1D Kinematic Items - Master Item List - All Items

June 2024

1 Kinematics Assessment

The questions which follow ask about the motion of an object in one dimension. All objects move along the x axis. The positive x axis is to the right of the page. For any vector quantity (acceleration, velocity, etc.), the problem asks about the x component of the vector.

Problem 1: (KD1-1)
An object is initially at the point +2m on the x-axis. The object is moved to the point +1m.

What is the displacement of the object?

  A. 0m
  B. +1m
  C. −1m
  D. +2m
  E. +3m

Status: inactive - Too easy
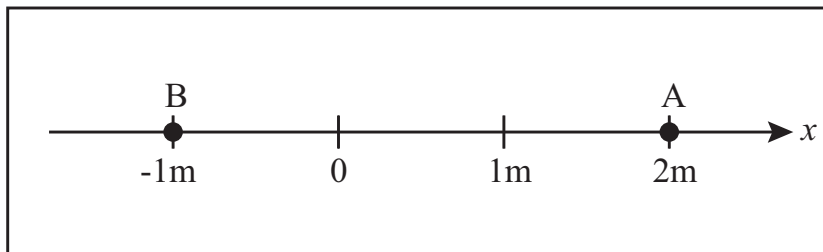Provides Evidence for Displacement 1D - JCS1-1
Knowledge Model: (K12) Displacement 1D
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K2) position along axis
Distractors: The set represents a fairly complete set of possible answers.

Problem 2: (KD1-1-V2)

An object is initially at the point A a distance of 2m on the positive x axis. The object is moved to the point B. Point B is located a distance of 1m along the negative x axis as drawn in the figure above. Which of the follow best describes the displacement of the object from point A to point B?

  A. The displacement has a magnitude of 1m to the left of the page.
  B. The displacement has a magnitude of 2m to the left of the page.
  C. The displacement has a magnitude of 3m to the left of the page.
  D. The displacement has a magnitude of 2m to the right of the page.
  E. The displacement has a magnitude of 3m to the right of the page.

Provides Evidence for Displacement 1D - JCS1-1

Knowledge Model: (K12) Displacement 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: inactive - Could be used, translates KD1-1 into magnitude and direction.
Revision of: KD1-1. Changes: Translates distractors into magnitude and direction.

Problem 3: (KD1-1-V3)
An object is initially at the point +2m along the x-axis. The object then moves to the point +1m. What is the displacement of the object?

    A. The displacement is 1m.
    B. The displacement is 1m in the positive x direction.
    C. The displacement is 1m in the negative x direction.
    D. The displacement is 2m.
    E. The displacement is 2m in the positive x direction.
    F. The displacement is 2m in the negative x direction.

Provides Evidence for Displacement 1D - JCS1-1
Knowledge Model: (K12) Displacement 1D
Knowledge Model: (K5) direction positive-negative
Knowledge Model: (K2) position along axis
Status: active - OSU pretest
Revision of: KD1-1. Changes: Converts to magnitude and direction and adds distractors
Distractors: The set represents a fairly complete set of possible answers.

Problem 4: (KD1-2)
In general, what is the relation of the distance between point A and point B and the displacement from point A to point B?

    A. Distance and displacement mean the same thing.
    B. The distance is the magnitude of the displacement and has no direction, while the displacement has both a magnitude and a direction.
    C. The displacement is the magnitude of the distance and has no direction, while the distance has both a magnitude and a direction.

Provides Evidence for Distance and Displacement 1D - JCS6-1
Knowledge Model: (K12) Displacement 1D
Knowledge Model: (K13) distance
Status: inactive - Too easy.
Distractors: Exhaustive

Problem 5: (KD1-3)
An object is initially at the point $x = +1$m on the x-axis. The object is moved to the point $x = +2$m.

What is the sign of the displacement of the object?

A. The displacement is zero.
B. The displacement is positive.
C. The displacement is negative.

Provides Evidence for 1D Displacement - JCS1-2
Knowledge Model: (K12) Displacement 1D
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K2) position along axis
Status: discontinued -
Distractors: Exhaustive

Problem 6: (KD1-3-V2)
An object is initially at the point $x = -2$m on the x-axis. The object is moved to the point $x = -1$m. What is the direction of the displacement of the object?

A. The displacement is zero.
B. The positive x direction.
C. The negative x direction.

Provides Evidence for 1D Displacement - JCS1-2
Knowledge Model: (K12) Displacement 1D
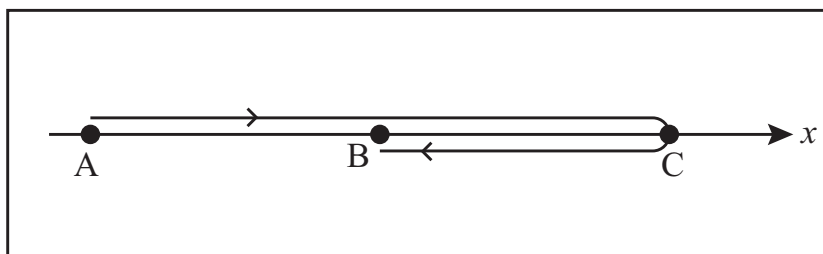Knowledge Model: (K5) direction positive-negative
Knowledge Model: (K2) position along axis
Distractors: Exhaustive
Status: new - Problem usable, never tested.
Revision of: KD1-3. Changes: JCS: Change distractor location to negative x axis.

Problem 7: (KD1-4)

The figure above shows the trajectory of an object that starts at point A, travels to the right until it reaches point C, then reverses direction and travels to the left to point B.

Compare the distance between point A and B to the total distance traveled.

A. The distance between points A and B is equal to the total distance traveled.
B. The distance between points A and B is greater than the total distance traveled.
C. The distance between points A and B is less than the total distance traveled.

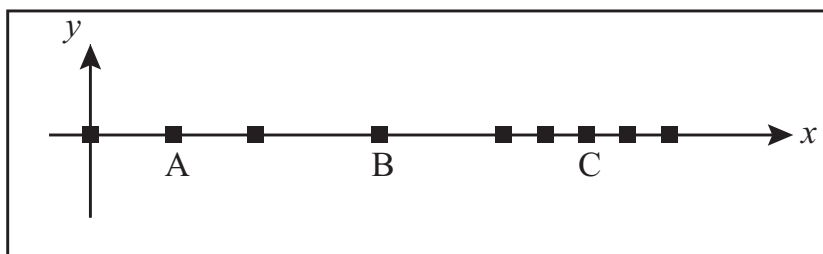Provides Evidence for Compare 1D distance and total distance traveled - JCS5-1
Knowledge Model: (K14) distance 1D
Knowledge Model: (K74) Relation trajectory curve and total distance traveled
Status: active - Too easy.
Distractors: Exhaustive

Problem 8: (KD1-5)

The figure above shows the locations of an object moving to the right along the x axis. Each square represents the location at a point in time. The amount of time between each pair of sequential squares is the same. Select the inequality below which best represents the relation of the velocity in the x direction, v, at the points A, B, and C.
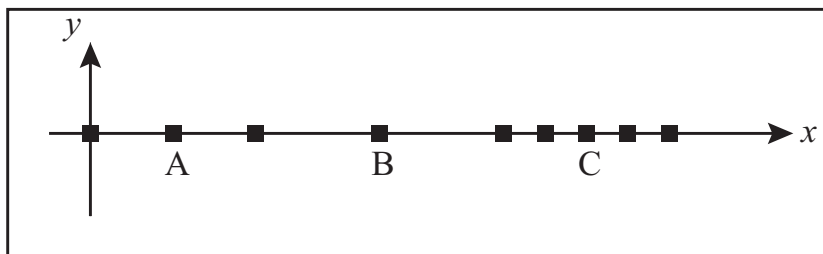
   A. $v_A = v_B = v_C$
   B. $v_A > v_B > v_C$
   C. $v_A < v_B < v_C$
   D. $v_C > v_A > v_B$
   E. $v_C < v_A < v_B$

Provides Evidence for Average velocity 1D - JCS2-2
Knowledge Model: (K31) 1D average velocity and motion diagrams
Status: has newer version - Different order of distractors led to revision

Problem 9: (KD1-5-V2)

The figure above shows the location of an object moving to the right along the x axis. Each square represents the location at a point in time. The amount of time between each pair of sequential squares is the same. Select the response that best describes the relation of the velocity at the points A, B, and C.

A. The magnitude of the velocity is equal at all three points.
B. The magnitude of the velocity is largest at point A, second largest at point B, and smallest at point C.
C. The magnitude of the velocity is largest at point C, second largest at point B, and smallest at point A.
D. The magnitude of the velocity is largest at point C, second largest at point A, and smallest at point B.
E. The magnitude of the velocity is largest at point B, second largest at point A, and smallest at point C.
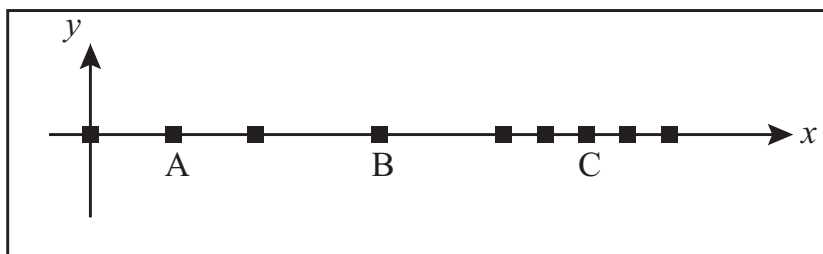
Provides Evidence for Average velocity 1D - JCS2-2
Knowledge Model: (K31) 1D average velocity and motion diagrams
Revision of: KD1-1. Changes: changed distractors to text
Status: discontinued - Problem was too wordy with change.

Problem 10: (KD1-5-V3)

The figure above shows the locations of an object moving to the right along the x axis. Each square represents the location at a point in time. The amount of time between each pair of sequential squares is the same. Select the inequality below which best represents the relation of the velocity in the x direction, v, at the points A, B, and C.

A. $v_A = v_B = v_C$
B. $v_A > v_B > v_C$
C. $v_C > v_B > v_A$
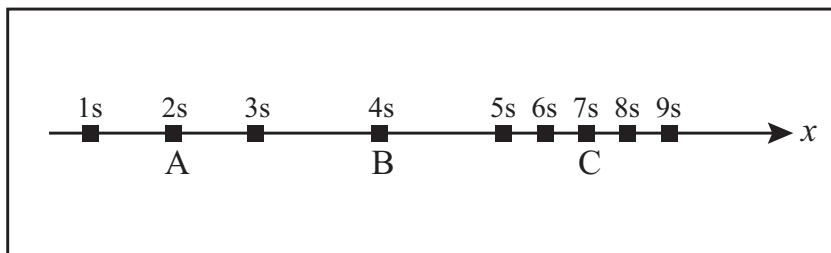D. $v_C > v_A > v_B$
E. $v_B > v_A > v_C$

Provides Evidence for Average velocity 1D - JCS2-2
Knowledge Model: (K31) 1D average velocity and motion diagrams
Status: discontinued - Qualitative validation produced similar item
Revision of: KD1-5. Changes: AH: Repaired inequality order

Problem 11: (KD1-5-V4EC)

The figure above shows the location of an object moving to the right along the x axis. Each square represents the location at a point in time. The amount of time between each pair of sequential squares is one second.

Select the inequality below which best represents the relation of the average velocity in the x direction, v, at the points A, B, and C.

A. $v_A = v_B = v_C$
B. $v_A > v_B > v_C$
C. $v_C > v_B > v_A$
D. $v_C > v_A > v_B$
E. $v_B > v_A > v_C$

Provides Evidence for Average velocity 1D - JCS2-2
Knowledge Model: (K31) 1D average velocity and motion diagrams
Status: active -
Revision of: KD1-5. Changes: A number of revisions detailed in notes Notes: Removed y-axis that some students found distracting. Altered choices C and E as students indicated it was confusing to have to switch between less than and greater than from choice to choice. Second count is indicated above each box in figure to make more concrete. The hope is that this will make the figure more readily comprehensible, reducing the number of students who switch from D to E when prompted "Call you tell me more about how you made sense of the figure in this problem?"

Problem 12: (KD1-6)
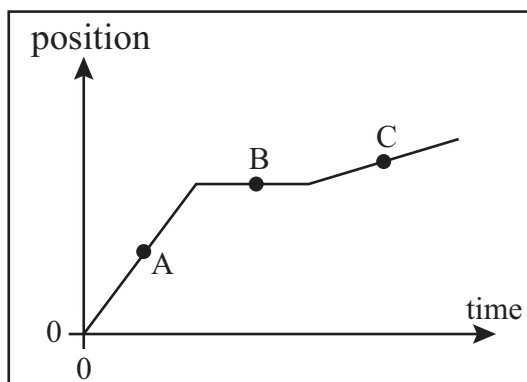
7

An object moves along the x axis. The figure above shows the graph of the position on the x axis as a function of time. Three locations on the plot have been marked. Select the inequality below which best represents the relation of the velocity in the x direction, v, at the points A, B, and C.
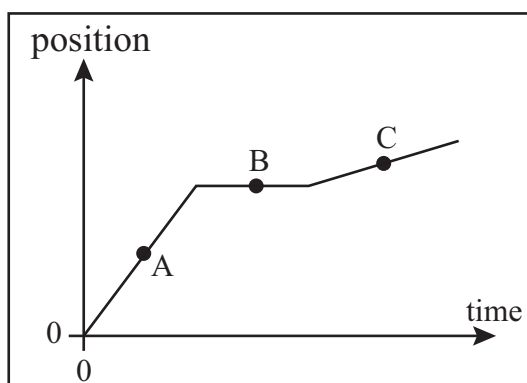
 A. $v_A = v_B = v_C$
 B. $v_A > v_C > v_B$
 C. $v_A < v_B < v_C$
 D. $v_C > v_A > v_B$
 E. $v_C < v_A < v_B$

Provides Evidence for Instantaneous velocity 1D - JCS7-1
Knowledge Model: (K34) slope is velocity
Status: has newer version -

Problem 13: (KD1-6-V2)

An object moves along the x axis. The figure above shows the graph of the position on the x axis as a function of time. Three locations on the plot have been marked. Select the inequality below which best represents the relation of the velocity in the x direction, v, at the points A, B, and C.

 A. The magnitude of the velocity is equal at all three points.
 B. The magnitude of the velocity is largest at point A, second largest at point C, and smallest at point B.
 C. The magnitude of the velocity is largest at point C, second largest at point B, and smallest at point A.
 D. The magnitude of the velocity is largest at point C, second largest at point A, and smallest at point B.
 E. The magnitude of the velocity is largest at point B, second largest at point A, and smallest at point C.
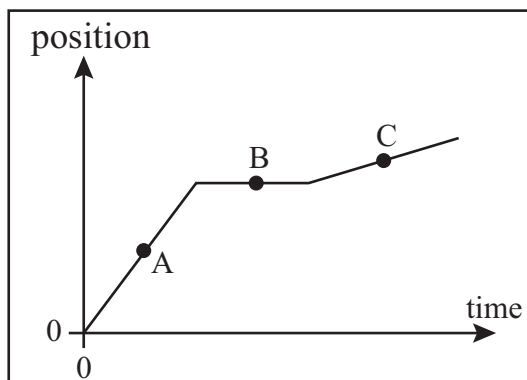
Provides Evidence for Instantaneous velocity 1D - JCS7-1
Knowledge Model: (K34) slope is velocity
Status: notunderconsideration - Revision was too wordy
Revision of: KD1-6. Changes: Converted distractors to magnitude and direction

Problem 14: (KD1-6-V3)

An object moves along the x axis. The figure above shows the graph of the position on the x axis as a function of time. Three locations on the plot have been marked. Select the inequality below which best represents the relation of the velocity in the x direction, v, at the points A, B, and C.

    A. $v_A = v_B = v_C$
    B. $v_A > v_C > v_B$
    C. $v_C > v_B > v_A$
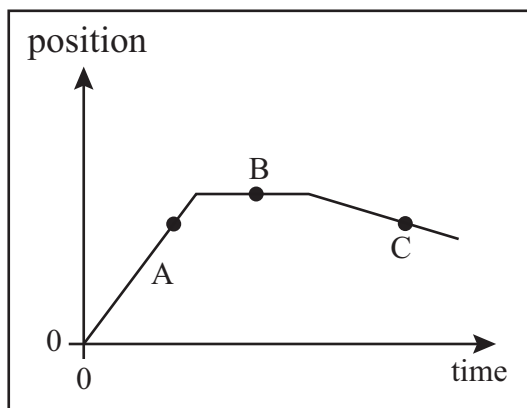   D. $v_C > v_A > v_B$
    E. $v_B > v_A > v_C$

Provides Evidence for Instantaneous velocity 1D - JCS7-1
Knowledge Model: (K34) slope is velocity
Revision of: KD1-6. Changes: Fixed distractor order
Status: active - OSU pretest

Problem 15: (KD1-6-V4EC)

An object moves along the x axis. The figure above shows the graph of the position along the x axis as a function of time. Three positions on the plot have been marked.

Select the inequality below that best represents the relation of v, the velocity in the x direction, at the points A, B, and C.

