Year 11 Physics Progress Check

Heat

Q1

- What quantity of heat is required to raise the temperature of 450 grams of water from 15°C to 85°C? The specific heat capacity of water is 4.18 J/g/°C.

Q2

- It takes 487.5 J to heat 25 grams of copper from 25 °C to 75 °C. What is the specific heat in Joules/g·°C?

Q3

- *Calculate the heat energy required to raise the temperature of a copper can (mass 50g) containing 200cm^3 of water from 20 to 100^{o}C. (Copper =* 385 J kg $^{-1}$ ^{o}C $^{-1}$) (Hint density of water)

Q4

Calculate (a) the heat energy required to change 100g of ice at –5^{o}C to steam at 100^{o}C. (Use the data on the following table)

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SHC of Common Substances

Water	4.18×10^3
Alcohol	2.50×10^3
Ice	2.10×10^3
Steam	2.00×10^3
Air	1.01×10^3
Aluminium	8.80×10^2
Glass	8.40×10^2
Iron	4.35×10^2
Copper	3.90×10^2
Mercury	1.50×10^2
Human body	3.5×10^3
Brass	3.70×10^2

$$Q = m c \Delta T$$

Q = quantity of heat energy (J)
m = mass of substance (kg)
c = specific heat of substance (J kg^{-1} K^{-1})
ΔT = temperature change (K)

LH and SLH

Substance	State change	SLH (Jkg^{-1})C
ice → water	solid → liquid **specific latent heat of fusion**	336 000
water → steam	liquid → gas / vapour **specific latent heat of vaporisation**	2 250 000

Substance		LH (Jkg^{-1})C
ice		2100
steam		4200

Q5

Find the rate of heat transfer through a 5 mm thick glass window with a cross-sectional area of 0.4 m^2 if the inside temperature is 300K and the outside temperature is 250K.

(glass thermal conductivity = 0.9w/m/degrees C)

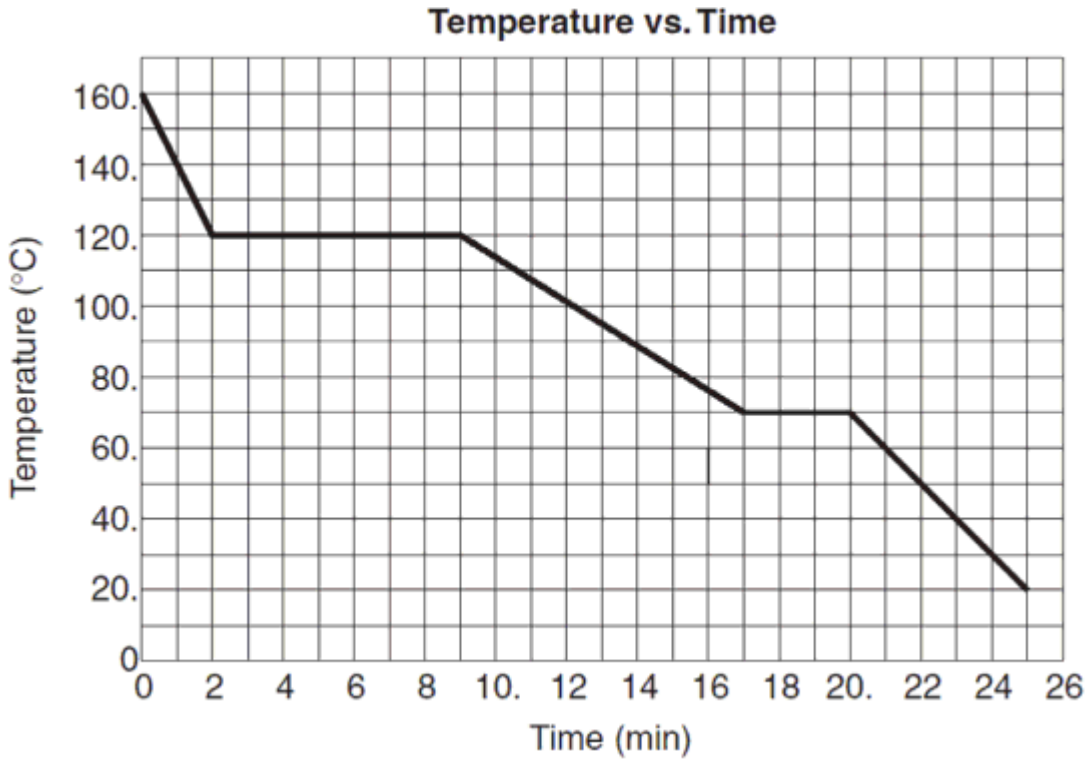
Q6

One end of a 1.5-meter-long stainless steel rod is placed in an 850K fire. The cross-sectional radius of the rod is 1 cm, and the cool end of the rod is at 300K. Calculate the rate of heat transfer through the rod.

