Multi-step energy calculations Worksheet

Mr Charman

Exam question

Exam questions

1. Calculate the total energy transferred when 250 g of ice cubes at 0 °C are changed to steam at 100 °C.

   Specific latent heat of fusion of ice = 334 000 J/kg °C
   Specific heat capacity of water = 4200 J/kg °C
   Specific latent heat of vapourisation of water = 2260 000 J/kg

2. A block of ice at -3 °C was heated. After 7500 J of energy was transferred to the ice, the ice had melted and reached a temperature of 5 °C . Calculate the mass of the ice.

   Specific latent heat of ice = 2100 J/kg °C
   Specific latent heat of fusion of ice = 334 000 J/kg °C
   Specific heat capacity of water = 4200 J/kg °C

Answers

Exam question - review

1) Mass = 0.25 kg **(1)**

   Ice melting = 0.25 X 334000 = 83500 J **(1)**

   Temperature change = 100 - 20 = 80 °C **(1)**

   Water heating = 0.25 X 4200 X 80 = 84000 J **(1)**

   Water boiling = 0.25 X 2260000 = 565000 J **(1)**

   Total thermal energy = 83500 + 84000 + 565000 = **732500 J (1)**

Exam question - review

2)

Ice heating:

E = m X 2100 X 3 = m X 6300 **(1)**

Ice melting:

E = m X 340000 **(1)**

Water heating:

E = m X 4200 X 5 = m X 21000 **(1)**

Total thermal energy transfer:

