Chapter 8. Modern Physics

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Solution 1

The minimum amount of energy required to emit electrons from a metal surface is called work function of that material.

Solution 2

The electrons in the outer orbits are weakly attracted by the nucleus and are loosely bound. When a solid is formed, the loosely bound electrons leave their individual atom and become a part of the solid as a whole. They are called conduction electrons.

Solution 3

when certain metals are heated to a high temperature, they emit thermions (electrons) and the phenomenon is called thermionic emission. Thermionic emission can be used to produce cathode rays oscilloscope.

Solution 4

Rate of emission of electrons from a heated surface depends upon:(i) Work function of the material.(ii)Melting point of the material.

Solution 5

Materials of low work function are preferred as electron emitters because they emit electrons even at a low temperature.

Solution 6

Work function of a material is generally expressed in electron volt (eV).1 eV = 1.6 ?10^{-19} J.

Solution 7

(i)Electrons are the charged particles.

(ii)Amount of charge on each particle is 1.6 ? 10^{-19} J.

(iii)Approximately 3000 V of voltage is applied to heat the filament.

(iv)Potential difference V_1 applied between the anode and filament is few hundred volts.

(v)Beam of electrons gets deflected when it passes through the magnetic field.

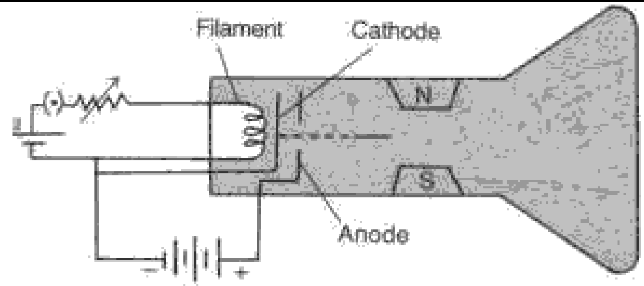

Fig. 4

Solution 8

Pressure inside a cathode ray tube should be kept very low because cathode rays are made up of electrons and mass of electrons are very low. If air exists inside the cathode ray tube then electrons would be deflected by air molecules and cathode would not be able to strike on screen properly.So pressure inside cathode ray tube should be kept very low.

Solution 9

A layer of graphite is made on the inner side of the cathode ray tube close to the fluorescent screen. As a result of impacting electrons, the screen acquires a negative charge. To reduce this effect, the graphite is electrically connected to 'earth' (zero volts).This allows excess charge to drain away. Otherwise the accumulated charge would reduce the numbers of electrons arriving at the screen, reducing brightness.

Solution 10

Brightness of the pattern on the screen of CRT can be controlled by varying the potential applied to the cathode.

Solution 11

Cathode ray tube has three main sections

(i) Electron gun : arrangement of electrodes where a stream of electrons is produced is known as electron gun
(ii)Deflection system: Stream of emerging electrons is deflected in its passage between the gun and the screen. This deflection is produced by two pairs of parallel plates arranged at right angles.
(iii)Fluorescent screen: At the end of the tube screen is coated with a mixture of fluorescent material and phosphorescent material. The phosphorescent material is responsible for the persistence of the image on the screen.

Solution 12

(i)If hotter filament is used then no of electron would increase and a brightness of the spot on the screen would increase.(ii)If anode voltage is increased then this would collimate the beam into a narrower, faster stream of electrons, producing a smaller, sharper dot on the screen.

Solution 13

(i) Cathode ray tubes are used in science research laboratories by scientist for converting electrical signals into visual signals and television tubes.
(ii) Cathode ray tubes are used by doctors for converting electrical impulses corresponding to heart beats into visual signals in ECG, EEG etc.

Solution 14

The end of the tube screen is coated with a mixture of fluorescent material and phosphorescent material. The phosphorescent material is responsible for the persistence of the image on the screen. While fluorescence material coated inside screen is responsible for production of bright spot on the screen when electron beam strikes on the screen.

