Dear PHY104 students

In marking your last homework, we came across a few points where we felt that you had not really understood what you were being asked to do. This might lose you a lot of marks in the exam, so please **read** this note and take action!

1. *Show*, *prove* or *derive*

If you are asked to *show*, *prove* or *derive* an expression, this means that you have to obtain it **from first principles**. Simply changing variables is not enough! In the homework, you were asked to show that $E_n = -\frac{A}{n^2}$. Several people simply assumed $E_n = -\frac{me^4}{8\varepsilon_0^2 h^2} \cdot \frac{1}{n^2}$ (from the formula sheet) and wrote that this is of the required form because m, e, ε_0 and h are constants! **This will not do**: you need to start by applying Newton's second law ($F = ma$) to an electron in a circular orbit about a proton. Then introduce the quantisation of angular momentum, which gives you an expression for n, and combine the two to get the equation you need.

If you are asked to show, prove or derive an equation, you should normally expect to start from

- Newton's laws of motion, especially $F = ma$;
- Newton's law of gravity;
- the expression for acceleration in uniform circular motion, $a = v^2/r$;
- the expression for the position of the centre of mass, $m_1 r_1 = m_2 r_2$;
- the relation between luminosity and flux, $f = L/4\pi r^2$;
- the magnitude equation, $m_1 - m_2 = -2.5 \log(f_1/f_2)$;
- the conservation of energy and momentum;
- the wave equation, $c = v\lambda$.

Occasionally you might need something else: for example, in the homework you needed the electrostatic force between two charges, and the quantisation condition for angular momentum.

Always define your symbols (for example, m_1 in the magnitude equation above does not mean the same as m_1 in the centre of mass equation), and always explain what you are doing – don't just write down a string of equations.

Note that you need to be able to derive any equation that is marked D in the formula sheet. All of these were derived in class, and you should have them in your lecture notes. If you did not take good enough notes, you need to read a textbook to find the derivations.

As a general rule, always look at the number of marks allotted to a question. If you think you have answered a question that is worth 4 marks by writing down one line, you are almost guaranteed to be kidding yourself. Generally, in a mathematical question, 4 marks means 4 distinct steps to be negotiated; in a descriptive question, it may mean 4 significant points (or 8 minor points) to be made, or it may just reflect the level of detail: in a 2-hour exam totalling 50 marks, a 4 mark descriptive question implies about 10 minutes' writing.

2. Read the question!
Please, please, **please** read the question, and answer the question that you have been asked. The homework asked you to "sketch the variation in the strength of the Balmer absorption lines of hydrogen along the Harvard spectral classification sequence, and give physical explanations for the main trends." Several people instead sketched the pattern of hydrogen lines in a single spectrum, and explained – or at least described – the line spacing. **This is not what you were asked**, and it gets you zero marks.

Similarly, you lost a mark if you forgot to "indicate the *ground state*" on your energy level diagram, or if you did not "use the diagram to show the meaning of the term *ionisation energy*." (Note that explaining 'ionisation energy' without any reference to your diagram will **not** get full marks, even if the explanation is correct, because you were told to use the diagram!)

3. Show working.
When you are doing a numerical question, *always* show your working – don't just write down the numerical answer. The reason for this is quite simple: if you get the answer *wrong*, the only chance of rescuing any marks is your working. If you clearly knew what you were doing, but made a silly mistake in the arithmetic, you will get nearly all the marks if you have shown your working. If all you write down is the wrong answer, all we can give you is zero.

We hope that you will all do well in the exam. If there are any points in the course that you are not sure about, please come and see someone: your problems class leaders are all here and willing to help you, but you do need to ask!

Best regards

The PHY104 problems class staff