both Case 1 and 2

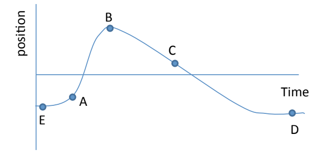
Acceleration during crash = $\frac{\text{change in velocity}}{\text{time elapsed during crash}}$

Shorter in Case 1 Than Case 2

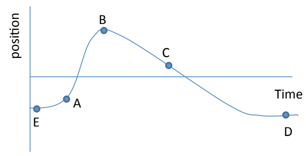


- During crash acceleration _ 1 > acceleration of 2.
- $F_{net} = ma$
  ⇒ Crash force greater on 1 … ouch!

Car safety (air bags, crumple zones etc) all designed to increase deceleration time, reduce force on humans



What is the person's velocity at A
a) Positive
b) Negative
c) Zero
d) Can't be determined



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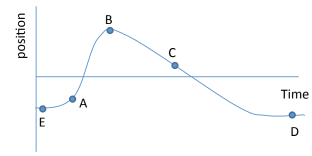
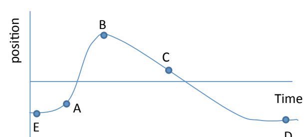
Velocity is the slope of a position vs time graph



Name all points where the person is stationary

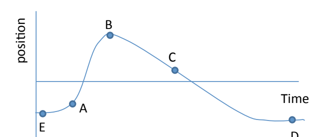
a) E, B and D
b) E and D
c) All points
d) E, C and D
e) B only



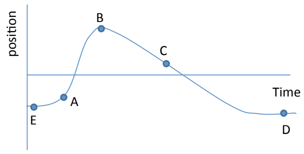
Name all points where the person is stationary

a) E, B and D
b) E and D
c) All points
d) E, C and D
e) B only

person is stationary when velocity = 0.
Velocity is the slope of a position vs time graph.
person is stationary when the graph has zero slope (horizontal) , even is only instantaneously



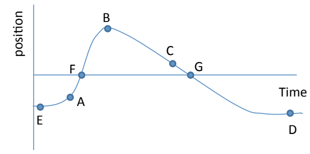
Name all the points where the person is accelerating
a) A, B and C
b) B only
c) All points
d) A and C
e) A and B



Name all the points where the person is accelerating

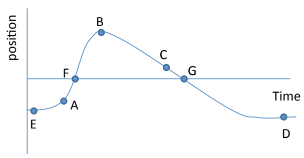
a) A, B and C
b) B only
c) All points
d) A and C
e) A and B

When the person is accelerating his velocity is changing
Velocity is the slope of a position vs time graph
⇒ So when he is accelerating, the slope of this graph is changing



What is the person's average velocity between points F and G?

a) Something greater than zero (positive)
b) Something less than zero (Negative)
c) Zero
d) Can't determine from this graph



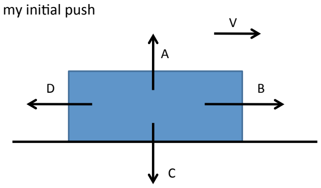
What is the person's average velocity between points F and G?

a) Something greater than zero (positive)
b) Something less than zero (Negative)
c) Zero
d) Can't determine from this graph

Average velocity = change in position/time taken
At F and G the person is at the SAME position, so the change in position is 0.
⇒ Average velocity is zero

Motion questions

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



Which of the forces above has zero magnitude in this situation?

Motion questions

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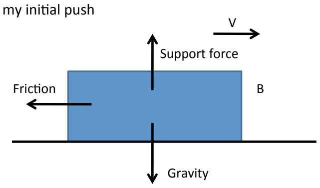

Which of the forces above has zero magnitude in this situation? B

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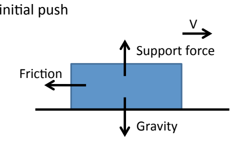

What is the approximate size of the support force?

a) 2N b) 10 N c) 20N d) 40 N e) Can't be determined

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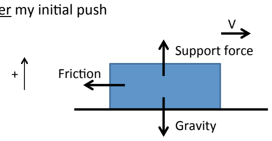

What is the approximate size of the support force?

a) 2N b) 10 N c) 20N d) 40 N e) Can't be determined

Vertical direction: $F_{net} = F_{support} - mg$
$a = 0 \Rightarrow F_{net} = 0$
} $F_{support} - mg = 0$

