

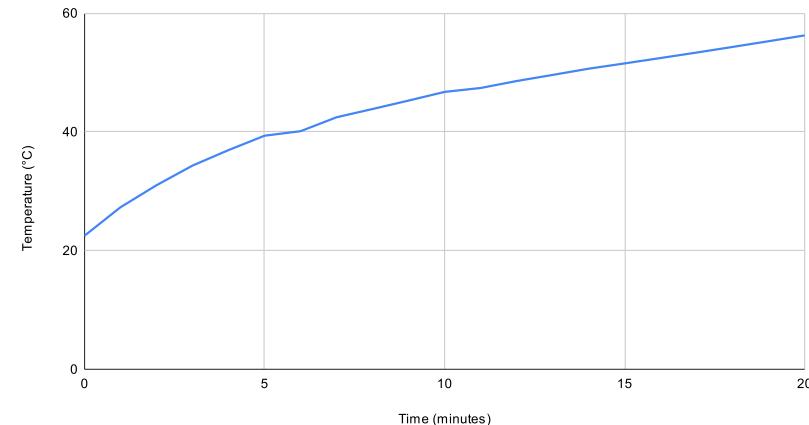
1.3.4 Renewable Insulation

Data Collection and Analysis

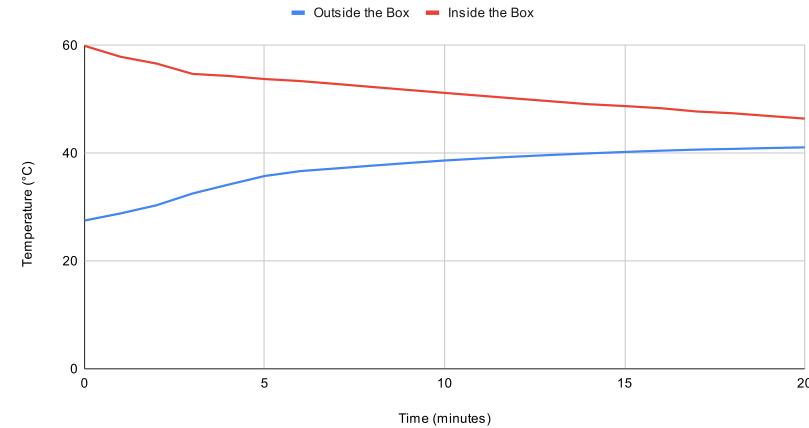
Data

| # | Heating Phase | | Cooling Phase (out) | | Cooling Phase (in) | |
|----|---------------|---------------------|---------------------|--------------------|--------------------|----------|
| | Time (min) | Temp (C) | Time (min) | Temp (C) | Time (min) | Temp (C) |
| 1 | 0 | 22.51 | | | | |
| 2 | 1 | 27.31 | | | | |
| 3 | 2 | 31.02 | | | | |
| 4 | 3 | 34.33 | | | | |
| 5 | 4 | 36.94 | | | | |
| 6 | 5 | 39.36 | | | | |
| 7 | 6 | 40.12 | | | | |
| 8 | 7 | 42.47 | | | | |
| 9 | 8 | 43.86 | | | | |
| 10 | 9 | 45.28 | | | | |
| 11 | 10 | 46.74 | | | | |
| 12 | 11 | 47.4 | | | | |
| 13 | 12 | 48.57 | | | | |
| 14 | 13 | 49.6 | | | | |
| 15 | 14 | 50.65 | | | | |
| 16 | 15 | 51.54 | | | | |
| 17 | 16 | 52.45 | | | | |
| 18 | 17 | 53.37 | | | | |
| 19 | 18 | 54.32 | | | | |
| 20 | 19 | 55.28 | | | | |
| 21 | 20 | 56.26 | | | | |
| # | | Cooling Phase (out) | | Cooling Phase (in) | | |
| # | | Time (min) | Temp (C) | Time (min) | Temp (C) | |
| 1 | 0 | 27.5 | 0 | 59.91 | | |
| 2 | 1 | 28.83 | 1 | 57.88 | | |
| 3 | 2 | 30.34 | 2 | 56.62 | | |
| 4 | 3 | 32.52 | 3 | 54.7 | | |
| 5 | 4 | 34.17 | 4 | 54.32 | | |
| 6 | 5 | 35.76 | 5 | 53.75 | | |
| 7 | 6 | 36.68 | 6 | 53.37 | | |
| 8 | 7 | 37.18 | 7 | 52.83 | | |
| 9 | 8 | 37.69 | 8 | 52.27 | | |
| 10 | 9 | 38.18 | 9 | 51.72 | | |
| 11 | 10 | 38.64 | 10 | 51.18 | | |
| 12 | 11 | 39.02 | 11 | 50.65 | | |
| 13 | 12 | 39.37 | 12 | 50.12 | | |
| 14 | 13 | 39.68 | 13 | 49.6 | | |
| 15 | 14 | 39.96 | 14 | 49.08 | | |
| 16 | 15 | 40.22 | 15 | 48.74 | | |
| 17 | 16 | 40.46 | 16 | 48.34 | | |
| 18 | 17 | 40.66 | 17 | 47.73 | | |
| 19 | 18 | 40.79 | 18 | 47.4 | | |
| 20 | 19 | 40.95 | 19 | 46.9 | | |
| 21 | 20 | 41.08 | 20 | 46.41 | | |

