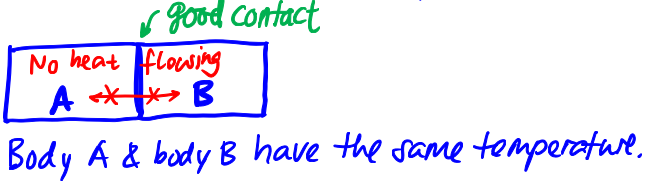
T4 Solutions

1. What is the thermal energy of an object?

Thermal energy (a.k.a. internal energy) of an object is the total sum of the kinetic and potential energies of all atoms and molecules in the object.

2. What is temperature?

Every body has a property called temperature. When two bodies are in thermal equilibrium, we say that they have the same temperature.



Body A & body B have the same temperature.

3. Fill in the blanks shown in Table 4.1.

Situation	^{0} C	K	^{0} F
Water boils	100	373	212
Water freezes	0	273	32
Absolute zero	-273	0	-459

Table 4.1

4. Convert 25°C to Kelvin.

$(25 + 273)\,K = 298\,K$ //

5. Convert 180 K to °C.

$(180 - 273)^\circ C = -93^\circ C$ //

6. Convert 180 °F to °C.

No need to memorise the formula.

$\frac{(180 - 32) \times 5}{9} = 82.2^\circ C$ //

7. Convert 6 BTU to calories, and to Joules.

No need to memorise

1 BTU = 1054.87 J = 252 Calories

Answers: 1512 calocries or 6329 Joules.

8. What is heat capacity and what is its unit?

The heat capacity C, of a body is defined as the amount of heat energy needed to raise the body's temperature by 1°C (or 1K).

C is given in [J/°C] or [J/K].

9. How much heat energy is required to raise the temperature of an object from 30 °C to 130°C given that its heat capacity is 5.2 J/°C?

$\Delta E = C \times \Delta T = 5.2 \times 100\ J = 520\ J$

5.2 J/°C; (130−30)°C

10. What is specific heat capacity and what is its unit?

Specific heat capacity c is heat capacity per unit mass.

$c = \frac{C}{m}$, C in [J/°C], m in [kg] $\Rightarrow$ unit for c is $\left[\frac{J}{kg\,°C}\right]$

small letter

Note: c is a better parameter than C for comparing how different materials respond to heat energy transferred to, or taken away from them.

11. How much heat energy is required to raise the temperature of 20 g of water from 10 °C to 20 °C given that the specific heat capacity of water is 4.2 J/g °C?

$\Delta E = m c \Delta T = 20\,g \times 4.2\,\frac{J}{g\,°C} \times (20-10)\,°C$

$= 840\ J$

The amount of heat to effect a phase change of 1 kg of substance from solid to liquid. (1 kg of ice to water at °C)

12. Explain Latent Heat of Fusion and Latent Heat of Vaporisation using water as example.

The amount of heat to effect a phase change of 1 kg of substance from liquid to gas. (1 kg of water to steam at 100°C).

13. Draw a diagram to show how a substance changes from solid to gaseous states.

Figure 4.7 in notes.

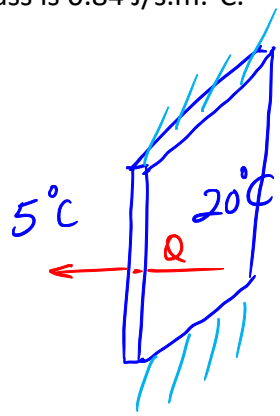
14. What is heat of combustion?

The heat of combustion of a substance is the amount of heat energy released when 1 mole of the substance is completely burnt.

15. Explain what 1 mole of water is.

1 mole is defined as 6.022×10^{23} (a.k.a. the Avogrado's number) of a chemical substance.
1 mole of water is thus 6.022×10^{23} of water molecules (H_2O).

16. A 2 cm thick single-paned window in a house measures 0.65 m by 1.25 m. The temperature outside and inside of the house are 5 °C and 20 °C respectively. Determine the amount of heat energy transferred from the house in 1 hour. The thermal conductivity of the window glass is 0.84 J/s.m.°C.



$$\frac{Q}{t} = \frac{kA(T_2 - T_1)}{d}$$ ← no need to memorise formula.

0.84, 0.65×1.25, (20−5), 3600, d ~ 0.02

$$Q = \frac{0.84 \times 0.65 \times 1.25 \times 15 \times 3600}{0.02} \text{ J}$$

$$= 1.84 \times 10^6 \text{ J or } 1.84 \text{ MJ}$$

17. Refer to notes on modes of heat transportations.