PAGE 156:

Q1.
(a) Nuclear fission
(b) Nuclear fusion
Q2.
Neutrons.
Q3.
Neutrons.
Q4.
By the low energy neutrons.
Q5.
(a) Nuclear fusion.
(b) Nuclear fission.
Q6.
Graphite.
Q7.
Boron.
Q8.
Thick concrete chamber is required to prevent the radioactive rays to travel outside.

PAGE 157

Q9.
Uranium is used up in the reactor.
Q10.
Nuclear fission reactions are used for generating electricity at a nuclear power plant.
Q11.
Million electron volt (MeV)
Q12.
1 atomic mass unit=931 MeV
Q13.
(a) nuclear fission
(b) neutrons; nuclear fission
(c) fission
(d) reactor
Q14.
The process in which the heavy nucleus of a radioactive atom(such as uranium) splits up into smaller nuclei when bombarded with low energy neutrons, is called nuclear fission.
E.g., When uranium-235 atoms are bombarded with slow moving neutrons, the heavy uranium nucleus breaks up to produce two medium-weighted atoms and 3 neutrons, with the emission of tremendous amount of energy.

$$^{235}_{92}U + ^{1}_{0}n \xrightarrow{\text{Fission}} ^{13}_{56}Ba + ^{94}_{36}Kr + 3\,^{1}_{0}n + \text{tremendous amount of energy}$$

Q15.
(a) The process in which two nuclei of light elements (like that of hydrogen) combine to form a heavy nucleus (like that of helium), is called nuclear fusion.
When deuterium atoms are heated to an extremely high temperature under extremely high pressure, then two deuterium

nuclei combine together to form a heavy nucleus of helium, and a neutron is emitted. A tremendous amount of energy is liberated in the process.

$${}^{2}_{1}H + {}^{2}_{1}H \xrightarrow{\text{Fusion}} {}^{3}_{2}He + {}^{1}_{0}n + \text{tremendous amount of energy}$$

(b) Because very high energy is required to force the lighter nuclei (which repel each other) to fuse together to form a bigger nuclei.

Q16.

The nuclear fuel in the sun is hydrogen gas.
The sun can be considered as a big thermonuclear furnace where hydrogen atoms continuously get fused into helium atoms. Mass gets lost during these fusion reactions and energy is being produced.
Nuclear reaction:

$$4\,{}^{1}_{1}H \xrightarrow{\text{Fusion}} {}^{4}_{2}He + 2\,{}^{0}_{+1}e + \text{tremendous amount of energy}$$

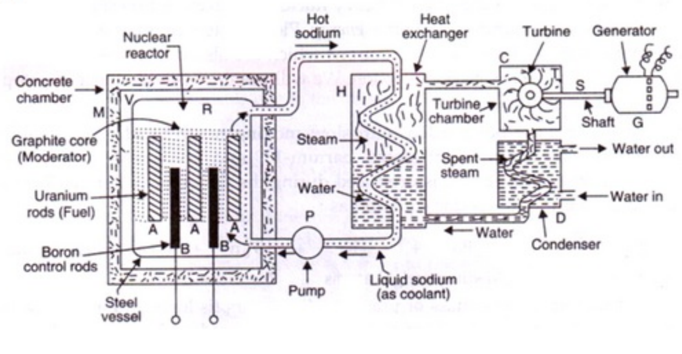
Q17.
(a) Einstein's equation: $E=mc^2$
where E is the amount of energy produced if mass m is destroyed, and c is the speed of light in vacuum.
(b) 1 atomic mass unit = 931 MeV
25 atomic mass unit = 931 x 25 MeV = 23275 MeV
23275 MeV of energy is released.
Q18.
(a) Nuclear fusion reactions 0f hydrogen.
(b) The hydrogen bomb consists of heavy isotopes of hydrogen (deuterium and tritium) alongwith lithium-6. The explosion of hydrogen bomb is done by using an atom bomb. When the aton bomb is exploded, its fission reaction produces a lot of heat which raises the temperature of deuterium and tritium to 107oC in a few microseconds. Then fusion reactions of deuterium and tritium take place producing a tremendous amount of energy. This explodes the hydrogen bomb. Lithium-6 is used to produce more tritium needed for fusion.
(c) The source of energy is same for both the sun and the hydrogen atom, i.e. nuclear fusion.
Q19.
(a) When slow moving neutrons are made to strike the atoms of a heavy element uranium-235, the heavy uranium nucleus breaks up to produce two medium-weighted atoms and 3 neutrons, with the emission of tremendous amount of energy. This process is called nuclear fission.

