PHYSICS 1004 Environmental 2005

Radiation and its Effects on Matter Module Study Guide

This study guide is to assist you in studying for the Radiation section of the final exam.

General Comments: You should understand and be able to do all worked examples (most are from the text) presented in the lectures. Any formulae you might need should be in the formula sheet (except for things you should remember from 1st semester such as F=ma etc.) You should attempt as many past exam questions as practical because this year's questions are similar in style and content.

You should study a copy of the Radiation formula sheet that will be on your exam. There was a copy on the back page of the quiz you did in Lecture 8. You can also download a copy from WebCT. Ensure you understand what every equation means. Some may be written in slightly different form from in the textbook so study it so there are no surprises in the exam.

Comments about various formulae:

• Don’t memorise the constant \( b \) from the formula for Wien's displacement law;

\[ \lambda_p = \frac{b}{T} \]

It would be given to you if needed.

• The equation for energies (in J) of the Bohr orbits

\[ E_n = -\frac{\hbar^2}{8m_e^2\varepsilon} n^2 \]

is in slightly different form in the textbook. They have used the constant \( k_b \) in place of the collection of constants;

\[ \frac{1}{4\pi\varepsilon_0} \]

You should familiarise yourself with the version in the formula sheet. Or more simply, you can work energies using the "eV" version of the formula and convert to J afterwards if needed.

Comments about "Specific Objectives":

Radiant energy...: Don’t need to know every aspect of EM spectrum in great detail. Know the correct order of the categories of EM radiation. Know the energies (eV) and wavelengths (nm) at both ends of the visible spectrum

Evolution of...: Don’t need to memorise separate formulae for Lyman, Balmer and Paschen series. Just remember \( n_f \) for each series and use the \( E_n \) formula for Bohr orbit energies to work out photon frequencies from \( hf = E_i - Ef \). The "Bohr Correspondence Principle" is NOT examinable.

Quantum Mechanics; Don’t study Davisson-Germer experiment in more detail than in lecture handouts. Don’t memorise Schrödinger’s equation. Do learn how to locate positions on a plot of wavefunction \( \psi \) (and \( \psi^2 \)) where the particle is most likely (\( \psi^2 = \text{max} \)) and least likely to be found (\( \psi^2 = \psi = 0 \)).

More About Matter Waves; Don’t study "normalisation". I did not teach it.

Do know how to use the formula for the energies \( E_n \) of energy levels in an Infinite Square Potential Well (ISPW).

Don’t confuse the equation for energy levels in an ISPW with the equation for the energies of Bohr orbits in hydrogen. The ISPW equation has \( n^2 \) on the top of the fraction and the Bohr orbit equation has \( n^2 \) on the bottom of the fraction

Atomic Structure; "Spectroscopic notation" means using \( s, p, d \) & \( f \) as labels for sub-shells instead of \( l=0, l=1, l=2 \) & \( l=3 \)

Don’t study the detailed explanation of Zeeman effect. It is enough to know that Zeeman effect means that an applied magnetic field causes energies of orbitals within \( p, d \) or \( f \) sub-shells to split (NOT \( s \) sub-shells which contain just a single orbital and can’t split). This results in the splitting of spectral lines involving \( p, d \) or \( f \) sub-shells.

Nuclear Physics; Don’t memorise minor isolated numerical facts e.g. "Nucleus is ~99.97% atom’s mass but ~0.01% its radius" or "280 naturally occurring stable isotopes mentioned.

Don’t learn off-by-heart the number of important boundary etc. for example, naturally occurring Fe nucleus is most stable nuclide.

Don’t memorise the values of nuclear magic numbers. Do understand what they represent. Don’t learn about neutrinos in a lot of detail. Do remember that \( \beta^- \) decay is always accompanied by an anti-neutrino \( \bar{\nu} \) while \( \beta^+ \) decay (& electron capture) is always accompanied by a neutrino \( \nu \). Don’t learn in detail the equations for fusion reactions in the sun. Don’t learn off-by-heart the number of ionisations (or coulombs) in a Röntgen. Do remember that 100 Röntgen of X or \( \gamma \) rays gives an absorbed dose of 1 Gy or 100 rad. Don’t memorise all the Q factors, LD50/30 values and other data in tables. If needed they will be supplied. Don’t memorise details of all the medical isotopes mentioned. Do remember that background equivalent dose is ~2mSv/yr and the maximum allowable \( H \) for general public is and additional 2mSv/yr.

The Duty Tutor system will operate during Stuvac and the exam period. It will (as usual) operate within the Duty Tutor room 201. However, if the number of students is large on any particular day, it will move up to the tutorial room 320.

Copies of the duty tutor timetable are available on WebCT (http://www.physics.usyd.edu.au/ugrad/jphys/jp_notices.html)

1004 Environmental sessions will be on:

Week starting Monday 31 October (Stuvac week, NEXT week): Environmental Session Thursday 3/11
Week starting Monday 7 November: Environmental Session Thursday 10/11
Week starting Monday 14 November: Environmental Session Monday 14/11