Solution 15

In presence of electric field, beam of electrons experience a force and deflected towards the positive plate. The path is parabolic within the electric field and after electric field the beam of electron travels straight.In presence of magnetic field, the electrons experience a force, the direction of which is given by Fleming left hand rule. The beam of electrons gets deflected and follows a circular path. The magnetic field is perpendicular to the plane of paper inwards and is represented X. On emergence from the magnetic field, they travel along a straight path in opposite direction to their velocity.

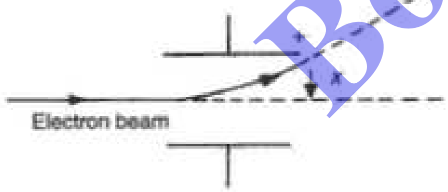

Fig. 5. *Deflection of electron beam by the electric field*

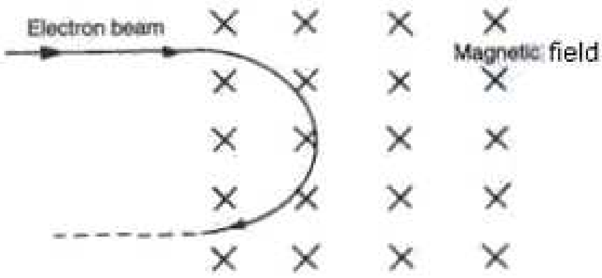

Fig. 6. *Deflection of electron beam by the magnetic field*

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Solution 1

Atom consists of three elementary particles, neutrons, protons and electrons. Neutron and protons form the central part of atom called nucleus where electrons revolve around this central part in orbits called electronic orbits.

Solution 2

Nucleus is central part of an atom which consist of elementary particles protons and neutrons.

Solution 3

(i) Atomic number is the number of protons present in the nucleus. As number of protons is equal to the number of electrons so atomic number also gives the number of electrons in an atom.
(ii) Mass number is the sum of protons and neutrons present in the nucleus.
(iii) Atomic mass of element is the relative mass of its atom as compared to the mass of carbon atom taken as 12.

Solution 4

(i) The penetrating power of α particle is least. Penetrating power of β particles is less but 100 times more than that of α particle. Y radiations have maximum penetration power. They are 100 times more penetrating than β particles.

(ii) Ionisation power of α particle is maximum. It is about 100 times more than that of β particles. Ionisation power of β particle is about 100 times more than that of Y radiations. Y radiations have least ionisation power.

Solution 5

β radiations are similar to a beam of electrons.

Solution 6

The atoms of same elements having the same atomic number Z but different mass number

A are called isotopes.

Solution 7

Isotopes have same chemical properties but have different physical properties.

Solution 8

The atoms of different elements having same mass number but different atomic number are called isobars.

Solution 9

Similarities:

Both ?-radiations and X-rays affect photographic plate, both travel with the speed of light.

Dissimilarities:

?-radiations areobtained in emissions from the radioactive substances due to energy change in the nucleus of their atoms and X- rays are obtained when highly energetic cathode rays are stopped by a heavy metal target of high melting point.

?-radiations have high penetration power but X-rays do not have have very high penetration power.

Solution 10

(i) β particles are negatively charged particles with negligible mass so when a element emits a β particle its mass remain same but atomic number decreases by 1 unit. So after emitting a β particle position of element would shift 1 unit left to the periodic table in same row.

(ii) γ radiations are uncharged and have no mass. So there is no change in atomic mass and atomic number of element emitting γ radiations and position of element remain same in periodic table.

Solution 11

(i) α particle is represented by $_2He^4$ this means it contains 2 protons so after emitting a α particle atomic number of element would decrease by 2 unit.

(ii) β particle is represented by $_{-1}e^0$ after emitting a β particle atomic number of element would increase by 1 unit.

(iii) γ radiations have no charge and no mass so after emitting a γ radiation atomic number of element remain unchanged.

Solution 12

(i) α particle is represented by $_2He^4$ this means it contains 2 protons and 2 neutrons so mass of α particle is 4 unit. Thus after emitting α particle mass number of element would decrease by 4 unit.

(ii) β particle is represented by $_{-1}e^0$ so after emitting a β particle mass number of element would remain unchanged.

