R1-2005 Q1(a)

Q1

a) An accurate thermometer, of heat capacity 20.0 JK^{-1}, reads 18.0 °C. It is then placed in 0.250 kg of water and both reach the same final temperature of 50.0 °C. Calculate the temperature of the water before the thermometer was placed in it. The specific heat capacity of water is 4200 $Jkg^{-1}K^{-1}$.

[4]

R1-2005 Q1(e)

e) Wet clothing at 0 ^{0}C is hung out to dry. The air temperature is 0 ^{0}C and there is a dry wind blowing. After some time it is found that some of the water has evaporated and the water remaining on the clothes has frozen. The specific heat of fusion of ice is 333 kJ kg^{-1} and the specific latent heat of evaporation of water is 2500 kJ kg^{-1}.

(i) What is the source of energy required to evaporate the water? Explain the mechanism for evaporation.

(ii) Estimate the fraction, by mass, of water originally in the clothing that freezes.

[5]

R1-2007 Q1(f)

(f) A lead bullet at 320K is stopped by a sheet of steel so that it reaches its melting point of 600K and completely melts. If 80% of the kinetic energy of the bullet is converted into its internal energy, calculate the speed with which the bullet hit the steel sheet. The specific heat capacity of lead is 0.12 kJ $kg^{-1}K^{-1}$ and its specific latent heat of fusion is 21 $kJkg^{-1}$.

[4]

R1-2009 Q1(a)

(a) A 10 W immersion heater is placed in 0.25 kg of a liquid which is contained in a calorimeter of heat capacity 50 JK^{-1}. It is switched on, and after a time the temperature of the liquid reaches a constant value. The heater is now switched off and the rate of fall of temperature is 15 mKs^{-1}. What is the specific heat capacity of the liquid ?

[3]

R1-2010 Q1(a)

(a) Molten lead, mass 3.0 kg and melting point 600 K, is allowed to cool down until it has solidified. It is found that the temperature of the lead falls from 605 K to 600 K in 10 s, remains constant at 600 K for 300 s, and then falls to 595 K in a further 8.4 s.
Assuming that the rate of loss of energy remains constant, and the specific heat of solid lead is 140 $Jkg^{-1}K^{-1}$, calculate:

(i) the rate of loss of energy from the lead
(ii) the specific latent heat of fusion
(iii) the specific heat capacity of liquid lead [4]

R1-2011 Q1(n)

n) The tangential frictional force produced by a band break on a rotating metal drum of circumference 0.25 m is 20 N. The mass of the drum is 0.40 kg and its specific heat capacity is 0.35 kJ $kg^{-1}K^{-1}$. Calculate the number of complete revolutions required to increase its temperature by 5.0 K.

[3]

R1-2012 Q1(h)

(h) A beaker is fitted with a heating coil and stirrer and contains 40.0 cm^3 of liquid A. When the power dissipated in the heating coil is 4.80 W, the temperature of the contents rises from 15.0°C to 35.0°C in 400 s. The experiment is repeated using 20.0 cm^3 of liquid A mixed with 20.0 cm^3 of liquid B. It is found that, with a heater power of 4.90 W, the temperature again rises from 15.0°C to 35.0°C in 400 s.

Determine
(i) the specific heat capacity, *s*, of B and
(ii) the heat lost, *H*, in both experiments.

Density of A is 1.60×10^3 kg m^{-3}, Specific heat capacity of A is 8.60×10^2 J kg^{-1} K^{-}
Density of B is 2.00×10^3 kg m^{-3}

[6]

R1-2013 Q1(g)

(g) To determine the specific heat capacity, *s*, of a liquid flowing at a constant rate of 0.060 kg min^{-1} down a pipe, heat from an electrical supply is maintained at the rate of 12 W. It produces a temperature rise of 2.0 C along the flow. Calculate s.

[2]

R1-2011 Q3(a)

a) A calorimeter, heat capacity $H = 42.7$ J K^{-1} , contains 0.80 kg of water at 15 C. 0.40 kg of molten lead, specific heat capacity c = 157 J kg^{-1} K^{-1} and latent heat of fusion $L = 2.31 \times 10^4$ J kg^{-1}, is poured into the calorimeter. The final temperature of the system is 25.0 C. What was the initial temperature of the lead?

The specific heat capacity of water is 4182 J kg^{-1} K^{-1}.
The melting temperature of lead is 327 C.
The specific heat capacity of solid lead is 136 J kg^{-1} K^{-1}.

[6]

R1-2002 Q2

a) Write down an energy equation expressing the first law of thermodynamics. Define all the terms in the equation. [5]

b) Water in an electric kettle is brought to the boil in 180 s by raising its temperature from 20° C to 100° C. It then takes a further1200 s to boil the kettle dry. Calculate the specific latent heat of vaporisation of water, *L*, at 100° C. The specific heat capacity of water is 4200 J $kg^{-1}K^{-1}$.
State any assumptions made. [4]

c) A cylinder, with a weightless piston, has an internal diameter of 0.24 m. The cylinder contains water and steam at 100° C. It is situated in a constant temperature bath at 100° C, Figure 2.1. Atmospheric pressure is 1.01×10^5 Pa. The steam in the cylinder occupies a length of 0.20 m and has a mass of 0.37 g.

Figure 2.1

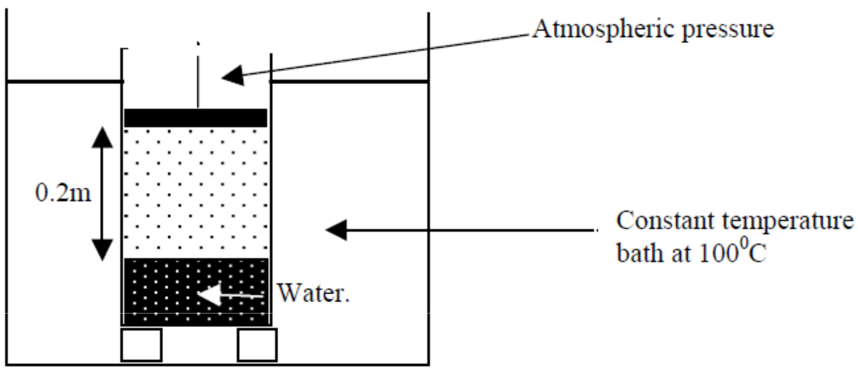

Figure 2.1

(i) What is the pressure *P* of the steam in the cylinder?
(ii) If the piston moves very slowly down a distance 0.10 m, how much work, W, will be done in reducing the volume of the system?
(iii) What is the final temperature, T_f, in the cylinder?
(iv) Determine the heat Q_c produced in the cylinder. [6]

d) A molecule of oxygen near the surface of the Earth has a velocity vertically upwards equal in magnitude to the root mean square (rms) value. If it does not encounter another molecule, calculate:

(i) the height *H* reached if the surface temperature is 283 K
(ii) the surface temperature T_s required for the molecule to escape from the Earth's gravitational field if the potential energy per unit mass at the Earth's surface is $(-GM_E/R_E)$.

The oxygen molecule has a molar mass of 0.032 kg. [5]