1. Describe the principle of working liquid-in thread-thermometer, thermocouple thermometer, termistor thermometer. Every thermometer depends on some property of a material that varies with temperature. What property used in each of these thermometers.
2. Give linking between Celsius scale and Kelvin scale (what is the value of temperature given in °C converted into Kelvins, absolute zero, melting ice, boiling water). Is the temperature difference given in °C same or different as the temperarature difference given in K?
3. Say which of the below is the temperature of:
    a) boiling water in °C
    b) boiling water in K
    c) absolute zero in °C
    d) absolute zero in K
    e) melting ice in °C
    f) melting ice in K

    -273 0 100 273 373
4. Imagine two blocks in contact. Block A of lower temperature, block B of higher temperature.
    a) How does the motion of the particles in A compare with that in B?
    b) In what direction is thermal energy transferred?
    c) When does the transfer of thermal energy cease?
5. Write the definition of given physical quantities. Give the formula how to calculate the physical quantity and write all the base units of all the used physical quantities.
    a) heat
    b) specific heat capacity
    c) heat capacity
    d) latent heat
    e) specific latent heat
6. Calculate and write the calorimetric equation:

A cube of an ice of mass 100g at -5°C is dropped into a copper container with a water at 70°C. Mass of the copper container is 200g and mass of the water inside of the copper container is 300g. Calculate the final temperature of the system. (specific heat capacity of water is 4200 J/kg.K^{-1}, specific latent heat of fusion of an ice is 3,3x10^3J/kg and specific heat capacity of copper is 400 J/kg.K^{-1}, specific heat capacity of ice is 2100 J/kg.K^{-1}).

7. How much thermal energy is needed to remove from 3kg of water at 20°C to turn it into ice at -10°C (specific latent heat of fusion of an ice is 3,3 x 10^6 J/kg and specific heat capacity of water is 4200 J/kg.K^{-1}, specific heat capacity of ice is 2100 J/kg.K^{-1}).

8. An electric heater has a power rating of 2 kW. How long after the heater is switched on will the water start to boil if its initial temperature is 20°C and its mass is 1,5 kg? (specific heat capacity of water is 4200 J/kg.K^{-1}).

Thermal conduction

9. Describe the process called thermal conduction.
10. Give three essentials that influence value of thermal energy transerred every second.
11. Give the formula how to calculate the thermal energy transferred per second.
12. Arrange in order of conducting ability staring with the best: solids, liquids, gases.
13. Why are metals good electrical as well as good thermal conductors? How do metals conduct thermal energy?

14. A shop window has thickness of 5 mm and area of 3m2. Calculate amount of heat passed per 1 second through the window, if the internal temperature is 20°C and temperature outside is -10°C. K of the glass is 0.84 J.s-1m-1K-1.
15. Why can we observe convection (convection current) in liquids? Write an example of convection in liquids.
16. Why can we observe convection (convection current) in gases? Write an example of convection in gases.
17.

1 Explain the following:
a) A radiator quickly warms all the air in a room, even though air is a poor thermal conductor.
b) The smoke from a bonfire rises upwards.
c) Anyone standing near a bonfire feels a draught.
d) The freezer compartment in a refrigerator is placed at the top.
e) A refrigerator does not cool the food inside it properly if the food is too tightly packed.

2 On a hot summer's day, coastal winds often blow in from the sea.
a) What causes these winds?
b) Why do the winds change direction at night?

18. What does the thermal radiation include?
19.

1 *white* *silvery* *matt black*
Which of the above surfaces is the best at
a) absorbing thermal radiation
b) emitting thermal radiation
c) reflecting thermal radiation?

2 When a warm object is heated up, the thermal radiation it emits changes. Give *two* ways in which the thermal radiation changes.

3 What feature does a vacuum flask have to reduce the transfer of heat by thermal radiation?

20. Describe the green house effect.
21. 4 kg of copper at 25°C are heated and increase in temperature to 80°C; how much heat energy is required to do this? (Specific heat capacity of copper is 380 J/ (kgK)). Assume no heat is lost to the surroundings.
22. A 12V electric heater draws 2A for 12 minutes to raise the temperature of 3kg block of metal. If the initial temperature is 20°C, what would the final temperature be? (Specific heat capacity of the metal is 500 J/ (kgK)).