(iii) γ radiations have no charge and no mass so after emitting a γ radiation mass number of element remain unchanged.

Solution 13

A radioactive source emits three types of radiations. These are α radiations, β radiations and γ radiations.

(i) α radiations and β radiations are charged radiations.

(ii) γ radiations are most penetrating radiations.

(iii) γ radiation travels with speed of light.

(iv) α radiations have largest mass.

Solution 14

Radioactivity is the spontaneous random emission of particles from within the nucleus of atom. Radiations are emitted from nucleus of atom thus radioactivity is a nuclear phenomenon.

Solution 15

β particle is represented by $_{-1}e^0$ after emitting a β particle atomic number of element would increase by 1 unit and mass number of element would remain unchanged.

Solution 16

(i) Atomic number is the number of protons present in the nucleus. As number of protons is equal to the number of electrons so atomic number also gives the number of electrons in an atom.

(ii) Atomic mass of element is the relative mass of its atom as compared to the mass of carbon atom taken as 12.

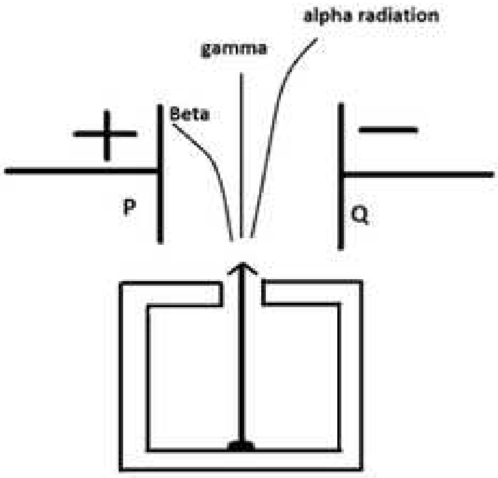
Yes, these quantities are conserved in a radioactive β-decay.

Solution 17

(i) Alpha particles are heavy in mass and are positively charged so they are deflected less by magnetic field and direction is upward which can be calculated by Fleming left hand

rule.
(ii) Beta particles are negligible in mass so they are highly deflected by magnetic field and they are negatively charge particle so they are deflected in downward direction.
(iii) Gamma radiations have no mass and no charge so they are not deflected by magnetic field.

Solution 18



(i) Alpha particles are heavy in mass and are positively charged so they are deflected less and are deflected towards – charged plate.

(ii) Beta particles are negligible in mass so they are highly deflected by electric field anc they are negatively charge particle so they are deflected towards positive charged plate.

(iii) Gamma radiations have no mass and no charge so they are not deflected by electric field.

Source S is placed in thick lead container because it is radioactive substance and radiates. Thick walls of lead absorb all the radiation except radiation going straight outside towards opened end. Thus, thick walls help to reduce leakage of radiations outside.

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Solution 19

Initially element is represented by ${}_{84}X^{202}$

α particle is represented by ${}_{2}He^{4}$ this means it contains 2 protons and 2 neutrons so mass of α particle is 4 unit. Thus after emitting α particle mass number of element would decrease by 4 unit and atomic number of element would decrease by 2.

So after emitting α particle ${}_{84}X^{202}$ would become ${}_{84-2}X^{202-4}$ = ${}_{82}X^{198}$.

β particle is represented by ${}_{-1}e^{0}$ after emitting a β particle atomic number of element would increase by 1 unit and mass number of element would remain unchanged.

So after emitting a β particle ${}_{82}X^{198}$ would become ${}_{82+1}X^{198}$ = ${}_{83}X^{198}$.

The daughter nucleus is represented by ${}_{b}Y^{a}$.

${}_{b}Y^{a}$ = ${}_{83}X^{198}$.

a= 198

b= 83.

Solution 20

The mass number of an element is not changed when it emits β and Υ radiations.

Solution 21

The atomic number of a radioactive element is not changed when it emits Υ radiations.

Solution 22

Initially element is represented by $_{Z}X^{A}$.