   A. $v_A = v_B = v_C$
   B. $v_A > v_C > v_B$
   C. $v_A > v_B > v_C$
   D. $v_C > v_A > v_B$
   E. $v_B > v_A = v_C$

Provides Evidence for Instantaneous velocity 1D - JCS7-1
Knowledge Model: (K34) slope is velocity
Knowledge Model: (K8) vector as signed number Notes: Altered choices as students indicated it was confusing to have to switch between less than and greater than from choice to choice. Changed label on vertical axis to "position" instead of "x" since numerous students felt the need to add "position" label by hand on figure. (Hypothesis is they are trying to reduce cognitive load by writing down this information from the text of problem.) Notes: JCS: Figure modified from previous versions to have negative slope.
Status: active -
Revision of: KD1-6. Changes: EC: See notes Notes: JCS- 5/31/24 - Changed location to position.

Problem 16: (KD1-7)
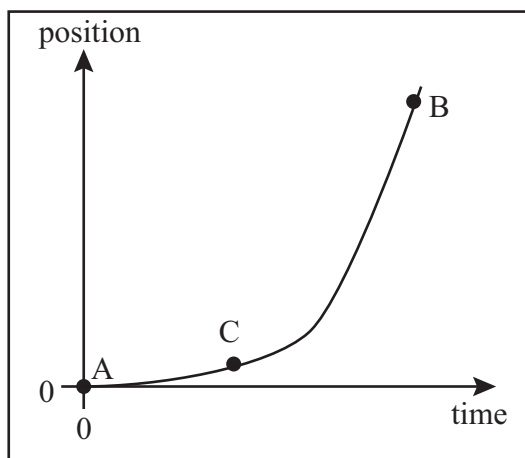
An object moves along the x axis. The figure above shows the graph of the position on the x axis as a function of time. Three locations on the plot have been marked: A, B, and C.

Select the answer which best represents the relation of the velocity at point C and the average velocity between points A and B.

   A. The average velocity between point A and B equals the velocity at point C.
   B. The average velocity between point A and B is less than the velocity at point C.
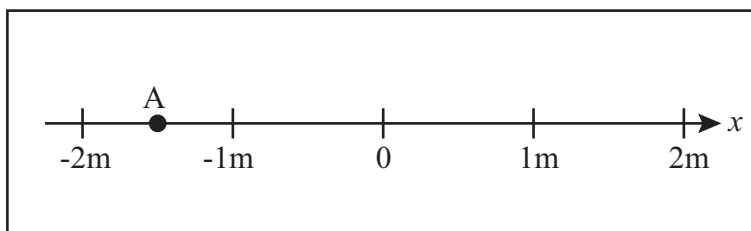   C. The average velocity between point A and B is greater than the velocity at point C.

Provides Evidence for Compare Instantaneous velocity 1D and Average Velocity - JCS8-1
Knowledge Model: (K34) slope is velocity
Knowledge Model: (K41) 1D average velocity and slope
Status: active -

Problem 17: (KD1-8)

An object moves along the x axis. At time t_A, the object is at point A. The object's position is negative at point A as shown in the figure above. The object has a constant negative velocity.

Select the response that best describes the motion of the object after time t_A.

A. The object moves to the left.
B. The object moves to the right.
C. The object moves to the right until it reaches the origin and then stops.
D. The object moves to the right until it reaches the origin, stops, then moves to the left.
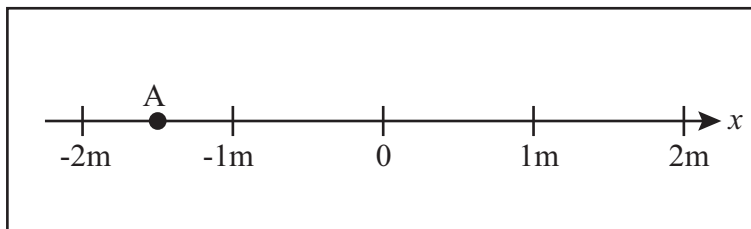
Provides Evidence for Average Velocity 1D - JCS2-5
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: has newer version -

Problem 18: (KD1-8-V2)

An object moves along the x axis. At time zero, the object is at point A. The object's position at point A is on the negative x axis as shown in the figure above. The object moves with a constant velocity pointing to the left of the page. Select the response that best describes the motion of the object after time zero.

    A. The object moves to the left.
    B. The object moves to the right.
    C. The object moves to the right until it reaches the origin and then stops.
    D. The object moves to the right until it reaches the origin, stops, then moves to the left.

Provides Evidence for Average Velocity 1D - JCS2-5
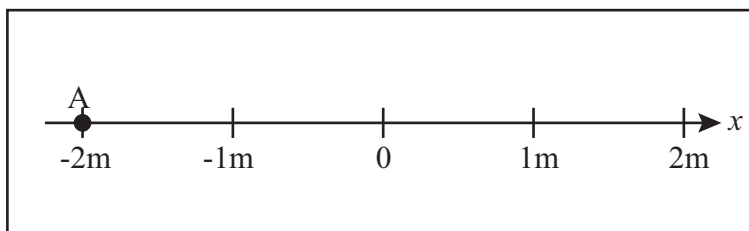Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: notunderconsideration - Too wordy
Revision of: KD1-8. Changes: Changed wording to the direction and magnitude

Problem 19: (KD1-8-V3)

An object moves along the x axis. The object is initially at point A, which is at $x = -2$m, as shown in the diagram above. The x component of the velocity is negative and constant. Select the response that best describes the subsequent motion of the object.

    A. The object moves to the left.
    B. The object moves to the right.
    C. The object does not move.
    D. The object moves to the right until it reaches the origin, stops, then moves to the left.

Provides Evidence for Average Velocity 1D - JCS2-5
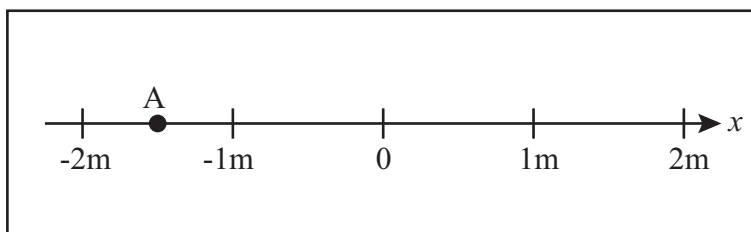Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: active - OSU pretest
Revision of: KD1-8. Changes: AH: Changed problem wording. After pretest at OSU figure updated to match test Notes: Version tested in OSU pretest had figure that did not match text.

Problem 20: (KD1-8-V4EC)

An object moves along the x axis. At time t_A, the object is at point A. The object's position is negative at point A as shown in the figure above. The object has a constant negative velocity.

Select the response that best describes the motion of the object after time t_A.

    A. The object moves to the left.
    B. The object moves to the left until it reaches the origin and then stops.
    C. The object moves to the left until it reaches the origin, stops, then moves to the right.
    D. The object moves to the right.
    E. The object moves to the right until it reaches the origin and then stops.
    F. The object moves to the right until it reaches the origin, stops, then moves to the left.

Provides Evidence for Average Velocity 1D - JCS2-5
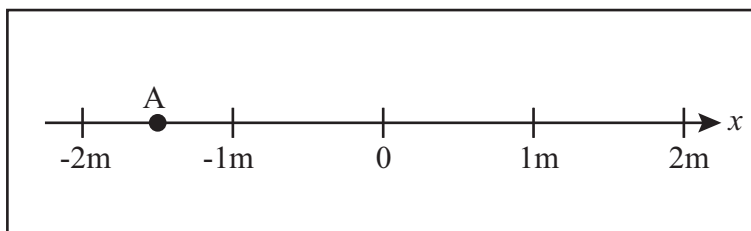Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Revision of: KD-8. Changes: symmeterized distractor set
Status: active -

Problem 21: (KD1-9)

An object moves along the x axis. At time t_A, the object is at point A. The object's position is negative at point A as shown in the figure above. The object has a constant positive velocity.

Select the response that best describes motion of the object after time t_A.

    A. The object moves to the left.
    B. The object moves to the right.
    C. The object moves to the right until it reaches the origin and then stops.
    D. The object moves to the right until it reaches the origin, stops, then moves to the left.

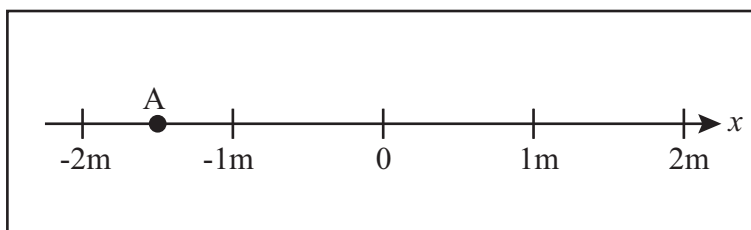Provides Evidence for Average Velocity 1D - JCS2-5
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: has newer version -

Problem 22: (KD1-9-V2)

An object moves along the x axis. At time zero, the object is at point A. The object's position at point A is on the negative x axis as shown in the figure above. The object moves with a constant velocity pointing to the right of the page. Select the response that best describes the motion of the object after time zero.

  A. The object moves to the left.
  B. The object moves to the right.
  C. The object moves to the right until it reaches the origin and then stops.
  D. The object moves to the right until it reaches the origin, stops, then moves to the left.

Provides Evidence for Average Velocity 1D - JCS2-5
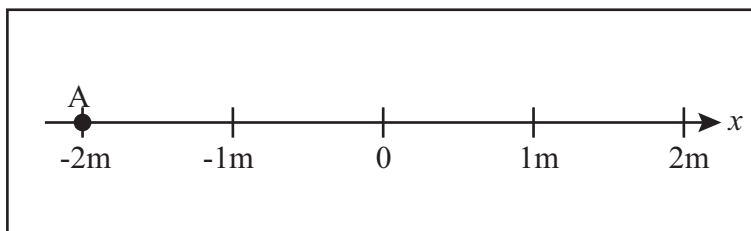Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: notunderconsideration - Andrew's item 8 wording was better
Revision of: KD1-9. Changes: JCS: changed velocity to direction and magnitude

Problem 23: (KD1-9-V3)

An object moves along the x axis. The object is initially at point A, which is at $x = -2$m, as shown in the diagram above. The x component of the velocity is positive and constant.

Select the response that best describes the motion of the object.

   A. The object moves to the left.
   B. The object moves to the right.
   C. The object moves to the right until it reaches the origin and then stops.
   D. The object moves to the right until it reaches the origin, stops, then moves to the left.

Provides Evidence for Average Velocity 1D - JCS2-5
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Status: new - I am not sure about this one
Revision of: KD1-9. Changes: Changed problem wording changed wording to match KD1-8-V3 Notes: Unsure about subsequent in version KD1-8-V3

Problem 24: (KD1-10)
At time t_A, an object is at point A at $x = +1$m along the positive x axis. The object is moving is the negative x direction with velocity -2m/s.

What is the speed of the object?

   A. 1m/s
   B. -1m/s
   C. 2m/s
   D. -2m/s

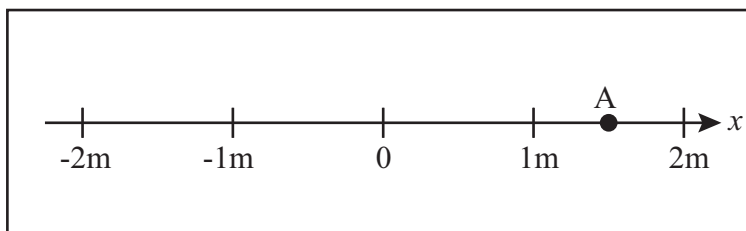Provides Evidence for Speed - JCS9-1
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K2) position along axis
Knowledge Model: (K27) speed
Status: active -

Problem 25: (KD1-10-V2)

At time zero, an object is at point A along the positive x axis as shown in the figure above. The object is moving is the left of the page with a velocity with magnitude 2m/s. Select the following which best describes the speed and velocity of the object?

A. The speed and the velocity are equal; speed and velocity mean the same thing.
B. The speed is 2m/s and does not have a direction while the velocity has a magnitude of 2m/s and points to the left of the page.
C. The velocity is 2m/s and does not have a direction while the speed has a magnitude of 2m/s and points to the left of the page.

Provides Evidence for Speed - JCS9-1
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Knowledge Model: (K27) speed
Status: notunderconsideration -
Revision of: KD1-10. Changes: Added figure and more textual distractors

Problem 26: (KD1-10-V3)
Object A moves with a velocity of 2m/s to the north. Object B moves with a velocity of 2m/s to the south. Which of the following best describes the speeds and velocities of the objects?

A. Object A and Object B have the same speed and velocity.
B. Object A and Object B have the same speed but different velocities.
C. Object A and Object B have different speeds, but the same velocity.
D. Object A and Object B have different speeds and different velocities.

Provides Evidence for Speed - JCS9-1
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K6) direction north-south
Knowledge Model: (K27) speed
Status: has newer version - OSU pretest
Revision of: KD1-10. Changes: AH: Changed statement to use North/South Should be view as different item Notes: Removed word "relative"

Problem 27: (KD1-10-V6EC)
Object A moves at a rate of 2m/s to the north. Object B moves at a rate of 2m/s to the south. Which of the following best describes the speeds and velocities of the objects?

A. Object A and Object B have the same speed and velocity.
B. Object A and Object B have the same speed but different velocities.
C. Object A and Object B have different speeds, but the same velocity.
D. Object A and Object B have different speeds and different velocities.

Provides Evidence for Speed - JCS9-1
Knowledge Model: (K21) velocity 1D
Knowledge Model: (K6) direction north-south
Knowledge Model: (K27) speed
Status: has newer version -
Revision of: KD1-10-V3. Changes: replaced "moves at a velocity of" with "moves at a rate of" Notes: Removed word "relative" Notes: JCS: The rate of wording seems inconsistent with other items

Problem 28: (KD1-10-V7EC)
Object A moves at a rate of 2m/s to the north. Object B moves at a rate of 2m/s to the south. Which of the following best describes the speeds and velocities of the objects?

    A. Object A and Object B have the same speed, and Object A and Object B have the same velocity.
    B. Object A and Object B have the same speed, but Object A and Object B have different velocities.
    C. Object A and Object B have different speeds, but Object A and Object B have the same velocity.
    D. Object A and Object B have different speeds, and Object A and Object B have different velocities.

Provides Evidence for Speed - JCS9-1
Knowledge Model: (K21) velocity 1D
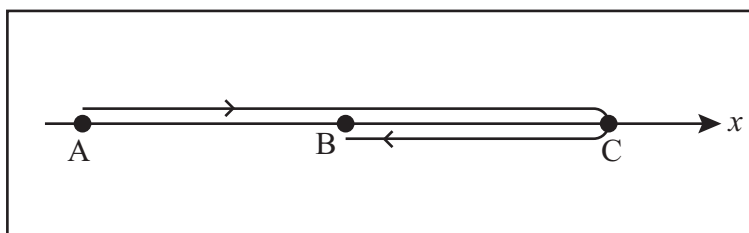Knowledge Model: (K6) direction north-south
Knowledge Model: (K27) speed
Status: active -
Revision of: KD1-10-V3. Changes: replaced "moves at a velocity of" with "moves at a rate of" Notes: Removed word "relative" Notes: JCS: The rate of wording seems inconsistent with other items

Problem 29: (KD1-11-V6EC)

The figure above shows the trajectory of an object that starts at point A, travels to the right with a constant velocity in the x direction of $+1$m/s until it reaches point C, then reverses direction and travels to the left with a constant velocity in the x direction of -1m/s to point B.

Select the response which best represents the relation of the average speed of the object and the average velocity in the x direction over the entire trajectory.

    A. The average speed and the average velocity are equal.
    B. The average speed is greater than the average velocity.
    C. The average speed is less than the average velocity.

Provides Evidence for Average Speed - JCS10-2
Knowledge Model: (K74) Relation trajectory curve and total distance traveled
Knowledge Model: (K19) Relation trajectory curve and displacement
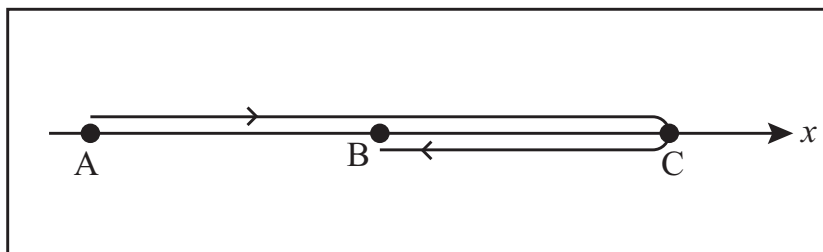Knowledge Model: (K26) 1D average velocity
Knowledge Model: (K27) speed
Knowledge Model: (K8) vector as signed number
Distractors: Exhaustive
Status: unknown - Not sure how this is different from KD1-11

Problem 30: (KD1-11)

The figure above shows the trajectory of an object that starts at point A, travels to the right with a constant velocity in the x direction of $+1$m/s until it reaches point C, then reverses direction and travels to the left with a constant velocity in the x direction of -1m/s to point B.

Select the response which best represents the relation of the average speed of the object between points A an B and the average velocity in the x direction over the entire trajectory.

   A. The average speed and the average velocity are equal.
   B. The average speed is greater than the average velocity.
   C. The average speed is less than the average velocity.

