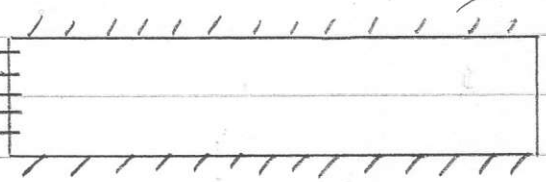
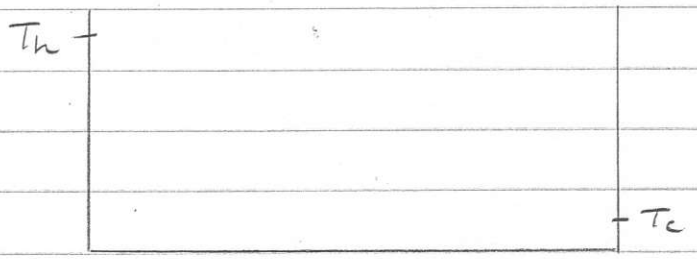
Heat Energy flow + thermal conductivity

A Physics

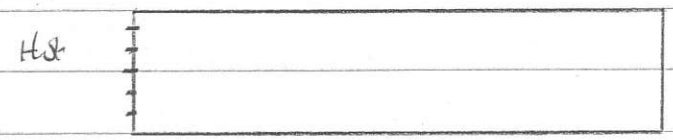
1. Patterns of heat energy flow

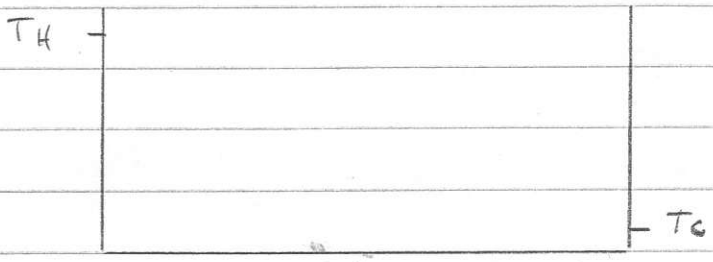
a) Insulated





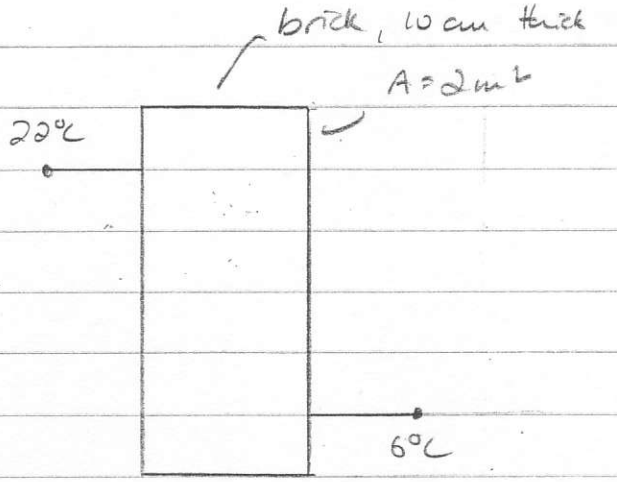
b) Un-insulated





2. Calculating heat flow rates

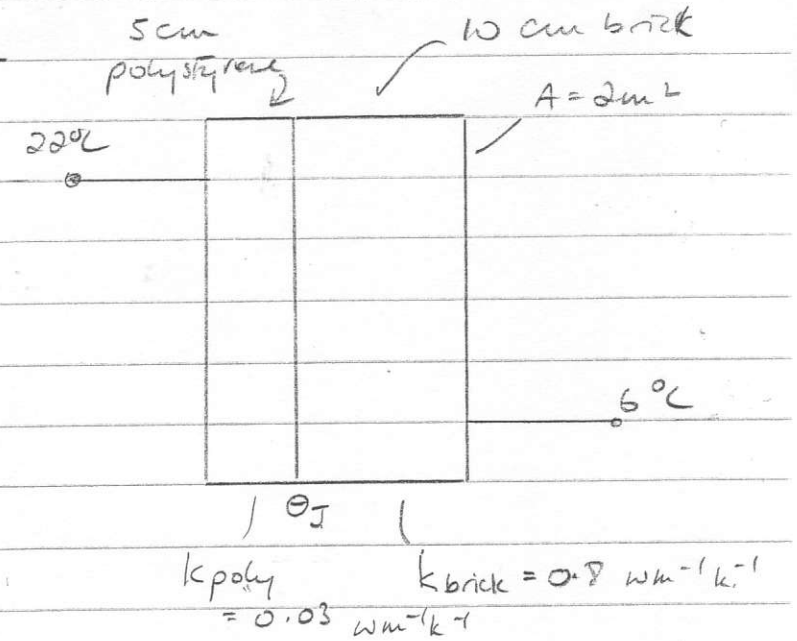
a) Simple - Single material



$Q/t =$

$k_{brick} = 0.8$ w/m/k

2 (b) Advanced – two materials



3. Problems.

Calculate the rate of heat loss through 5 m² of brick wall (12 cm thick) with a 3 cm layer of polystyrene on the inside.

4. Heat flow can be given in U-value – units Watts/m²/K.

What is the U value of ...

(a) the brick wall in 2(a) ?

(b) the wall in 2 (b) ?

ANSWERS

Heat Energy flow + Thermal Conductivity — A Physics (the hard stuff).

1 – done in class.

2.(a) Simple $Q/t = kA\frac{\Delta\theta}{\Delta l} = 0.8 \times 2 \times \frac{16}{0.1} = 256$ J/s

(b) Advanced

When everything is steady....

rate of heat flow through polystyrene = rate of heat flow through brick

So... $Q/t = k_{poly} A_{poly} \frac{(22-\theta_J)}{l_{poly}} = k_{brick} A_{brick} \frac{(\theta_J - 6)}{l_b}$

Areas cancel!

$\frac{0.03}{0.05}(22-\theta_J) = \frac{0.8}{0.1}(\theta_J - 6)$

$13.2 + 48 = 8.6\,\theta_J$ So $\theta_J = 7.12°C$

Put back into one of the equations... say brick

$Q/t = \frac{0.8 \times 2}{0.1}(7.12-6) = 17.9$ J/s ← for brick

don't forget AREA!

3. Once more, with feeling....

$Q/t = \frac{0.03 \times A}{0.03}(22-\theta_J) = \frac{0.8 \times A}{0.12}(\theta_J - 6)$

$\Rightarrow \theta_J = 8.08\ °C$

bigger area

$\Rightarrow Q/t = 0.03 \times 5 \times (22-8.08)/0.03 = 69.6$ J/s.

4.(a) – from 2a $Q/t = 256$ J/s for $2m^2$ and 16 °C diff

$= U \times A \times \Delta\theta$

So $U_{wall} = 256/2 \times 16 = 8$ W/m²/k

(b) – from 2b $Q/t = 18$ J/s $= U \times A \times \Delta\theta$

So $U = 18/2 \times 16 = 0.56$ W/m²/k

TW
a.99