Adetoun Adeyemi Physics Correction

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.

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(1)

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

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(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).

(The blue arrow starts from -0.85eV)

(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.

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(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}.

(16 divided by 60) seconds divided by $1.5 \times 10^{16} = 1.8 \times 10^{-17}\ s^{-1}$.

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(3)

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

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(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

$$n \boxed{?} p + e +.$$

(a) Deduce the value of the electric charge of the antineutrino.

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(1)

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

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(1)

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

(1)

……The Electromagnetic force .

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

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(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.

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(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.

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(2)

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

.....The mass defect of a nucleus is the sum of the individual masses of the separated nucleons minus the mass of the intact nucleus.....

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(1)

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

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(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.

…….This is because nucleons of elements such as helium with a low binding energy will react to fusion to attain the optimal binding energy whilst nucleons of elements too many nucleons will react to fission to attain the optimal binding energy value where they are stable

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(3)

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

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(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.

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(2)

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

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(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.

……This is because quarks are fermions and of the 2 up quarks and one down quark. The up quarks have opposite spins ..

(2)

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

In the proton the three quarks align themselves so that two of them have their spin in one direction and one is in the other direction

(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 electrons	**Number of protons**	**Number of neutrons**
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)