CHAPTER **(10)**

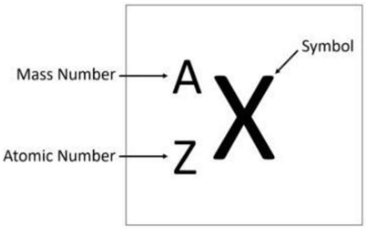
Nuclear physics

Nuclear physics:

Nucleus structure:

- Nucleus contains:

1. Protons H (p) have positive charge equals to the charge of electron.
2. Neutron n: (n) has no charge.



- Atomic number (Z): equals the number of protons.
- Mass number (A): equals the sum of protons and neu-trons.

  Number of neutrons = A – Z

  Example: In the Nitrogen nucleus N714, how many protons and neutrons?

Solution:

A = 14 and Z = 7
Number of protons = Z = 7 protons
Number of neutrons = A – Z = 14 – 7 = 7 neutrons.

- Determine the charge of the nucleus:

  Charge of nucleus = Ze

  Where Z is the atomic number, and e is the charge of electron (basic charge) (C).

- Nucleons: protons or neutrons are called nucleons.
- Nucleons exist inside the nucleus and form most of its mass.

10.1 The mass number in the atom is:

A Number of neutrons
B Number of protons and electrons
C Number of protons
D The atomic number and number of neutrons

10.2 The number of neutrons is:

A Atomic number
B Mass number
C Mass number – Atomic number
D Atomic number – mass number

10.3 Element $_{82}Pb^{210}$ the number of protons equals to:

A 82 | B 128
C 210 | D 292

Solution:

The number of proton = Z = 82 protons The answer is A

10.4 The number of neutrons in $_{19}K^{39}$ is

A 19 | B 20
C 39 | D 58

10.5 In the nucleus of iron $^{56}_{26}Fe$ there is:

A 26 protons and 26 neutrons
B 26 electrons and 26 neutrons
C 26 protons and 30 electrons
D 26 protons and 30 neutrons

10.6 A nucleus X contains 10 protons and 12 neutrons, which of the following is the right symbol for the nucleus:

A $^{12}_{10}X$ | B $^{10}_{12}X$
C $^{22}_{10}X$ | D $^{10}_{22}X$

Solution:

Z = 10 protons
A = Z + n = 10 + 12 = 22
And the symbol is written as X^{22}_{10}, The answer is C

10.7 A nucleus has basic unit charge inside it e, if the number of protons is A and the of neutrons is B, then its total charge equals:

A $\frac{B}{e}$ | B $\frac{A}{e}$
C $A \times e$ | D $B \times e$

10.8 The particles that can be found inside the nucleus are:

A Electrons and protons | B Electrons and neutrons E
C Protons and neutrons | D Protons

Isotopes:

- Each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties; in particular, a radioactive form of an element.
- Properties: Its mass depends on the mass number, the isotope that has greater number of neutrons has the bigger mass, isotopes of same element have the same chemical properties.
- The atomic mass for an element: is the average of isotopes masses in nature.
- The main factor which estimates the stability of the nucleus is the ratio of protons to neutrons.

10.9 Atoms have the same number of protons and different number of neutrons are.

A Alternative atoms
B Isotopes
C Nucleons
D Quarks

10.10 Isotopes are atoms that have the same.

A Number of protons
B Number of neutrons
C Atomic volume
D Mass number

10.11 Isotopes are atoms for the same element and all equal in ..

A Number of electrons
B Mass number
C Number of neutrons
D Atomic volume

10.12 The atomic mass for an element equals to..

A The average mass of isotopes
B The mass of the biggest isotope
C The mass of the smallest isotope
D The mass of the greatest isotope in density

10.13 Which of the following isotopes has the greatest mass?

A $^{11}_{6}C$
B $^{12}_{6}C$
C $^{13}_{6}C$
D $^{14}_{6}C$

The strong nuclear forces:

- Definition: is the force that exerted among the nucleons inside the nucleus.
  $E = mc^2$
  E is the nuclear energy [J], m is the mass [kg], and c is the speed of light [m/s].
- Mass difference: is the difference between the masses of the separated nucleons and the actual mass of the nucleus. (Δm).

