Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

(a) When a nucleus of uranium -235 fissions into barium -141 and krypton -92, the change in mass is 3.1×10^{-28} kg. Calculate how many nuclei must undergo fission in order to release 1.0 J of energy by this reaction.

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(2)

(b) A nuclear power station produces an electrical output power of 600 MW. If the overall efficiency of the station is 35%, calculate the decrease in the mass of the fuel rods, because of the release of energy, during one week of continuous operation.

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(4)
(Total 6 marks)

Q2.

In a geothermal power station, water is pumped through pipes into an underground region of hot rocks. The thermal energy of the rocks heats the water and turns it to steam at high pressure. The steam then drives a turbine at the surface to produce electricity.

(a) Water at 21°C is pumped into the hot rocks and steam at 100°C is produced at a rate of 190 kg s^{-1}.

(i) Show that the energy per second transferred from the hot rocks to the power station in this process is at least 500 MW.

specific heat capacity of water = 4200 J kg^{-1} K^{-1}
specific latent heat of steam = 2.3×10^6 J kg^{-1}

(ii) The hot rocks are estimated to have a volume of 4.0×10^6 m^3. Estimate the fall of temperature of these rocks in one day if thermal energy is removed from them at the rate calculated in part (i) without any thermal energy gain from deeper underground.

specific heat capacity of the rocks = 850 J kg^{-1} K^{-1}
density of the rocks = 3200 kg m^{-3}

(7)

(b) Geothermal energy originates as energy released in the radioactive decay of the uranium isotope $^{238}_{92}$U deep inside the Earth. Each nucleus that decays releases 4.2 MeV. Calculate the mass of $^{238}_{92}$U that would release energy at a rate of 500 MW.

half-life of $^{238}_{92}$U = 4.5×10^9 years

molar mass of $^{238}_{92}$U = 0.238 kg mol^{-1}

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(5)

(Total 12 marks)