EASY AND SCORING AREAS:-

1. Energy of orbit of Rutherford atomic model….E=-13.6 Ev/n^2
2. Bohr model of hydrogen atom……
3. Line spectra of hydrogen atom
4. De-broglie explanation of Bohr's second postulate

EASY AND SCORING AREAS:-

1. Binding Energy
2. Mass energy relation
3. Law of radioactivity
4. α– decay, β–decay, γ– decay
5. Nuclear fission reaction, nuclear fusion reaction.

QUESTIONS

Q1. Define Nuclear forces and gives their important characteristics/properties.
Ans.The nucleus of an atom has a number of protons and neutrons (nucleons) which are held together by the forces known as Nuclear forces in the tiny nucleus, inspite of strong force of repulsion between protons.

Characteristics/Properties of nuclear forces:

1. Nuclear forces are strongest forces in nature.
2. Nuclear forces are short range forces.
3. Nuclear forces are basically strong attractive forces but contain a small component of repulsive forces.
4. Nuclear forces are saturated forces.
5. Nuclear forces are charge independent
6. Nuclear forces are spin- dependent
7. Nuclear forces are exchange forces

Q2.Define atomic mass unit (a.m.u.) and calculate its value in SI unit of mass. Also find energy equivalent in MeV corresponding to it.

Ans.Atomic mass unit is defined as $\frac{1}{12}$th of mass of one ${}^{12}_{6}C$ atom.

According to Avogadro's hypothesis number of atoms in 12 g of ${}^{12}_{6}C$ is equal to Avogadro number. i.e $6.023\text{x}10^{23}$.

Therefore the mass of one carbon atom ${}^{12}_{6}C = \frac{12}{6.023x10^{23}} = 1.99\ \text{x}10^{-23}\text{g} = 1.99\ \text{x}10^{-26}\text{kg}$

Or, 1a.m.u. $= \frac{1}{12}\text{x}1.99\ \text{x}10^{-26} = 1.665\text{x}10^{-27}\text{kg}$

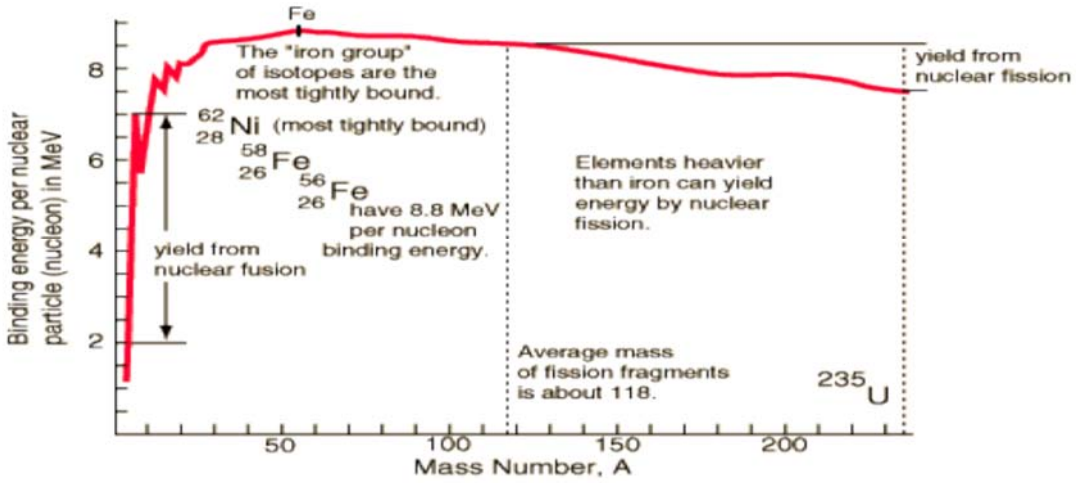
Energy equivalent of 1 a.m.u ,

$\Delta m = 1$ a.m.u $= 1.665\text{x}10^{-27}\text{kg}$

$E = \Delta m\, C^2$ J $= 1.665\text{x}10^{-27}\ \text{x}\ (3\text{x}10^{8})^2 / 1.6\ \text{x}\ 10^{-13}$ MeV $= 931.5$ MeV

Q3. Define binding energy per nucleon and packing fraction? Draw the curve showing the variation of binding energy per nucleon with mass number (A). Discuss its conclusions and explain how nuclear fission and fusion processes are explained with its help.