Heating Phase

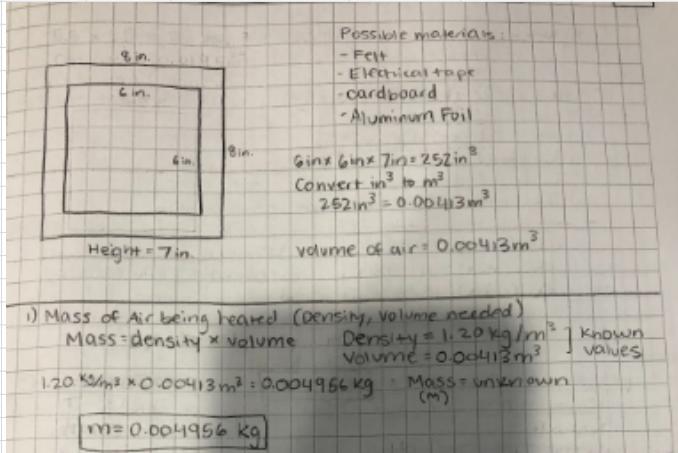


Cooling Phase Inside/Outside Box



Problems: Work each problem showing all work. For each problem, select equation(s), list all knowns and unknowns, substitute known values into equation(s), simplify and solve for desired value.

1 Mass of air being heated $m = 0.004956 \text{ kg}$



2 Energy gained by the air in the box during heating - Q (heat) in J (joules)

$$Q = 167.265 \text{ J}$$

2) Energy gained by the air in the box during heating
 $Q = mc\Delta T$

$$m = 0.004956 \text{ kg}$$

$$c = 1000 \text{ J/kg°C}$$

$$\Delta T = (56.26^\circ\text{C} - 22.51^\circ\text{C}) = 33.75^\circ\text{C}$$

$$Q = \text{unknown}$$

$$Q = 167.265 \text{ J}$$

3 Energy lost by the air in the box during cooling - Q (heat) in J (joules)

$$Q = -66.906 \text{ J}$$
 (Energy is being lost, so answer should be negative)