β particle is represented by $_{-1}e^{0}$ after emitting a β particle atomic number of element would increase by 1 unit and mass number of element would remain unchanged.

So after emitting a β particle $_{Z}X^{A}$ would become $_{Z+1}X^{A}$.

α particle is represented by $_{2}He^{4}$ this means it contains 2 protons and 2 neutrons so mass of α particle is 4 unit. Thus after emitting α particle mass number of element would decrease by 4 unit and atomic number of element would decrease by 2.

So after emitting α particle $_{Z+1}X^{A}$ would become $_{Z+1-2}X^{A-4} = {}_{Z-1}X^{A-4}$.

The daughter nucleus is represented by $_{Q}Y^{P}$.

$_{Q}Y^{P} = {}_{Z-1}X^{A-4}$.

P= A-4.

Q= Z-1.

Solution 23

Artificial radioactive substances can be produced by bombarding lighter nuclides withalpha particles, protons and neutron. The radioactive substances produces in this manner are called radioisotopes. Radioisotopes can be used as:
(i) Rays from Radium produce satisfactorily improvement in skin diseases.
(ii) Radioactive Sulphur S35 helps to study advantages and disadvantages of fungicides.

Solution 24

Following precautions should be taken while handling the radioactive substances.(i) The sources should only be handled by the forceps provided and never touched by hand.(ii) They should never be pointed towards a person.(iii) Food should not be taken where the sources are being used, as it may be contaminated.(iv) Never smoke near a radioactive source.

Solution 25

Radioactive substances should not be touched by hands because radiation emitted by radioactive substances can cause burns, Leukaemia, eye cataract, sterility or many other dangerous disease.

PAGE NO-283:

Solution 1

(a) Mass number of copper = 63Atomic number of copper = 29As atomic number of element gives number of proton and electrons while mass number of element gives number of protons +number of neutrons.So, number of protons in copper = atomic number of copper = 29.Number of electron in copper = number of protons in copper =29.Number of neutrons = mass number ? atomic number = 63 ? 29 =34.So answer is (iii) as copper contains 29 protons and 29 electrons.

(b) Initially element is represented by $_{86}Ra^{226}$

α particle is represented by $_2He^4$ this means it contains 2 protons and 2 neutrons so mass of α particle is 4 unit. Thus after emitting α particle mass number of element would decrease by 4 unit and atomic number of element would decrease by 2.

So after emitting 2 α particle $_{86}Ra^{226}$ would become $_{86-2-2}Ra^{226-4-4} = {}_{82}Ra^{218}$.

β particle is represented by $_{-1}e^0$ after emitting a β particle atomic number of element would increase by 1 unit and mass number of element would remain unchanged.

So after emitting a β particle $_{82}Ra^{218}$ would become $_{82+1}Ra^{218} = {}_{83}Ra^{218}$.

Gamma radiations have zero mass and no charge so after emission of gamma radiation mass and atomic number remains unaltered.

The daughter nucleus is represented by $_bX^a$.

$_bX^a = {}_{83}Ra^{218}$.

So answer is B.

(c) Initially element is represented by $_{92}X^{238}$

α particle is represented by $_2He^4$ this means it contains 2 protons and 2 neutrons so mass of α particle is 4 unit. Thus after emitting α particle mass number of element would decrease by 4 unit and atomic number of element would decrease by 2.

So after emitting α particle $_{92}X^{238}$ would become $_{92-2}X^{238-4} = {}_{90}X^{234}$.

So answer is A.

(d) Initially element is represented by $_{92}P^{239}$

β particle is represented by $_{-1}e^0$ after emitting a β particle atomic number of element would increase by 1 unit and mass number of element would remain unchanged.

So after emitting a β particle $_{92}P^{239}$ would become $_{92+1}P^{239} = {}_{93}P^{239}$.

$_bQ^a = {}_{93}P^{239}$.

So answer is C.

(e) Answer is (iv) as both alpha and beta particles are deflected by magnetic

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Solution 2

The phenomenon of spontaneous disintegration of an unstable nucleus of naturally occurring isotope accompanied by emission of active radiations α particles, β particles and γ radiations is called radioactivity.

