

Here are problems to help you revise important ideas. Also study the example sheets and solutions, as well as the examples done in lectures.

**1** *Sound waves*

Do sound waves produce adiabatic or isothermal compressions? Hint: Imagine a sound wave of frequency  $f$  and consider the time for heat to diffuse between a compressed and rarefied area.

**2** *Breath*

Why can you see your breath on a cold day?

**3** *Freezing locks*

High-pressure carbon dioxide comes out of a cannister at, say, 5 atm. What temperature does it reach when it has expanded and reached atmospheric pressure?

**4** *Turkey*

What is cooking? A small turkey takes 3 hours to cook. How long does it take to cook a geometrically similar turkey with twice the mass?

**5** *Tungsten*

Here is vapour pressure data for tungsten:

$T$ ( $^{\circ}\text{C}$ )	$p$ ( $\text{Pa}$ )
2550	$10^{-3}$
3205	$10^0$

Find its heat of vaporisation.

**6** *Pluto*

What is the blackbody temperature of Pluto?

**7** *Iron*

Estimate the specific heat of iron.

**8** *Gases*

Estimate the specific heat of helium and nitrogen gases.

**9** *Thermal diffusivity*

Discuss why thermal diffusivity is given by

$$\kappa \sim \text{mean free path} \times \text{speed},$$

including how heat transport in a solid or liquid different from that in a gas. Estimate  $\kappa$  for ice and for air.

**10** *Thermal conductivity*

Discuss why thermal conductivity is given by  $K = \rho c_p \kappa$ . Estimate  $K$  for air.

**11** *Conduction*

What is heat flux? Discuss

$$F = K \frac{\Delta T}{\Delta x},$$

including the reason for  $\Delta x$  in the denominator.

**12** *Lakes*

In problem C2 from sheet 2 (ice on lakes), sketch the temperature profile within the ice. Make several sketches on one graph showing the profile at different times (i.e. as the ice thickens).

**13** *Vaporisation*

Estimate heat of vaporisation of water using any reasonable method.

**14** *Sun's surface*

Estimate the temperature of the sun's surface.

**15** *Size of molecules*

Estimate size of air molecules given that the mean free path is  $10^{-7}$  m.

**16** *Rain shadows*

Pick a mountain you like. What fraction of water gets dumped as air rises up the mountain?

**17** *Fogged windows*

Why do windows fog on a cold day? Why on the inside?

**18** *Blanket*

How does a blanket keep you warm? Be as quantitative as you can.

**19** *Random walks*

Explain why time is proportional to distance squared.

**20** *Gravity*

Explain gravity slingshots.