Standard Grade Physics

Measuring Heat

Name: ______________________________ **Class:** ______ **Teacher:** ______________________

Section 4: HEAT in the HOME

• Heat and Temperature

Temperature tells us how h _ _ or c _ _ _ an object is.

Temperature is measured in units of
d _ _ _ _ _ _ C _ _ _ _ _ _ _ (° _).

Heat is a form of energy which flows from places at
h _ _ _ _ _ temperature to places at l _ _ _ _ temperature.

• Heat Loss From a House

The heat energy lost from a house in a given time depends on the temperature difference between the inside and outside of the house.
(The inside is usually warmer than the outside).

The h _ _ _ _ _ the temperature difference, the m _ _ _ heat energy is lost.

Explain which house (A or B) loses most heat energy to the air outside in a given time:

____

____

____

____

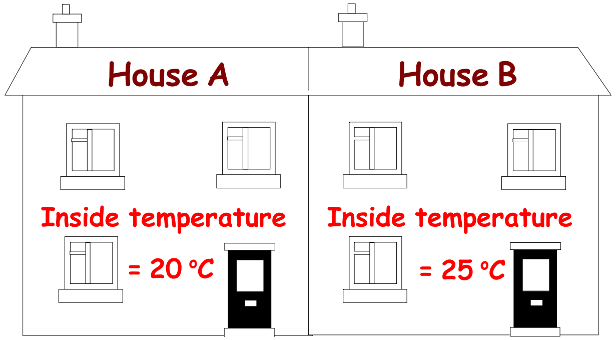
____

____

____

____

Outside air temperature = 10 °C.



Heat energy can be lost from a house by:

- **Conduction** - Happens mainly in solids. Particles vibrate against each another, passing heat energy from one particle to the next.
- **Convection** - Happens in liquids and Gases. Hot particles move up while cold particles move down. This creates a convection current.
- **Radiation** - Does not involve particles. Infra-red heat energy travels through gases and liquids as waves.

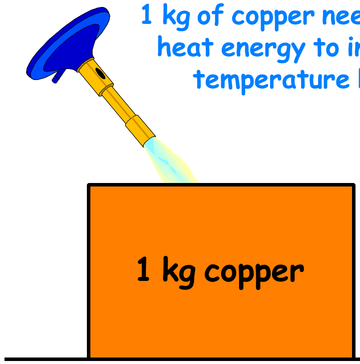
To reduce the amount of heat energy escaping from a house by conduction, convection and radiation we can:

conduction	
convection	
radiation	

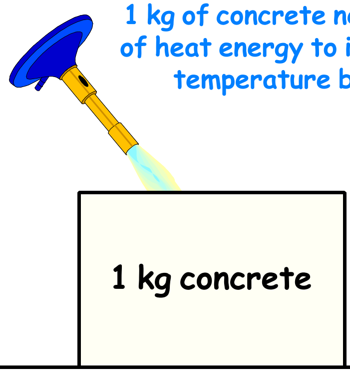
• Specific Heat Capacity

Different substances need different amounts of heat energy to increase the temperature of 1 kg of them by 1 °C.

1 kg of copper needs 386 J of heat energy to increase its temperature by 1 °C.



1 kg of concrete needs 850 J of heat energy to increase its temperature by 1 °C.



The s _ _ _ _ _ _ _ _ h _ _ _ c _ _ _ _ _ _ _ _ of a substance is the amount of h _ _ _ energy needed to change the temperature of 1 kg of the substance by 1 °C
- Each substance has a different value of s _ _ _ _ _ _ _ _ h _ _ _ c _ _ _ _ _ _ _ _.

This formula applies to any substance, so long as it does not melt, freeze, evaporate or condense while heat energy is being added to it or taken away from it:

$$E_h = m\,c\,\Delta T$$

heat energy added to or taken away from substance (J)

mass of substance (kg)

specific heat capacity of substance (J/ kg °C)

change in temperature of substance (°C)

The table shows the specific heat capacity of different substances:

substance	specific heat capacity
alcohol	2 350 J/ kg °C
aluminium	902 J/ kg °C
concrete	850 J/ kg °C
copper	386 J/ kg °C
glass	500 J/ kg °C
water	4 180 J/ kg °C

Use the values given in the table to solve these problems:

25) How much heat energy would you need to add to 3 kg of copper to increase its temperature by 2 °C?

26) How much heat energy would you need to add to 5 kg of concrete to increase its temperature by 3 °C?

27) How much heat energy does 1.5 kg of alcohol need to take in to increase its temperature by 5 °C?

31) Amy puts 0.8 kg of water with a temperature of 20 °C in an electric kettle. How much heat energy must the kettle supply in order to increase the temperature of the water to boiling point (100 °C)?

28) How much heat energy is given out by a 4 kg sheet of glass when its temperature falls by 4 °C?

32) During a chemistry lesson, Jack was asked to heat 0.05 kg of alcohol up to its boiling point of 79 °C. If the temperature of the alcohol just before heating was 19°C, how much heat energy was needed?

29) How much heat energy is given out by a 2.5 kg aluminium sheet when its temperature falls by 12 °C?

33) Melissa measured the temperature of water in an electric kettle and found it to be 25 °C. When the kettle was switched on, it increased the water temperature to 95 °C by supplying 175 560 J of heat energy. Calculate the mass of water in the kettle.