10.14 The stability of atom can be determined using the ratio of

A Neutrons to protons
B Neutrons to electrons
C Protons to electrons
D Electrons to neutrons

10.15 The exerted force on protons and neutrons in the nucleus is called as:

A Electrical
B Magnetic
C Electromagnetic
D Nuclear

10.16 The nuclear binding energy is determined as.

A mc
B m/c
C mc^2
D m/c^2

10.17 Mass difference: is the difference between the masses of ……………and the actual mass of the nucleus. (Δm).

A Separated nucleons
B Protons
C Neutrons
D Electrons

Nuclear decay:

- Also called radioactive decay, an unstable nucleus emits radiation and is transformed into the nucleus of one or more other elements. The resulting daughter nuclei have a lower mass and are lower in energy (more stable) than the parent nucleus that decayed.
- The nuclear radiations: Alpha particles, Beta particles, and Gamma rays.

Alpha decay:

- Alpha particle (α): consists of two protons and two neutrons, and equivalent to Helium nucleus He24, it is charge +2 (3.2 x 10^{-19} C), in the electric field it deviates to the negative plate.
- Alpha decay: when the nucleus emits alpha particle, then the mass number A decreased by 4 and the atomic number Z decreased by 2, and a new nucleus forms.

Beta decay:

- Beta particle (β): is an electron e-10 its charge is (-1) (-1.6x10^{-19}), it is mass number =0. In the electric field deviates into the positive plate.
- Beta decay: produces from decay of neutron to the proton and emits beta particle and anti-neutrino, the mass number doesn't change A, and the atomic number increases by 1, and new nucleus is produced.

Gamma decay:

- Gamma ray: is an electromagnetic radiation consists of high energy photons, has no charge, not response for the electric field.
- Gamma decay: in gamma decay process the energy of nucleus is redistributed without any change in the mass number A and the atomic number Z.

10.18 When an unstable nucleus emits radiation and is transformed into the nucleus of one or more other elements, this statement is called ……… decay

A Light B Atomic
C Natural D Radioactive

10.19 The charge of He nucleus is.

A 1.6 x 10^{-19} C B 3.2 x 10^{-19} C
C 4.8 x 10^{-19} C D 6.4 x 10^{-19} C

Solution:

He contains of 2 protons , so the charge of He = 2 x 1.6 x 10^{-19} =3.2 x 10^{-19} C, Answer is B

10.20 Alpha radiation is …….

A $^{4}_{2}He$ B $^{3}_{2}He$
C $^{2}_{2}He$ D $^{1}_{2}He$

10.21 What is the type of radiation that is produced from this nuclear reaction?

$^{238}_{92}U \rightarrow ^{234}_{90}Th + ...$

A Alpha B Beta
C Gamma D X-Rays

10.22 What are the values of A and Z that make the following nuclear equation is truly balanced?

$^{238}_{92}U \rightarrow \alpha + ^{A}_{Z}X$

A Z=94, A=242 B Z=92, A=238
C Z=90, A=238 D Z=90, A=234

Solution:

238–4=234=A
92–2=90=Z
The answer is D

10.23 Beta decays will.

A Increase the atomic number B Decrease the atomic number
C Increase the mass number D Decrease the mass number

10.24 The right symbol for X nucleus in the following nuclear reaction is: $^{210}{}_{83}Bi \rightarrow X + {}_{-1}{}^{0}e$

A $^{210}_{83}X$ B $^{209}_{84}X$
C $^{210}_{84}X$ D $^{209}_{83}X$

The nuclear reactions:

- Change in the identity or characteristics of an atomic nucleus, induced by bombarding it with an energetic particle. In any case, the bombarding particle must have enough energy to approach the positively charged nucleus to within range of the strong nuclear force.

