PROBLEM SOLVING STRATEGY

FOCUS the PROBLEM

Picture and Given Information

Construct a mental image of the problem situation.

Draw a picture which show the important objects, their motion, and their interactions.

Label all known information.

Question — *What is being asked? How does this translate into some calculable quantity?*

Physics Principle(s) — *Outline the concepts and principles you think will be useful in solving the problem. (e.g., definition of velocity and acceleration, Newton's Second Law, conservation of energy, static equilibrium).*

Specify convenient systems to use in the problem solutions.

Specify specific time intervals over which the application of each principle will be the most useful.

Identify any constraints present in this situation.

Specify any approximations or simplifications which you think will make the problem solution easier, but will not affect the result significantly.

DESCRIBE the PHYSICS

Idealized Diagram and Define Variables

Translate your picture into a diagram(s) which gives only the essential information for a mathematical solution.

*Define a symbol for **every** important physics variable on your diagram. Usually you need to draw a coordinate system showing the + and - directions.*

If you are using kinematics concepts,, draw a motion diagram specifying the objects' velocity and acceleration at definite positions and times.

If interactions are important, draw idealized, free body, and force diagrams.

When using conservation principles, draw "before", "transfer" (i.e., during), and "after" diagrams to show how the system changes.

To the side of your diagram(s), give the value for each physics variable you have labeled on the diagram(s) or specify that it is unknown.

Target Variable — *What unknown is it that you must calculate from the list of variables? Will the calculated quantity answer the question?*

Quantitative Relationships — *Assemble your toolbox of mathematical expressions which use the principles and constraints from your approach to relate the physics variables from your diagrams.*

PLAN the SOLUTION

Construct *specific* algebraic equations

Determine how the equations in your toolbox can be combined to find you target variable.
Begin with an equation that contains the target variable.
Identify any unknowns in that equation.
Find equations from your toolbox which contain these unknowns.
Continue this process until your equations contain no new unknowns.

Label each equation for easy reference.

*Do **not** solve equations numerically at this time.*

Check for Sufficiency

You have a solution if your plan has as many independent equations as there are unknowns.
If not, determine other equations or check the plan to see if it is likely that a variable will cancel from your equations.

Outline of Math Solution

Indicate the order (i.e, number the equations) in which to solve the equations for a desired variable and which equation to substitute the expression for that variable.
Typically, you begin at the end of your plan and work backwards to the first step, which is an equation containing your target variable.

EXECUTE the PLAN

Follow the Plan

Do the algebra in the order given by your outline.

When you are done you should have a single equation with your target variable isolated on one side and only known quantities on the other side.

Substitute the values (numbers with units) into this final equation.

Make sure units are consistent so that they will cancel properly.

Calculate Target Variable(s)

Calculate the numerical result for the target variable(s).

EVALUATE SOLUTION

Is answer properly stated? Is answer reasonable? Is answer complete?

Do vector quantities have both magnitude and direction?
Can someone else follow your solution?
Is the result reasonable and within your experience?
Do the units make sense?
Have you answered the question?