(a) α particles have positive charge.

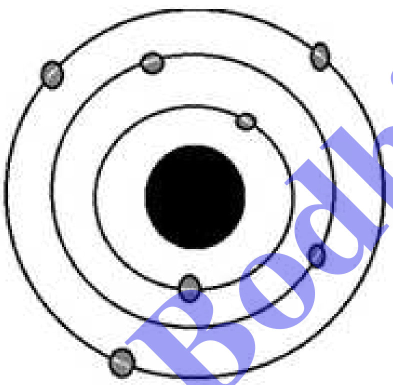
(b) γ radiation is most penetrating.

(c) γ radiation has no electric charge.

Solution 3

(a) Electron has
(ii) a mass less than that of a proton.
(b) Neutrons have
(iv) no electric charge.

Solution 4



The central sphere is nucleus where small spheres are electron moving in circular orbit around nucleus.

(a) There is positive charge on nucleus.

(b) Charge on proton is equal to $+1.6 \times 10^{-19}$ C and neutron is neutral so value of charge on nucleus is $p \times 1.6 \times 10^{-19}$ C where p is the number of proton in nucleus.

Solution 5

A radioactive source emits three types of radiations. These are α radiations, β radiations and γ radiations.

α radiation

(i) α particles are Helium nucleus $_2He^4$.

(ii) α particles are positively charged.

(iii) The mass of each α particle is 4 a.m.u.

(iv) Ionization power of α particle is maximum. It is about 100 times more than that of β particles.

(v) α particle has velocity less than the velocity of light i.e 1×10^7 ms^{-1}.

(vi) The penetrating power of α particle is least.

(vii) α particles are less deflected by electric and magnetic fields.

β particles

(i) β particles are like electrons $_{-1}\beta^0$.

(ii) β particles are negatively charged.

(iii) The mass of each β particle is negligible.

(iv) Velocity of β particle is comparable to the velocity of light.

(v) Ionization power of β particle is about 100 times more than that of γ radiations.

(vi) Penetrating power of β particles is less but 100 times more than that of α particle.

(vii) β particles are more deflected by electric and magnetic field but in opposite direction.

γ radiations

(i) γ radiations are electromagnetic radiations.

(ii) γ radiations have no charge.

(iii) γ radiations have no mass.

(iv) Velocity of γ radiation is equal to the velocity of light.

(v) Ionization power is least.

(vi) γ radiations have maximum penetration power. They are 100 times more penetrating than β particles.

(vii) γ radiations are unaffected by electric and magnetic field.

Heavy nucleus undergo radioactivity because they are unstable.

Solution 6

(a)Mass number of uranium = 235Atomic number of uranium = 92As atomic number of element gives number of proton and electrons while mass number of element gives number of protons +number of neutrons.So, number of protons in uranium = atomic number of uranium = 92.(b) Number of electron in uranium = number of protons in uranium =92.(c)The atoms of same elements having the same atomic number Z but different mass number A are called isotopes. So, for another isotope of uranium mass number 235 changes.(d)Number of protons in isotopes is same and as U238 is isotope of $_{92}U^{235}$. So, number of protons in U^{235} is also 92.

Solution 7

A radioactive source emits three types of radiations. These are α radiations, β radiations and γ radiations.

(i) α particles are heavy in mass and have positive charge so they are less deflected by magnetic field. β particles are lighter in mass and have negative charge so they are deflected more by magnetic field in opposite direction to α particle's deflection. γ radiations are charge less and mass less so they are not deflected by magnetic field.

(ii) α particles are heavy in mass and have positive charge so they are less deflected by electric field towards negative plate. β particles are lighter in mass and have negative charge so they are deflected more by electric field towards positive plate. γ radiations are charge less and mass less so they are not deflected by electric field.

(iii) The penetrating power of α particle is least. They can't penetrate lead sheet very much. Penetrating power of β particles is less but 100 times more than that of α particle. So, it will penetrate lead sheet more than α particles. γ radiations have maximum penetration power. They are 100 times more penetrating than β particles. So, γ radiations would penetrate in lead sheet by largest amount.