Provides Evidence for Average Speed - JCS10-2
Knowledge Model: (K74) Relation trajectory curve and total distance traveled
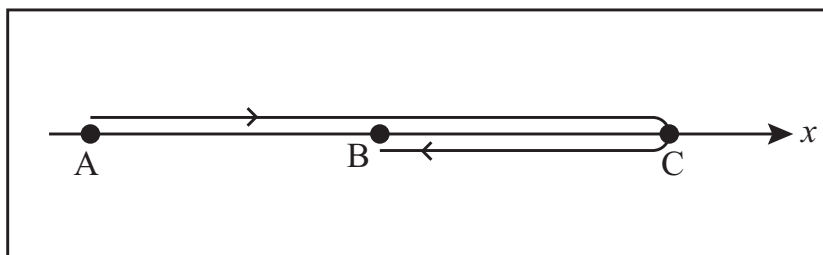Knowledge Model: (K19) Relation trajectory curve and displacement
Knowledge Model: (K26) 1D average velocity
Knowledge Model: (K27) speed
Distractors: Exhaustive
Status: active -

Problem 31: (KD1-11-V2)

The figure above shows the trajectory of an object that starts at point A, travels to the right with a constant velocity with magnitude 1m/s until it reaches point C, then reverses direction and travels to the left with a constant velocity with magnitude 1m/s until it reaches point B. Select the response which best represents the relation of the average speed of the object between points A an B and the magnitude of the average velocity in the x direction between points A and B.

A. The average speed and the average velocity are equal.
B. The average speed is greater than the average velocity.
C. The average speed is less than the average velocity.

Provides Evidence for Average Speed - JCS10-2
Knowledge Model: (K74) Relation trajectory curve and total distance traveled
Knowledge Model: (K19) Relation trajectory curve and displacement
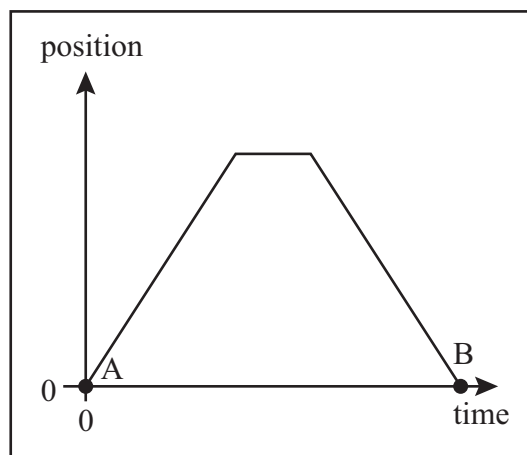Knowledge Model: (K26) 1D average velocity
Knowledge Model: (K27) speed
Distractors: Exhaustive
Status: notunderconsideration -
Revision of: KD1-11. Changes: Changed wording to remove signed velocity

Problem 32: (KD1-12)

The position versus time graph of an object moving along the x axis is shown above. The object starts at point A at time zero.

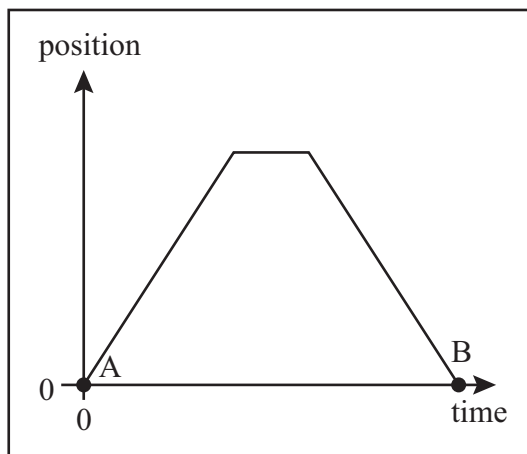Select the response below that best describes its motion after time zero.

A. The object first moves in the positive x direction at constant velocity, then stops moving, then moves in the negative x direction with constant velocity.
B. The object first moves in the positive x direction at constant velocity, then stops moving, then moves in the positive x direction with constant velocity.
C. The object first moves in the positive x direction with increasing velocity, then moves with in the positive x direction with constant velocity, then moves in the positive x direction with negative velocity increasing in magnitude with time.

Provides Evidence for Constant Velocity Kinematics - JCS11-2
Knowledge Model: (K34) slope is velocity
Status: active -

Problem 33: (KD1-12-V2)

The position versus time graph of an object moving along the x axis is shown above. The object starts at point A at time zero. Select the response below that best describes its motion after time zero.

A. The object first moves in the positive x direction at constant velocity, then stops moving, then moves in the negative x direction with constant velocity.
B. The object first moves in the positive x direction at constant velocity, then stops moving, then moves in the positive x direction with constant velocity.
C. The object first moves in the positive x direction with increasing velocity, then moves with in the positive x direction with constant velocity, then moves in the positive x direction with a negative velocity that increases in magnitude with time.

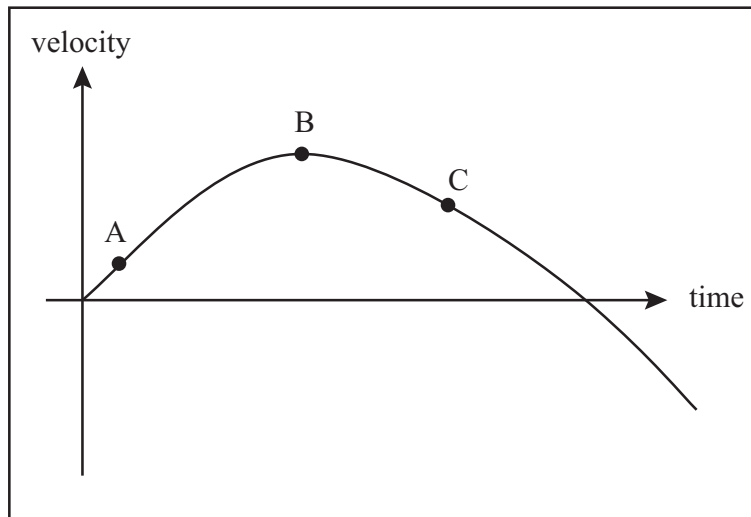Provides Evidence for Constant Velocity Kinematics - JCS11-2
Knowledge Model: (K34) slope is velocity
Knowledge Model: (K45) horizontal line represents constant velocity
Status: notunderconsideration -
Revision of: KD1-12. Changes: Changed wording to remove signed velocity

Problem 34: (KD1-13)

An object moves along the x axis. The figure above shows the graph of the velocity of the object as a function of time. Select the inequality which represents the relation of the acceleration in the x direction, a, at points A, B, and C.

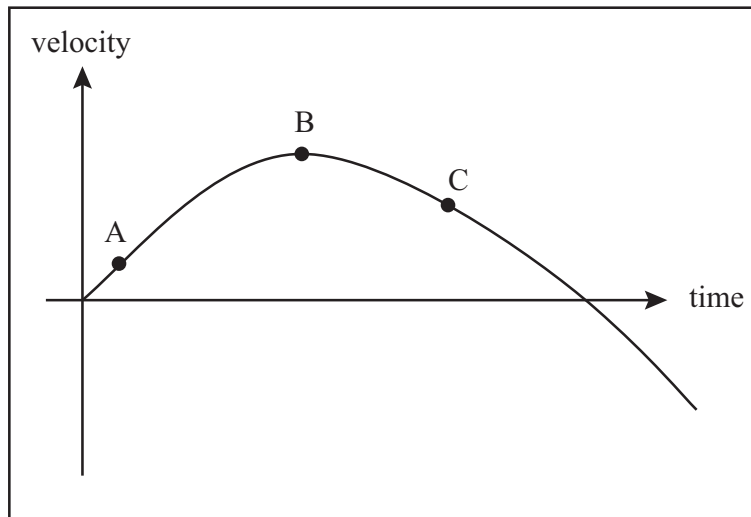   A. $a_B > a_C > a_A$
   B. $a_C > a_A > a_B$
   C. $a_A > a_B > a_C$

Provides Evidence for acceleration 1D - JCS12-1
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K8) vector as signed number
Status: has newer version -

Problem 35: (KD1-13-V2)

An object moves along the x axis. The figure above shows the graph of the velocity of the object as a function of time. Select the response that best describes the relation of the acceleration in the x direction, a, at points A, B, and C.

A. The magnitude of the acceleration is largest at B and points in the positive x direction. The magnitude of the acceleration at C is smaller than at B but larger than A and points in the positive x direction. The magnitude of the acceleration at A is the smallest and points in the positive x direction.

B. The magnitude of the acceleration is largest at B and points in the positive x direction. The magnitude of the acceleration at C is smaller than at B but larger and A and points in the negative x direction. The magnitude of the acceleration at A is the smallest and points in the positive x direction.

C. The magnitude of the acceleration is largest at A and points in the positive x direction, the magnitude of the acceleration at C is smaller than at A and points in the negative x direction. The magnitude of the acceleration at B is approximately zero.

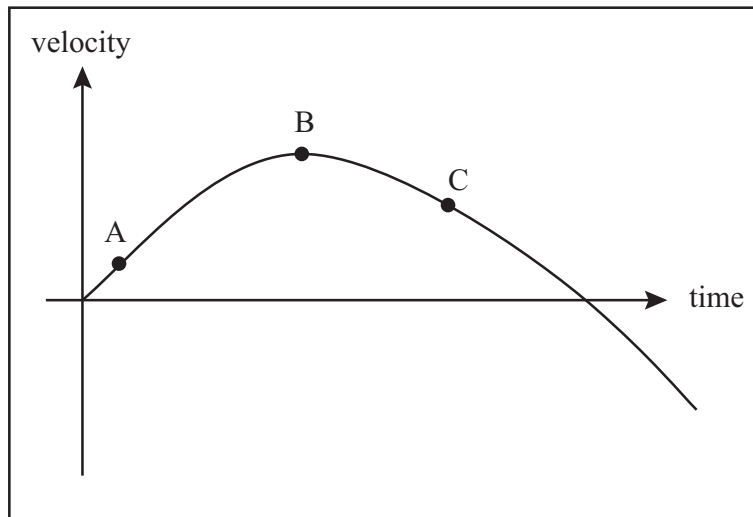Provides Evidence for acceleration 1D - JCS12-1
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K4) magnitude and direction
Status: notunderconsideration - Distractors too wordy.
Revision of: KD1-13. Changes: Changed distractors to defocus signed acceleration.

Problem 36: (KD1-13-V3)

An object moves along the x axis. The figure above shows the graph of the velocity of the object as a function of time.

At which point is the magnitude of the acceleration the greatest?

   A. Point A
   B. Point B
   C. Point C

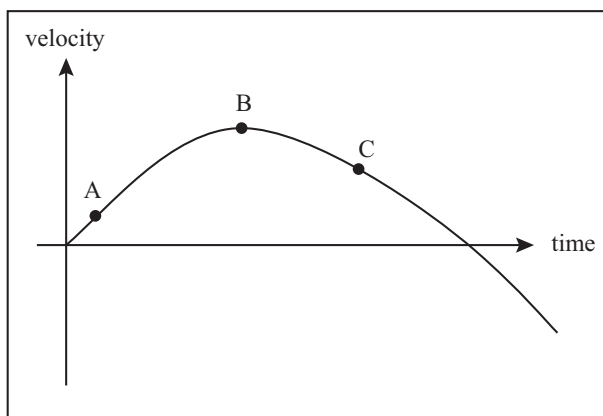Provides Evidence for acceleration 1D - JCS12-1
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K7) magnitude
Status: active - OSU pretest
Revision of: KD1-13. Changes: AH: Changed problem to test magnitude of acceleration. Not sure figure makes relative magnitude clear.

Problem 37: (KD1-13-V4EC)

An object moves along the x axis. The figure above shows the graph of the velocity of the object as a function of time.

Select the inequality that represents the relation of a, the acceleration in the x direction, at points A, B, and C.

   A. $a_B > a_C > a_A$
   B. $a_C > a_A > a_B$
   C. $a_A > a_B > a_C$
   D. $a_C > a_A > a_B$
   E. $a_C = a_A = a_B$

Provides Evidence for acceleration 1D - JCS12-1
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K8) vector as signed number Notes: Additional distractor needed to account for students who considered only the steepness of the slope, not the direction.
Status: active - Not sure where this stands in retesting.
Revision of: KD1-13. Changes: Changed distractors.

Problem 38: (KD1-13-V5EC)
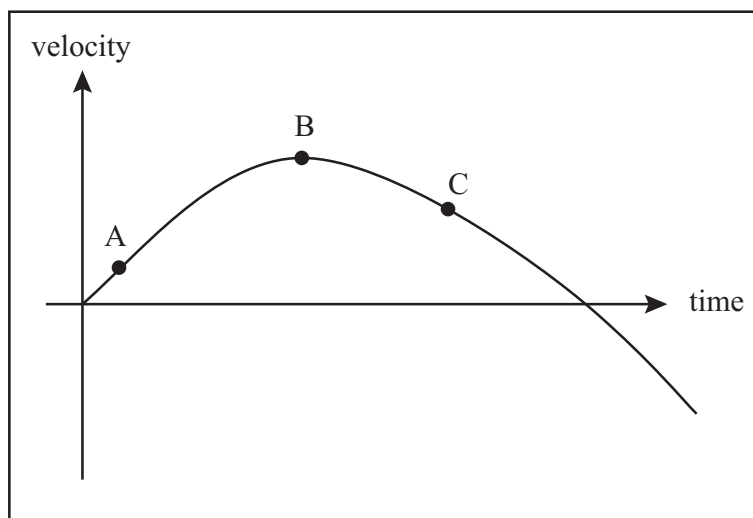
An object moves along the x axis. The figure above shows the graph of the velocity of the object as a function of time. Select the response that best describes the relation of the acceleration in the x direction, a, at points A, B, and C.

A. magnitude of the acceleration at B > magnitude of the acceleration at C > magnitude of acceleration at A
and
The accelerations at B, C, and A all point in the positive x direction.

B. magnitude of acceleration at B > magnitude of acceleration at C > magnitude of acceleration at A.
and
The accelerations at B and A point in the positive x direction, and the acceleration at C points in the negative x direction.

C. magnitude of acceleration at A > magnitude of acceleration at C > magnitude of acceleration at B.
and
The acceleration at A points in the positive direction. The acceleration at C points in the negative direction. The acceleration at B is approximately zero.

Provides Evidence for acceleration 1D - JCS12-1
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K4) magnitude and direction
Status: notunderconsideration - Distractors too wordy.
Revision of: Attempted rewrite of KD1-13-V2 to separate information and reduce wordiness. Changes:
Revision of: KD1-13. Changes: Changed distractors to defocus signed acceleration.

Problem 39: (KD1-14)
An object moves in the positive x direction along the x axis. When the object passes through $x = +1$m, the object has a positive velocity of $v = +2$m/s. When the object passes through $x = +2$m, the object has a positive velocity of $v = +1$m/s.

Select the response which best describes the average acceleration in the x direction of the object between the two points.

A. The object's average acceleration is zero.
B. The object's average acceleration is positive.
C. The object's average acceleration is negative.
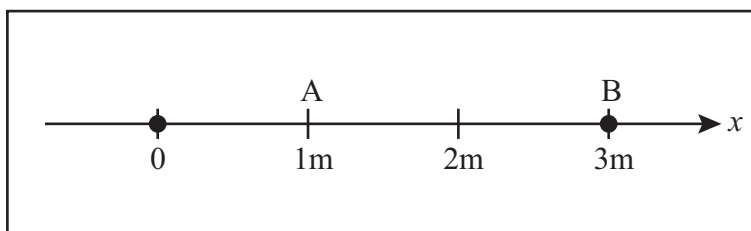
Provides Evidence for average acceleration 1D - JCS13-2
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K60) average acceleration 1D Notes: added commas
Status: active -

Problem 40: (KD1-14-V2)

An object moves in the positive x direction along the x axis as shown above. When the object passes through point A, the object has a positive velocity. When the object passes through point B, the object has a positive velocity of half the magnitude of the velocity at point A.

Select the response which best describes the average acceleration in the x direction of the object between points A and B.

A. The object's average acceleration is zero.
B. The object's average acceleration is positive.
C. The object's average acceleration is negative.

Provides Evidence for average acceleration 1D - JCS13-2
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K60) average acceleration 1D
Status: new - This is an interesting modification
Revision of: KD1-14. Changes: Changed to remove numeric velocity

Problem 41: (KD1-14-V3)
An object moves along the x axis. When the object passes through $x = +1$m the object has a velocity of $v = +2$m/s in the positive x direction. When the object passes through $x = +2$m the object has a velocity of $v = +1$m/s in the positive x direction. Select the response which best describes the average acceleration of the object between the two points.

A. The object's average acceleration is zero.
B. The object's average acceleration is in the positive x direction.
C. The object's average acceleration is in the negative x direction.