Hint : Cross sectional area

(stainless steel thermal conductivity = 16.5w/m/degrees C)

Q7



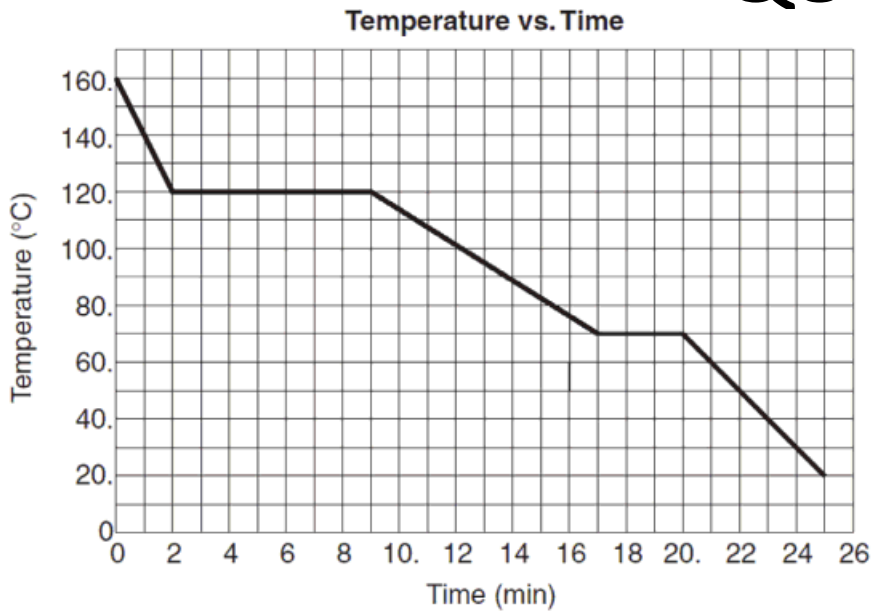
While the substance is cooling during the liquid phase, the average kinetic energy of the molecules of the substance

(1) decreases

(2) increases

(3) remains the same

Q8



Based on the graph of the previous problem, the melting point of the substance is

(1) 0°C

(2) 70°C

(3) 100°C

(4) 120°C

Q9

How much heat must be added to a 10 kg lead bar to change the bar from a solid to a liquid at 327°C?

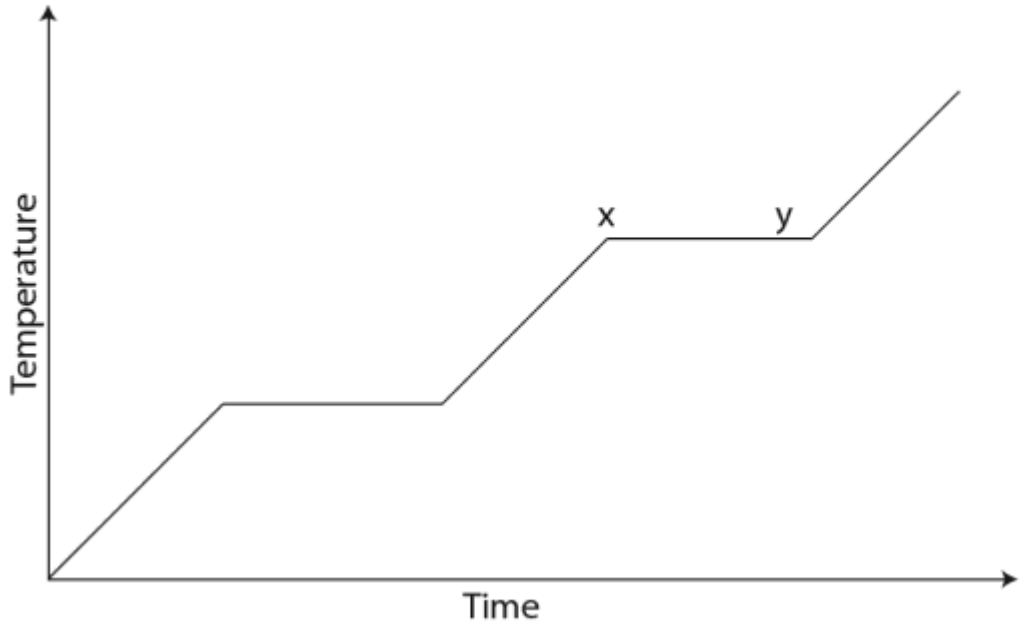
(LH of fusion for Pb 25 000 J kg)

Q10

How much heat must be added to 1 kg of water to change it from a 50°C to 100°C steam at standard pressure?

Q11

The graph below shows temperature vs. time for one kilogram of an unknown material as heat is added at a constant rate.



During interval *xy*, the material experiences

(1) a decrease in internal energy and a phase change

(2) an increase in internal energy and a phase change

(3) no change in internal energy and a phase change

(4) no change in internal energy and no phase change

Q12

Five thousand joules of heat is added to a closed system, which then does 3000 joules of work. What is the net change in the internal energy of the system?

Q13

- Given that the specific heat capacity of water is 11 times that of copper, calculate the mass of copper at a temperature of 100 °C required to raise the temperature of 200 g of water from 20.0 °C to 24.0 °C, assuming no energy is lost to the surroundings.

Hint : Heat lost by copper = heat gained by water

Q14

- Three litres of water at 100 °C are added to 15 litres of water at 40 °C. Calculate the temperature of the mixture. Take the mass of 1 litre of water to be 1 kg and the specific heat capacity of water to be 4.2×10^3 J kg $^{-1}$ K $^{-1}$

Q15

- 1 kg of water at a temperature of 45 °C is mixed with 1.5 kg of alcohol at 20 °C. Find the final temperature of the mixture.
- Take the specific heat capacity of water to be 4200 J kg^{-1} K^{-1} and the specific heat capacity of alcohol to be 2400 J kg^{-1} K^{-1}. Assume no other exchange of heat occurs.

Q16

- Calculate the energy released when

  (a) 10 g water at 100 °C and

  (b) 10 g of steam at 100 °C

  are each spilt on the hand.
  Take the specific heat capacity of water to be 4200 J kg^{-1} K^{-1} and the specific latent heat of vaporisation of water to be 2.2 MJ kg^{-1}.
  Assume that the temperature of the skin is 33 °C.