Ans. The binding energy per nucleon is the average energy required to extract one nucleon from the nucleus.
Binding energy per nucleon = B.E./ A
Greater is the binding energy per nucleon greater is the stability of nucleus.
PACKING FRACTION
The packing fraction of a nucleus is defined as the mass defect per nucleon of the nucleus.
Packing fraction = MASS DEFECT/A
BINDING ENERGY CURVE



It is found that binding energy of $_3Li^7$ is greater than that of $_2He^4$, but the value of its binding energy per nucleon is lesser. However, $_2He^4$ is found to be more stable than $_3Li^7$. Therefore, it may be concluded that the stability of nucleus depends upon binding energy per nucleon rather than the total binding energy of nucleus. Fig. shows the graph between the binding energy per nucleon and mass number of different nuclei. From the binding energy curves the following conclusions can be drawn:
1. The binding energy per nucleon for light nuclei, such as $_1H^2$, is very small.
2. The binding energy per nucleon increases rapidly for nuclei upto mass number 20 and the curve possesses peaks corresponding to nuclei $_2He^4$, $_6C^{12}$ and $_8O^{16}$. The peaks indicate that these nuclei are more stable than those in their neighbourhood.
3. After mass number 20, binding energy per nucleon increases gradually and for mass number between 40 and 120 , the curve becomes more or less flat
4. After mass number 120, binding energy nucleon starts decreasing and drops to 7.6MeV for uranium such nuclei are unstable and are found to disintegrate.

5. The binding energy per nucleon has a low value for both very high and very heavy nuclei in order to attain very higher value of binding energy per nucleon, the lighter nuclei may unite together to form a heavier nucleus **(process of nuclear fusion**) or a heavier nucleus may split into lighter nuclei (**process of nuclear fusion**). In both the nuclear processes, the resulting nucleus acquires greater value of binding energy per nucleon along with the liberation of energy.

Q4. What is radioactivity? State the law of radioactive decay. Show that the radioactive decay is exponential in nature.

Ans. **Radioactive decay**

The spontaneous emission of radiation from a radioactive element is called radioactive decay.

Decay Law

The number of nuclei disintegrating per second of a radioactive sample at any instant is directly proportional to the number of
undecayed nuclei present in the sample at that instant.

i,e,

$$\frac{dN}{dt} \propto N$$

$$\Rightarrow \quad \frac{dN}{dt} = -\lambda N \quad \text{--- (1)}$$

Where λ is constant of proportionality & is called decay constant.

From equation (1) we have

$$\frac{dN}{dt} = -\lambda N$$

$$\Rightarrow \quad \frac{dN}{N} = -\lambda \, dt$$

Integrating on both sides we get,

$$\int \frac{dN}{N} = -\lambda \int dt$$

$$\Rightarrow \quad \log_e N = -\lambda t + C \quad \text{(2)}$$

But, when t= 0, N= N_0, therefore from equation (2) we get

$$\log_e N_0 = -\lambda \times 0 + C$$

$$\Rightarrow \quad \log_e N_0 = C$$

On putting this value of C in equation (2) we get

$$\log_e N = -\lambda t + \log_e N_0$$

$$\Rightarrow \quad \log_e N - \log_e N_0 = -\lambda t$$

$$\Rightarrow \quad \log_e \frac{N}{N_0} = -\lambda t$$

$$\Rightarrow \quad \frac{N}{N_0} = e^{-\lambda t}$$

$$\Rightarrow \quad \boxed{N = N_0 e^{-\lambda t}} \qquad \text{----------(3)}$$

This equation is known as decay equation.

From eqn (3) we have $N = N_0 e^{-\lambda t}$

Substituting $t = \frac{1}{\lambda}$ in the above equation we get

$$N = N_0 e^{-1}$$

$$\Rightarrow \quad N = N_0 \left(\frac{1}{e}\right)$$

Thus decay constant of a radioactive element may be defined as the reciprocal of the time in which number of UN decayed nuclei of that radioactive element falls to $\frac{1}{e}$ times of its initial value.

S.I. unit of decay constant is sec^{-1}.

COMMUNICATION SYSTEMS

EASY AND SCORING AREAS

1. Block diagrams of communication system, transmitter, receiver, Detector, square law modulator(see NCERT textbook)
2. Difference between point to point communication and broadcasting
3. Basic terminology used in communication system
4. Need for modulation
5. Range of T V Transmission

QUESTIONS

1. What is a communication system? Describe briefly the major constituents of a communication system.

Ans:- Communication system: The set up used to transmit information from one point to another is called a communication system. The essential parts of communication system are transmitter, communication channel and receiver.

i) Transmitter: it's the set up that transmits the message to the receiving end through a communication channel. Its main function is to convert the message signal produced by the information source into a form suitable for transmission through the channel and to transmit it.

ii) Communication channel or transmission medium: it's the medium or physical path that connects a transmitter to a receiver. It carries modulated wave from the transmitter to the receiver. It can be a transmission line, an optical fibre or free space.

iii) Receiver: it's a set-up that receives the transmitted signals from the transmission medium and converts those signals back to their original form. This process of recovering the original signal is called demodulation or detection, which is reverse of the modulation process used at the transmitter.

