A. Writing out Solutions of Homework Problems

1. Restate the problem in your own words. Write it down on your paper! Fill in the blank: "I want to find ______________." What is the answer suppposed to be? An electric charge? A force? An energy? What are its units?

2. If appropriate, sketch a diagram of the situation. Show important vector quantities on it.

3. List known quantities, their symbols, numerical values and units. Label them on the diagram, too.

4. What other information (or *keyword*) is given in the question, that might relate your unknown to the known quantities? Think what physics concept(s) might have to be applied. Maybe the physics concept is *implied* rather than stated explicitely. Is there a uniform electric field? Is there energy conservation? Is there charge conservation? Do you need to use one of the Laws of Mechanics, or some principle of Optics, etc.

5. The needed concepts should translate into equations involving your knowns and unknown. If you can, write these equations down. Write the name of the physics concept you are using on your paper, next to its equation. If stuck, think again how your known information is related to what you are seeking. Do the knowns seem related to some important Law, Principle or Rule? That's what you need! Without that, you can't proceed. (Example: A question involving forces should lead you to consider Newton's Laws.)

6. Use words and sentences to explain what you are doing, and what the equations mean. Check that these really apply to your problem.

7. Check your equations. Can you solve for the desired quantity? Do so using algebra. Get the desired symbol on the left hand side of the equals sign, and all other symbols on the right hand side.

8. Now substitute the symbols on the right hand side of your solution expression, with their numerical values and units (write this on your paper)! Check that the units will combine to give the units you were looking for. Now you can punch in the numbers in your calculator. [Look to see if some prefixes can be cancelled, it could speed up your calculation. Using all SI units also may help.]

9. Round off the answer to the correct number of significant figures, then write it down, with units, and draw a box around it. [You might also like to use a prefix instead of a power of 10 on the units to make it simpler, like 68.0 MJ instead of 68.0×10^6 J.]

10. You're almost done! Check again that you really answered the stated question. Look at your answer, and think whether it makes sense. Does the size seem reasonable? Or is it ridiculously large or small? Is it negative when you were expecting a positive number, or *vice-versa*? Or is negative OK, if you interpret the result correctly?

11. If you couldn't solve the problem, try to understand why you got stuck. You were probably missing some important concept (see steps 4 and 5 above). If you can't get anywhere, formulate a question or two. Write them on your paper. Ask these during recitation.

B. Grading of recitation quizzes and homework problem solutions:

You will gain points for:

Stating the problem, identifying the quantity you are looking for with its symbol and units.

Identifying each known quantity with a symbol, its numerical value and units.

Showing a clear diagram of the situation, if applicable.

Explaining what physics concepts (Law, Principle, or Rule) are being applied.

Showing and explaining how you solved for the unknown quantity (symbol on the left hand side of the equation, everything else to the right), using words as well as equations.

Solving the problem correctly, getting a numerical result with correct units and significant figures.

Checking that the answer makes sense, not too large or too small or wrong sign.

Asking a good question if you can't solve the problem.

You can lose points for:

Not identifying what you know and what you are looking for.

Not making a sketch or diagram, if applicable.

Not explaining what physics concepts are being used.

Not explaining your solution using words as well as equations.

Not including units on the results.

Not rounding off to the appropriate number of significant figures.

Not checking if the answer makes sense.

C. Writing out Problem Solutions on Exams

You need to have some of the elements that would be included for homework, but it can be brief. Especially, you MUST include these items:

1. If applicable, draw a **diagram** or **make additions** to the provided diagram, to show forces, acceleration, or other important vectors or other quantities.

2. If applicable, state what **physics law or principle** needs to be applied. Such as, "there is no external force on the system, so the total momentum is conserved." Or like, "Because there is no net force on the system, the law of conservation of momentum holds." Or, "I am applying Newton's 2nd Law." This can be a word statement of something that may have an associated equation that you will use. For example: "The Capacitor Relation," with the related equation $Q = CV$ next to the words.

3. Write down the **equations** that you are using, that are relevant to the problem. Show them in the order that you apply them, not just randomly in the space on the page. Show the flow of your reasoning. (Irrelevant equations will not gain you partial credit. They only get in the way.)

4. When you evaluate a result numerically, based on an equation written in your solution, make sure the final answer has **units**. Try also to control the number of **significant figures**.