Provides Evidence for average acceleration 1D - JCS13-2
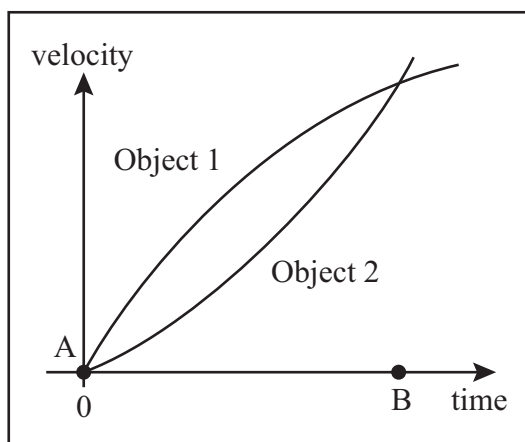Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K60) average acceleration 1D
Status: inactive - Minor wording changes which were made to KD1-14
Revision of: KD1-14. Changes: Reworded in the same way as the original item

Problem 42: (KD1-15)

Two objects, Object 1 and 2, move along the x axis. The figure above shows their velocity as a function of time. Compare the distance traveled by each object between time A and time B. The two curves in the figure cross at point B.
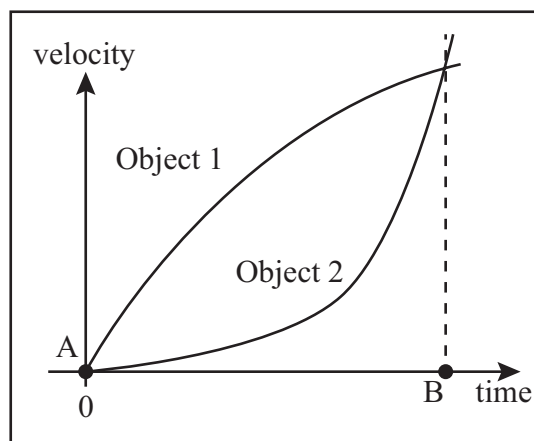
A. The distance traveled is the same for both objects.
B. Object 1 travels farther than Object 2.
C. Object 2 travels farther than Object 1.

Provides Evidence for velocity 1D - JCS7-6
Knowledge Model: (K46) area under velocity-time graph is displacement
Status: has newer version -

Problem 43: (KD1-15-V2EC)

Two objects, Object 1 and 2, move along the x axis. The figure above shows their velocity as a function of time.

Compare the distance traveled by each object between time A and time B.

  A. The distance traveled is the same for both objects.
  B. Object 1 travels farther than Object 2.
  C. Object 2 travels farther than Object 1.

Provides Evidence for velocity 1D - JCS7-6
Knowledge Model: (K46) area under velocity-time graph is displacement
Status: active -
Revision of: KD1-15. Changes: Broke symmetry in figure Notes: Figure modified. Dotted line from B added as some students indicated uncertainty about whether time B corresponds to where curves cross. Object 2's curve has been modified as a couple of students thought that the curves being mirror images of each other was a/the salient detail. (Curious if this change will impact anything in student problem-solving.)

Problem 44: (KD1-16)
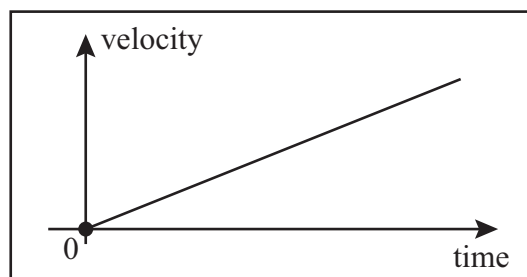
The figure above shows the velocity of an object as a function of time.

Select the response which best describes the velocity of the object and the acceleration of the object. The object moves in one dimension.

  A. The velocity and acceleration are constant.
  B. The velocity and acceleration increase with time.
  C. The velocity is constant and acceleration increases with time.
  D. The velocity increases with time and acceleration is constant.

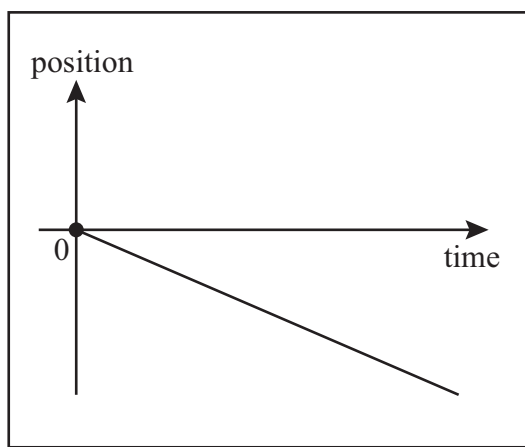Provides Evidence for distinguish 1D kinematic concepts - JCS14-1
Provides Evidence for velocity 1D - JCS7-7
Provides Evidence for acceleration 1D - JCS12-2
Knowledge Model: (K44) straight line represents constant acceleration
Knowledge Model: (K21) velocity 1D
Status: active - Notes: JCS- 5/31/24 - conformed wording to be "as a function of time"

Problem 45: (KD1-17-V3AH)

The figure above shows how the position of an object changes with time. Compare the velocity of the object with the acceleration of the object.

  A. The velocity and acceleration both decrease in magnitude with time.
  B. The velocity and acceleration are constant. Both are less than zero.
  C. The velocity is constant and negative while the acceleration is constant and positive.
  D. The velocity is constant and negative while the acceleration zero.

Provides Evidence for distinguish 1D kinematic concepts - JCS14-1
Provides Evidence for velocity 1D - JCS7-8
Provides Evidence for acceleration 1D - JCS12-3
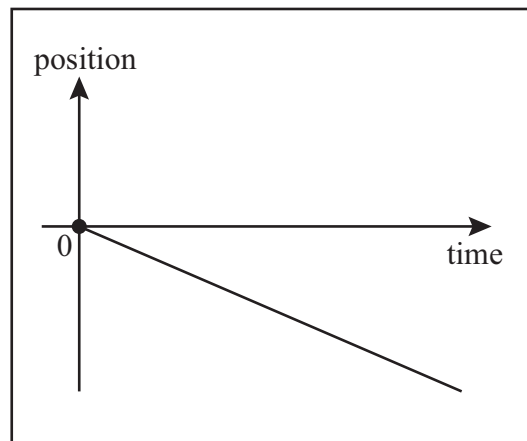Knowledge Model: (K35) straight line represents constant velocity
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K8) vector as signed number
Status: active -

Revision of: KD1-17. Changes:

Problem 46: (KD1-17)

The figure above shows how the position of an object changes with time. Compare the velocity of the object with the acceleration of the object. The object moves in one dimension.

  A. The velocity and acceleration are constant. Both are greater than zero.
  B. The velocity and acceleration both decrease in magnitude with time.
  C. The velocity and acceleration are constant. Both are less than zero.
  D. The velocity is constant and negative while the acceleration is constant and positive.
  E. The velocity is constant and negative while the acceleration zero.

Provides Evidence for distinguish 1D kinematic concepts - JCS14-1
Provides Evidence for velocity 1D - JCS7-8
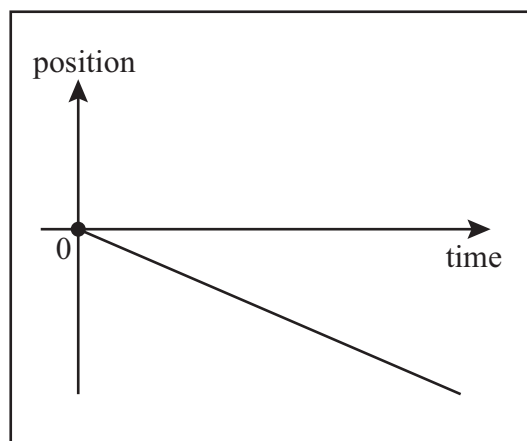Provides Evidence for acceleration 1D - JCS12-3
Knowledge Model: (K35) straight line represents constant velocity
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K8) vector as signed number
Status: has newer version - AH: Distractor set reworked.

Problem 47: (KD1-17-V2EC)

The figure above shows the position of an object as a function of time. Compare the velocity of the object with the acceleration of the object.

   A. The velocity and acceleration are constant. Both are greater than zero.
   B. The velocity and acceleration both decrease in magnitude with time.
   C. The velocity and acceleration are constant. Both are less than zero.
   D. The velocity is constant and negative while the acceleration is constant and positive.
   E. The velocity is constant and negative while the acceleration is zero.

Provides Evidence for distinguish 1D kinematic concepts - JCS14-1
Provides Evidence for velocity 1D - JCS7-8
Provides Evidence for acceleration 1D - JCS12-3
Knowledge Model: (K35) straight line represents constant velocity
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K8) vector as signed number
Status: active -
Revision of: KD1-17. Changes: Removed "Changes with time" wording Notes: I don't love the changes with time wording. Changed to be consistent with phrasing in KD-1-24 Notes: My ninth graders tended to arrive trained that "compare" means give similarities and only similarities. That didn't seem to be an issue with WVU 111 and 112 students, but might be worth exploring with other populations.

Problem 48: (KD1-18)
An object moves in one dimension, along the x-axis. The object is at $x = -1$m on the x axis at time $t = 0$. The object's velocity at time $t = 0$ is positive. The object travels along the x axis with a constant positive acceleration in the x direction.

Select the response which best describes the motion of the object at times after $t = 0$.

   A. The object moves in the positive x direction with increasing speed.
   B. The object moves in the negative x direction with increasing speed.
   C. The object moves in the positive x direction with constant speed.

D. The object moves in the positive x direction with decreasing speed until it stops. Then it remains stationary.

E. The object moves in the positive x direction with decreasing speed until it stops. Then it travels in the negative x direction with increasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
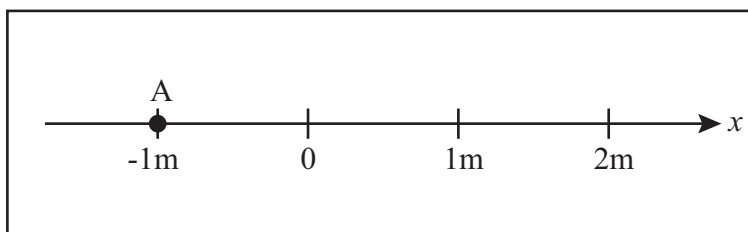Status: active -
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K77) qualitative trajectory from signs of acceleration and velocity Notes: JCS 5/25/2024 - An changed to the at beginning of second sentence. Notes: EC 5/31/2024 "It, then" changed to "Then it"

Problem 49: (KD1-18-V2)

An object is at the point A on the negative x axis at time $t = 0$ as shown in the figure above. The object's velocity at time $t = 0$ is positive. The object travels along the x axis with a constant positive acceleration in the x direction. Select the response which best describes the motion of the object at times after $t = 0$.

A. The object moves in the positive x direction with increasing speed.
B. The object moves in the negative x direction with increasing speed.
C. The object moves in the positive x direction with constant speed.
D. The object moves in the positive x direction with decreasing speed until it stops. It, then, remains stationary.
E. The object moves in the positive x direction with decreasing speed until it stops. It, then, travels in the negative x direction with increasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K77) qualitative trajectory from signs of acceleration and velocity
Status: notunderconsideration -

Problem 50: (KD1-18-V3)
An object moves in one dimension, along the x-axis. At time $t = 0$, the object is at $x = -1$m on the x-axis.

The object's velocity is negative at time $t = 0$, and the object has constant positive acceleration. Select the response which best describes the motion of the object.

  A. At $t = 0$, the object moves in the negative x direction with increasing speed.
  B. At $t = 0$, the object moves in the negative x direction with decreasing speed.
  C. At $t = 0$, the object moves in the negative x direction with constant speed.
  D. At $t = 0$, the object moves in the positive x direction with constant speed.
  E. At $t = 0$, the object moves in the positive x direction with decreasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K53) relation of signs of acceleration and velocity
Status: has newer version -
Revision of: KD1-18. Changes: AH: Changed sign of velocity making it different item.

Problem 51: (KD1-18-V4EC)
An object moves in one dimension, along the x-axis. At time $t = 0$, the object is at $x = -1$m on the x-axis. The object's velocity is negative at time $t = 0$, and the object has constant positive acceleration. Select the response which best describes the motion of the object.

  A. At $t = 0$, the object moves in the negative x direction with increasing speed.
  B. At $t = 0$, the object moves in the negative x direction with decreasing speed.
  C. At $t = 0$, the object moves in the negative x direction with constant speed.
  D. At $t = 0$, the object moves in the positive x direction with increasing speed.
  E. At $t = 0$, the object moves in the positive x direction with decreasing speed.
  F. At $t = 0$, the object moves in the positive x direction with constant speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K53) relation of signs of acceleration and velocity
Status: active -
Revision of: KD1-18. Changes: AH: Changed sign of velocity making it different item.
Revision of: KD1-18-V3. Changes: added additional distractor for symmetry of distractor set and reordered distractors

Problem 52: (KD1-18-V5EC)
An object moves in one dimension, along the x-axis. At time $t = 0$, the object is at $x = -1$m on the x-axis. The object's velocity is negative at time $t = 0$, and the object has constant positive acceleration. Select the response which best describes the motion of the object at $t = 0$.

  A. The object moves in the negative x direction with increasing speed.
  B. The object moves in the negative x direction with decreasing speed.
  C. The object moves in the negative x direction with constant speed.

D. The object moves in the positive x direction with increasing speed.
E. The object moves in the positive x direction with decreasing speed.
F. The object moves in the positive x direction with constant speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K53) relation of signs of acceleration and velocity
Status: active -
Revision of: KD1-18. Changes: AH: Changed sign of velocity making it different item.
Revision of: KD1-18-V3. Changes: added additional distractor for symmetry of distractor set and reordered distractors

Problem 53: (KD1-19)
An object moves in one dimension, along the x-axis. An object is at $x = +1$m on the x axis at time $t = 0$. The object's velocity at time $t = 0$ is positive. The object travels with a constant negative acceleration.

Select the response which best describes at motion of the object at times after $t = 0$.

A. The object moves in the positive x direction with increasing speed.
B. The object moves in the negative x direction with increasing speed.
C. The object moves in the positive x direction with constant speed.
D. The object moves in the positive x direction with decreasing speed until it stops. It, then, remains stationary.
E. The object moves in the positive x direction with decreasing speed until it stops. It, then, travels in the negative x direction with increasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
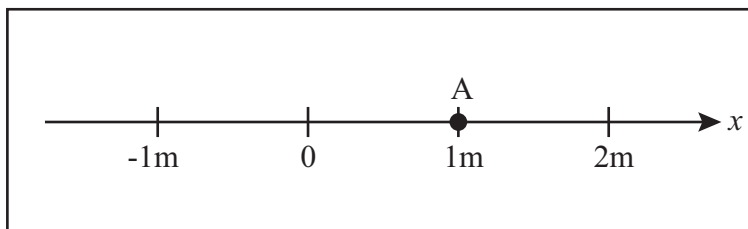Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K77) qualitative trajectory from signs of acceleration and velocity
Status: active -

Problem 54: (KD1-19-V2)

An object is at point A on the positive x axis at time $t = 0$ as shown in the figure above. The object's velocity at time $t = 0$ is positive. The object travels along the x axis with a constant acceleration in the negative x direction. Select the response which best describes at motion of the object at times after $t = 0$. Note, the speed of an object is always positive.

A. The object moves in the positive x direction with increasing speed.
B. The object moves in the negative x direction with increasing speed.
C. The object moves in the positive x direction with constant speed.
D. The object moves in the positive x direction with decreasing speed until it stops. It, then, remains stationary.
E. The object moves in the positive x direction with decreasing speed until it stops. It, then, travels in the negative x direction with increasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K77) qualitative trajectory from signs of acceleration and velocity
Status: new -
Revision of: KD1-19. Changes: Added figure

Problem 55: (KD1-19-V3)
An object moves in one dimension, along the x-axis. At time $t = 0$, the object is at $x = +1$m on the x-axis. The object's velocity is positive at time $t = 0$, and the object has constant negative acceleration.

Select the response which best describes the motion of the object, starting at $t = 0$.

A. The object moves in the negative x direction with increasing speed until it eventually stops, then travels in the positive x direction with decreasing speed.
B. The object moves in the positive x direction with decreasing speed until it eventually stops, then travels in the negative x direction with increasing speed.
C. The object moves in the positive x direction with decreasing speed until it eventually stops, then continues to travel in the positive x direction with decreasing speed.
D. The object moves in the negative x direction with decreasing speed until it eventually stops, then travels in the positive x direction with decreasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K77) qualitative trajectory from signs of acceleration and velocity
Status: active -
Revision of: KD1-19. Changes: Distractors substantially changed

Problem 56: (KD1-20)
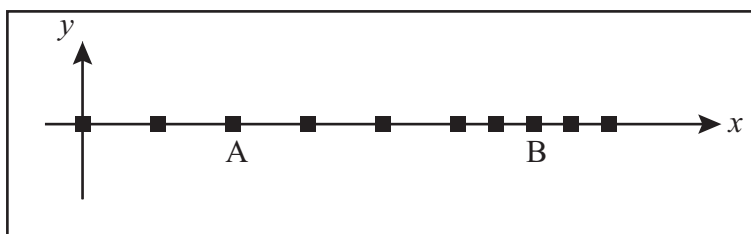
The figure above shows the motion of an object in the positive x direction. The location of the object is indicated by a set of squares. Each sequential square is one second apart in time. Select the response which best describes the average acceleration in the x direction of the object between point A and point B.

  A. The average acceleration is zero.
  B. The average acceleration is positive.
  C. The average acceleration is negative.