3) Energy lost by the air in the box during cooling
 $Q = mc\Delta T$

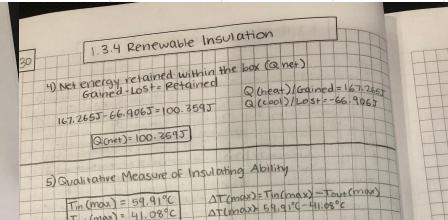
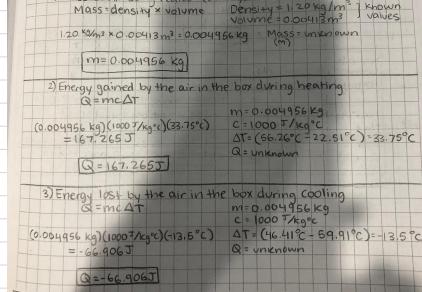
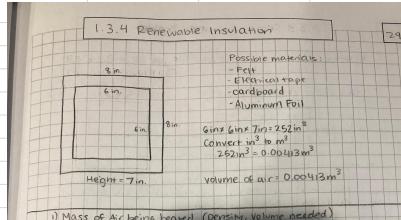
$$m = 0.004956 \text{ kg}$$

$$c = 1000 \text{ J/kg°C}$$

$$(0.004956 \text{ kg})(1000 \text{ J/kg°C})(-13.5^\circ\text{C}) = -66.906 \text{ J}$$

$$Q = \text{unknown}$$

$$Q = -66.906 \text{ J}$$



| Material | Bulk / Industrial Cost | Amount per panel | Cost per panel |
|----------------|--------------------------|------------------|----------------|
| Natural Cotton | \$15.00 / 1.789 m² | 2.56 m² | \$1.48 |
| Wool | \$48.94 per m² | 2.56 m² | \$124.06 |
| Polyester | \$25.00 / 5.1097 m² | 0.9 m² | \$0.20 |
| Tape | \$34.94 per m | 0.44 m | \$15.53 |
| Total Costs | Cost per m² of materials | Cost per Panel | \$1.68 |

| Signature: [Signature] | Date: 10/17/22 |
|------------------------|----------------|
| Witness: [Signature] | Date: 10/17/22 |
| Signature: [Signature] | Date: 10/17/22 |
| Witness: [Signature] | Date: 10/17/22 |

Complete Pages from Engineering Notebook

| | | | | | | | | | | |
|------------------------------|---|-----------------------------|---|-----------------------|------------------------------|---|-----------------------|-------------------|---|-----------------------|
| 4 | Net energy retained within the box - Q (heat) in J (joules) $Q(\text{net}) = 100.369 \text{ J}$ | | | | | | | | | |
| | <p>4) Net energy retained within the box (@ net)</p> <p>Gained - Lost = Retained</p> $Q(\text{heat})/\text{Gained} = 167.265 \text{ J}$ $Q(\text{cool})/\text{Lost} = -66.906 \text{ J}$ $167.265 \text{ J} - 66.906 \text{ J} = 100.359 \text{ J}$ $Q(\text{net}) = 100.369 \text{ J}$ | | | | | | | | | |
| 5 | <p>A qualitative measure of your insulating ability is the difference between the maximum inside temperature and the maximum outside temperature (larger is better)</p> <table> <tr> <td>$T_{\text{in}}(\text{max})$</td> <td>=</td> <td>$59.91^\circ\text{C}$</td> </tr> <tr> <td>$T_{\text{out}}(\text{max})$</td> <td>=</td> <td>$41.08^\circ\text{C}$</td> </tr> <tr> <td>Change in T (max)</td> <td>=</td> <td>18.83°C</td> </tr> </table> <p>5) Qualitative Measure of Insulating Ability</p> $T_{\text{in}}(\text{max}) = 59.91^\circ\text{C}$ $T_{\text{out}}(\text{max}) = 41.08^\circ\text{C}$ $\Delta T(\text{max}) = 59.91^\circ\text{C} - 41.08^\circ\text{C}$ $\Delta T(\text{max}) = 18.83^\circ\text{C}$ | $T_{\text{in}}(\text{max})$ | = | 59.91°C | $T_{\text{out}}(\text{max})$ | = | 41.08°C | Change in T (max) | = | 18.83°C |
| $T_{\text{in}}(\text{max})$ | = | 59.91°C | | | | | | | | |
| $T_{\text{out}}(\text{max})$ | = | 41.08°C | | | | | | | | |
| Change in T (max) | = | 18.83°C | | | | | | | | |