Year 12 Physics Revision Table

Topics 13-16

Topic 13: The Structure of the Atom

Expectation From SACE Subject Outline *Note: these can be asked in converse*	***Summary of things I know about this*** (for formulae, for example, this could be: what the symbols mean, what the units of each variable is, and some possible rearrangements)	***Example question(s) to practice until I can do under test conditions without help*** There are likely to be some in the textbook too; also take note of questions you'd like examples of from the teacher
Describe the general characteristics of the line emission spectra of elements.		Assignment Q1
Explain how the uniqueness of the spectra of elements can be used to identify the presence of an element.		Assignment Q1
Explain how the presence of discrete frequencies in line emission spectra provides evidence for the existence of states with discrete energies in atoms.		
Solve problems involving the use of $E_n - E_m = hf$		Assignment Q10 (a) Test Q1 (b) (ii)
Draw energy-level diagrams to represent the energies of different states in an atom.		Assignment Q9
Given an energy-level diagram, calculate the frequencies and wavelengths of lines corresponding to specified transitions.		Assignment Q10 (b)
Draw, on an energy-level diagram of hydrogen, transitions corresponding to each of the series terminating at the three lowest-energy levels.		Test Q1 (a)
Relate the magnitude of the transitions on an energy-level diagram to the region in the electromagnetic spectrum of the emitted photons (ultraviolet, visible, or infrared).		Assignment Q2 (b) Test Q1 (b) (iii)

Draw, on an energy-level diagram, the transition corresponding to the series limit for a given spectral series of hydrogen.		Test Q1 (b) (i)
Using an energy-level diagram, determine the ionisation energy of an atom. Express this energy in either joules or electronvolts.		Assignment Q3
Describe the changes in the spectrum of a filament globe as the temperature of the filament increases.		Assignment Q4
Describe the line absorption spectrum of atomic hydrogen.		
Draw, on an energy-level diagram, transitions corresponding to the line absorption spectrum of hydrogen.		
Explain why there are no absorption lines in the visible region for hydrogen at room temperature.		Assignment Q5
Account for the presence of absorption lines (Fraunhofer lines) in the Sun's spectrum.		Assignment Q6 Test Q1 (c)
Draw, on an energy-level diagram of hydrogen, the process of fluorescence.		Assignment Q7
Compare the process of stimulated emission with that of ordinary (or spontaneous) emission.		Assignment Q8

Describe the conditions required for stimulated emission to predominate over absorption when light is incident on a set of atoms.		Assignment Q10 (d) Test Q2 (a)
Describe the structure and purpose of the main components of a helium–neon gas laser: • pump (electrodes) • gain medium • laser cavity		Assignment Q10 (e) Test Q2 (c)
Describe the useful properties of laser light		Assignment Q10 (f) Test Q2 (d)
Discuss the requirements for the safe handling of lasers.		Assignment Q10 (h) Test Q2 (f)
Identify some uses of lasers.		Assignment Q10 (g) Test Q2 (e)

Topic 14: The Structure of the Nucleus

Expectation	*Summary of things I know about this*	*Example question(s) to practice*
Specify a nucleus in the form ${}^{A}_{Z}\mathrm{X}$		Assignment Q1
Given the specification for any nucleus in the form ${}^{A}_{Z}\mathrm{X}$, determine the number of protons, neutrons, and nucleons it contains.		Assignment Q1
Explain how it is possible to have stable nuclei despite the strong repulsive electrostatic force between the protons.		Assignment Q2
Explain why the isotopes of a given element are chemically identical.		Assignment Q3
Given the masses of a nucleus and its constituent nucleons, calculate the mass defect and binding energy (in J and MeV) of the nucleus.		Assignment Q4 Test Q10
Complete simple nuclear equations for reactions between two nuclei or nucleons.		Assignment Q5 (a)
In given nuclear reactions, calculate the differences in masses, and hence determine whether energy is absorbed or released.		Assignment Q5 (b)
Explain, using the law of conservation of momentum, why a particle of relatively small mass that is emitted by a nucleus acquires most of the kinetic energy released in the reaction.		Assignment Q6 Test Q9
Describe how a nucleus may be changed into a nucleus of a different element by the absorption of particles such as neutrons, protons, and deuterons.		