2. What are analog and digital signals and analog communication? Give examples.

Ans: Analog signal: it's the signal in which current or voltage varies continuously with time.

Digital signal: it's the signal in which current or voltage can only take two discrete values. A digital signal can take only two values, 1 and 0. Digital signals are in the form of pulses of equal level.

Analog communication: it makes use of analog electronic circuit and analog signal in such a way that the output voltage varies continuously in accordance with the input voltage. For example, telegraphy, telex, TV network etc. it is less reliable due to its many valued output.

3. What is digital communication? Enumerate some of its advantages?

Ans-Digital communication: digital communication makes use of an electronic circuit that can handle only digital signals. Modern communication systems like FAX, e-mail, etc. are purely based on digital electronic circuits because of the following advantages:

1. As compared to many valued analog operation, the two-valued digital operation is more reliable because here all the signals are easily identified as low and high.

2. As the information to be transmitted is already in pulse form, so its transmission needs simple technique.

3. A large number of digital signals can be sent through a single channel only.

4. What is modulation? What is the need of modulation in communication system?

Ans- A high frequency carrier wave is used to carry the audio signal to large distances. Modulation is the process by which some characteristic, usually amplitude, frequency or phase angle of a high frequency carrier wave is varied in accordance with the instantaneous value of the low frequency of the low frequency audio signal, called the modulating signal.

Need of modulation in communication systems: audio signals have a bandwidth of 20 kHz. Such low frequency signals cannot be transmitted directly to long distances because of the following reasons:
1) Practical antenna length: to transmit a signal effectively, the height of the antenna should be comparable to the wavelength of the signal so that the antenna properly senses the time variations of the signal. So to transmit a signal of frequency 20 kHz, we need an antenna of height= $3 \times 10^8 / 20 \times 10^3$ m= 15 km. antenna of such a height cannot be constructed. On the other hand, if the carrier wave of 1MHz is used, required antenna height comes down to just 300 m.

2) Effective power radiated by an antenna: for the same antenna length, the power radiated by the short wavelength or high frequency signals would be large. If the audio signals are directly radiated into space, they die out after covering some distance due to their low power.

3) Mixing up signals from different transmitters: when audio signals are transmitted by many transmitters simultaneously, their signals get mixed up and it's not possible to separate them.

Thus, there is need for translating the original low frequency message signal into a high frequency wave before transmission such that the transmitted signal continues to possess the information contained in the original signal.

5. What are carrier waves? Mention the two types of carrier waves generally used.
Ans: Carrier waves: An alternating current of a frequency, at least twice that of the highest frequency component in the information signal, is used to provide a carrier wave. Since this frequency signal is the signal which is actually transmitted and carries the information, so it is known as a carrier wave.
Following are its two commonly used types:
1) Continuous sinusoidal waves, and
2) pulse shaped signals.

6. What is need of modulation?
Ans:- simultaneous transmission: consider u transmit speech signal without modulation then this signal will interfere with the normal voice in the air (from people and radios and everything) that's why u get radio station at different frequencies
Multiplexing signals: the same concept as simultaneous transmission but from the sender perspective, say u need DSL on your landline then u need to modulate the DSL data on a higher carrier to prevent interfering with telephone signal.
7. What is communication channel? Describe the various communication channels employed in communication.
Ans: - communications channel: - the physical path between the transmitter and receiver is called communication channel or transmission medium of communication system.
Types of communications:

i) LINE COMMUNICATION: - it invokes point –to-point contact between transmitter and receiver. It occurs through guided media such as twisted pair and coaxial cable.
Coaxial cable is widely used wire medium, which offers a bandwidth of 750MHz.
ii) OPTICAL COMMUNICATION:- it makes use of a light beam in carrying an information from one point to another through a guided medium like optical fibre.
Optical communication using fibers is carried in the frequency range of 1THz to 1000 THz. An optical fiber can have a bandwidth above 100GHz.
iii) SPACE COMUNNICATION: - Here electromagnetic waves of different frequencies are used to carry the information through the physical space acting as the transmission medium. Radio, television and satellite communications are all space communications.

Q12. Discuss the advantages and disadvantages of amplitude modulation?

Ans. Advantages
i. It is an easier method for transmitting and receiving voice signals.
2. It requires simple and cheaper transmitters and receivers.
3. Its transmission requires low carrier frequencies of 0.5-20 Mhz.
4. Area in each AM transmission can be received in much larger than that in case of FM transmission.
Disadvantages
1. Amplitude modulation suffers from noise.
2. Quality of audio signals is poor.
3. Efficiency of FM transmission is low.