## 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?

surface?	
(A) Pictorial Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematics quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(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.	
<ul> <li>(E) Evaluation</li> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 11BCP(FALLING OBJECT 2 - 1B1A) Problem: A ball is thrown directly downward with an initial speed of 8.00 m/s from a beight of

15.0 m. When does	the ball strike the ground?
(A) Pictorial Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematics quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(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	
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 12ACP (CRASHING CAR -1B1A)

**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.

	ation 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	
• a symbol representing the	
unknowns that you wish to	
determine.	
(B) Physical	
Representation	
<b>F</b>	
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	
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.	
· (F) 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 - 12BCP\* (SPACESHIP -1B1A)

<b>Problem:</b> A spacecraft has an attain a velocity of 1	acceleration of magnitude 5 g. What distance is needed for it to 0 km/s if it started from rest.
(A) Pictorial Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(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.	
<ul> <li>(E) Evaluation</li> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

## MULTIPLE REPRESENTATION PROBLEM SOLVING -13ACP (CRASHING ROCK-1B1A)

**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.

water in the lake? A	ssume the stopping acceleration was constant.
(A) Pictorial	
Representation	
Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(B) Physical	
Representation	
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	
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

## MULTIPLE REPRESENTATION PROBLEM SOLVING -13BCP\* (BASEBALL-1B1A)

Drohland A mitch on theory with	h a smooth of 00 mmh. How much time does it toly the hell to
<b>Problem:</b> A pitcher throws will reach the batter 60 ft	In a speed of 90 mpn. How much time does it take the ball to
	. away havening at this speed:
(A) Pictorial Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(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	
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

Is the magnitude reasonable?
 \*Based on a problem written by Stephanie Ingle.

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 14ACP (STOPPING CAR-1B1A)

**Problem:** On a dry road my old car is able to brake with a deceleration of 3.25 m/s<sup>2</sup> (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?

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(A) Pictorial		Ī
Representation		
Representation		
<ul><li>Construct a pictorial representation of the situation described in the problem. Include:</li><li>a coordinate axis ,</li></ul>		
<ul> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> </ul>		
• 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		Г
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		ł
Use the results of the previous calculation and other information in the pictorial representation to determine the unknown.		
<ul> <li>(E) Evaluation</li> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> </ul>		
• Is the magnitude reasonable?		

MULTIPLEREPRESENTATIONPROBLEMSOLVING-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<br/>this increase. (b) The car's velocity then decreases from 20 m/s to 10 m/s in 5 s.<br/>What is the acceleration?

what is the accelera	
(A) Pictorial	
Representation	
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<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
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(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	
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

 
 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.

	<b>1000</b> 01 20 m/s.
(A) Pictorial	
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Construct a pictorial representation	
of the situation described in the	
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for each part of the problem,	
• symbols that represent the known	
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unknowns that you wish to	
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(C) Math Representation	
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(E) Evaluation	
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• Is the unit of the answer correct?	
• Is the magnitude reasonable?	

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 15BCP\* (PELLET - 1B1A)

<b>Problem:</b> A lead pellet is prop	elled upward vertically by an air rifle with an initial velocity of
(A) Pictorial	
Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(B) Physical	
Representation	
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	
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

## 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?

MULTIPLEREPRESENTATIONPROBLEMSOLVING-16BCP(BALLOON-1B1A)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.

balloon descending	
(A) Pictorial	
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for each part of the problem	
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<ul> <li>a symbol representing the</li> </ul>	
unknowns that you wish to	
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for the object during each part of the	
problem. Use the directions of the	
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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?	
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• Is the unit of the answer correct?	