Provides Evidence for average velocity 1D - JCS2-2
Provides Evidence for average acceleration 1D - JCS13-2
Knowledge Model: (K60) average acceleration 1D
Knowledge Model: (K31) 1D average velocity and motion diagrams
Knowledge Model: (K8) vector as signed number
Status: has newer version -

Problem 57: (KD1-20-V2EC)
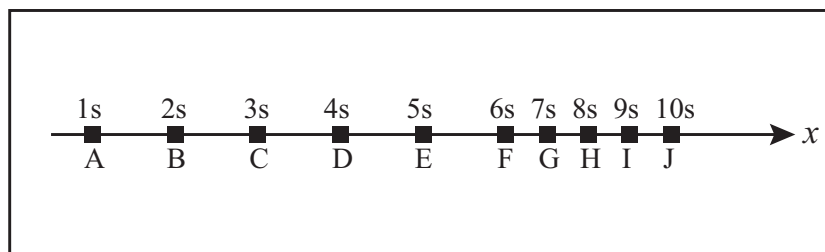
The figure above shows the motion of an object in the positive x direction. The position of the object is indicated by a set of squares. Each sequential square is one second apart in time.

Select the response which best describes the average acceleration of the object between point C and point H.

  A. The average acceleration is zero.
  B. The average acceleration is positive.
  C. The average acceleration is negative.

Provides Evidence for average velocity 1D - JCS2-2
Provides Evidence for average acceleration 1D - JCS13-2

Knowledge Model: (K60) average acceleration 1D
Knowledge Model: (K31) 1D average velocity and motion diagrams
Knowledge Model: (K8) vector as signed number
Status: active -
Revision of: KD1-20. Changes: Modified figure to clarify problem

Problem 58: (KD1-21)
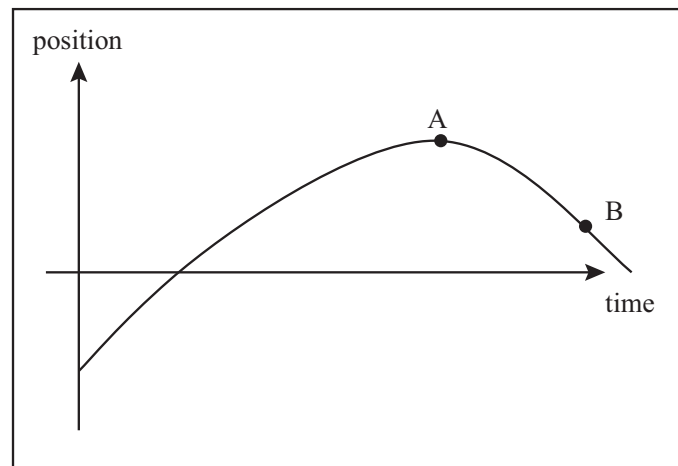
The figure above shows the graph of the position of an object with respect to time.

Compare the magnitude of the acceleration of the object at point A and B.

   A. The magnitude of the acceleration is approximately equal at points A and B.
   B. The magnitude of the acceleration is larger at point A than point B.
   C. The magnitude of the acceleration is larger at point B than point A.

Provides Evidence for acceleration 1D - JCS12-3
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K7) magnitude
Status: has newer version -

Problem 59: (KD1-21-V2)
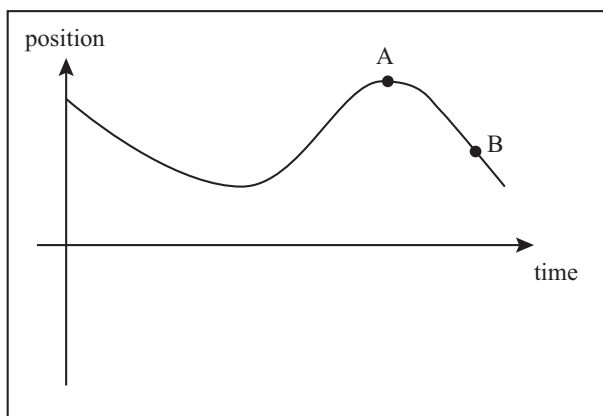
The figure above shows the graph of the position of an object as a function of time.

Compare the magnitude of the acceleration of the object at point A and B.

  A. The magnitude of the acceleration is approximately equal at points A and B.
  B. The magnitude of the acceleration is larger at point A than point B.
  C. The magnitude of the acceleration is larger at point B than point A.

Provides Evidence for acceleration 1D - JCS12-3
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K7) magnitude
Status: active -
Revision of: KD1-21. Changes: Notes: JCS- 5/31/24 - conformed wording to be "as a function of time"

Problem 60: (KD1-22)
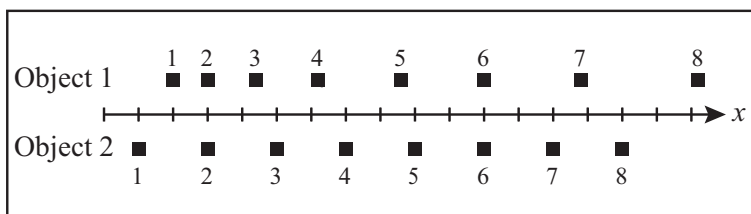
The figure above shows the position of two objects moving in the positive x direction. The time interval between each numbered square is one second. Do the objects ever have the same speed?

  A. No. The objects never have the same speed.
  B. The objects have the same speed at points 2 and 6.
  C. The objects have the same speed somewhere between points 2 and 5.

Provides Evidence for average velocity 1D - JCS2-2 Source: FCI 19
Knowledge Model: (K31) 1D average velocity and motion diagrams

Knowledge Model: (K27) speed
Status: has newer version -

Problem 61: (KD1-22-V2EC)
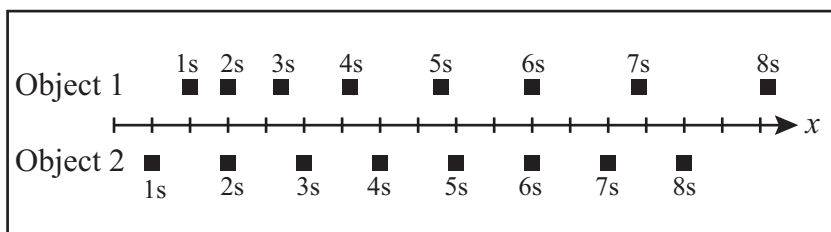
The figure above shows the position of two objects moving in the positive x direction. The time interval between each numbered square is one second.

Do the objects ever have the same speed?

    A. No. The objects **never** have the same speed.
    B. The objects have the same speed **at** points 2s and 6s.
    C. The objects have the same speed somewhere **between** points 2s and 5s.

Provides Evidence for average velocity 1D - JCS2-2
Knowledge Model: (K31) 1D average velocity and motion diagrams
Knowledge Model: (K27) speed Source: FCI 19 Notes: Modified figure by adding s to indicate numbers are seconds.
Status: active -
Revision of: KD1-22. Changes: Modified figure. bolded words to call attention to the difference in phrasing between choices B and C as students often did not notice without multiple reads

Problem 62: (KD1-23-V2)
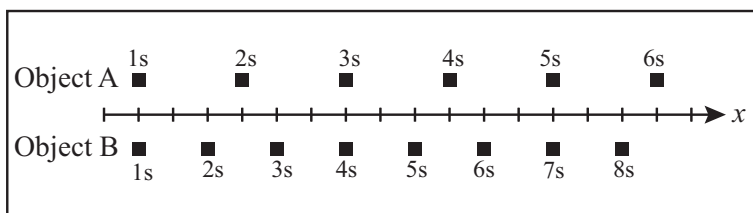
The figure above shows the position of two objects moving in the positive x direction. The time interval between each numbered square is one second.

Select the response that best describes the relation of the acceleration of the two objects.

    A. The acceleration of object A is greater than the acceleration of object B.

B. The acceleration of objects A and B are equal. Both accelerations are greater than zero.
C. The acceleration of object B is greater than the acceleration of object A.
D. The acceleration of objects A and B are equal. Both accelerations are zero.
E. The acceleration of objects A and B are equal. Both accelerations are less than zero.

Provides Evidence for average velocity 1D - JCS2-2 Source: FCI 20 Notes: Version 1 of figure had an error. This was revised to produce version 2 without retaining version 1. Notes: On May 28, 2024 changed choice E from "Not enough information is given to answer the question."
Status: active -
Knowledge Model: (K32) equally spaced points represents constant velocity
Knowledge Model: (K60) average acceleration 1D

Problem 63: (KD1-24)
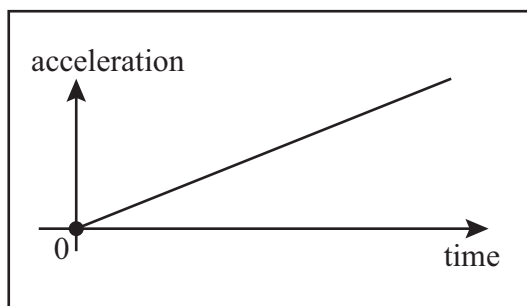
The figure above shows the acceleration of an object as a function of time. The object moves along the x axis. The positive direction is to the right of the page. The object is at the origin and has a positive velocity at time zero.

Select the response which best describes the motion of the object after time zero.

A. The object moves to the right speeding up at a constant rate.
B. The object moves to the right slowing down at a constant rate.
C. The object moves to the right with constant speed.
D. The object moves to the right speeding up at an increasing rate.
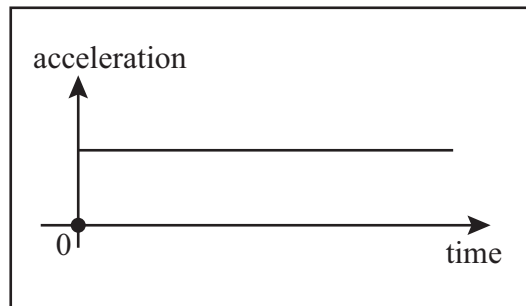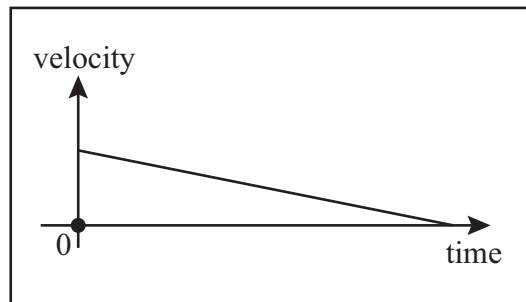E. The object moves to the right speeding up at an decreasing rate.

Provides Evidence for acceleration 1D - JCS12-4
Knowledge Model: (K27) speed
Knowledge Model: (K62) slope and changing acceleration Source: FMCE 22-26
Status: active -

Problem 64: (KD1-25)

The figure above shows the acceleration of an object as a function of time. The object moves along the x axis. The object is at the origin and has a positive velocity at time zero.

Select the response which best describes the motion of the object.

  A. The object is stationary.
  B. The object moves to the right speeding up at a constant rate.
  C. The object moves to the right with constant speed.
  D. The object moves to the right speeding up at an increasing rate.
  E. The object moves to the right slowing down at a constant rate.

Provides Evidence for acceleration 1D - JCS12-4
Knowledge Model: (K27) speed
Knowledge Model: (K63) horizontal line represents constant acceleration Source: FMCE 22-26
Status: active -

Problem 65: (KD1-26)

The figure above shows the velocity of an object as a function of time. The object moves along the x axis. The positive direction is to the right.

Select the response which best describes the motion of the object.

  A. The object moves to the left with constant speed.
  B. The object moves to the right with constant speed.

C. The object moves to the left with decreasing speed.
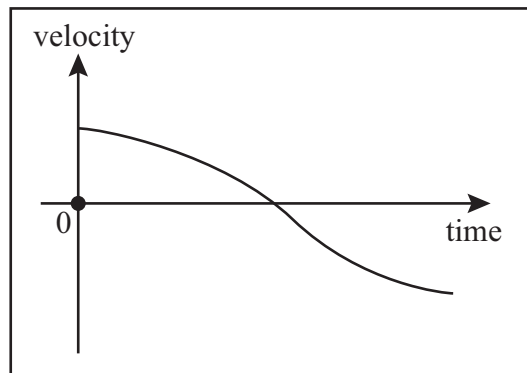D. The object moves to the right with decreasing speed.

Provides Evidence for acceleration 1D - JCS12-4 Source: FMCE 40-43
Knowledge Model: (K27) speed
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Status: requires revision -

Problem 66: (KD1-27)
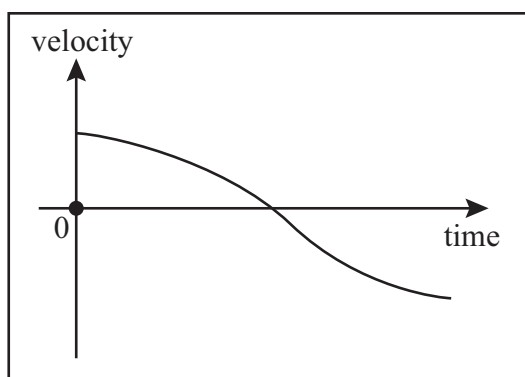
The figure above shows the velocity of an object as a function of time. The object moves along the x axis. The positive direction is to the right.

Select the response which best describes the motion of the object.

A. The object moves to the right with decreasing speed.
B. The object moves to the right with constant speed.
C. The object moves to the right with decreasing speed until it changes direction and moves to the left.

Provides Evidence for velocity 1D - JCS7-7 Source: FMCE 40-43
Knowledge Model: (K27) speed
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Status: requires revision -

Problem 67: (KD1-27-V2)

The figure above shows the velocity of an object as a function of time. The object moves along the x axis. The positive direction is to the right. Select the response which best describes the motion of the object.

  A. The object moves to the right with decreasing speed.
  B. The object moves to the right and then goes below level ground.
  C. The object moves to the right with decreasing speed until it changes direction and moves to the left.

Provides Evidence for velocity 1D - JCS7-7 Source: FMCE 40-43
Knowledge Model: (K27) speed
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Status: notunderconsideration -
Revision of: KD1-27. Changes: Very similar to prior version

Problem 68: (KD1-28)
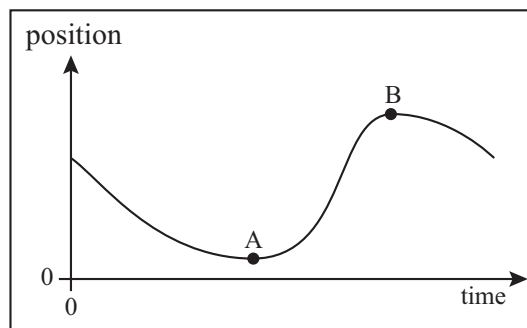
The figure above shows the position of an object traveling along the x axis as a function of time.

Select the response that best describes the acceleration of the object at point A and at point B.

  A. The acceleration at point A is approximately equal to the acceleration at point B. Both are zero.
  B. The acceleration at point A is less than the acceleration at point B. Both are positive.
  C. The acceleration at point A is negative and the acceleration at point B is positive.
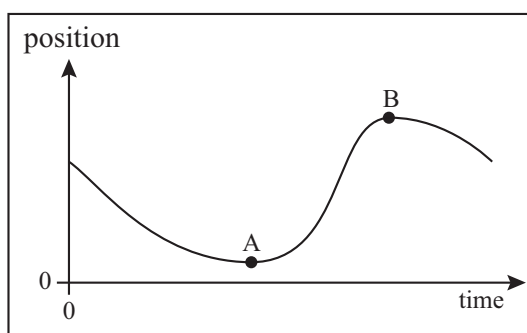
D. The acceleration at point A is positive and the acceleration at point B is negative.

Knowledge Model: (K8) vector as signed number
Knowledge Model: (K39) Curvature position-time graph is acceleration Notes: Not sure whether to add information about negative and positive acceleration and expand to 5 choices Notes: JCS: Changed distractors to include positive and negative acceleration.
Status: active -

Problem 69: (KD1-28-V2AH)

The figure below shows the position of an object traveling along the x axis as a function of time.

Select the response that best describes a_A the acceleration of the object at point A, and a_B

 A. $a_A = a_B = 0$
 B. $a_A < a_B$. Both are positive.
 C. a_A is negative, and a_B is positive.
 D. a_A is positive, and a_B is negative.

Knowledge Model: (K8) vector as signed number
Knowledge Model: (K39) Curvature position-time graph is acceleration
Status: active -
Revision of: KD1-28. Changes: V2AH: reworded stem and answers to be more symbolic

Problem 70: (KD1-29)
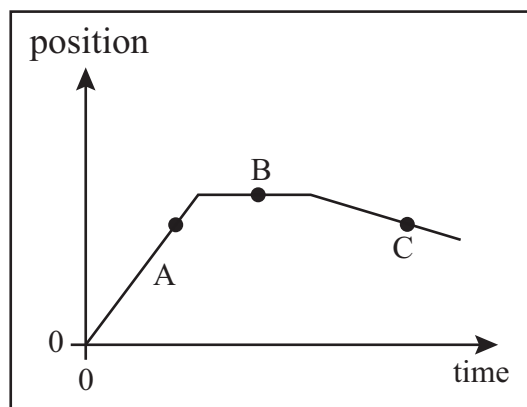
44

An object moves along the x axis. The figure above shows the graph of the position along the x axis as a function of time. Three locations on the plot have been marked.

Select the inequality below that best represents the relation of the speed at points A, B, and C.

    A. $\text{speed}_A = \text{speed}_B = \text{speed}_C$
    B. $\text{speed}_A > \text{speed}_C > \text{speed}_B$
    C. $\text{speed}_C > \text{speed}_B > \text{speed}_A$
    D. $\text{speed}_C > \text{speed}_A > \text{speed}_B$
    E. $\text{speed}_B > \text{speed}_A > \text{speed}_C$

Provides Evidence for Instantaneous velocity 1D - JCS7-1
Knowledge Model: (K27) speed
Knowledge Model: (K34) slope is velocity Notes: New problem to assess speed using a position-time graph.
Notes: After Spr 24 tests, updated typo in first sentence from positive to position.
Status: active -

Problem 71: (KD1-30)
An object has a constant negative velocity in the x direction at time $t = 0$s. The object travels for a total of 10 seconds.