30) How much heat energy does 0.75 kg of alcohol need to give out to decrease its temperature by 1.8 °C?

34) Kevin put 0.25 kg of hot water in a beaker. As the water cooled, it gave out 36 575 J of heat energy to the surroundings. Calculate the decrease in water temperature.

• Change of State

When a substance melts, freezes, evaporates or condenses, we say it is changing s _ _ _ _.

For a substance to melt or evaporate, it must g _ _ _ h _ _ _ energy.

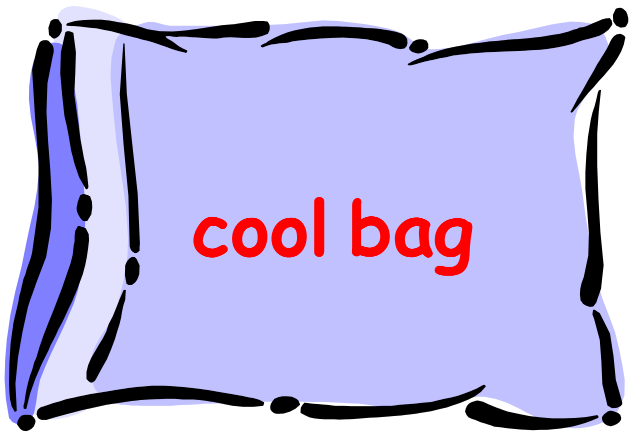
For a substance to freeze or condense, it must l _ _ _ h _ _ _ energy.

When melting, freezing, evaporating or condensing takes place, the t _ _ _ _ _ _ _ _ _ _ of the substance does not change.

This is very useful. For example:

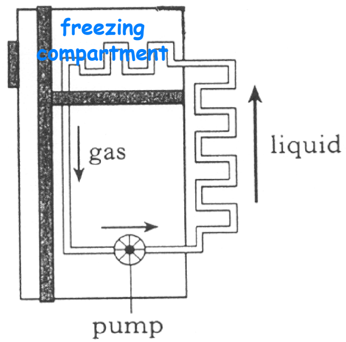
1) A cool bag/box for food - This contains a special block containing ice or other frozen material. The frozen material takes h _ _ _ energy away from the food in the bag/box and m _ _ _ _, turning into a liquid.

As a result, the t _ _ _ _ _ _ _ _ _ _ of the material and the food does not increase.



2) A fridge - A special liquid is pumped through the walls of the freezing compartment. The liquid takes h _ _ _ energy away from the food in the compartment and e _ _ _ _ _ _ _ _ _, turning into a gas - As a result, the t _ _ _ _ _ _ _ _ _ _ of the food d _ _ _ _ _ _ _ _.

The gas is pumped to the back of the fridge where it gives out the heat energy into the room. The gas c _ _ _ _ _ _ _ _, turning back to liquid, which is pumped into the freezing compartment again.



fridge

• Specific Latent Heat

• The specific latent heat of fusion is the amount of heat energy taken in to change 1kg of a solid at its melting point temperature to a liquid (or the amount of heat energy given out when 1 kg of a liquid at its freezing point temperature changes to a solid).

• The specific latent heat of vaporisation is the amount of heat energy taken in to change 1 kg of a liquid at its boiling point temperature to a gas (or the amount of heat energy given out when 1 kg of a gas at its condensing point temperature changes to a liquid).

$$E_h = m\,l$$

E_h – heat energy added to or taken away from substance (J)

m – mass of substance (kg)

l – specific latent heat of fusion or vaporisation of substance (J/kg)

35) Calculate how much heat energy 2 kg of ice (frozen water) at its melting point temperature must take in so that it all changes to liquid water. (Specific latent heat of fusion for water = 3.34×10^5 J/kg).

36) 0.5 kg of liquid alcohol at its freezing point temperature freezes, thereby turning into a solid. How much heat energy does the alcohol give out to the surroundings? (Specific latent heat of fusion for alcohol = 0.99×10^5 J/kg).

37) Calculate how much heat energy 1.5 kg of liquid water at its boiling point temperature must take in so that it all changes to steam. (Specific latent heat of vaporisation for water = 22.6×10^5 J/kg).

38) 0.4 kg of gaseous alcohol at its condensing point temperature changes into liquid alcohol. How much heat energy does the alcohol give out to the surroundings? (Specific latent heat of vaporisation for alcohol = 11.2×10^5 J/kg).

39) How much heat energy is needed to completely melt a 5 kg block of solid copper which is at its melting point temperature? (Specific latent heat of fusion for copper = 2.05×10^5 J/kg).

40) When a mass of liquid water at its freezing point temperature freezes, it gives out 5.01×10^6 J of heat energy to the surroundings. Calculate the mass of water. (Specific latent heat of fusion for water = 3.34×10^5 J/kg).

41) How much heat energy is needed to completely turn 0.6 kg of liquid turpentine at its boiling point temperature into turpentine gas? (Specific latent heat of vaporisation for turpentine = 2.90×10^5 J/kg).

42) When a mass of gaseous glycerol at its condensing point temperature condensess, it gives out 1.245×10^6 J of heat energy to the surroundings. Calculate the mass of glycerol. (Specific latent heat of vaporisation for glycerol = 8.30×10^5 J/kg).

• Temperature-Heat Energy Graph

This is a typical graph showing how the **temperature** of a **solid substance** changes as **heat energy** is supplied to it:

Label the graph to explain the various changes in its slope: