Teacher notes

Solving problems in Physics.

There is no unique recipe to apply for solving problems in Physics. However, the steps that follow help a lot in approaching any problem.

Make a diagram.

There is hardly a problem in Physics where a diagram does not help. A diagram might reveal geometrical relationships between different quantities. It tells you how to analyze forces and find the resultant force so you can apply $F = ma$ correctly. It helps in applying conservation of momentum with before/after diagrams. It helps with finding path differences in interference problems or determining emitted wavelengths in an atomic transition etc.

Count the unknown quantities.

How many unknown quantities are there in your problem? And how many equations do you have? You get equations by applying laws of Physics such energy conservation, momentum conservation, Newton's second law in each direction etc. If the number of equations is less than the number of unknowns, you have forgotten some fact that would lead to another equation.

Use symbols and solve symbolically.

Assign symbols to the various quantities in the problem and solve the problem symbolically. Only then substitute numbers. This is not only neater, but it also saves you a lot of work. If your solution is independent of a variable, say *m*, and you are then asked to find the solution again when *m* doubles you know the answer does not change. If you hadn't used symbols, you would solve the problem all over again only to find you get the same answer. And if your answer depended on the cube of *m* then doubling *m* gives a new answer which is 8 times larger than the previous one without any further work.

A block of mass *m* slides down a frictionless inclined plane. How does the acceleration change when the mass of the block is doubled?

We know that $a = g\sin\theta$ so it is independent of the mass. The acceleration stays the same.

Suppose you are given a solid cylinder of base radius *R* and height *H*. How does the pressure the cylinder exerts on the surface change when the height and base radius both double?

$P=\frac{Mg}{A}=\frac{\rho Vg}{A}=\frac{\rho AHg}{A}=\rho Hg$. We conclude right away that the pressure doubles. Without the formula you would have to argue that the mass increases by a factor of $4\times 2=8$ and the base area by 4 and so the pressure increases by $\frac{8}{4}=2$.

Check the units.

You derived a result. What are its units? If you calculated a mass, does it have units of kilograms? If not, you made a mistake. (if you do get kilograms it does not mean you got it right, but if you did not get kilograms you **definitely** got it wrong.) This is particularly useful in multiple choice questions. You can quickly eliminate answers if they have the wrong unit.

Use limiting cases.

In Atwood's machine with hanging masses m_1 and m_2 a multiple-choice question might ask about the acceleration of the masses when they are released. The answer must contain the difference m_1-m_2 in the numerator. This is because if the masses are equal, we will have zero acceleration. You cannot have m_1-m_2 in the denominator, that would imply infinite acceleration for equal masses.

Suppose you calculate the maximum speed with which a car can a take a bend of radius *R*. You got $v=\sqrt{\frac{gR}{\mu}}$. Does this make sense? If there is less friction (μ smaller) the formula says the speed will be higher which makes no sense. This formula cannot be right.