When will the object's displacement be one-half of what the displacement will be at $t = 10$s?

    A. $t = 5$s
    B. $t < 5$s
    C. $t > 5$s

Knowledge Model: (K50) constant velocity kinematic equation 1D
Status: notunderconsideration -

Problem 72: (KD1-31)
An object has a positive velocity in the x direction and a constant positive acceleration in the x direction

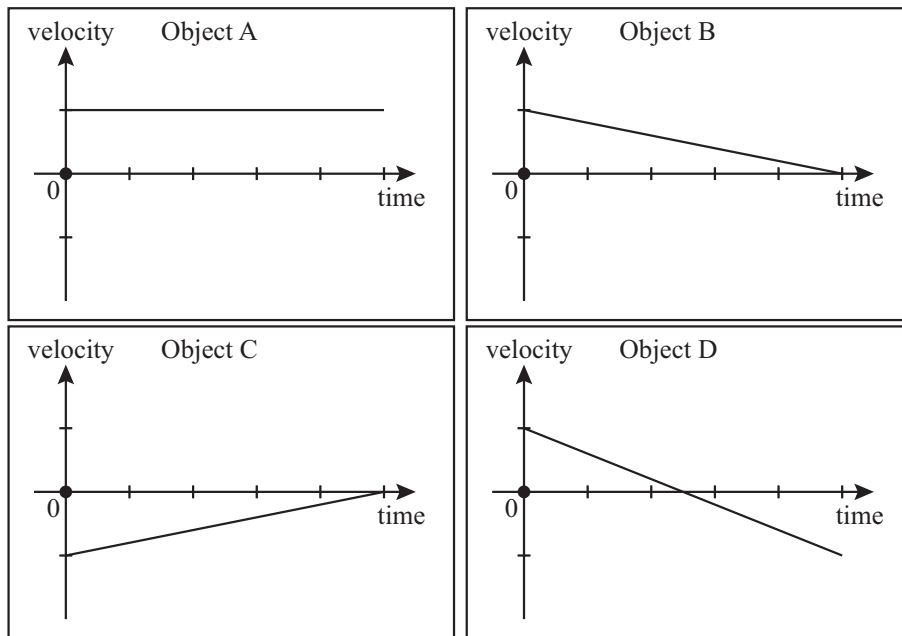at time $t = 0$s. The object travels for a total of 10 seconds.

When will the object's displacement be one-half of what the displacement will be at $t = 10$s?

    A. $t = 5$s
    B. $t < 5$s
    C. $t > 5$s

Knowledge Model: (K70) displacement under constant acceleration (acceleration form)
Status: notunderconsideration -

Problem 73: (KD1-32)

Four objects travel along the x axis. Each figure above shows the velocity along the x axis of a different object as a function of time. All graphs are plotted on the same scale.

Select the response that best describes the relationship of the displacements of the objects over the entire time shown.

    A. displacement$_A$ > displacement$_B$ > displacement$_C$ > displacement$_D$
    B. displacement$_A$ > displacement$_B$ = displacement$_C$ > displacement$_D$
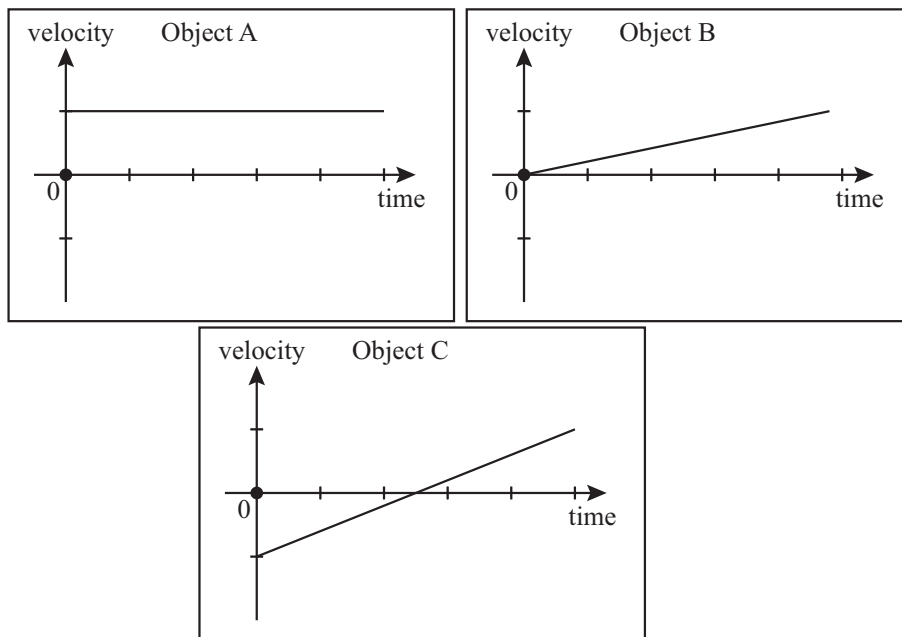   C. displacement$_A$ > displacement$_B$ > displacement$_D$ > displacement$_C$

Knowledge Model: (K8) vector as signed number
Knowledge Model: (K46) area under velocity-time graph is displacement

Problem 74: (KD1-32-V3AH)
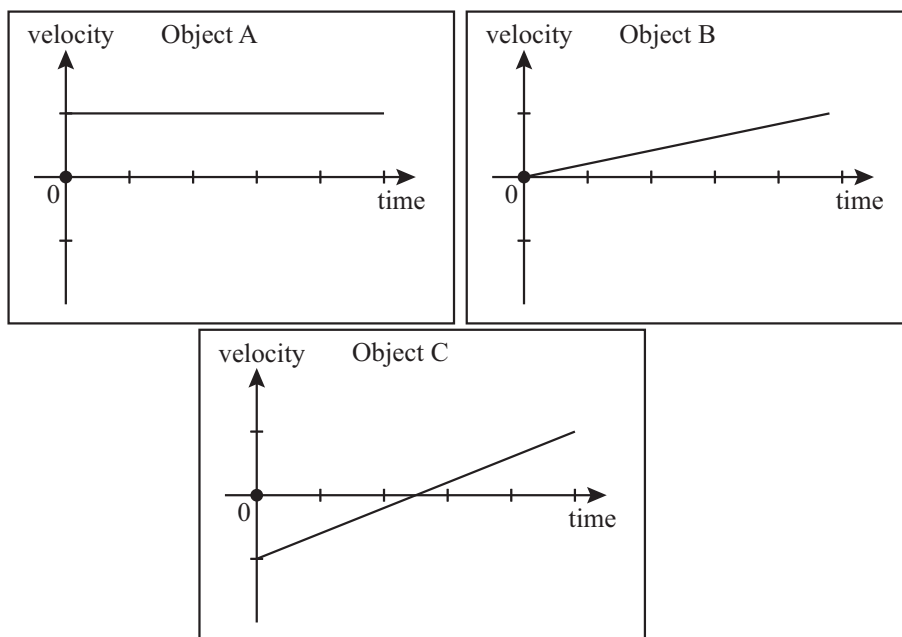
Three objects travel along the x axis. The figures above shows the velocity along the x axis of each object as a function of time. All graphs are plotted on the same scale.

Select the response that best describes the relationship of the displacements of the objects over the entire time shown.

    A. displacement$_A$ > displacement$_B$ > displacement$_C$
    B. displacement$_A$ = displacement$_B$ = displacement$_C$
    C. displacement$_B$ > displacement$_A$ = displacement$_C$
    D. displacement$_B$ = displacement$_C$ > displacement$_A$

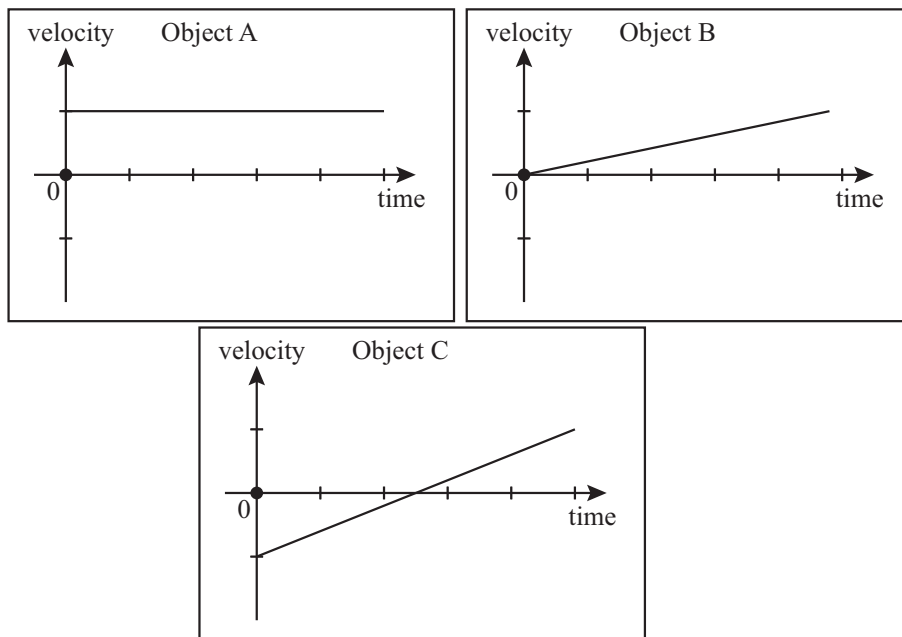Knowledge Model: (K8) vector as signed number
Knowledge Model: (K46) area under velocity-time graph is displacement
Status: active -
Revision of: KD1-32. Changes: AH: changed graph and responses Notes: JCS: 5/25/2024 Each figure changed to The figures in second sentence.

Problem 75: (KD1-32-V4EC)

velocity   Object A

0   time

velocity   Object B

0   time

velocity   Object C

0   time

Three objects travel along the x axis. The figures above show the velocity along the x axis of each object as a function of time. All graphs are plotted on the same scale.

Select the response that best describes the relationship of the displacements of the objects over the entire time shown.

    A. displacement$_A$ > displacement$_B$ > displacement$_C$
    B. displacement$_A$ = displacement$_B$ = displacement$_C$
    C. displacement$_A$ = displacement$_C$ > displacement$_B$
    D. displacement$_B$ > displacement$_A$ = displacement$_C$
    E. displacement$_B$ = displacement$_C$ > displacement$_A$

Knowledge Model: (K8) vector as signed number
Knowledge Model: (K46) area under velocity-time graph is displacement
Status: active -
Revision of: KD1-32. Changes: AH: changed graph and responses
Revision of: KD1-32-V3AH. Changes: added additional distractor and may continue to add on rolling basis after student sessions Notes: JCS: 5/25/2024 Each figure changed to The figures in second sentence. Notes: fixed subject-verb agreement problem introduced by JCS

Problem 76: (KD1-32-V4EC)

velocity   Object A

0   time

velocity   Object B

0   time

velocity   Object C

0   time

Three objects travel along the x axis. The figures above show the velocity along the x axis of each object as a function of time. All graphs are plotted on the same scale.

Select the response that best describes the relationship of the displacements of the objects over the entire time shown.

    A. $\text{displacement}_A > \text{displacement}_B > \text{displacement}_C$
    B. $\text{displacement}_A = \text{displacement}_B = \text{displacement}_C$
    C. $\text{displacement}_A = \text{displacement}_C > \text{displacement}_B$
    D. $\text{displacement}_B > \text{displacement}_A = \text{displacement}_C$
    E. $\text{displacement}_B = \text{displacement}_C > \text{displacement}_A$

Knowledge Model: (K8) vector as signed number
Knowledge Model: (K46) area under velocity-time graph is displacement
Status: active -
Revision of: KD1-32. Changes: AH: changed graph and responses
Revision of: KD1-32-V3AH. Changes: added additional distractor and may continue to add on rolling basis after student sessions Notes: JCS: 5/25/2024 Each figure changed to The figures in second sentence. Notes: fixed subject-verb agreement problem introduced by JCS

Problem 77: (KD1-34)
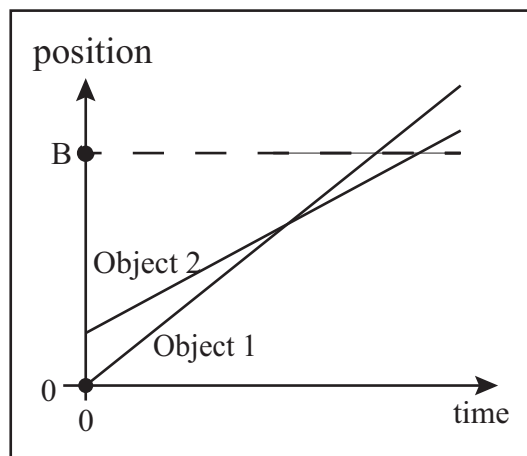
The figure above shows the position of two different objects as a function of time.
Select the response that best describes how the motion of Object 2 differs from the motion of Object 1.

   A. Object 2 begins at a positive position while object 1 begins at the origin. Both objects travel in the
      positive direction with constant velocities, but object 1 is going faster. Object 1 passes object 2 and
      arrives at position B first.
   B.
   C.

Notes: Need to see how students respond. Give as open response.
Status: active -
Knowledge Model: (K35) straight line represents constant velocity

Problem 78: (KD1-35)
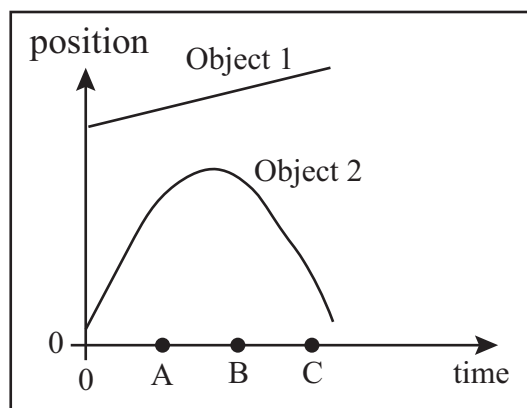
The figure above shows the position of two different objects as a function of time.

Do the two objects ever have the same velocity?

    A. No, the two objects never have the same velocity.
    B. The objects have the same velocity at time A.
    C. The two objects have the same velocity at some time between time A and time B.
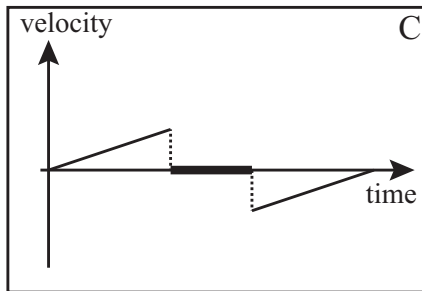
Knowledge Model: (K34) slope is velocity
Status: active -

Problem 79: (KD1-35-V3AH)
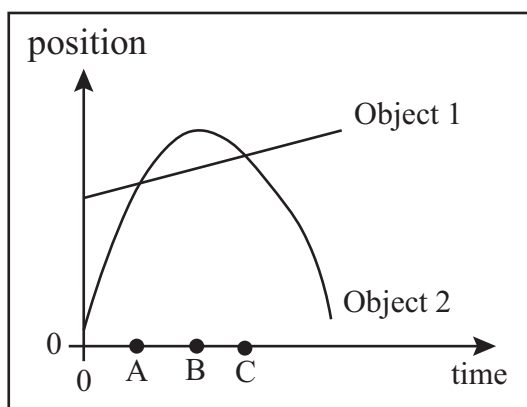
The figure below shows the position of two different objects as a function of time.

Do the two objects ever have the same velocity?

    A. No, the two objects never have the same velocity.
    B. Yes, the objects have the same velocity at times A and C.
    C. Yes, the two objects have the same velocity at some time between time A and time B.
    D. No, because two objects have different accelerations.
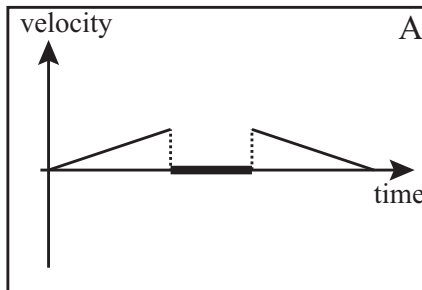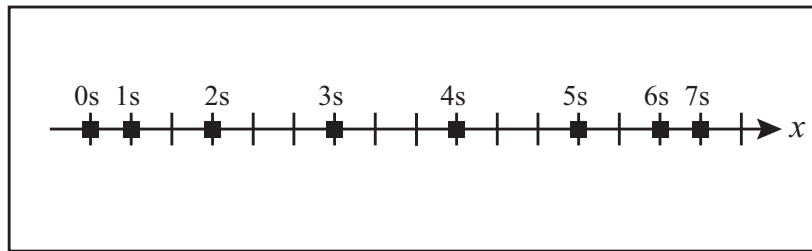
Knowledge Model: (K34) slope is velocity
Status: active -
Revision of: KD1-35. Changes: ah: changed graph and responses

Problem 80: (KD1-36)
The top figure shows the position of an object moving in the x direction. The time interval between each pair of consecutive squares is one second.