$F_{support} = mg$
$= 2kg \times 10m/s^2 = 20N$

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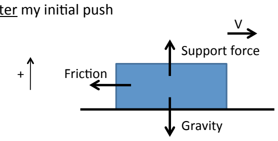
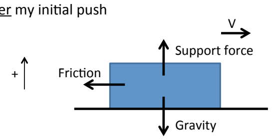


What is the approximate size of the friction force?

a) 2N b) 6 N c) 20N d) 60 N e) Can't be determined

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push

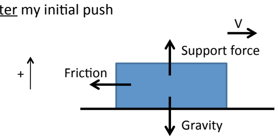


What is the approximate size of the friction force?

a) 2N b) 6 N c) 20N d) 60 N e) Can't be determined

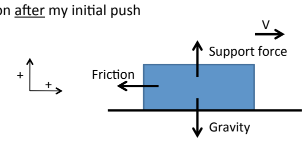
Force of sliding friction ≈ $0.3 \times mg$
≈ $0.3 \times 20N$
≈ 6N

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



What is acceleration of the box?
a) 0 b) $6\ m/s^2$ c) $-6\ m/s^2$ d) $3\ m/s^2$ e) $-3m/s^2$

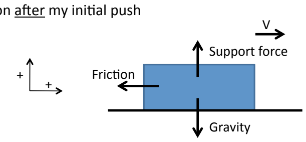
I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



What is acceleration of the box?
a) 0 b) $6\ m/s^2$ c) $-6\ m/s^2$ d) $3\ m/s^2$ e) $-3m/s^2$

Net force = ma
$a = F_{net}/m = -6N / 2kg$
$= -3m/s^2$

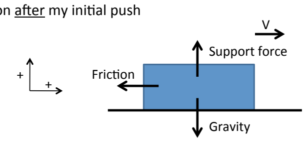
I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



What is the velocity of the box after 1.5s?

a) 6m/s b) 4.5m/s c) 3m/s d) 1.5m/s e) 0

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push

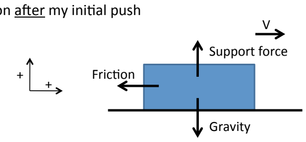


What is the velocity of the box after 1.5s?

a) 6m/s b) 4.5m/s c) 3m/s d) 1.5m/s e) 0

- We know v_0, a and t, want v
- Use $v = v_0 + at$
- $v = 6m/s + (-3m/s^2)(1.5s)$
  $= 1.5m/s$

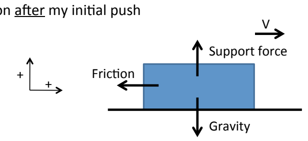
I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



How long does box travel for before it stops?

a) 0s b) 0.5s c) 1s d) 1.5s e) 2s

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push



How long does box travel for before it stops?

a) 0s b) 0.5s c) 1s d) 1.5s e) 2s

- We know v_0, a and v, want t
- Use $v = v_0 + at$
- Rearrange: $v - v_0 = at$
  $(v - v_0)/a = t$
  $(0 - 6m/s)/(-3m/s^2) = t$
  $t = 2s$

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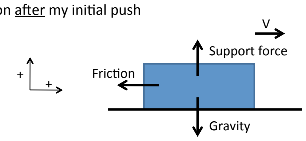
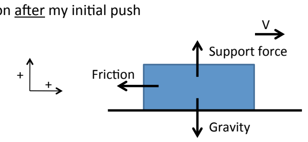


How far does box travel for before it stops?

a) 0m b) 2m c) 3m d) 6m e) 12m

I push a shoebox of mass 2kg across a lino floor. I give it an initial velocity of +6m/s and after that it travels on its own. The next few questions relate to its motion <u>after</u> my initial push

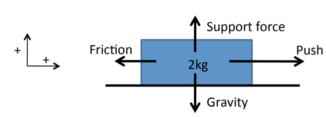


How far does box travel for before it stops?

a) 0m b) 2m c) 3m d) 6m e) 12m

We know x_0, v_0, a and t and we want x.
Use $x = x_0 + v_0 t + ½ at^2$
$x = 0 + (6)(2) + ½ (-3)(2^2)$
$= 12 - 6m$
$= 6m$

The box comes to a stop. I start pushing it again, this time continuously. It accelerates at $2m/s^2$. What is the size of my horizontal pushing force? (Remember from previous questions that $F_{friction}$ = 6N when box is moving)



a) 2N b) 4N c) 6N d) 10N e) 12N

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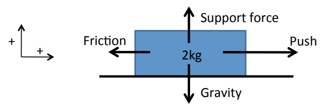

a) 2N b) 4N c) 6N d) 10N e) 12N

$F_{net} = ma$
$F_{push} - F_{friction} = ma$
$F_{push} = ma + F_{friction}$
$= (2kg)(2m/s^2) + 6N$
$= 4N + 6N$
$= 10\ N$

