Second Law of Thermodynamics – Part 2

Instructions:

- This tutorial is linked with the video lesson "2nd Law of Thermodynamics – Part 2"
- Carefully follow the video lesson prior to this tutorial.

Q1) Distinguish the difference between a heat pump and a refrigerator.

Q2) State the Corollary 1 (the Clausius Statement) of the 2nd law of thermodynamics.

Q3) A domestic refrigerator that runs one-third of the time removes on average 1800 kJ/h of heat from the food compartment. If the power consumed is 0.50 kW, determine its COP.

Q4) A household refrigerator has to freeze 10 kg of water to 0 °C from 20 °C. COP of the refrigerator is 2.5 and the power input is 400 W. Specific heat capacity of water is 4.2 kJ/kg. How long will it take for the water to freeze?

Q5) A cold storage plant requires 30 tonnes of refrigeration. The freezing temperature is -20 °C and the ambient temperature is 30 °C. If the performance of the refrigeration plant is 25% of the Carnot COP of the plant working between the same temperature limits, determine the power supply required to run the plant. One tonne of refrigeration is equivalent to 211 kJ/min.

Q6) A steam power plant with a thermal efficiency of 20 % consumes coal at a rate of 55 tonnes/h. If the heating value of coal is 27 MJ/kg, determine the power output of the plant.

Q7) Two reversible heat engines operate in series between a source at 527 0C and a sink at 17 °C. If the engines have equal efficiencies and the first rejects 400 kJ to the second, calculate:

a) The temperature at which heat is supplied to the second engine

b) The heat taken from the source

c) The work done by each engine

Q8) A reversible heat engine operating between thermal reservoirs at 800 °C and 30 °C drives a reversible refrigerator which refrigerates a space at -15 °C and delivers heat to a thermal reservoir at 30 °C. The heat input to the heat engine is 1900 kJ and there is a net work output from the combined plant (heat engine and refrigerator) of 290 kJ. Determine the heat transfer to the refrigerant and the total heat transfer to the 30 °C thermal reservoir.