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 17ACP (CAT- 1B1A)

<b>Problem:</b> A startled cat leaps u speed? (b) What is	upward, rising 0.300 m in 0.150 s. (a) What was its initial its speed at this height? (c) How much higher does it go?
<ul> <li>(A) Pictorial Representation</li> <li>Construct a pictorial representation of the situation described in the problem. Include: <ul> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul> </li> </ul>	
(B) Physical Representation	
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.	
<b>(D) Solution</b> Use the results of the previous calculation and other information in the pictorial representation to determine the unknown.	
<ul> <li>(E) Evaluation</li> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>	

MULTIPLEREPRESENTATIONPROBLEMSOLVING-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	
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Construct a pictorial representation	
of the situation described in the	
problem Include:	
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• 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	
<ul> <li>a symbol representing the</li> </ul>	
unknowns that you wish to	
determine.	
(B) Physical	
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Construct a senarate motion diagram	
for the object during each part of the	
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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	
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equation describes the way in which	
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In the motion diagram?	
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## MULTIPLE REPRESENTATION PROBLEM SOLVING - 18ACP (GOLF BALL- 1B1A)

**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?

ms, what was its average acceleration during contact?	
(A) Pictorial	
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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	
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• symbols that represent the known	
values of kinematic quantities at	
these times, and	
<ul> <li>a symbol representing the</li> </ul>	
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	
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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?	
<ul> <li>Is the magnitude reasonable?</li> </ul>	

MULTIPLEREPRESENTATIONPROBLEMSOLVING-18BCP\*(MARS-1B1A)Problem:The acceleration due to gravity at the surface of Mars is 3.7 m/s². A stone thrown<br/>upward on Mars reaches a height of 25 m. (a) Find the initial velocity of the stone.<br/>(b) What is the total time of flight?

	time of hight:
(A) Pictorial	
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Construct a pictorial representation	
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Use the results of the previous	
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(E) Evaluation	
• Does the sign of the answer agree	
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• Is the unit of the answer correct?	
<ul> <li>Is the magnifulde reasonable?</li> </ul>	

MULTIPLEREPRESENTATIONPROBLEMSOLVING-19ACP(STOPPINGCAR-1B1A)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	
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Construct a pictorial representation	
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problem. Include:	
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• symbols that represent the known	
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unknowns that you wish to	
determine.	
(B) Physical	
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(C) Math Representation	
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determine the unknown.	
(E) Evaluation	
• Does the sign of the answer agree	
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in the motion diagram?	
• Is the unit of the answer correct?	
• Is the magnitude reasonable?	
- is the magnitude reasonable?	

## MULTIPLE REPRESENTATION PROBLEM SOLVING - 19BCP (ROCKET- 1B1A)

**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?

	is exhausted? (b) what is the altitude at this time?	
(A) Pictorial		ſ
Representation		l
Representation		l
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>		
(B) Physical		Γ
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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		F
Use the results of the previous calculation and other information in the pictorial representation to determine the unknown.		
(E) Evaluation		F
<ul> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer correct?</li> <li>Is the magnitude reasonable?</li> </ul>		

# MULTIPLEREPRESENTATIONPROBLEMSOLVING-19CCP(BASEBALL2-1B1A)Problem:A baseball pitcher throws a baseball with a speed of 44 m/s. In throwing the

**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	
Representation	
<ul> <li>Construct a pictorial representation of the situation described in the problem. Include:</li> <li>a coordinate axis ,</li> <li>a sketch that shows the object at the initial and final situations for each part of the problem,</li> <li>symbols that represent the known values of kinematic quantities at these times, and</li> <li>a symbol representing the unknowns that you wish to determine.</li> </ul>	
(B) Physical	
Representation	
Construct a concrete motion diagram	
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.	
<ul> <li>(E) Evaluation</li> <li>Does the sign of the answer agree with the direction of the arrow in the motion diagram?</li> <li>Is the unit of the answer agree at 2</li> </ul>	
<ul><li>Is the unit of the answer correct?</li><li>Is the magnitude reasonable?</li></ul>	

MULTIPLEREPRESENTATIONPROBLEMSOLVING-19DCP(BOND-1B1A)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	
(D) Dhysical	
(D) Physical	
Representation	
Construct a separate motion diagram	
for the object during each part of the	
to 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	
(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?	
<ul> <li>Is the magnitude reasonable?</li> </ul>	