Which of the graphs best represents the object's velocity as a function of time?
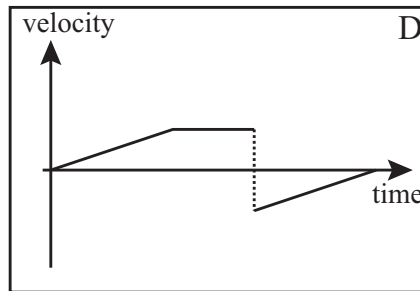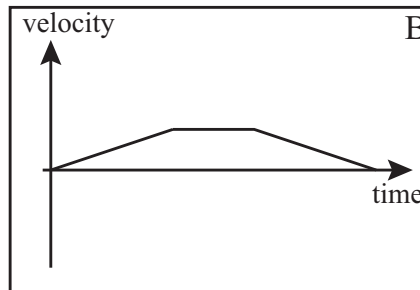
0s 1s   2s   3s   4s   5s   6s 7s x

velocity   A
time

velocity   B
time

velocity   C
time

velocity   D
time

Status: active -
Knowledge Model: (K45) horizontal line represents constant velocity
Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K31) 1D average velocity and motion diagrams
Knowledge Model: (K32) equally spaced points represents constant velocity
Knowledge Model: (K8) vector as signed number Notes: 36: At OSU graphs are randomly ordered and chosen directly (not labelled A,B,C,D

Problem 81: (KD1-37)
An object is initially moving in the positive x direction with a constant negative acceleration.

Which of the following could be a graph of the object's position as a function of time?

position   A   position   B

0   0
0   time   0   time

position   C   position   D

0   0
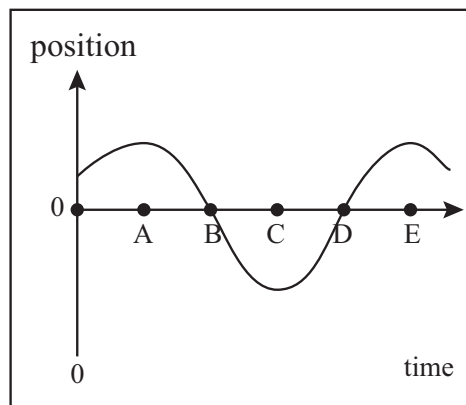0   time   0   time
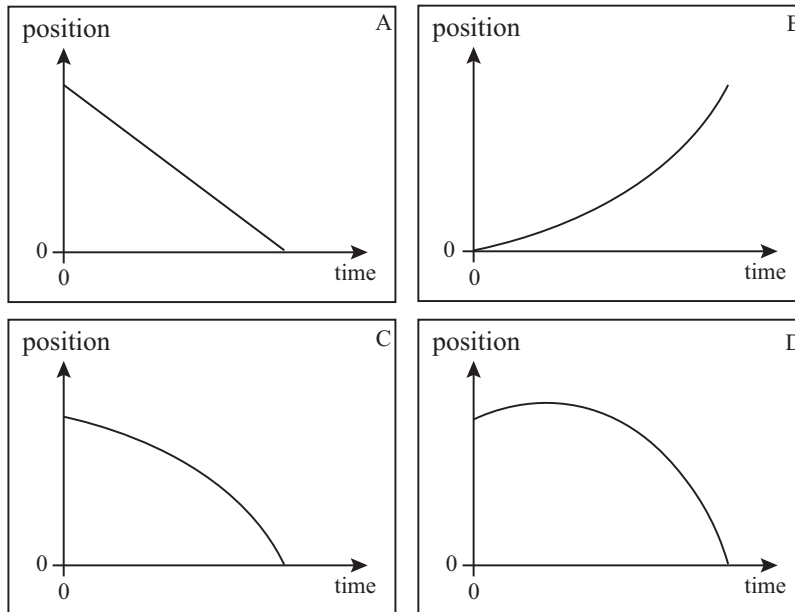
Notes: adapted from Mazur Ch. 3 checkpoint 3
Knowledge Model: (K53) relation of signs of acceleration and velocity
Knowledge Model: (K34) slope is velocity
Status: active -

Problem 82: (KD1-38-V6EC)

position

0
   A   B   C   D   E

0   time

An object is moving along the x axis. The position of the object as a function of time is shown in the figure above.

When does the object turn around?

A. At times A and E
B. At times B and D
C. At time C
D. At times A, C, and E
E. At times A, B, C, D, and E

Knowledge Model: (K38) Velocity at turning point - $x - t$ Notes:
Revision of: KD1-38. Changes: EC:turn around tested as more clear than change direction of motion with WVU students
Status: active -

Problem 83: (KD1-38)
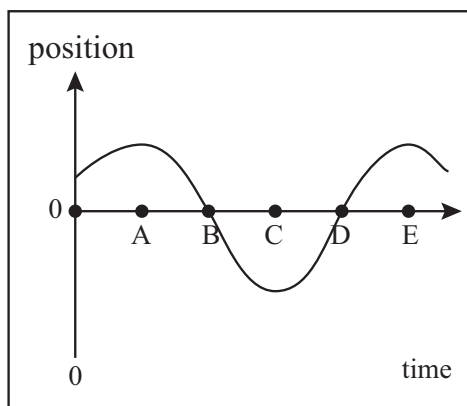
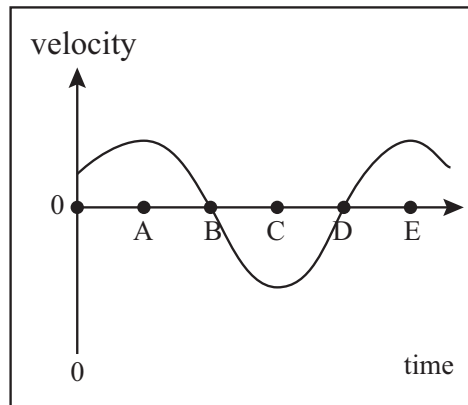An object is moving along the x axis. The position of the object as a function of time is shown in the figure above.

When does the object change its direction of motion?

A. At times A and E
B. At times B and D
C. At time C
D. At times A, C, and E
E. At times A, B, C, D, and E

Knowledge Model: (K38) Velocity at turning point - $x - t$
Status: has newer version - Notes:

Problem 84: (KD1-38-V3AH)

An object is moving along the x axis. The velocity of the object as a function of time is shown in the figure above.

When does the object change its direction of motion?
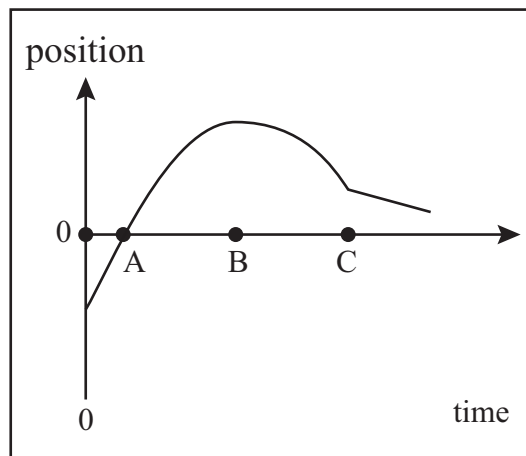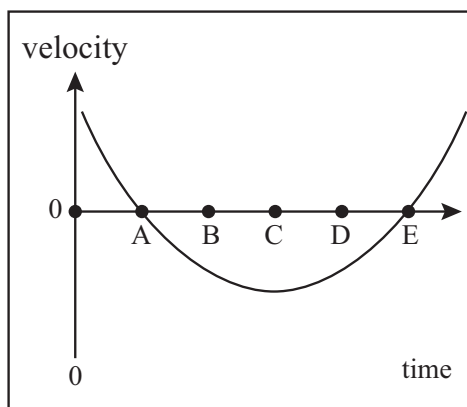
   A. At times A and E
   B. At times B and D
   C. At time C
   D. At times A, C, and E
   E. At times A, B, C, D, and E

Status: active -
Knowledge Model: (K47) Turning points velocity-time
Revision of: KD1-38. Changes: ah:changed vertical axis label, changed text, omitted a response choice

Problem 85: (KD1-39-V3AH)

An object is moving along the x axis. The velocity of the object as a function of time is shown in the figure below.

When does the object change its direction of motion?

A. At time A.
B. At time B.
C. At time C.

Knowledge Model: (K47) Turning points velocity-time
Revision of: KD1-39. Changes: ah:changed graph and vertical axis label, changed text and responses. Figure dramatically changed, may be new version.
Status: active -

Problem 86: (KD1-39)

An object is moving along the x axis. The velocity of the object as a function of time is shown in the figure above.

When does the object change its direction of motion?

A. At times A and E
B. At times B and D
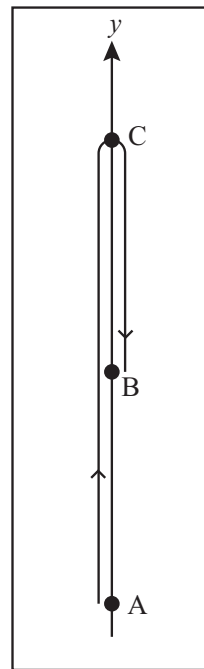C. At time C

Knowledge Model: (K47) Turning points velocity-time
Status: active -

Problem 87: (KD1-40)

An object is launched straight upwards in the positive y direction. Its trajectory is shown in the figure to the right.

Select the response that best describes the object's velocity and acceleration at point C.

A. At point C, the object's velocity in the y direction is zero, and its acceleration in the y direction is zero.
B. At point C, the object's velocity in the y direction is positive and it's acceleration is negative.
C. At point C, the object's velocity in the y direction is zero and its acceleration in the y direction is negative.
D. At point C, the object's velocity in the y direction is negative, and its acceleration in the y direction is negative.

Knowledge Model: (K18) trajectory diagram
Knowledge Model: (K22) velocity at turning point is zero.
Knowledge Model: (K8) vector as signed number
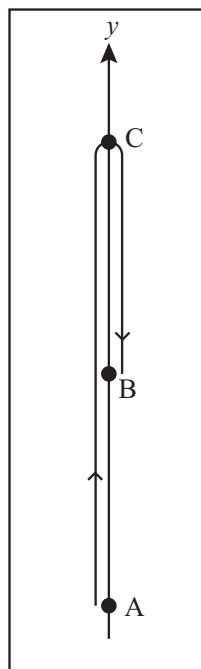Knowledge Model: (K55) acceleration at turning point is non-zero.
Status: active -

Problem 88: (KD1-40-V3AH)

An object is launched straight upwards in the positive y direction. Its trajectory is shown in the figure below.

Select the response that best describes the object's velocity and acceleration at **point C**.

A. The object's velocity in the y direction is zero, and its acceleration in the y direction is zero.
B. The object's velocity in the y direction is positive and it's acceleration is negative.
C. The object's velocity in the y direction is zero and its acceleration in the y direction is negative.
D. The object's velocity in the y direction is negative, and its acceleration in the y direction is negative.

Knowledge Model: (K18) trajectory diagram
Knowledge Model: (K22) velocity at turning point is zero.
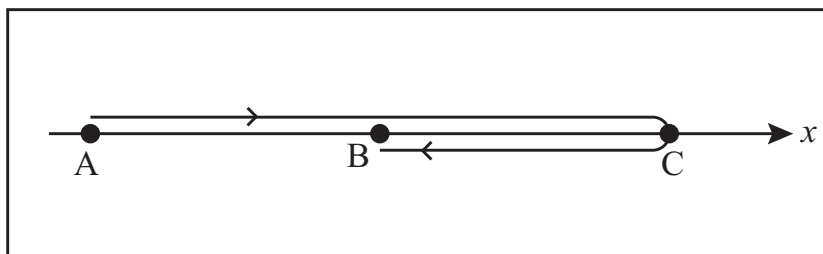Knowledge Model: (K8) vector as signed number
Knowledge Model: (K55) acceleration at turning point is non-zero.
Revision of: KD1-40. Changes: AH: reworded (simplified) responses
Status: has newer version -

Problem 89: (KD1-40-V4EC)

The figure below shows the path of an object that starts at point A, travels to the right along the x axis until it reaches point C, then reverses direction and travels to the left along the x axis to point B.

Select the response that best describes the object's velocity and acceleration at **point C**.

A. The object's velocity in the x direction is zero, and its acceleration in the x direction is zero.

B. The object's velocity in the x direction is positive, and its acceleration is negative.
C. The object's velocity in the x direction is zero, and its acceleration in the x direction is negative.
D. The object's velocity in the x direction is negative, and its acceleration in the x direction is negative.

Knowledge Model: (K18) trajectory diagram
Knowledge Model: (K22) velocity at turning point is zero.
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K55) acceleration at turning point is non-zero.
Revision of: KD1-40. Changes: AH: reworded (simplified) responses
Revision of: KD1-40. Changes: EC: adjusted to horizontal trajectory Notes: 5/31/2024 EC regularized commas Notes: updated based on AH feedback to include written description of motion; JCS and EC believe trajectory
Status: active -

Problem 90: (KD1-41)
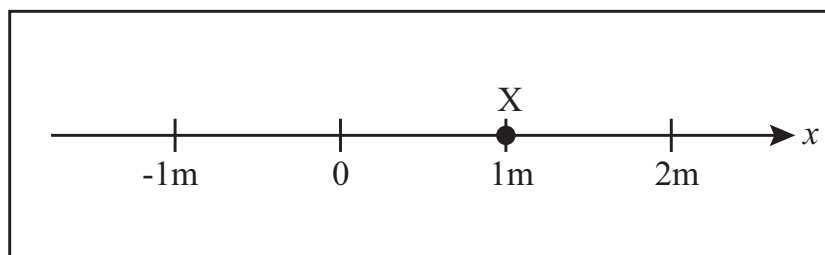
An object moves along the x axis as shown above. When it passes the point X, it has velocity +2m/s.

Which of the following could be true about the acceleration at point X?

A. The acceleration is not zero and points to the right.
B. The acceleration is not zero and points to the left.
C. The acceleration is zero.
D. Both A and B are possible.
E. Both A and C are possible.
F. Both A and D are possible.
G. A, B, and C are possible.

Knowledge Model: (K57) the magnitude or direction of acceleration cannot be determined from velocity at point
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis Notes: Added distractor to match KD1-42 revision Notes: pn May 28, 2024 changed from "What can be said about the acceleration at point X?" wording to wording paralleling that of KD1-42-V6EC, which students found less confusing in qualitative testing
Status: active - Source: FVA-17

Problem 91: (KD1-42-V6EC)
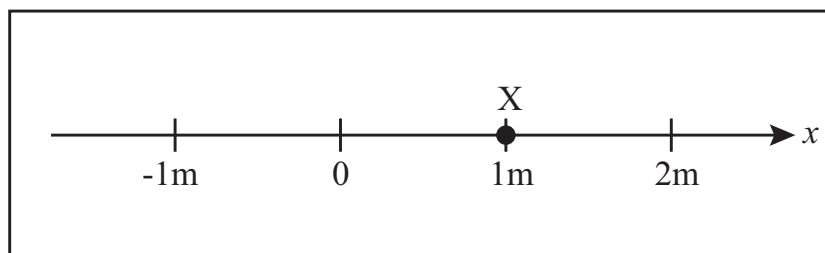
An object moves along the x axis as shown above. It is traveling either to the left or the right. When it passes the point X, it has acceleration $+2\text{m/s}^2$.

Which of the following could be true about the motion of the object when it passes through point X?

   A. The object is moving to the right and its speed is increasing.
   B. The object is moving to the right and its speed is decreasing.
   C. The object is moving to the left and its speed is increasing.
   D. The object is moving to the left and its speed is decreasing.
   E. Both A and B are possible.
   F. Both A and C are possible.
   G. Both A and D are possible.
   H. A, B, C, and D are possible.

Knowledge Model: (K56) direction of velocity and change in velocity cannot be determined from acceleration
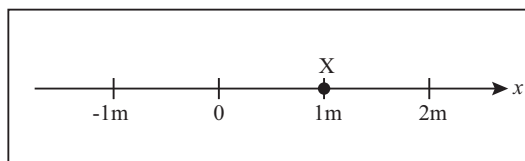Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Knowledge Model: (K27) speed Source: FVA-8
Status: active -
Revision of: KD1-42-V6EC. Changes:

Problem 92: (KD1-42)

An object moves along the x axis as shown above. It is traveling either to the left or the right. When it passes the point X, it has acceleration $+2\text{m/s}^2$.

What is the most that can be said about the motion of the object when it passes through point X?

   A. The object is moving to the right and its speed is increasing.
   B. The object is moving to the right and its speed is decreasing.
   C. The object is moving to the left and its speed is increasing.

D. The object is moving to the left and its speed is decreasing.
E. Both A and B are possible.
F. Both A and C are possible.
G. Both A and D are possible.
H. A, B, C, and D are possible.

