MULTIPLE REPRESENTATION PROBLEM SOLVING-11ACP (FALLING OBJECT-1B1A)

Problem: A falling object has a velocity of 15 m/s when it hits a spongy surface. If the object comes to rest in 2 cm, what acceleration does the object 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 kinematics 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 kinematics 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 ball is thrown directly downward with an initial speed of 8.00 m/s from a height of 15.0 m. When does the ball strike the ground?

(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 kinematics 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 kinematics 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 traveling at 30 m/s runs into the barrels at an exit ramp. If the car travels 30 m during the stopping process, what acceleration did it feel due to the barrels? Assume the stopping acceleration was constant.

(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 spacecraft has an acceleration of magnitude 5 g. What distance is needed for it to attain a velocity of 10 km/s if it started from rest.	
(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?	

*Based on a problem written by Stephanie Ingle.

Problem: A runaway cart is traveling at 30 m/s down a 30° incline when it runs into a lake. If the cart comes to a complete stop in 1.0 m, what acceleration did it feel due to the water in the lake? Assume the stopping acceleration was constant.

(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 –13BCP* (BASEBALL-1B1A)

Problem: A pitcher throws with a speed of 90 mph. How much time does it take the ball to reach the batter 60 ft. away traveling at this speed?

(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?	

*Based on a problem written by Stephanie Ingle.

Problem: On a dry road my old car is able to brake with a deceleration of 3.25 m/s^2 (assume that it is constant). How long and how far does my car, initially traveling at 20.5 m/s, take to come to rest?

(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.

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(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 – 14BCP* (CAR-1B1A)

Problem: A car's velocity increases from 8 m/s to 20 m/s in 10 s. (a) Find the acceleration for this increase. (b) The car's velocity then decreases from 20 m/s to 10 m/s in 5 s. What is the acceleration?

(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?	

*Based on a problem written by Stephanie Ingle.

MULTIPLE REPRESENTATION PROBLEM SOLVING - 15ACP (CAR - 1B1A)

Problem: A car started from rest and moved with constant acceleration. At one time the car was traveling at 20 m/s, and 100 m farther on it was traveling 30 m/s. Calculate (a) the acceleration, (b) the time required to travel the 100 m mentioned, (c) the time required to attain the speed of 20 m/s, and (d) the distance moved from rest to the time the car had a speed of 20 m/s.

(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 – 15BCP* (PELLET - 1B1A)

Problem: A lead pellet is propelled upward vertically by an air rifle with an initial velocity of 16 m/s. Find the maximum height for the pullet.		
(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?		

*Based on a problem written by Stephanie Ingle.

MULTIPLE REPRESENTATION PROBLEM SOLVING - 16ACP (FALLING HAMMER - 1B1A)

Problem: At a construction site a worker accidentally knocks a hammer off the roof. The hammer strikes the ground with a speed of 19 m/s. (a) From what height was it dropped? (b) For how long was it falling?

(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 hot air balloon is traveling vertically upward at a constant speed of 5.00 m/s. When it is 25.0 m above the ground, a package is released from the balloon. (a) After it is released, for how long is the package in the air? (b) What is its velocity just before impact with the ground? (c) Repeat (a) and (b) for the case of the balloon descending at 5.00 m/s.

(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 startled cat leaps upward, rising 0.300 m in 0.150 s. (a) What was its initial speed? (b) What is its speed at this height? (c) How much higher does it go?

(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 – 17BCP* (AIRPLANE- 1B1A)

Problem: A 727 airplane has a takeoff velocity of 80 m/s, which it reaches 35 s after starting from rest. (a) How much time does the airplane spend in going from 0 to 20 m/s? What distance does it cover in doing so? (b) How much time does the airplane spend in going from 60 m/s to 80 m/s? (c) What is the minimum length of the runway? Assume the airplane's acceleration is constant.

(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?	

*Based on a problem written by Stephanie Ingle.

Problem: To test the quality of a golf ball, you drop it onto the floor from a height of 2.00 m. It rebounds to a height of 1.95 m. If the ball was in contact with the floor for 5.0 ms, what was its average acceleration during contact?

(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 – 18BCP* (MARS- 1B1A)

Problem: The acceleration due to gravity at the surface of Mars is 3.7 m/s^2. A stone thrown upward on Mars reaches a height of 25 m. (a) Find the initial velocity of the stone. (b) What is the total time of flight?

(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?	

*Based on a problem written by Stephanie Ingle.

Problem: The brakes of a car moving at 15 m/s are suddenly applied and the car comes to a stop in 4.0 s. (a) What was its acceleration? (b) How long would the car take to come to a stop starting from 25 m/s with the same acceleration? (c) How long would the car take to slow down from 25 m/s to 15 m/s with the same acc.?

(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 rocket is fired vertically & ascends with a constant vertical acceleration of 100 m/s^2 for 4.50 s. Its fuel is exhausted in 4.5 seconds. (a) What is the velocity of the rocket when the fuel is exhausted? (b) What is the altitude at 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.	
(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 baseball pitcher throws a baseball with a speed of 44 m/s. In throwing the baseball, the pitcher accelerates the ball through a displacement of about 3.5 m, from behind the body to the point where it is released. Estimate the average acceleration of the ball during the throwing motion.

(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: Agent Bond is standing on a bridge, 12 m above the road below, and his pursuers are getting too close for comfort. He spots a flatbed truck approaching at 25 m/s, which he measures by knowing that the telephone poles the truck is passing are 25 m apart in this country. The bed of the truck is 1.5 m above the road, and Bond quickly calculates how many poles away the truck should be when he jumps down from the bridge onto the truck to make his getaway. How many poles is it?

(A) Pictorial Representation (B) 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?		