GIVEN

Insulated copper block
>> recieves energy @ rate $\dot{W} = 100\ W$
>> vol $\equiv \forall = 10^{-3}\ m^3$
>> initial temp. $\equiv T_i = 20°C$
>> $C_{cu} = 0.385\ kJ/kgK$
>> $\rho_{cu} = 8930\ kg/m^3$

FIND

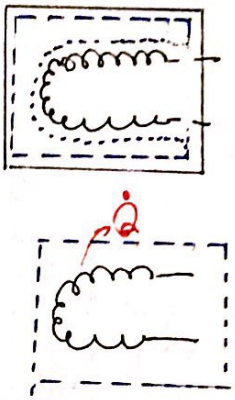
How long it takes to reach 60°C, t? KEEP

ASSUMP

- Closed sys.
- Insulated
- $\Delta PE = \Delta KE = 0$

EQN

- $\frac{dm}{dt}|_{sys} = \dot{m}_{in} - \dot{m}_{out}$
- $\dot{W} = \frac{dE}{dt}$
- $E = Cm\Delta T$



SOLN

The energy required to reach 60°C from 20°C is

$$E_{required} = C_{cu} \cdot m_{cu} \cdot \Delta T = C_{cu} \cdot \rho_{cu} \cdot \forall \Delta T$$

$$= \left(\frac{0.385 \times 10^3\ J}{kg \cdot K}\right)\left(\frac{8930\ kg}{m^3}\right)\left(10^{-3}\ m^3\right)[(60-20)K]$$

$$\approx 1.38 \times 10^5\ J$$

$$\therefore t = \frac{E_{required}}{\dot{W}} = \frac{(1.38 \times 10^5\ J)}{\left(\frac{100\ J}{s}\right)} = 1.38 \times 10^3\ s$$

$$\approx 23.0\ min$$

$t = 23.0$ min