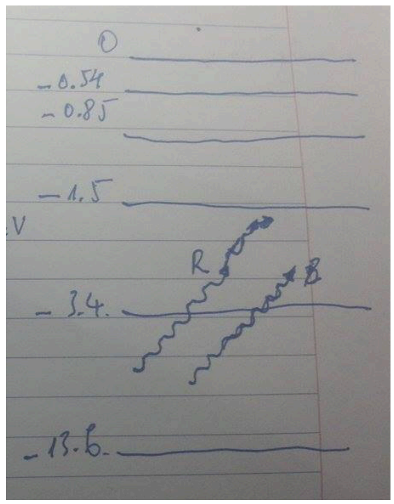
1. This question is about atomic spectra and energy levels.

Diagram 1 below shows part of the emission line spectrum of atomic hydrogen. The wavelengths of the principal lines in the visible region of the spectrum are shown.

Diagram 2 shows some of the principal energy levels of atomic hydrogen.



(a) Name the spectral series shown in diagram 1.

According to Bohr, the spectral series showed is emission spectrum (1)

(b) Show, by calculation, that the energy of a photon of red light of wavelength 656 nm is 1.9 eV.

E = h.f/ λ

=> $\frac{6.63\times10^{-34}\times3x10^{8}}{6.56\times10^{-7}\times1,6x10^{8-19}}$

(3)

(b) On diagram 2, draw arrows to represent

(i) the electron transition that gives rise to the red line (label this arrow R).

(1)

(ii) a possible electron transition that gives rise to the blue line (label this arrow B).

(1)

(Total 6 marks)

2. This question is about the radioactive decay of potassium-40.

A nucleus of the nuclide K (potassium-40) decays to a stable nucleus of the nuclide Ar (argon-40).

(a) State the names of the **two** particles emitted in this decay.

Gramma Particles and Alpha Particles

(2)

(b) A sample of the isotope potassium-40 initially contains 1.5×10^{16} atoms. On average, 16 nuclei in this sample of the isotope undergo radioactive decay every minute.

Deduce that the decay constant for potassium-40 is 1.8×10^{-17} s^{-1}.

(3)

C = $\frac{16}{60\times1,5\times10^{16}}$ = $1,78\text{x}10^{-17}$/s

(c) Determine the half-life of potassium-40.

Half life is $1,5\times10^{16}$ = 0.75×10^{16}

T = $\frac{0.75\times10^{16}}{16/60\text{s}}$ = 2.81×10^{16} s

=> T = 7.81×10^{12} h

(1)
(Total 6 marks)

3. This question is about particle physics.

A neutron can decay into a proton, an electron and an antineutrino according to the reaction

n ® *p* + *e* +.

(a) Deduce the value of the electric charge of the antineutrino.
Antineutrino differs from neutrino because they have opposite lepton number rather than charge. Therefore, the electric charge of the antineutrino equals zero.

(1)

(b) State whether a proton is a baryon or a lepton.

Baryon

(1)

(b) State the name of the fundamental interaction (force) that is responsible for this decay.

(1)

Eletromagnetic

(c) State how an antineutrino differs from a neutrino.

Because they have opposite lepton numbers.

(1)
(Total 4 marks)

4. Nuclear binding energy and nuclear decay

(a) State what is meant by a *nucleon*, giving an example of two nucleons.

A particle make up atomic nuclears.

Ex: Neutron, Proton.

(2)

(b) Explain what a nucleon is made of and what force holds it together. Include a description of the exchange particle that mediates the interaction between nucleons.

A nucleon is made up of proton and neutron and electron and a blinding energy to hold it together.

(2)

(c) Define what is meant by the *mass defect* of a nucleus.

In general, the mass of the protons plus the mass of the neutrons is larger than the mass of the neucleus. Their difference is defined as the mass defect.

(1)

(c) Define what is meant by the *binding energy* of a nucleus.

Is the work (energy) required to completyly separate the nucleons of a nucleus.

