YEAR 11 PHYSICS
ASSIGNMENT 6: HEATING AND COOLING

NAME: ______________________ **DUE DATE:** ______________ **TOTAL:** —/34

1. If, during summer, today's maximum temperature is 40.0 °C, and tomorrow's maximum temperature is 20.0 °C, is today twice as hot as tomorrow? Explain your answer.

no. (1)

Temperature scale is based on Kelvin (°K).

$\therefore 40°C = 313°K$

$\Rightarrow$ Twice as hot $= 616°K = 343°C$. (1)

(2)

2. Why are burns caused by steam more serious than those caused by boiling water?

- Steam has greater E_p than water at the same temperature. (1)
- The amount of E_p is very high ($2{\cdot}25 \times 10^6$ J kg^{-1}). (1)
- This additional energy must be released during the phase change, causing a more serious burn. (1)

(3)

3. Explain why a bench top in the Science laboratory feels cold when you first place your hand on it.

- Bench top is at a lower temperature than the hand. (1)
- Heat flows from the hand into the bench, so it feels cold. (1)

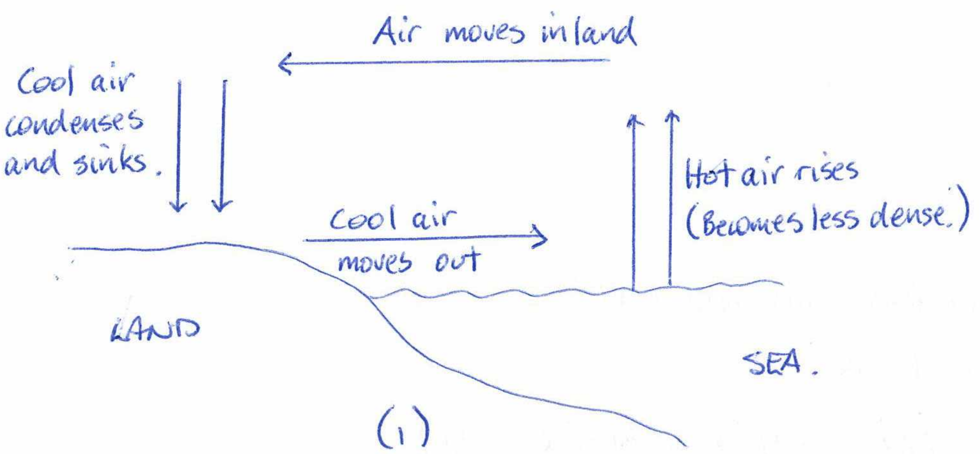
(2)

4. Why do you feel cold when, during a hot summer's day, you emerge from a pool or the ocean and a reasonably strong wind is blowing? Explain your answer.

- H_2O evaporates from the skin by absorbing heat from the skin. (1)
- Air moving over the skin blows evaporated H_2O molecules away, so more H_2O can evaporate. (1)
- This takes more heat from the skin so we feel colder. (1)

(3)

5. Explain, using a clear diagram, how a strong land breeze forms over Perth during the summer.



- Ocean is hotter than the land. (1)
- Hot air rises over the ocean and cool air moves out from the land to take its place. (1)

(3)

6. During the winter, when Perth has clear and cold nights around 2-4 °C, Rottnest generally has a minimum around 14-16 °C. Explain why there is such a difference.

- Ocean loses heat slowly compared to the land. ($1\frac{1}{2}$)
- Air above and around Rottnest is warm compared to the air above the land. ($1\frac{1}{2}$).

(3)

7. A 65.0 kg athlete transforms chemical energy at the rate of about 4.00×10^3 W during a 1500 m run. Assume all of this energy is converted into the internal energy of the body tissues.

(a) What maximum rise in body temperature could be expected after completing the run in 4.00 minutes? (Take $c_{body} = 3.50 \times 10^3$ $Jkg^{-1}K^{-1}$)

$$P = \frac{E}{t}$$

$$\Rightarrow E = Pt$$

$$= (4.00 \times 10^3)(4.00 \times 60.0)$$

$$= 9.60 \times 10^5 \text{ J}$$

$$Q = m_b c_b \Delta T$$

$$\Rightarrow 9.60 \times 10^5 = (65.0)(3.50 \times 10^3)\Delta T$$

$$\Rightarrow \underline{\Delta T = 4.22\ °C}.$$

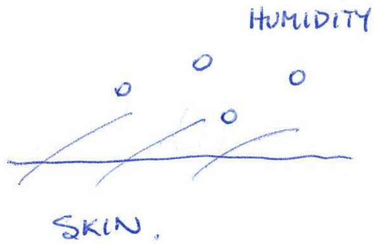
(4)

(b) Would the athlete's body temperature rise by this amount? Explain your answer.

