Preliminary

Strategies for solving problems

The best solutions to exam questions are those which easily convey a student's knowledge of the physics in the problem. It is almost always insufficient to write down an equation and find a numerical answer—we care more about the physics that you know rather than your ability to type numbers into your calculator.

1. **Set the scene to your solution**

   In classical mechanics and relativistic kinematics, you should almost always draw a fully-labelled diagram showing any forces, lengths, masses or durations as appropriate. Some problems become very easy to solve with the aid of a diagram.

   You should also write a few bullet points or brief sentences outlining the physics involved in the problem. This could include any assumptions you make (e.g., "ignoring any dissipative forces", "assuming an ideal pendulum", ...), physical principles you may consider (e.g., "the net torque is zero which implies...", "by conservation of energy...") and the equations you might use.

   I refer to this as 'setting the scene'—ensuring that you and your examiner are on the same page with the physics that you know.

2. **Solve things symbolically first**

   It is quicker. It is easy to spot mistakes. It is easier for an examiner to follow. It is easier to check dimensions and units. It is easy to spot dependancies of variables with one another.

Never leave numbers lying around on the page on their own without a definition or equation. For example, if you're adding two distances together, state symbolically what they individually represent and what the total quantity represents (and then add the numbers together).

3. **Check units and significant figures**

   At the end of the question, and (if time) at the end of your examination, check what precision your final answer should be given to. Remember: your answer should almost always be given to the same precision as your least precise value. Adding extra precision is meaningless and unphysical—it implies that we know more than we really do.

   Some quantities have well-known units. Some do not. If the units are unclear, perform dimensional analysis to find them.

   Forgetting the units and significant figures means that your answer is physically incorrect.

4. **Check to see if your answer is of the right order of magnitude, and observe any limiting behaviour of your final result.**

   Admittedly, this is easier said than done! It is difficult for us to think about very small or very large quantities and orders of magnitude. Over time, you will develop an intuition about what order of magnitude particular values should be. For example, energies of the order of 10^{-10} J are associated with the rest mass-energy of some particles, energies of the order of 10^{5} J are typical for a car travelling on a motorway, and energies of the order of 10^{69} J are associated with the total mass-energy of the observable universe.

   If you are deriving an equation (e.g., in a model building exercise or via dimensional analysis), check how the solution behaves as variables get very large or very small. Does this align with your physical intuition?

   No marks will be awarded for these checks (unless you're asked for it specifically!) but it is always worth doing in your head.

5. **Be able to sketch graphs properly**

   To start sketching a graph, draw some axes. Label them with the quantity you are looking at (not just x or y, unless that is how the quantity is defined) and their units. If no units are specified, writing 'arbitrary units' or 'arb. units' is acceptable.

Draw some tick marks on both axes. If the horizontal axes is time, and the timescale is 8 seconds, then drawing tick marks at $t = 0, 4, 8$ s is acceptable. If the vertical axis is displacement, and the total displacement is 10 metres, then drawing tick marks at $x = 0, 5, 10$ m is acceptable.

Identify the equation you are sketching and, if possible, identify the first order derivative. The equation will give you the general shape of the curve, and the first order derivative will tell you about the gradient of the curve (e.g., is the gradient 0 at $t = 0$?)

A good sketch should have a brief description accompanying it, stating the equation shown and any key features you wish to highlight (e.g., discontinuities in the gradient, the limiting behaviour if there are asymptotes, etc.)