23. A car of mass 1400 kg is travelling at 30 m/s. Whaen it applies its brakes, each of mass 26 kg, what will be the increase in the temperature oof the brakes? (Specific heat capacity of brake material is 600 J/ (kgK)).
24. What is the temperature difference between the top and the bottomof the waterfall of a height 400 m. (Specific heat capacity of water is 4200 J/ (kgK)).
25. 200 g of ice at 0°C are dropped into a copper container of mass 100 g containing 300 g of water at 21°C. What is the final temperature of the mixture? (Specific heat capacity of copper is 380 J/ (kgK), specific heat capacity of water is 4200 J/ (kgK), laten heat of fusionof ice is 3300 J/kg.
26. Write Wien´s law for black bodies.
27. Write Stefan´s law for black bodies.
28. The radius of the Sun is approximately $7x10^8$ m and its surface temperature is 5800K. Estimate the total emitted power of the Sun.

Questions 1

In questions 3, 4, and 5, assume that no heat energy is lost to the surroundings. Where appropriate, use the values for specific heat capacity given in the chart on page 144.

1 Aluminium has a specific heat capacity of 900 J/(kg K). What does this mean? A 10 kg block of aluminium cools from 100 °C to 50 °C. How much thermal energy does it give out? What thermal energy would be given out by the same mass of water over the same temperature fall?

2 Water has a very high specific heat capacity. In what ways is this useful?

3 A 210 W heater is placed in 2 kg of water. What temperature rise is produced if the heater is switched on for 200 s?

4 An electric kettle has a power rating of 2.1 kW. The kettle is filled with 1.5 kg of water at a temperature of 20 °C. How long after the kettle is switched on will the water start to boil?

5 A lump of metal of mass 0.2 kg and temperature 100 °C is placed in water of mass 0.4 kg and temperature 16 °C. If the final temperature of the metal and water is 20 °C, what is the specific heat capacity of the metal?

Questions 2

Where necessary, use the value of the specific latent heat of fusion of ice given in question 2.

1 Why is thermal energy needed to turn a solid into a liquid?

2 The specific latent heat of fusion of ice is 334 000 J/kg. What does this mean?

3 How much thermal energy must be removed from 5 kg of water at 0 °C to turn it into ice?

4 A substance is melted and then allowed to cool. A cooling curve is plotted as shown in figure 9. What is the melting point of the substance? What is happening to the substance between B and C? Over which of the sections AB, BC and CD, is the substance losing heat?

5 What is the effect on the melting point of ice of a) exerting a high pressure on the ice b) adding salt to the ice?

6 How much thermal energy must be removed from 2 kg of water at 100 °C to turn it into ice at 0 °C? (The specific heat capacity of water is 4200 J/(kg K)).

7 A panful of crushed ice at 0 °C is heated by a 167 W heater. What mass of ice will melt if the heater is switched on for 100 s? State any assumptions you make in your calculation.

Questions 3

In all calculations, assume there are no heat losses to the container or to the outside. Where necessary, use the values of the specific heat capacity of, and specific latent heat of vaporization of, water given in questions 1 and 3.

1 At 100 °C, water has a specific latent heat of vaporization of 2 260 000 J/kg. What does this mean? How much thermal energy would be needed to change 2 kg of water at 100 °C into steam at the same temperature? How much thermal energy would be needed to change 10 kg?

2 Explain in terms of the kinetic theory why a) thermal energy is needed to turn a liquid into a gas b) evaporation produces cooling.

3 How much thermal energy is needed to turn 3.0 kg of water at 50 °C into steam at 100 °C? (The specific heat capacity of water is 4200 J/(kg K).)

4 Give two ways, other than by direct heating, in which a liquid may be made to evaporate more rapidly.

5 Describe two practical applications of the cooling effect produced by evaporation.

6 The heating element of a kettle has a power rating of 2.26 kW. If the kettle contains boiling water, what mass of steam will be produced in 10 minutes?

7 0.9 kg of water at 0 °C is heated by bubbling through it a jet of steam at 100 °C. What is the temperature of the water when 0.1 kg of steam have condensed?