- Types of nuclear reactions:
  1. Decay
  2. Fusion reaction
  3. Fission reaction.
  4.
- Conservation of mass number in the nuclear reaction:
- The mass number for reactants = the mass number of products

- Conservation of atomic number in the nuclear reaction:

- The sum of atomic number in both sides of nuclear reaction equation is the same.

10.25 Gamma rays is.

A Electromagnetic waves B Particles
C Positive ions D Negative ions

10.26 The radiation that has high energy and massless is.

A Gamma B Beta+
C Alpha D Beta-

10.27 Which of the following radiations has no electrical charge?

A Alpha B Positron
C Gamma D Beta

10.28 Gamma decays from nucleus will.

A Released electrons B Emitting of He nucleus
C The energy of nucleus is redistributed D Losing protons

10.29 Which of the following radiations decay doesn't change the number of protons and neutrons in the nucleus?

A Positron B Alpha
C Beta D Gamma

10.30 When gamma decay takes place for a nucleus, then.

A The mass number increases by 1
B The atomic number increases by 1
C Mass and atomic numbers stay the same
D Mass number decreases by 1, and atomic number increases by 1

10.31 The value of r that makes the following nuclear equation balanced and true is

$$^{234}_{90}X \rightarrow {}^{234}_{r}Pa + {}^{0}_{-1}e + \overline{{}^{0}_{0}v}$$

A 90 B 91
C 92 D 124

Solution:

90 = r – 1 , r = 90 +1 = 91 , The answer is B

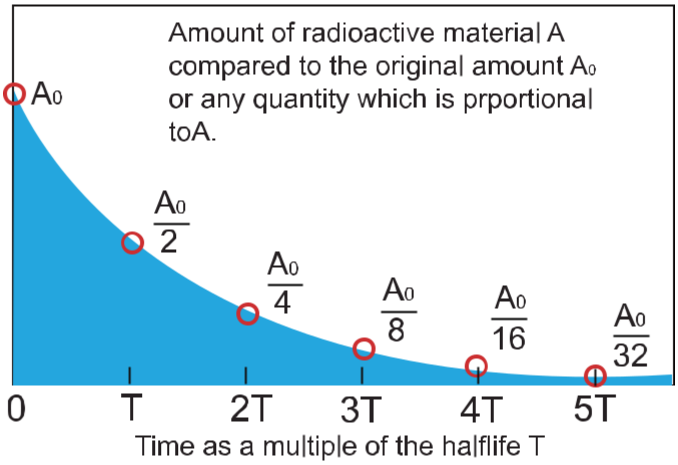
10.32 The following nuclear equation represents the collision of proton with Nitrogen isotope, the products are alpha particle and new nucleus, what is the new nucleus?

$$^{15}_{7}N + {}^{1}_{1}H \rightarrow {}^{4}_{2}He + ...$$

A $^{14}_{8}Z$ B $^{12}_{8}Z$
C $^{12}_{6}Z$ D $^{15}_{6}Z$

Half life time:

- The interval of time required for one-half of the atomic nuclei of a radioactive sample to decay (change spontaneously into other nuclear species by emitting particles and energy).
- Applications:



A_0 is the original mass before decaying.
For each radioactive isotope a specific half life time.

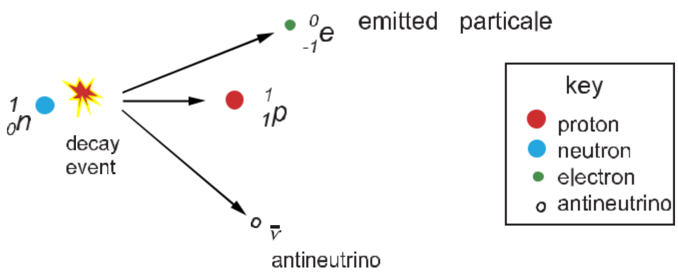
Radioactivity:

- The rate of decay, or activity, of a sample of a radi-oactive substance is the decrease in the number of radioactive nuclei per unit time.
- The decay rate depends on: number of radioactive atoms (sample size), and the half life time of decay.