Also Note the following:

If you do intermediate steps like unit conversions, and you want to receive partial credit, write the units on the numbers being used, so we can understand what you are doing.

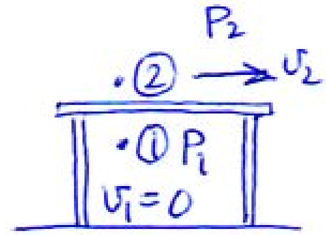
A numerical calculation and/or answer with no supporting equations or explanation will not receive any credit.

If the question says words like "show" or "calculate" or "determine" or "explain" then it is a good hint that a single word answer or a single numerical answer will not receive credit. An individual number with no supporting statements will never receive credit.

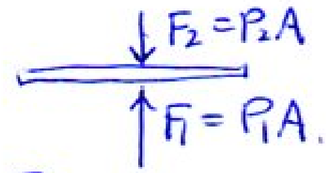
These requirements do not apply to true/false and multiple-choice questions. For those, you do not need to explain anything.

Example: Chapter 10 Problem 43.

If wind blows at 35 m/s over a house, what is the net force on the roof if its area is $240\ m^2$ and is flat?



I want to find the net force in newtons acting on the roof, due to the pressure difference between inside and outside.



Force comes from pressure on each side.

$$F_{net} = F_1 - F_2 = P_1 A - P_2 A = (P_1 - P_2) A.$$

where I used the definition of pressure, $P = \frac{F}{A}$.

There is a pressure difference due to the Bernouli effect: where fluid is moving, the pressure is lower.

Bernouli equation: $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$ (with: $y_1 = y_2$)

Then $P_1 - P_2 = \frac{1}{2}\rho_{air}(v_2^2 - v_1^2) = \frac{1}{2}(1.29\ \frac{kg}{m^3})((35\frac{m}{s})^2 - 0^2)$

$P_1 - P_2 = 790\ N/m^2$ is diff. btwn inside and outside.

$$F_{net} = (P_1 - P_2) A = (790\ N/m^2)(240\ m^2) = 189600\ N \rightarrow 190\ kN$$

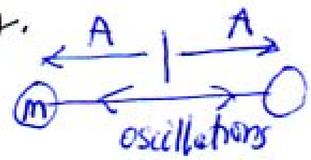
2. s.figs (upward)

The answer seems very large. It corresponds to the weight of around 19000 kg. But this is a hurricane force wind!

Also – really, the net force due to all forces acting on the roof is ZERO, if the roof does not fly off!

Example: Chapter 11. Problem 13

An object with mass 3.0 kg is attached to a spring with $k = 280\,N/m$ and is executing simple harmonic motion. When the object is 0.020 m from its equilibrium position, it is moving with a speed of 0.55 m/s. a) Calculate the amplitude of the motion. b) Calculate the max. velocity.



a) I want to find amplitude A in meters.

I know $m = 3.0\,kg$, $k = 280\,N/m$, and $v = 0.55\,m/s$ when $x = 0.020\,m$

The amplitude is the max. displacement from equilibrium, $X_{max} = A$.

When $x = X_{max}$, the KE is zero. Use energy conservation from given position until $x = X_{max}$.

$$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kX_{max}^2 \text{ or } = \frac{1}{2}kA^2.$$

Solve: $kA^2 = kx^2 + mv^2 \Rightarrow A = \sqrt{x^2 + \frac{m}{k}v^2}$

$$\text{Amplitude} = A = \sqrt{(0.020\,m)^2 + \frac{3.0\,kg}{280\,N/m}\left(0.55\,\frac{m}{s}\right)^2} = 0.0603\,m \rightarrow A = 0.060\,m$$

b) I want to find v_{max} in m/s.

I know I can get the total mechanical energy, from $E = \frac{1}{2}kA^2$

$$\Rightarrow E = \frac{1}{2}(280\,N/m)(0.0603\,m)^2 = 0.51\,J.$$

When passing $x = 0$ (equilibrium) all energy is $KE = \frac{1}{2}mv^2 = 0.51\,J$.

Then $v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(0.51\,J)}{3.0\,kg}} = 0.58\,m/s = v_{max}$.

Both A and v_{max} are slightly larger than the given x and v, so the answers are reasonable.