Tutorial 8 – Week 9

Aims:

Upon successfully completing these tutorial exercises, students should be able to:

- Demonstrate an understanding of concepts related to thermal conductivity, specific heat, thermal expansion
- Perform calculations related to thermal properties of materials

Exercise 1 A length of lead piping is 50.0 m long at a temperature of 16°C. When hot water flows through it the temperature of the pipe rises to 80°C. Determine the length of the hot pipe if the coefficient of linear expansion of lead is $29 \times 10^{-6}\ K^{-1}$. $\frac{\Delta L}{L_0} = \alpha \Delta T$

Exercise 2 A rod of metal is measured at 285K and is 3.521m long. At 373K the rod is 3.523m long. Determine the value of the coefficient of linear expansion (α) of the metal.

Exercise 3 A block of cast iron has dimensions of 50 mm by 30 mm by 10 mm at 15°C. Determine the increase in volume when the temperature of the block is raised to 75°C. Assume the coefficient of linear expansion of cast iron to be $11 \times 10^{-6}\ K^{-1}$.

Exercise 4 To what temperature would 11 kg of a 1025 steel specimen at 25°C (298 K) be raised if 130 kJ of heat is supplied?

Substance	c/J kg^{-1} K^{-1}
Aluminium	900
Iron/steel	450

Specific Heat capacity

$$C = \left(\frac{Q}{m * \Delta T}\right)$$

Exercise 5 If a rod of 1025 steel 0.5 m long is heated from 20 to 80°C (293 to 353 K) while its ends are maintained rigid,

$$\sigma = -E(\varepsilon_{thermal}) = -E\alpha_\ell (T_f - T_0) = E\alpha_\ell (T_0 - T_f)$$

E= $(207 \times 10^3\ \text{MPa})$

(a) determine the type and magnitude of stress that develops. Assume that at 20°C the rod is stress free.
(b) What will be the stress magnitude if a rod 1 m long is used?
(c) If the rod in part (a) is cooled from 20 to −10°C (293 K to 263 K), what type and magnitude of stress will result?

Exercise 6 A copper wire is stretched with a stress of 70 MPa at 20°C (293 K). If the length is held constant, to what temperature must the wire be heated to reduce the stress to 35 MPa.

E=110 GPa (Table 6.1) and α= $17.0 \times 10^{-6}\ (°C)^{-1}$