(b) ${}^{235}_{92}U + {}^{1}_{0}n \xrightarrow{\text{Fission}} {}^{13}_{56}Ba + {}^{94}_{36}Kr + 3\,{}^{1}_{0}n + \text{tremendous amount of energy}$
(c) Nuclear Power Station

(c) Nuclear Power Station
Q20.
(a) Advantages of nuclear energy:
(i) It produces a large amount of useful energy from a very small amount of a nuclear fuel.
(ii) Once the nuclear fuel is loaded into the reactor, the nuclear power plant can go on producing electricity for two to three years at a stretch. There is no need of feeding the fuel again and again.
(iii) It does not produce gases like CO2 or SO2.
(b) Disadvantages of nuclear energy:
(i) The waste products of nuclear fission reactions are radioactive which keep on emitting harmful radiations for thousands of years and are difficult to store or dispose safely.
(ii) Very high cost of installation is required.
(iii) There is a limited availability of uranium fuel.
Q21.
(a) Uranium-235
(b) No
(c) Nuclear fission
(d) Moderator slows down the speed of neutrons to make them fit for causing fission.
(e) Boron rods are used to absorb excess neutrons and prevent the

fission reaction from going out of control.
(f) Liquid sodium or carbon dioxide gas is used as a 'coolant' to transfer the heat produced to heat exchanger for converting water into steam.
Q22.
(a) Graphite
(b) Concrete
(c) Uranium-235
(d) Boron
(e) Liquid sodium
Q23.
(a) Control rods control the rate of fission by absorbing the excess neutrons and preventing the fission reaction from going out of control.
(b) Heat is removed from the nuclear reactor core with the help of liquid sodium, which absorbs the heat and transfers it to the heat exhanger. This heat is used for converting water in the heat exchanger into steam, which is then used to produce electricity by rotating a turbine and its shaft connected to a generator.
Q24.
On inserting the control rods in the graphite core, the rods start absorbing the excess neutrons and maintain the rate of reaction as per requirement. The rods can be raised or lowered in the reactor from outside. The part which is inside the reactor absorbs neutrons.
Q25.
Advantages of using nuclear fuel: Electricity can be produced for almost two to three years with the same uranium fuel in a nuclear power plant.
Disadvantages of using nuclear fuel: The nuclear wastes produced by the fission of uranium-235 during the generation of electricity are radioactive and extremely harmful.
Q26.
(a) Nuclear reactor is a device designed to maintain a chain reaction producing a steady flow of neutrons generated by the fission of heavy nuclei. Uranium-235 is used as a fuel in a nuclear reactor.

(b)




In a nuclear power plant, the fission of uranium-235 is carried out in a reactor R. Uranium-235 rods are inserted in a graphite core which acts as a moderator to slow down the neutrons. Boron rods B absorb excess neutrons and controls the rate of reaction. Liquid sodium or carbon dioxide gas, which is pumped continuously through pipes embedded in reactor by using a pump P, is used as a 'coolant' to transfer the heat produced to heat exchanger for converting water into steam. The hot steam at high pressure goes into a turbine chamber and makes the turbine rotate. The shaft of the generator also rotates and drives a generator connected to it.
(c) By inserting the boron control rods fully into the reactor.
(d) Five places in India where nuclear powerplants are located are:
(i) Tarapur.
(ii) Kalpakkam.
(iii) Narora.
(iv) Kaprapur.

(vi) kaiga.

PAGE 158:

Q27.

(a).

| | Nuclear Fission | Nuclear Fusion |
|---|---|---|
| Natural occurrence of the process: | Fission reaction does not normally occur in nature. | Fusion occurs in stars, such as the sun. |
| Byproducts of the reaction: | Fission produces many highly radioactive particles. | Few radioactive particles are produced by fusion reaction, but if a fission "trigger" is used, radioactive particles will result from that. |
| Energy Ratios: | The energy released by fission is a million times greater than that released in chemical reactions; but lower than the energy released by nuclear fusion. | The energy released by fusion is three to four times greater than the energy released by fission. |
| Nuclear weapon: | One class of nuclear weapon is a fission bomb, also known as an atomic bomb or atom bomb. | One class of nuclear weapon is the hydrogen bomb, which uses a fission reaction to "trigger" a fusion reaction. |
| Energy requirement: | Takes little energy to split two atoms in a fission reaction. | Extremely high energy is required to bring two or more protons close enough that nuclear forces overcome their electrostatic repulsio. |

(b) (i) Nuclear fission

(ii) Nuclear fusion

(c) Nuclear fusion

(d) Mass,m=5g=0.005kg, Speed of light, $c=3\times10^8$ m/s

We know that, $E=mc^2$

$E=0.005\times(3\times10^8)^2$

$E=4.5\times10^{14}$ J

(e)

$$1\text{MeV} = 1.602\times10^{-13}\text{ J}$$

$$1\text{J} = \frac{1}{1.602\times10^{-13}}\text{MeV}$$

$$4.5\times10^{14}\text{ J} = \frac{4.5\times10^{14}}{1.602\times10^{-13}} = 2.808\times10^{27}\text{MeV}$$

PAGE 159:

Q46.

(a) Nuclear fission; a large nucleus splits into two smaller nuclei with the release of energy, brought about by the absorption of a neutron.

(b) Particles c is neutron; x=3

(c) Energy liberated

(d) Nuclear power station

(e) Atom bomb

Q47.

(a) Nuclear fusion; two smaller nuclei combine to form a bigger nucleus with the release of energy, brought about under the conditions of high temperature and pressure.

(b) Particle c is neutron; x=1

(c) Energy liberated

(d) Millions of degree of temperature and millions of pascals of pressure.

(e) Hydrogen bomb.

Q48.

(i) D(mass number 235)

(ii) A(mass number2)

Q49.

We will insert the control rods of boron a little more into the reactor to reduce the rate of nuclear fission process.

Q50.

The control rods should be withdrawn a little more from inside the reactor. This will increase the rate of nuclear fission process and hence more heat.

Q51.

The control rods absorb all the neutrons, stopping the nuclear chain reaction.

*********** END **********