Solution 8

The atoms of same elements having the same atomic number Z but different mass number a are called isotopes. Hydrogen have 3 isotopes protium $_1H^1$, deuterium $_1H^2$, tritium $_1H^3$.

Solution 9

(a) Mass number is the sum of protons and neutrons present in the nucleus.

(b) Atomic number is the number of protons present in the nucleus. As number of protons is equal to the number of electrons so atomic number also gives the number of electrons in an atom.

(c) Isotopes have same number of atomic number and different number of atomic masses.

(d) Uses of radioactivity in medical, agriculture and industry:

Uses in medical field:

(i) Rays from Radium produce satisfactorily improvement in skin diseases.

(ii) Radiation from Co^{60} is used in cancer treatment.

(iii) Radio I^{131} is used to diagnose and treat thyroid disorders.

Uses in agriculture:

(i) Radioactive Phosphorus P^{32} is used in the study of metabolism.

(ii) Radioactive Sulphur S^{35} helps to study advantages and disadvantages of fungicides.

(iii) Pests and insects can be killed by γ-radiation.

Uses in industry:

(i) In manufacturing papers, plastic and metal sheets to control the thickness of the sheets.

(ii) Radioisotopes can be used to estimate the amount of wear in bearings.

(iii) Radioisotopes can be used to detect crack in welding, casting etc.

Solution 10

Sl. no	α particles	β particles	Υ radiations
1	α particles are Helium nucleus ${}_2He^4$.	β particles are like electrons ${}_{-1}\beta^0$.	Υ radiations are electromagnetic radiations.
2	α particles are positively charged.	β particles are negatively charged.	Υ radiations have no charge.
3	The mass of each α particle is 4 a.m.u.	The mass of each β particle is negligible.	Υ radiations have no mass.
4	α particles has velocity less than the velocity of light i.e 1×10^7 ms^{-1}.	Velocity of β particle is comparable to the velocity of light.	Velocity of Υ radiation is equal to the velocity of light.
5	Ionisation power of α particle is maximum. It is about 100 times more than that of β particles.	Ionisation power of β particle is about 100 times more than that of Υ radiations.	Ionisation power is least.
6	The penetrating power of α particle is least.	Penetrating power of β particles is less but 100 times more than that of α particle.	Υ radiations have maximum penetration power. They are 100 times more penetrating than β particles.
7	α particles are less deflected by electric and magnetic fields.	β particles are more deflected by electric and magnetic field but in opposite direction.	Υ radiations are unaffected by electric and magnetic field.

Solution 11

Following precautions should be taken while handling the radioactive substances.

(i) The sources should only be handled by the forceps provided and never touched by hand.

(ii) They should never be pointed towards a person.

(iii) Food should not be taken where the sources are being used, as it may be contaminated.

(iv) Never smoke near a radioactive source

Solution 12

The process of destruction of the original nucleus during the formation of new nucleus due to radioactivity is called radioactive decay.

Question is wrong as Thorium has atomic number 90 not 92.

Symbolic equation of decay is

$$ {}_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_2He^4. $$

Solution 13

Symbolic equation of decay is

$$_{11}Na^{24} \longrightarrow {}_{12}Mg^{24} + {}_{-1}e^{0}.$$

Solution 14

(a) When certain metals are heated to a high temperature, they emit thermions (electrons) and the phenomenon is called thermionic emission.

(b) Thermionic emission of electrons from a heated surface depends upon:

(i) Work function of the material.

(ii) Melting point of the material.

