Name of the Student:_____

Max. Marks : 18 Marks   **Time : 18 Minutes**

Q1.

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}

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   (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}

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   (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)

Q2.

(a) Calculate the energy released when 1.5 kg of water at 18 °C cools to 0 °C and then freezes to form ice, also at 0 °C.

specific heat capacity of water = 4200 J kg^{-1} K^{-1}
specific latent heat of fusion of ice = 3.4 × 10^5 J kg^{-1}

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(4)

(b) Explain why it is more effective to cool cans of drinks by placing them in a bucket full of melting ice rather than in a bucket of water at an initial temperature of 0 °C.

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(2)

(Total 6 marks)