7500 = m X 6300 + m X 340000 + m X 21000 = m X 361300 **(1)**

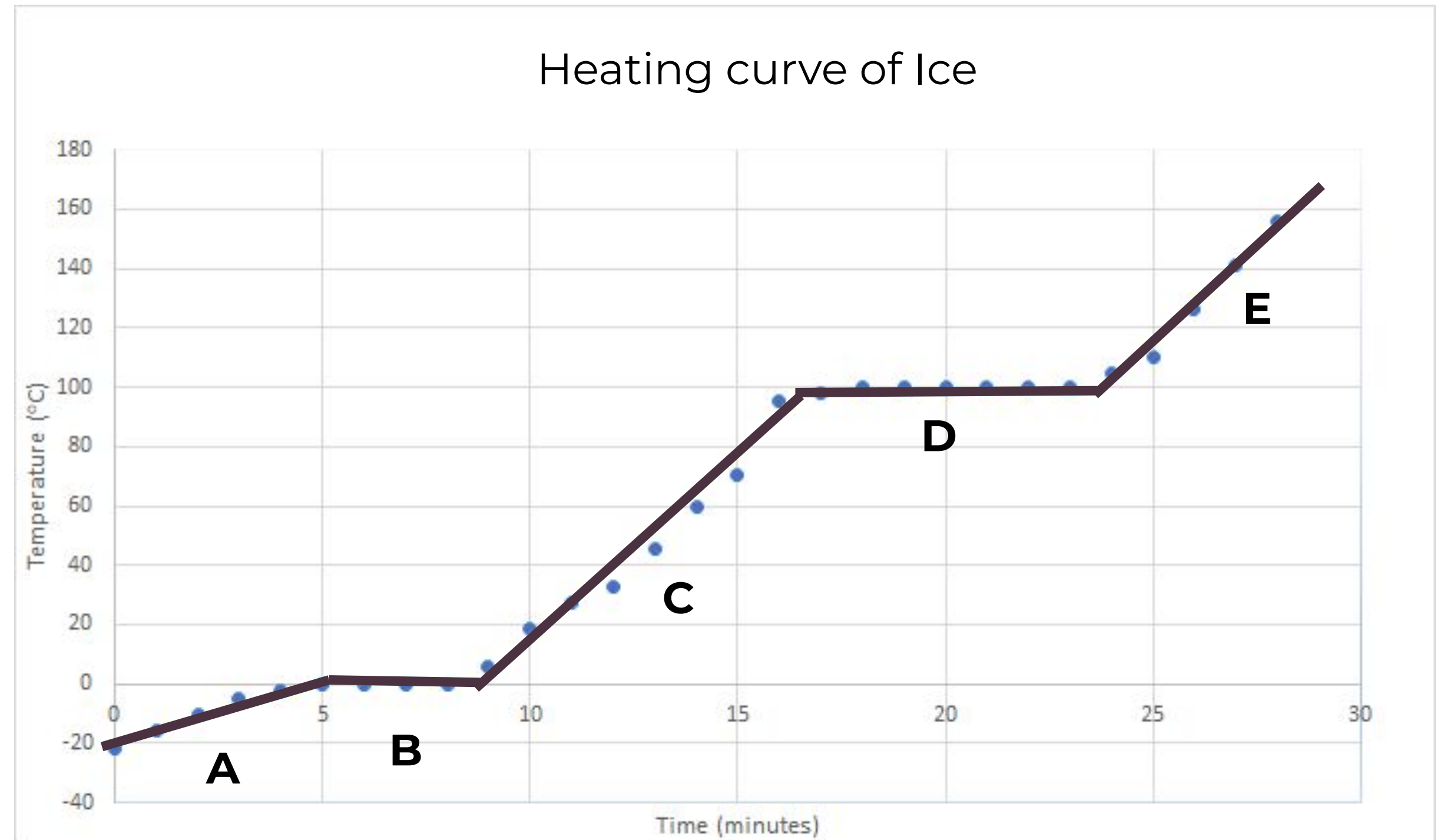m = 7500 / 361300 **(1)**

m = **0.02 kg (1)**

In lesson questions

Warm up

1. For each stage (A-E) write down if the kinetic store or potential store is increasing

2. Identify for each stage (A-E) if it relates to specific heat capacity or latent heat.

Heating curve of Ice

Image, Mr Charman

8

Independent practice

1. What mass of liquid hydrogen needs 910 000 J of heat energy to turn into a gas? The specific latent heat of vapourisation of hydrogen is 455 000 J/kg
2. What is the mass of an unknown material with a specific latent heat of 14 000 J/kg if it takes 42 kJ to turn it into a liquid from a solid?
3. **Challenge:** What mass of nitrogen gas is produced when 1.6×10^4 J is needed to turn it from a liquid to a gas? The specific latent heat of vapourisation of nitrogen is 2×10^5 J/kg.

Independent practice

1. What is the specific latent heat of copper if it requires 414 000 J of heat energy to melt 2 kg of copper?
2. What is the specific latent heat of lead if it requires 92 000 J of heat energy to melt 4 kg of lead?
3. **Challenge -** what is the specific latent heat of aluminium if it requires 203 400 J of heat energy to melt 600g of aluminium?

Worked example 1

An ice cube has a mass of 50 g and a temperature of -10 °C. Calculate the total thermal energy required to melt the ice cube.

Specific heat capacity of ice = 2100 J/kg °C
Specific latent heat of fusion of ice = 334 000 J/kg **(5)**

Energy = ………………………… J

Worked example 2

An ice cube has a temperature of –20.0 °C The total thermal energy needed to raise the temperature of this ice cube to 0.0 °C and completely melt the ice cube is 75200 J

Specific heat capacity of ice = 2100 J/kg °C
Specific latent heat of fusion of ice = 334 000 J/kg

Calculate the mass of the ice cube. **(5)**

Energy = ………………………… J

Answers

Review

1. For each stage (A-E) write down if the kinetic store or potential store is increasing.
   A, C and E - kinetic energy store increasing. B and D - potential energy store increasing.
2. Identify for each stage (A-E) if it relates to specific heat capacity or latent heat.
   A, C and E relate to specific heat capacity. B and D relate to latent heat.

Independent practice -review

1. What is mass of liquid hydrogen needs 910 000 J of heat energy to turn into a gas? The specific latent heat of vaporization of hydrogen is 455 000 J/kg. **2 kg**
2. What mass of an unknown material with a specific latent heat of 14 000 J/kg is produced when it takes 42 kJ to turn it into a liquid from a solid? **3 kg**
3. **Challenge:** What mass of nitrogen gas is produced when 1.6×10^4 J is needed to turn it from a liquid to a gas? The specific latent heat of vaporisation of nitrogen is 2×10^5 J/kg.

Independent practice -review

1. What is the specific latent heat of copper if it requires 414 000 J of heat energy to melt 2 kg of copper? **207 000 J/kg**
2. What is the specific latent heat of lead if it requires 92 000 J of heat energy to melt 4 kg of lead? **23 000 J/kg**
3. **Challenge** - what is the specific latent heat of aluminium if it requires 203 400 J of heat energy to melt 600g of aluminium? **339 000 J/kg**

1.