A 0.020-kilogram sample of a material is initially a solid at a temperature of 20° C. Heat is added to the sample at a constant rate of 100 joules per second until the temperature increases to 60° C. The graph above represents the temperature of the sample as a function of time.

a. Calculate the specific heat of the solid sample in units of joules per kilogram°C.
b. Calculate the latent heat of fusion of the sample at its melting point in units of joules per kilogram.
c. Referring to the three intervals AB, BC, and CD shown on the graph, select the interval or intervals on the graph during which:
   i. the average kinetic energy of the molecules of the sample is increasing
   ii. the entropy of the sample is increasing
A proposed ocean power plant will utilize the temperature difference between surface seawater and seawater at a depth of 100 meters. Assume the surface temperature is 25° Celsius and the temperature at the 100-meter depth is 3° Celsius.

a. What is the ideal (Carnot) efficiency of the plant?

b. If the plant generates useful energy (work) at the rate of 100 megawatts while operating with the efficiency found in part (a), at what rate is heat given off to the surroundings?

c. A nuclear power plant operates with an overall efficiency of 40 percent. At what rate must mass be converted into energy to give the same 100-megawatt output as the ocean power plant above? Express your answer in kilograms per second.

The diagram below represents the Carnot cycle for a simple reversible (Carnot) engine in which a fixed amount of gas, originally at pressure $p_0$ and volume $V_0$, follows the path ABCDA.

\[
\begin{align*}
\text{Pressure} & \quad \text{Volume} \\
\begin{array}{c}
p_0 \\
\frac{p_0}{2} \\
0 \\
2V_0 \\
V_0
\end{array} & \begin{array}{c}
0 \\
V_0 \\
2V_0 \\
V_0
\end{array}
\end{align*}
\]

\[A(V_0, p_0) \quad B(2V_0, \frac{p_0}{2}) \quad C \quad D \]

\[\begin{array}{c|c|c}
\text{Part} & Q & \Delta T \\
\hline
AB & + & + \\
BC & - & - \\
CD & + & + \\
DA & + & + \\
\end{array}\]

\(Q\) is positive when heat is added to the gas, and \(\Delta T\) is positive when the temperature of the gas increases.