Knowledge Model: (K56) direction of velocity and change in velocity cannot be determined from acceleration
Knowledge Model: (K76) direction left-right
Knowledge Model: (K2) position along axis
Knowledge Model: (K27) speed Notes: Fixed JCS revision, which resulted in no right answer. Item with error deployed to some students. Version with error not retained as separate version.
Status: has newer version - Source: FVA-8

Problem 93: (KD1-43-V6EC)
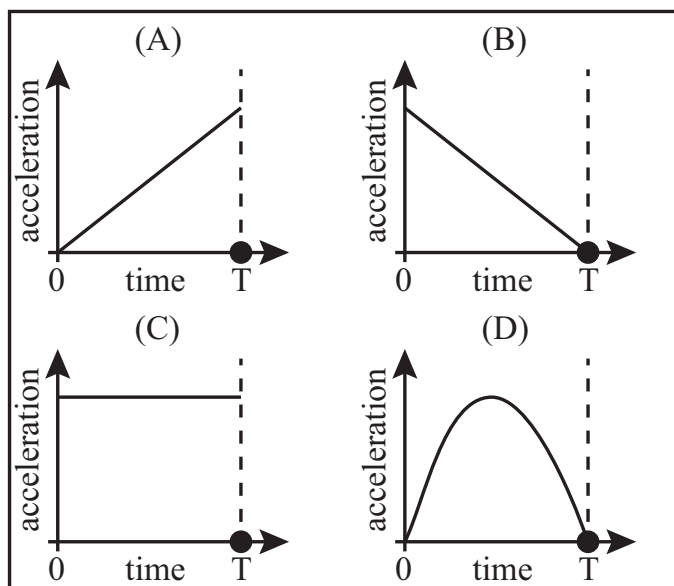
The figure above shows four acceleration versus time graphs for an object moving in a straight line. All graphs are plotted on the same scale.

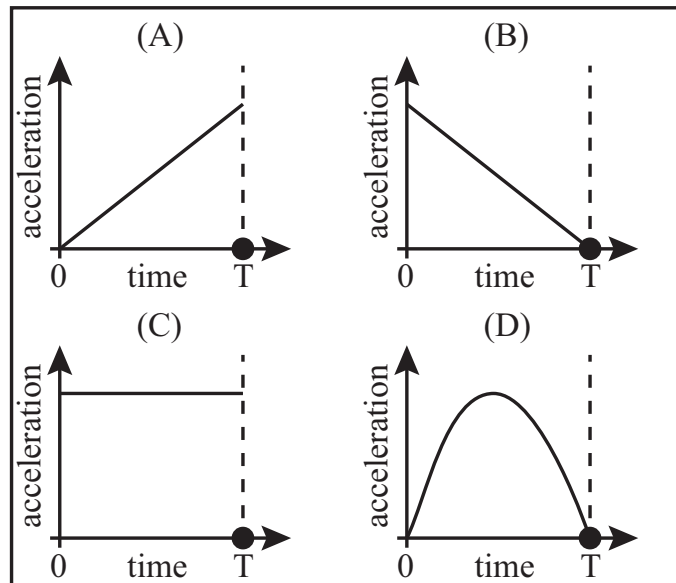Select the graph where the change in velocity from time 0 to time T is the greatest.

A. Graph A
B. Graph B
C. Graph C
D. Graph D
E. Graphs A and B

Knowledge Model: (K64) area under acceleration time curve is the change in velocity. Source: TUG-K-1

Problem 94: (KD1-43)

The figure above shows four acceleration versus time graphs for an object moving in a straight line.

Select the graph where the change in velocity from time 0 to time T is the greatest.
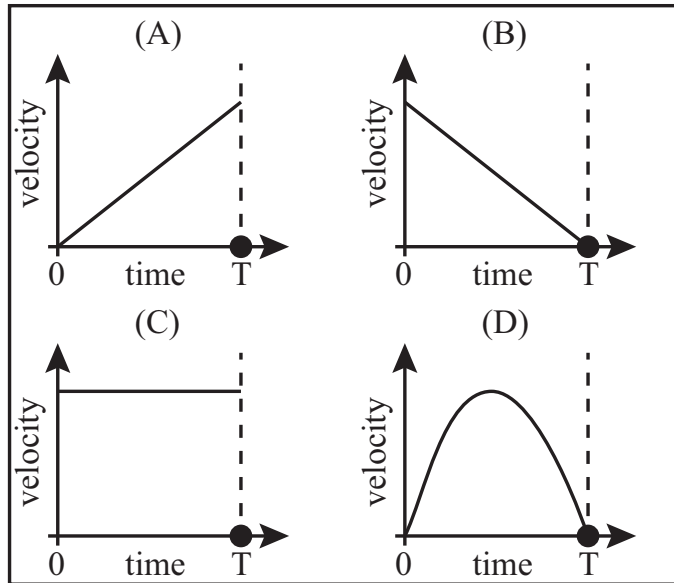
    A. Graph A
    B. Graph B
    C. Graph C
    D. Graph D
    E. Graph A and B

Knowledge Model: (K64) area under acceleration time curve is the change in velocity.
    Source: TUG-K-1

Problem 95: (KD1-44-V6EC)

The figure above shows four velocity versus time graphs for an object moving in a straight line. All graphs are plotted on the same scale.

Select the graph where the displacement from time 0 to time T is the greatest.
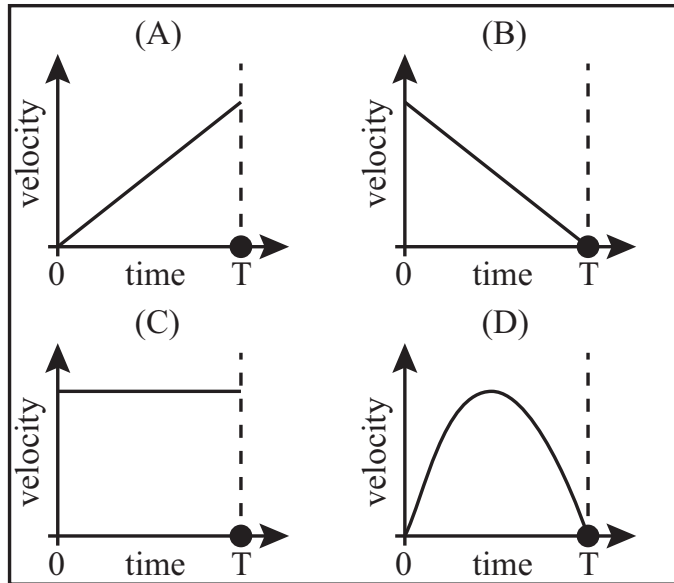
   A. Graph A
   B. Graph B
   C. Graph C
   D. Graph D
   E. Graphs A and B

Knowledge Model: (K46) area under velocity-time graph is displacement. Source: TUG-K-23
Status: active -
Revision of: KD1-44. Changes:

Problem 96: (KD1-44)

The figure above shows four velocity versus time graphs for an object moving in a straight line.

Select the graph where the displacement from time 0 to time T is the greatest.

A. Graph A
B. Graph B
C. Graph C
D. Graph D
E. Graphs A and B

Knowledge Model: (K46) area under velocity-time graph is displacement. Source: TUG-K-23
Status: has newer version -

Problem 97: (KD1-45)
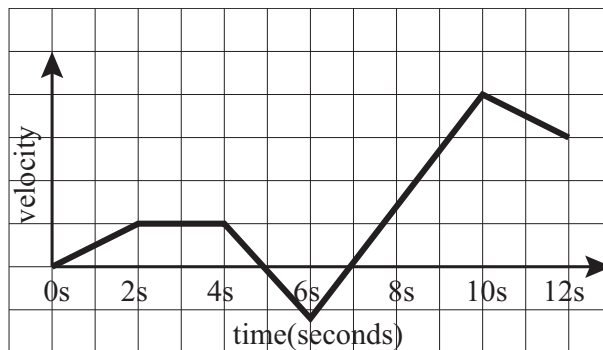
The figure above shows a velocity versus time graph for an object moving in a straight line.

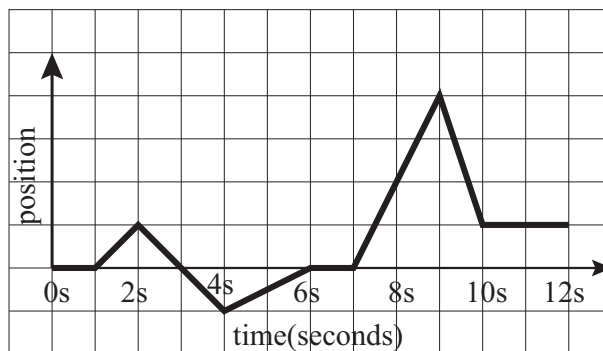Select the time or times with greatest negative acceleration.

    A. from 4s to 6s
    B. at 6s
    C. from 5s to 7s
    D. from 6s to 10s
    E. from 10s to 12s

Knowledge Model: (K43) slope of velocity vs. time graph is the acceleration
Knowledge Model: (K8) vector as signed number Source: TUG-K-2
Status: active -

Problem 98: (KD1-46)

The figure above shows a position versus time graph for an object moving in a straight line.

Select the time or times with greatest negative velocity.

    A. from 2s to 4s
    B. at 4s
    C. from 4s to 6s
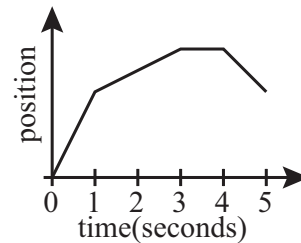   D. from 7s to 9s
    E. at 9s
    F. from 9s to 10s

Knowledge Model: (K34) slope is velocity
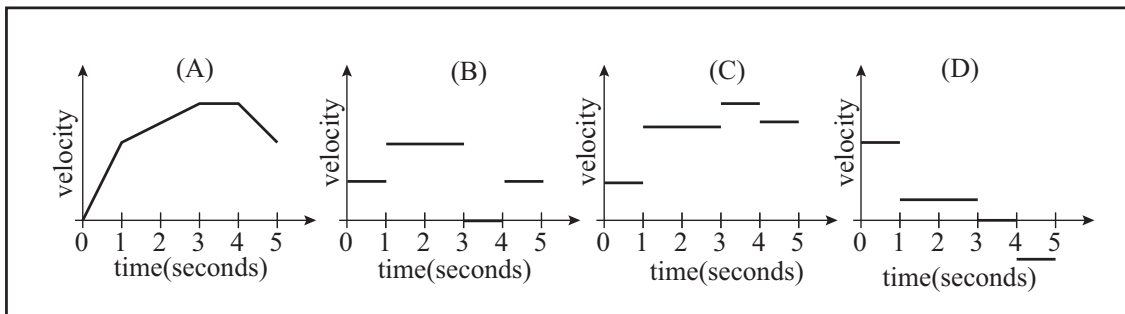Knowledge Model: (K8) vector as signed number Source: TUG-K-13
Status: active -

Problem 99: (KD1-47)

The figure to the right shows the position as a function of time for an object moving in a straight line.

position / time(seconds)

Select the figure below which represents the velocity as a function of time for the period from 0s to 5s.

(A) velocity / time(seconds) (B) velocity / time(seconds) (C) velocity / time(seconds) (D) velocity / time(seconds)
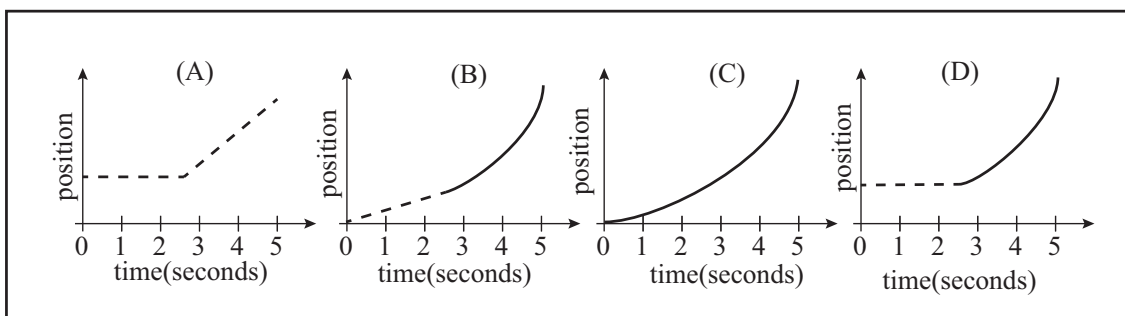
Knowledge Model: (K34) slope is velocity
Knowledge Model: (K8) vector as signed number Source: TUG-K-11
Status: active -

Problem 100: (KD1-48)
An object starts from rest at time $t = 0$ and travels with a constant positive velocity for 2.5 seconds. It then travels with a positive acceleration until 5 seconds.

Select the figure below which best represents its position as a function of time. To help read the graph, straight segments are dashed lines and curved segments are solid lines.

(A) position / time(seconds) (B) position / time(seconds) (C) position / time(seconds) (D) position / time(seconds)
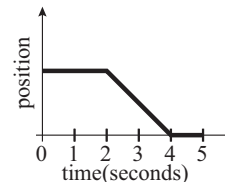
Knowledge Model: (K39) Curvature position-time graph is acceleration
Knowledge Model: (K35) straight line represents constant velocity Source: TUG-K-9
Status: active -

Problem 101: (KD1-49)

The figure to the right shows a position versus time graph for an object moving in a straight line.

Select the response which best describes the motion of the object.

A. The object moves along a flat surface for 2 seconds, then moves down an incline for two seconds and then comes to a stop.
B. The object moves along a flat surface for 2 seconds, then moves down an incline for two seconds and then moves along a flat surface for 1 second.
C. The object first moves at a constant speed for 2 seconds and then slows to a stop.
D. The object is stationary for 2 seconds, then moves backward at a constant speed for 2 seconds until coming to a stop.
E. The object is stationary for 2 seconds, then moves down an incline for 2 seconds and then comes to a stop.
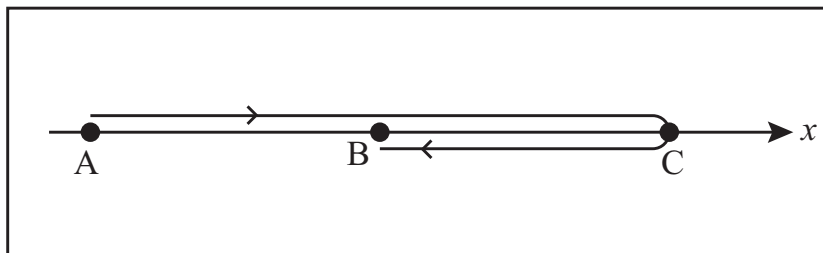
Knowledge Model: (K34) slope is velocity
Knowledge Model: (K35) straight line represents constant velocity
Knowledge Model: (K27) speed Source: TUG-K-8
Status: requires revision -

Problem 102: (KD1-50)

The figure above shows the trajectory of an object that starts at point A, travels to the right until it reaches point C, then reverses direction and travels to the left to point B. Which of the following best describes the relation between the distance traveled and the displacement of the object from point A to Point C?

A. The magnitude of the displacement is larger than the distance traveled.
B. The magnitude of the displacement is less than the distance traveled.
C. The magnitude of the displacement is equal to the distance traveled.

Provides Evidence for Compare 1D distance and total distance traveled - JCS5-1
Knowledge Model: (K74) Relation trajectory curve and total distance traveled

67

Knowledge Model: (K19) Relation trajectory curve and displacement
Distractors: ExhaustiveNotes: Students confusing whether from point A to point C applies to the distance traveled or just displacement. Place magnitude in the STEM.
Status: requires revision -

Problem 103: (KD1-51)
An object moves in one dimension, along the x-axis. An object is at $x = -1$m on the x axis at time $t = 0$. The object's velocity at time $t = 0$ is negative. The object travels along the x axis with a constant negative acceleration in the x direction.

Select the response which best describes the motion of the object at times after $t = 0$.

    A. The object moves in the positive x direction with increasing speed.
    B. The object moves in the negative x direction with increasing speed.
    C. The object moves in the positive x direction with constant speed.
    D. The object moves in the positive x direction with decreasing speed until it stops. It then remains stationary.
    E. The object moves in the positive x direction with decreasing speed until it stops. It then travels in the negative x direction with increasing speed.

Provides Evidence for Constant acceleration 1D velocity - JCS15-1
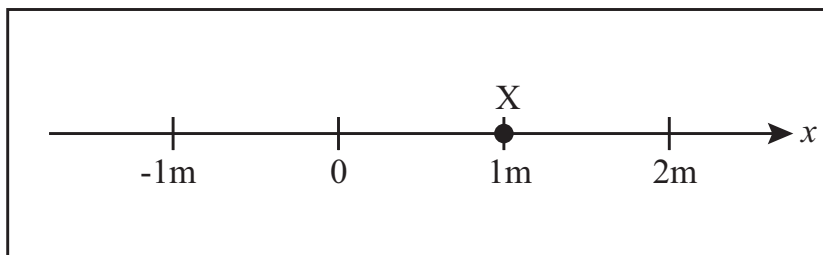Status: tested -
Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K27) speed
Knowledge Model: (K53) relation of signs of acceleration and velocity Notes: alternate version of KD-51?? to test common student misconception that negative acceleration always means slowing down
Status: active -

Problem 104: (KD1-52)

An object is located on the x axis as shown above. When it passes the point X, it has acceleration -2m/s^2.

Which of the following could be true about the speed of the object when it passes through point X?

    A. The speed is decreasing.
    B. The speed is increasing.

C. The speed is instantaneously zero.
D. Both A and B are possible.
E. Both A and C are possible.
F. A, B, and C are possible.

Knowledge Model: (K2) position along axis
Knowledge Model: (K8) vector as signed number
Knowledge Model: (K56) direction of velocity and change in velocity cannot be determined from acceleration
Notes: JCS- 5/31/24 - changed positioned to located Source: FVA-8
Status: active -