Multiple Representation Problem Solving - 20ACP (Falling Apple 2 - 1B2A)

Problem:	A falling apple, starting from rest, falls a distance of 8.00 m before hitting a spongy surface. If the apple comes to a complete stop in .05 s after hitting the spongy surface, what acceleration does the apple feel due to the spongy surface.

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

MULTIPLE REPRESENTATION PROBLEM SOLVING - 20BCP (FALLING APPLE 3 - 1B2A)

Problem:	A falling apple, starting from rest, falls a distance of 5.75 m before hitting a spongy surface. If the apple sinks 5.00 cm into the spongy surface, what acceleration does the apple feel due to the spongy surface.
(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem: In a 100-m linear accelerator, an electron is accelerated to 1.0 percent the speed of light in 40 m before it coasts 60 m to the target. (a) What is the electron's acceleration during the first 40 m? (b) How long does the total "flight" take?

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A model rocket starting from rest on the ground can accelerate at 4.50 m/s^2 for 3.2 s before it runs out of fuel. It then coasts straight upward until it reaches maximum height. (a) How high does it go? (b) How long does it take to reach this height?

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(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	JR can accelerate at an average rate of 2.8 m/s^2, but can not run faster than 10 m/s. In what minimum time can he run the 100 m dash?
(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem: A person jumps from a fourth-story window 15.0 m above a firefighter's safety net. The survivor stretches the net 1.0 m before coming to rest. What was the average deceleration experienced by the survivor when she was slowed to rest by the net?

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A speeding car is traveling at 25 m/s when the driver slams on the brake. The braking acceleration is 4.5 m/s^2. The braking car travels 50 m before hitting a barrier. If the barrier creates a braking acceleration of 25 m/s^2, how far does the car compress the barrier?

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A person jumps off a diving board 4.0 m above the water's surface into a deep pool. The person's downward motion stops 2.0 m below the surface of the water. Estimate the average deceleration of the person while under the water.

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A car can accelerate at the rate of 3.5 m/s^2. If the car started at rest and must not exceed a maximum speed of 35 m/s, what minimum time does it take the car to cover a distance of 300 m?

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A car can decelerate at the rate of 3 m/s^2. If the car is going 25 m/s and takes 1.5 s to start braking, what minimum time does it take the car to stop? How far did it go during this process?
(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Multiple Representation Problem Solving - 25ACP (Falling Woman - 1B2A)

Problem:	A person fell 20.5m from the top of a building, landing on the top of a metal ventilator box, which she crushed to a depth of .50 m. The person survived without serious injury. What acceleration (assumed uniform) did she experience during the collision?

(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	A Metro train in Washington D.C. starts from rest and accelerates at 2.0 m/s^2 for a time interval of 12s. The train then travels at a constant speed for 60s. The speed of the train then decreases for 12s until it comes to a stop. How far did the train travel during this trip?
(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
(B) Physical Representation Construct a separate motion diagram for the object during each part of the problem. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in your pictorial representation.	
(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	Ken is traveling at 20 m/s in his car when he passes a police car sitting on the side of the road. If the police car starts accelerating at 3 m/s^2 as soon as Ken passes, how far will Ken travel before the police car passes him? Assume Ken maintains his speed.
(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the cars at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the Ken's car and for the police car. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Ken's car at any time after the initial time. Write an equation that could be used to determine the position of the police car at any time after the initial time.	
(D) Solution Ken's car and the police car, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem: A car, initially at rest, accelerates toward the east at 2.0 m/s^2. At the same time that the car starts, a truck 500 m east of the car and moving at 32 m/s toward the west starts to move slower losing speed at a rate of 2.0 m/s^2. At what position and at what time will the car and truck pass each other?

(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the cars at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the Ken's car and for the police car. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Ken's car at any time after the initial time. Write an equation that could be used to determine the position of the police car at any time after the initial time.	
(D) Solution Ken's car and the police car, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	Two cars with dummy passengers start from rest at opposite ends of a 100 m long automobile test facility. A Chevy Malibu on the right accelerates toward the left at 5.0 m/s^2. A Ford Taurus on the left accelerates toward the right at 6.0 m/s^2. At what position should cameras be aimed to record the front ends of the cars as they collide?
(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the cars at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the Ken's car and for the police car. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
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(D) Solution Ken's car and the police car, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	Bob is driving down the interstate highway going 25 m/s. Jill is 75 m behind Bob and also doing 25 m/s. If Jill accelerates at the rate of 1.5 m/s^2, (a) how long will it take her to be directly opposite Bob (assume she is in a parallel lane)? (b) How far has she traveled during this period?
(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the cars at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the Ken's car and for the police car. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Ken's car at any time after the initial time. Write an equation that could be used to determine the position of the police car at any time after the initial time.	
(D) Solution Ken's car and the police car, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	Mike and Jason are two runners in the 400 m dash. With 50 m left in the race, Jason is 5 m behind Mike with both runners having a speed of 10 m/s. If Jason starts his "kick" at this time with an acceleration of .4 m/s^2, who wins the race?
(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the runners at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the runners. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Jason at any time after the initial time. Write an equation that could be used to determine the position of Mike at any time after the initial time.	
(D) Solution Will the runners, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	An automobile traveling 95 km/h overtakes a 1.10 km long train traveling in the same direction on a track parallel to the road. If the train's speed is 75 km/h, how long does it take the car to pass it, and how far will be car have traveled in this time?
(A) Pictorial Representation Construct a pictorial representation of the situation described in the problem. Include: • a coordinate axis , • a sketch that shows the object at the initial and final situations for each part of the problem, • symbols that represent the known values of kinematic quantities at these times, and • a symbol representing the unknowns that you wish to determine.	
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(C) Math Representation Choose one or more of the kinematic equations that relate the variables involved in the problem. This equation describes the way in which these variables are related to each other.	
(D) Solution Use the results of the previous calculation and other information in the pictorial representation to determine the unknown. .	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem:	An object falls from a bridge that is 30 m above the water. It falls directly into a small boat moving with constant velocity that was 15 m from the point of impact when the object was released. What was the speed of the boat?
(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the runners at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the runners. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Jason at any time after the initial time. Write an equation that could be used to determine the position of Mike at any time after the initial time.	
(D) Solution Will the runners, if continuing to move as indicated, pass each other. Use the equations above to determine the time at which they are at the same position.	
(E) Evaluation • Does the sign of the answer agree with the direction of the arrow in the motion diagram? • Is the unit of the answer correct? • Is the magnitude reasonable?	

Problem: Two objects begin a free fall from rest from the same height 1.0 s apart. How long after the first object begins to fall will the two objects be 10 m apart?

(A) Pictorial Representation Construct a pictorial representation of the initial situation and the final situation. Include: • a sketch that shows the runners at the initial and final situations, • symbols that represent the known values of kinematics quantities at these times, and • a symbol representing the unknown that you wish to determine.	
(B) Physical Representation Construct separate motion diagrams for the runners. Use the directions of the arrows in the motion diagrams to check the signs of the quantities in the pictorial representation.	
(C) Math Representation Write an equation that could be used to determine the position of Jason at any time after the initial time. Write an equation that could be used to determine the position of Mike at any time after the initial time.	
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