Unit 10 · Thermal Expansion

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

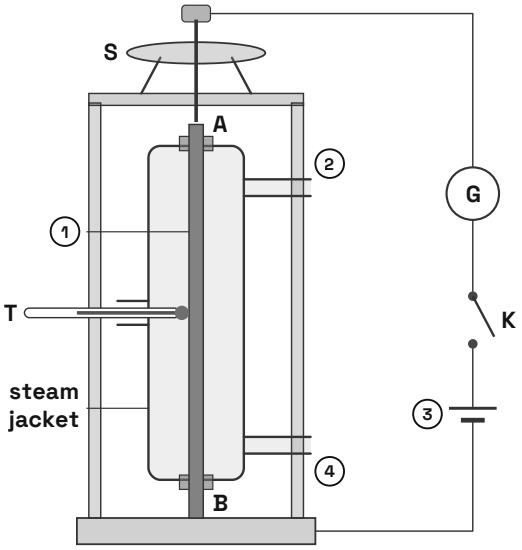
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

apparent expansion	**bimetallic strip**	**conduction**	**cubical expansion**	**elasticity**
linear expansion	**real expansion**	**superficial expansion**	**thermostat**	**three**

The increase in the length of a solid on heating is _____, in its area _____ and in its volume _____. For an isotropic solid the coefficient of cubical expansion is _____ times the coefficient of linear expansion. The expansion of a liquid we see in a vessel, ignoring the vessel's own expansion, is its _____; adding the vessel's expansion gives its _____. A strip of two metals joined along their length that bends when heated is a _____, used in a _____ to switch a heater off when it gets hot.

2 Label the diagram [2]

The diagram shows Pullinger's apparatus for finding the linear expansivity of a metal rod. Write the part that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The SI unit of the coefficient of linear expansion is: [1]

a. m/K
b. K^{-1}
c. m K
d. it has no unit

ii. The coefficient of linear expansion of iron is $1.2 \times 10^{-5}\ K^{-1}$. Its coefficient of cubical expansion is: [1]

a. $0.4 \times 10^{-5}\ K^{-1}$
b. $1.2 \times 10^{-5}\ K^{-1}$
c. $2.4 \times 10^{-5}\ K^{-1}$
d. $3.6 \times 10^{-5}\ K^{-1}$

iii. A steel rod is held between two rigid walls and heated. The force it pushes on the walls with does NOT depend on: [1]

a. its length
b. its cross-sectional area
c. its Young's modulus
d. the rise in temperature

iv. A flask full of coloured water is dipped into hot water. The water level in its neck first falls a little, then rises, because: [1]

a. water contracts when first heated
b. the glass is heated first and expands before the heat reaches the water
c. the air above the water is heated
d. the water evaporates

v. A platinum wire can be sealed through ordinary (soda) glass without the joint cracking as it cools, because: [1]

a. platinum doesn't melt in the flame
b. platinum and soda glass have almost the same linear expansivity
c. platinum is a good conductor of heat
d. glass doesn't expand at all

4 Short answers [7]

Write short answers to the following questions.

a. Why are bridges built with gaps between their steel girders, or with one end on rollers? [2]

b. Why does a thermometer need a liquid whose expansion is much larger than the glass's? [2]

c. A copper hot-water pipe is 20 m long at 15 °C. How much longer is it when hot water at 75 °C runs through it? (α for copper = 1.7×10^{-5} K^{-1}) **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

A thin square plate of side l_1 is heated through $\Delta\theta$. Show that its coefficient of superficial expansion β is twice its coefficient of linear expansion α.

6 Numerical problems **[8]**

Solve the following problems. Show your working.

a. A brass ring has an inner diameter of 4.990 cm at 20 °C. It must be slipped over a steel shaft 5.000 cm in diameter. To what temperature must the ring be heated (the shaft staying at 20 °C)? (α for brass = 1.9×10^{-5} K^{-1}) **[4]**

Answer:

b. The density of mercury is 13 600 kg/m^3 at 0 °C. Find its density at 50 °C, and the volume of 1.00 kg of mercury at both temperatures. (Real cubical expansivity of mercury = 1.82×10^{-4} K^{-1}) **[4]**

Answer: _____

7 Think **[3]**

A glass stopper is stuck in the neck of a glass bottle. Someone suggests warming the neck quickly over a flame. Why might this work, and why should it be done quickly?

8 Activity: A water thermometer (not marked)

Fill a small glass bottle to the brim with coloured water. Push a clear straw through a hole in its cap and seal round it with clay, so the water rises a little way up the straw. Mark the level. Hold the bottle in both hands, then stand it in warm water, then in cold water.

The bottle	Level in the straw (cm above the mark)
At room temperature	0
Held in both hands for 2 minutes	
In warm water for 2 minutes	
In cold water for 2 minutes	

When you first put the bottle in warm water, watch closely. What happens to the level before it rises?