Explain, using the equation ${}^{1}_{0}\mathrm{n} + {}^{32}_{16}\mathrm{S} \longrightarrow {}^{32}_{15}\mathrm{P} + {}^{1}_{1}\mathrm{H}$ how the medical radioisotope phosphorus-32 may be produced using neutrons emitted from a nuclear fission reactor.		Assignment Q7 (a) (i)
Identify one use of ${}^{32}_{15}\mathrm{P}$		Assignment Q7 (b) Test Q4 (c)
Explain, using the equations ${}^{1}_{1}\mathrm{H} + {}^{18}_{8}\mathrm{O} \longrightarrow {}^{18}_{9}\mathrm{F} + {}^{1}_{0}\mathrm{n}$ and ${}^{2}_{1}\mathrm{H} + {}^{14}_{7}\mathrm{N} \longrightarrow {}^{15}_{8}\mathrm{O} + {}^{1}_{0}\mathrm{n}$ how the medical radioisotopes fluorine-18 and oxygen-15 (commonly used in positron emission tomography scans) may be produced in hospitals, using cyclotrons.		Assignment Q7 (a) (ii) and (iii) Test Q4 (a)

Topic 15: Radioactivity

Expectation	***Summary of things I know about this***	***Example question(s) to practice***
Using the properties of the attractive nuclear force and the repulsive electrostatic force between protons, discuss the reasons for the increase in the neutron-to-proton ratio of stable nuclei as the atomic number increases.		Assignment 1 Q1 (b) Test Q7
Indicate, on an N versus Z graph, the regions corresponding to alpha decay, beta minus decay, beta plus decay, and spontaneous fission.		Assignment 1 Q1 (c)
Using an N versus Z graph, predict the likely type(s) of decay (if any) for a specified nucleus.		
State what characterises the region on the graph that corresponds to each type of decay.		Assignment 1 Q1 (d)
State the charge, mass, and nature of alpha and gamma emissions.		Assignment 1 Q2 Test Q5 (a)

Write and/or balance nuclear equations for a decay.		Assignment 1 Q3 Test Q8
Explain why the emitted alpha particles have discrete energies.		Assignment 1 Q4
State the charge, mass, and nature of the emissions in beta minus and beta plus decays.		Assignment 1 Q2
Justify appropriate charge and mass number values for an electron, a positron, a neutrino, and an antineutrino.		Assignment 1 Q5
Write and/or balance nuclear equations for beta minus and beta plus decays.		
Write a nuclear equation for the conversion of a neutron into a proton in beta minus decay.		Assignment 1 Q6 (a) (i)
Write a nuclear equation for the conversion of a proton into a neutron in beta plus decay.		Assignment 1 Q6 (a) (ii)
Using the laws of conservation of momentum and energy, justify the emission of an antineutrino in beta minus decay, and a neutrino in beta plus decay.		Assignment 1 Q6 (b)
Explain why alpha or beta decay is often accompanied by the emission of gamma rays with discrete energies.		Assignment 1 Q7 Test Q6
State the charge, mass, and nature of the emissions in gamma decay.		Assignment 1 Q2
Justify the appropriate charge and mass number values for a gamma ray.		Assignment 1 Q5 (e)
Write and/or balance nuclear equations for gamma decay.		
Compare the penetration through matter in various materials (including air) of alpha, beta, and gamma radiations.		Assignment 1 Q8 Test Q5 (b)

Determine the sign of the charge of the radiation from the deflections of alpha, beta, and gamma radiations in electric or magnetic fields.		
Sketch diagrams showing the deflections of alpha, beta, and gamma radiations in electric or magnetic fields.		Assignment 1 Q9
Give some examples of ionising radiations and their sources.		Assignment 2 Q1 (a) Test Q2 (a)
Explain how ionising radiation can damage living matter.		Assignment 2 Q1 (b)
Give some examples of how radiation dosages can be minimised.		Assignment 2 Q1 (c) Test Q2 (b)
Using a graph of number of radioactive nuclei or activity versus time, determine the half-life of a sample of radioactive material.		
Given the half-life of a sample of radioactive material, sketch a graph of number of radioactive nuclei or activity versus time.		Assignment 2 Q3 (b)
Use the unit of activity, becquerel (Bq), equal to the number of decays per second.		Assignment 2 Q4 Test Q1 (a)