(1)

The graph below shows the variation with nucleon (mass) number of the binding energy per nucleon.

(c) Use the graph to explain why energy can be released in both the fission and the fusion processes.

From this graph, it can be seen that the blinding energy per nuleon is almost constant for most nuleus. Therefor, during the fission and fusion process, when neutrons produced, a mass difference is created. This leads to higher bliding energy and energy is produced.

(3)

(c) Use the graph to explain why there is an abundance of iron (Fe) in the universe.

From the graph, it can be seen that the bliding energy per nucleon of iron is the closest to Nickel, the energertically most stable. The higher the blinding energy is, the more stable the nucleus is.

(2)

(d) A sample of carbon-11 has an initial mass of 4.0 ´ 10^{-15} kg. Carbon-11 has a half-life of approximately 20 minutes. Calculate the mass of carbon-11 remaining after one hour has elapsed.

4.0×10^{-15} kg => 2.0×10^{-15} => 1.0×10^{-15} => 0.5×10^{-15}

20 min 20 min 20 min

After 1 hour, the mass of carbon -11 is 0.5×10^{-15}

(2)

(e) Uranium-238, undergoes a-decay to form an isotope of thorium. Write down the nuclear equation for this decay.

$${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha g$$

(2)

(Total 11 marks)

5. This question is about a proton.

The proton is made out of three quarks.

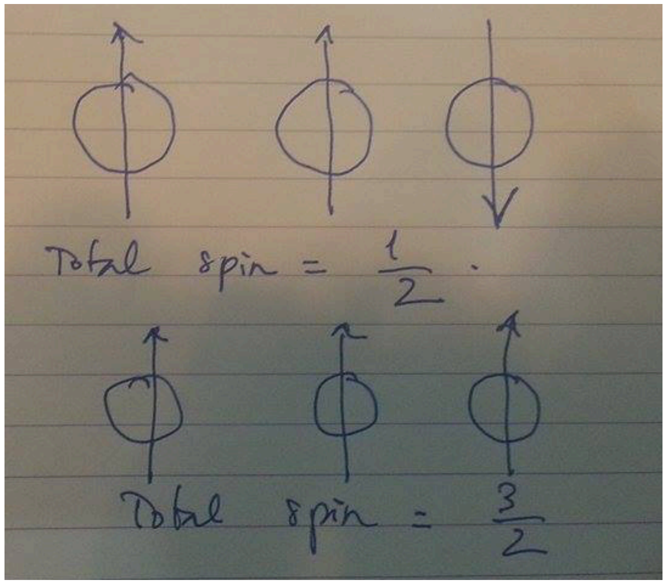
(a) Explain why the three quarks in the proton do not violate the Pauli exclusion principle.

The proton is a baryon made out of two u quarks and one d quark. According to Pauli exclusion principle, since the spin of the u quarks is ½, therefore, there are two quantum sttes availabe, one is “up” and another is “down”

(2)

(b) Quarks have spin ½. Explain how it is possible for the proton to also have spin ½:

The proton is a baryon made out of two u quarks and one d quark. The spin of proton in terms of the spins of the quarks is as follows:



Therefore, it is possible for the proton to have spin ½.

(2)
(Total 4 marks)

6. Which **one** of the following correctly gives the number of electrons, protons and neutrons in a neutral atom of the nuclide ?

	Number of electro	**Number of proton**	**Number of neutro**
A.	65	29	36
B.	36	36	29
C.	29	29	65
D.	29	29	36

(1)

7. The unified mass unit is defined as

A. the mass of one neutral atom of C.

B. of the mass of one neutral atom of C.

C. of the mass of one neutral atom of C.

D. the mass of the nucleus of C.

(1)

8. Which of the following provides evidence for the existence of atomic energy levels?

A. The absorption line spectra of gases

B. The existence of isotopes of elements

C. Energy release during fission reactions

D. The scattering of α -particles by a thin metal film

(1)