- No (1).
- The body sweats and evaporates moisture from the skin to remove heat. (1)

(2)

(c) What effect would a **high humidity** in the atmosphere have on the ability of the athlete to maintain a constant body temperature? Explain your answer.



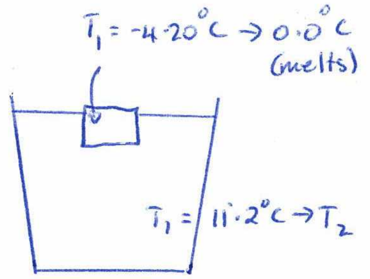
- With high humidity, there is already a large amount of H_2O in the air. (1)
- It is difficult for any water to evaporate from the skin as there is "no room" in the air. (1)

$\therefore$ Body overheats. (1)

(3)

8. A 125 g glass had 275 g of Coke placed into it. The temperature settled at 11.2 °C. A 30.0 g block of ice at -4.20 °C was taken from a freezer and placed into the Coke. Estimate the final temperature of the mixture.

Assumption: $C_{coke} = C_{water} = 4.18 \times 10^3 \ J\,kg^{-1}\,K^{-1}$.



$$Q_{lost} = Q_{gained}$$

$$\Rightarrow m_g C_g \Delta T + m_c C_c \Delta T = m_i C_i \Delta T + m_i L_f + m_i C_w \Delta T \quad (2)$$

$$\Rightarrow (0.125)(6.70 \times 10^2)(11.2 - T_f) + (0.275)(4.18 \times 10^3)(11.2 - T_f)$$

$$= (0.0300)(2.10 \times 10^3)(4.20) + (0.0300)(3.34 \times 10^5) + (0.0300)(4.18 \times 10^3)(T_f - 0) \quad (1)$$

$$\Rightarrow 9.38 \times 10^2 - 83.75\,T_f + 1.287 \times 10^4 - 1.150 \times 10^3\,T_f = 1.028 \times 10^4 + 1.254 \times 10^2\,T_f$$

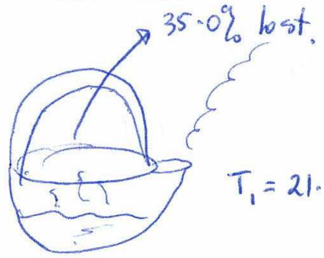
$$\Rightarrow 3.528 \times 10^3 = 1.359 \times 10^3\,T_f \quad (1)$$

$$\Rightarrow T_f = 2.596°C$$

$\therefore$ Final temp = 2.60 °C (1)

(5)

9. A 2.30 kW electric kettle of steel (mass = 1.10 kg) holds 1.95 kg of water at 21.0 °C. How long does it take to bring the water to the boil if 35.0 % of the heat generated by the heating element is lost to the environment?



$T_1 = 21.0^\circ C \rightarrow 100^\circ C$

$P = 2.30 \times 10^3 W.$

$$Q_{needed} = m_w c_w \Delta T + m_s c_s \Delta T \quad (1)$$

$$= (1.95)(4.18\times10^3)(79.0) + (1.10)(445)(79.0)$$

$$= 6.826 \times 10^5 \text{ J.} \quad (1)$$

$$\% \text{ efficiency} = \frac{Q_{needed}}{Q_{supplied}} \times \frac{100}{1}$$

$$\Rightarrow 65.0 = \frac{6.826\times10^5}{Q_{supplied}} \times \frac{100}{1}$$

$$\Rightarrow Q_{supplied} = 1.050\times10^6 \text{ J.} \quad (1)$$

$$P = \frac{Q_{supplied}}{t}$$

$$\Rightarrow t = \frac{1.050\times10^6}{2.30\times10^3}$$

(4)

$$= 4.566\times10^2 \text{ s}$$

$$\therefore \underline{\text{Time taken} = 4.57\times10^2 \text{ s.}} \quad (1)$$