Perform calculations of the number of radioactive nuclei that remain after a whole number of half-lives.		Assignment 2 Q2
Perform calculations of the activity of a radioactive sample after a whole number of half-lives.		Assignment 2 Q3 (a) Test Q1 (a)
State the fact that some radioisotopes used in PET can become concentrated in certain body tissues.		Assignment 2 Q6 (a)
Describe how the beta plus decay of a radioisotope can result in the production of photons through positron–electron annihilation.		Assignment 2 Q5 (a)
Use the law of conservation of momentum to explain why two photons travelling in opposite directions are produced in positron–electron annihilation.		Assignment 2 Q5 (a) Test Q3 (a)
Calculate the energy of the photons produced in positron–electron annihilation.		Assignment 2 Q5 (b)
Describe how a ring of photon detectors allows the location of a tracer radioisotope in a human body to be determined.		Assignment 2 Q6 (b) Test Q3 (b)
State one use of the radioisotope oxygen-15 in PET		Assignment 2 Q6 (d) (i)
State one use of the radioisotope fluorine-18 in PET		Assignment 2 Q6 (d) (ii) Test Q4 (b)
Explain why PET facilities need to be located near particle accelerators.		Assignment 2 Q6 (c)

Topic 16: Nuclear Fission and Fusion

Expectation	*Summary of things I know about this*	*Example question(s) to practice*
Given all relevant masses (in kg), calculate the energy (in J and MeV) released per fission reaction.		Assignment Q1 Test Q6
Compare the amount of energy released in a fission reaction with the (given) energy released in a chemical reaction.		Assignment Q2
Give a simple explanation of fission in terms of short-range nuclear-attractive forces and long-range coulomb-repulsive forces.		Assignment Q3 Test Q3
Explain why neutrons have to be slowed down in order to produce fission in ^{235}U.		Assignment Q4 (a) Test Q1 (b)
Explain why the most effective moderators have atoms of low mass and low absorption of neutrons.		Assignment Q4 (b) Test Q5 (a)
Explain why the nuclei produced by fission reactions are likely to have an excess of neutrons, and identify the type of radioactive decay they undergo.		Assignment Q4 (c) Test Q5 (b)
Explain why the fission products are hazardous and difficult to process.		Assignment Q4 (d) Test Q5 (c)
Explain why it is generally not possible to attain a continuous chain reaction using naturally occurring uranium unless it is enriched with ^{235}U.		Assignment Q4 (e) Test Q1 (c)
Given a diagram of a reactor, describe and discuss the function of the principal components of a water-moderated fission power reactor (core, fuel rods, moderator, control rods, heat exchanger, safety rods, and shielding).		Assignment Q5 (a) and (b) Test Q1 (a)

Explain why the uranium fuel needs to be enriched.		Assignment Q4 (e) Test Q1 (c)
Relate the starting, normal operation, and stopping of a nuclear reactor to the nature of the chain reaction.		Assignment Q5 (c) Test Q1 (d)
Explain briefly why the delayed emission of neutrons allows the chain reaction in a nuclear power reactor to be controlled.		Assignment Q5 (d)
Discuss some of the advantages and disadvantages of nuclear fission over fossil fuel power stations.		Assignment Q5 (e) Test Q4 (a)
Given all relevant masses (in kg), calculate the energy (in J and MeV) released per fusion reaction.		Assignment Q6
Compare the amount of energy released in a fusion reaction with the energy released in a chemical reaction.		
Describe how the conditions in the interiors of the Sun and other stars allow nuclear fusion to take place, and hence how nuclear fusion is their main energy conversion process.		Assignment Q7 Test Q2
Discuss the advantages and disadvantages of nuclear fusion over nuclear fission as a future source of power.		Assignment Q8 Test Q4 (b)