Beta decay and the weak reaction:

- Neutron decay n_1 : emits proton P^1 : and beta particle e_{-1}^{0} : in addition to anti-neutrino e_{-1}^{0}
- Proton decay P_1^1 : emits neutron n_0^1 , positron
- e_1^0 and neutrino.

Beta Decay of a Neutron



Proton decay p_1^1: emits neutron n_0^1, positron e_1^0 and neutrino.

$P ® n + e^+ + v$

- Positron or (anti-electron): positive small particle has the same mass as electron and the same amount of charge.

Nuclear particles detectors:
1- A Geiger counter.
2- Cloud chambers (Wilson cloud chamber)

- Quarks: any member of a group of elementary sub-atomic particles that interact by means of the strong force and are believed to be among the fundamental constituents of matter.
- Graviton: postulated quantum that is thought to be the carrier of the gravitational field. It is analogous to the well-established photon of the electromagnetic field. Gravitons, like photons, would be massless, electrically uncharged particles traveling at the speed of light.

10.33 A radioactive element has half life time of 8 days, its mass at Saturday 10 g what its mass will be at Sunday of next week?

A 10 B 5
C 2.5 D 1.25

Solution:

Half life time = 8 days
From Sunday to Saturday 8 days, the mass reduces by half
So m = 5 g , Answer is B

10.34 A radioactive specimen has mass of 8 g at Sat-urday and the half life time is 4 days, what its mass at Sunday of the next week?

A 0.5 B 0.25
C 2 D 4

10.35 A radioactive element has mass of 80 g, be-comes 10 g after 72 days, what is the half life time of the element?

A 24 B 12
C 30 D 60

10.36 The number of decays per unit time is called

A Nuclear diffusion
B Rate of decay
C Nuclear fission
D Nuclear force

10.37 When neutron decays to proton, then it will release.

A Alpha particle
B Beta particle
C Gamma rays
D Positron

10.38 When proton decays into neutron, then it will release.

A Positron
B Electron
C Neutron
D Proton

10.39 Particle has the same mass of electron and opposite charge is.

A Positron
B Anti-proton
C Neutron
D Antineutrino

10.40 Geiger counter is used to detect .

A Uncharged particles
B Anti-proton
C Neutron
D Antineutrino

10.41 A postulated quantum that is thought to be the carrier of the gravitational field and not discovered yet is:

A Quark
B Lipton
C Gravitons
D Neutrino

The basic quantities in physics:

Fundamental Quantity		S.I. Unit	
Name	**Symbol**	**Name**	**Symbol**
Mass	m	Kilogram	kg
Length	l	Meter	m
Time	t	Second	s
Current	I	ampere	A
Amount of Substance	n	Mole	mol
Luminous intensity	I_v	Candela	Cd

Some derived quantities in physics

Derived Quantity		S.I. Unit	
Name	**Symbol**	**Name**	**Symbol**
Displacement	d	meter	m
Area	A	Meter squared	m^2
Volume	V	Meter cubed	m^3
Speed	s	Meter/second	m/s
Velocity	v	Meter/second	m/s
Acceleration	a	Meter/second squared	m/s^2
Force	F	Newton	$N= kg.\ m/s^2$
Energy	E	Joule	J = N.m
Density	ρ	Kilogram/meter cubed	Kg/m^3

Chapter 10: Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D	C	A	B	D	C	C	C	B	A	A	A	D	A	D	C	A	D	B	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	D	A	B	A	A	C	C	D	C	B	C	B	C	A	B	B	A	A	A
41																			
C																			