Solution 15

(a)

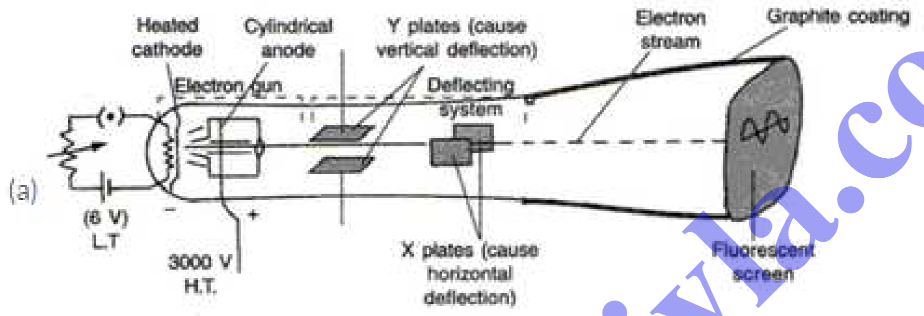


Fig. 2. *The principle of the cathode ray oscilloscope. Oscillating voltages applied across the X and Y plates cause deflection of the spot on the fluorescent screen tracing out the oscillation form*

(b) Uses of cathode ray tubes are:

(i) Cathode ray tubes are used in science research laboratories by scientist for converting electrical signals into visual signals and television tubes.

(ii) Cathode ray tubes are used by doctors for converting electrical impulses corresponding to heart beats into visual signals in ECG, EEG etc.

Solution 16

(a) The phenomenon of spontaneous disintegration of an unstable nucleus of naturally occurring isotope accompanied by emission of active radiations α particles, β particles and γ radiations is called radioactivity.

(b) Some of the radioactive isotopes are Co^{60}, I^{131}, P^{32}, Na^{24}, S^{35} etc.

Solution 17

Sl. no	α particles	β particles	γ radiations
1	α particles are Helium nucleus $_2He^4$.	β particles are like electrons $_{-1}\beta^0$.	γ radiations are electromagnetic radiations.
2	α particles are positively charged.	β particles are negatively charged.	γ radiations have no charge.
3	The mass of each α particle is 4 a.m.u.	The mass of each β particle is negligible.	γ radiations have no mass.
4	α particles has velocity less than the velocity of light i.e 1×10^7 ms^{-1}.	Velocity of β particle is comparable to the velocity of light.	Velocity of γ radiation is equal to the velocity of light.
5	Ionisation power of α particle is maximum. It is about 100 times more than that of β particles.	Ionisation power of β particle is about 100 times more than that of γ radiations.	Ionisation power is least.
6	The penetrating power of α particle is least.	Penetrating power of β particles is less but 100 times more than that of α particle.	γ radiations have maximum penetration power. They are 100 times more penetrating than β particles.
7	α particles are less deflected by electric and magnetic fields.	β particles are more deflected by electric and magnetic field but in opposite direction.	γ radiations are unaffected by electric and magnetic field.

Solution 18

Following precautions should be taken while handling the radioactive substances.(i) The sources should only be handled by the forceps provided and never touched by hand.(ii) They should never be pointed towards a person.(iii) Food should not be taken where the sources are being used, as it may be contaminated.(iv) Never smoke near a radioactive source.

Solution 19

Radioactive isotopes are used in medical field

(i) Rays from Radium produce satisfactorily improvement in skin diseases.

(ii) Radiation from Co^{60} is used in cancer treatment.

(iii) Radio I^{131} is used to diagnose and treat thyroid disorders.

Radioactive isotopes are used in agriculture

(i) Radioactive Phosphorus P^{32} is used in the study of metabolism.

(ii) Radioactive Sulphur S^{35} helps to study advantages and disadvantages of fungicides.

(iii) Pests and insects can be killed by γ-radiation.

Radioactive isotopes are used in industry.

(i) In manufacturing papers, plastic and metal sheets to control the thickness of the sheets.

(ii) Radioisotopes can be used to estimate the amount of wear in bearings.

(iii) Radioisotopes can be used to detect crack in welding, casting etc.

Solution 20

The low temperature microwave radiation that arrives at the earth's surface from all directions of outer space is called background radiation.Sources of background radiations are:

(a) Radiation from the sun.

(b) Rocks in the earth which contain traces of radioactive substances.

(c) Naturally occurring isotopes.

(d) Artificial radioisotopes.No, it is not possible to keep ourselves away from these radiations.