Problem 2.21

For the first bath,

$$\Delta S_{11} = C \ln\left(\frac{T_b}{T_a}\right) \tag{1}$$
$$= 4184 \ln\left(\frac{298}{273}\right)$$
$$= 366.6 \text{ J/K} \tag{2}$$

The energy transfer is

$$Q = C\,(T_b - T_a) \tag{3}$$
$$= 4184(25)$$
$$= 104600 \text{ J} \tag{4}$$

So the entropy of the first bath is

$$\Delta S_{12} = -\frac{Q}{T_b} \tag{5}$$
$$= -\frac{104600}{298}$$
$$= -351 \text{ J/K} \tag{6}$$

The total entropy change for the first bath is

$$\Delta S_1 = 366.6 - 351 \tag{7}$$
$$= 15.6 \text{ J/K} \tag{8}$$

Similarly, for the second bath,

$$\Delta S_{21} = 4184 \ln\left(\frac{323}{298}\right) \tag{9}$$
$$= 337.1 \text{ J/K} \tag{10}$$
$$\Delta S_{22} = -\frac{Q}{T_b} \tag{11}$$
$$= -\frac{104600}{323} \tag{12}$$
$$= -323.8 \text{ J/K} \tag{13}$$
$$\Delta S_2 = 337.1 - 323.8 \tag{14}$$
$$= 13.3 \text{ J/K} \tag{15}$$

The total entropy change for both processes is then

$$\Delta S = 15.6 + 13.3 \tag{16}$$
$$\boxed{\Delta S = 28.9 \text{ J/K}} \tag{17}$$

The value obtained is less than that of the water directly placed in contact with the 50° bath.