Part of the pushing force needed to counteract friction, the rest accelerates the box

Springs

I have a spring which is labeled 'Spring constant = 8 N/m'. I assume that this is correct and use it to measure the mass of an apple. I attach the apple to the bottom of the spring and it stretches 12.5cm (or 0.125m) . What is the mass of the apple? (assume $g = 10m/s^2$)

a) 0.1 kg b) 1kg c) 10kg d) 100kg e) Can't be determined.

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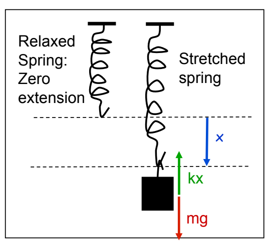
a) 0.1 kg b) 1kg c) 10kg d) 100kg e) Can't be determined.

In equilibrium, net force on apple = 0. Downwards force of gravity is exactly equal and opposite to upwards force from spring.

$\Rightarrow mg = kx$
$m = kx/g$
$= (8N/m)(0.125m)/(10m/s^2)$
$= 0.1\ kg$



Now I hang the same apple on a different spring and it stretches much less than 12.5cm. What is the spring constant of this spring?

a) Less than 8N/m
b) 8N/m
c) More than 8N/m
d) Can't determine from information given

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b) 8N/m
c) More than 8N/m
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Less extension for same force ⇒ stiffer spring ⇒ higher value of k.

$mg = kx$ in equilibrium when net force = 0.
$k = mg/x$
Smaller $x \Rightarrow$ bigger k

Which spring exerted the bigger upwards force on the apple?

a) The weak spring which had a large extension
b) The stiffer spring (smaller extension)
c) They exerted the same upwards force
d) Can't tell from this information

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c) They exerted the same upwards force
d) Can't tell from this information

In BOTH cases, in equilibrium, the net force = 0
⇒ mg = kx
mg is the weight of the apple and the same in both cases
⇒ The upwards force the the spring (kx) is the same in both cases

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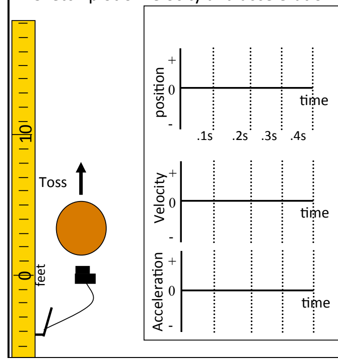
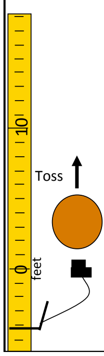
If we toss basketball up in air, reaches highest point in 0.2 s.
Sketch plot of velocity and acceleration and position vs time.



At what time does,
Position change sign
Velocity change sign
Acceleration change sign

a. .2 s, .2 s, .2 s
b. never, .2s, .2 s
c. .2 s, .2s, never,
d. never, .2s, never
e. never, never, never

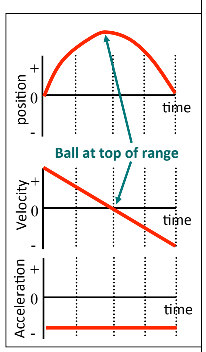
Acceleration (a) = $\frac{\text{change in velocity}}{\text{time elapsed}}$



Velocity: Starts large and positive
At top, velocity is zero for moment then changes to negative as heads down.

Position curve bends over at top because slowing down going up and speeding up coming down.

Acceleration is always negative because net force always down. (or equivalently because velocity always has same negative slope)
Acceleration = -(9.8 m/s)/s
= -9.8 m/s²



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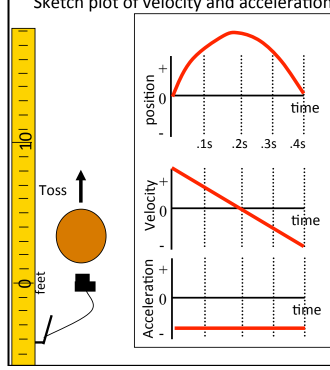

At what time does,
Position change sign
Velocity change sign
Acceleration change sign

a. .2 s, .2 s, .2 s
b. never, .2s, .2 s
c. .2 s, .2s, never,
d. never, .2s, never
e. never, never, never

d. position always pos.
vel. reverses at top
accel always negative.