AS-2009 Q2

An ungraduated mercury thermometer is stuck to a 30 centimetre ruler, alongside the scale. The readings on the scale when the thermometer is at 0.0 °C and 100.0 °C are 36 mm and 61 mm respectively. The length of the mercury column varies linearly with temperature.
What is the temperature when the mercury is at the 43 mm mark?

A. 4 °C   B. 72 °C   C. 58 °C   D. 28 °C

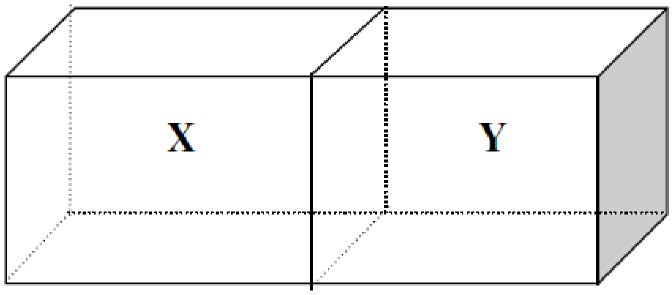
AS-2010 Q10

A long uniform metal plate has a square hole cut in it. The plate is uniformly heated so that it expands a small amount. What is a correct statement about the hole now?

A. It is still square   **B.** It is rectangular in shape   **C.** It has decreased in area   **D.** It has remained the same area

AS-2011 Q6

6. A container of helium gas shown below has two identical sections with a common wall between them which does not allow gas to leak through. The two sections contain helium gas with 2 g in compartment **X** and 1 g in compartment **Y**. The two halves of the container are at the same temperature. Which of the following is the same for the gas in the two sections **X** and **Y**?



A. The number of collisions per second on the common wall

B. The average speed of the atoms

C. The density of the helium

D. The pressure exerted by the helium

AS-2012 Q9

A tea urn has two elements used to heat the water; a slow one used for heating the full urn over a long period of time (taking t_1 minutes) and a fast one used for heating the full urn quickly (taking t_2 minutes). If both elements are used at the same time, how long will it now take to heat the full urn?

A. $t_1 + t_2$ mins.

B. $\frac{t_1}{t_2}$ mins.

C. $\sqrt{(t_1^2 + t_2^2)}$ mins.

D. $\frac{t_1 t_2}{t_1+t_2}$ mins.

AS-2008 Q11

When a metal rod is heated, it expands uniformly with temperature. The coefficient of linear thermal expansivity, α (alpha), is equal to the fractional increase in length per unit temperature rise.
If a rod of length ℓ expands by an amount $\Delta\ell$ when the temperature rises by $\Delta\theta$ in °C, α is given by,

$$\alpha = \frac{\Delta\ell}{\ell}\frac{1}{\Delta\theta}$$

a) What are the units of α?

[1]

A pendulum clock has a metal pendulum. The period of oscillation, T, of the pendulum is given by,

$\sqrt{\ell}$

b) When the clock gives the correct time, how many oscillations will occur in a day?

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[1] k

5 s

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c) For the two temperatures quoted, write down the number of oscillations that would occur in one day.

[2]

d) Calculate the periods of the pendulum, T_{15}, and T_{30}, at the two temperatures.

[2]

e) Calculate the corresponding values of lengths, ℓ_{15} and ℓ_{30}.

[2]

f) Calculate the value of α for the metal of the pendulum.

[3]

/11

AS-2009 Q13

This question requires you to consider the units of each quantity in order to follow the calculation.
In order to reduce its diameter, a wire is pulled through a small hole in a metal plate. The wire is made of metal whose specific heat capacity is 400 J kg^{-1} $^{o}C^{-1}$ and, on emerging from the hole, has a mass per unit length of 5 g per m. A steady force of 600 N is required. If all the heat generated is retained in the wire, we can calculate the rise in temperature of the wire.

Calculate all quantities using SI units (metre, kilogram, second).

a) Draw a simple sketch of the situation and mark on it the force applied to the thin wire.

[1]

c) How much work is done on one kilogram of wire?

[1]

d) Assuming all of the work done is converted into heat calculate the temperature rise of the wire.

[2]

AS-2009 Q13 (continued)

If, however, the temperature of the wire were kept constant by spraying it with cold wat then we can calculate what mass of water would be needed.

Specific heat capacity of water is 4,200 J kg^{-1} $^{o}C^{-1}$

e) Calculate the mass of wire, in kilograms, that is produced each second if it emerges from the hole at a speed of 8.4 ms^{-1}.

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____ [2]

f) Using your answer from part (c), calculate the work done on the wire each second.

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____ [1]

g) If the temperature rise of the water were to be 12 ^{o}C, calculate the mass of water used each second to keep the temperature constant.

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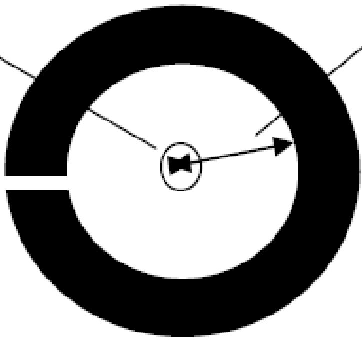
____ [2]

/10

AS-2010 Q14

Light travelling at speed c behaves both as a particle (a photon) and a wave. As a particle, the particle energy, E, is given by $E = hf$ where h is Planck's constant and f is the frequency of light. As a wave it is described by a frequency f and wavelength λ.

In figure 2 below, a thick walled insulating sphere, of internal radius 20 cm, behaves like the inside of a furnace. Negligible heat escapes through the walls when it is hot, but after a long period of time the 24 W heater at the centre has warmed the internal wall to such an extent that it is at equilibrium, having reached the same temperature as the heater. There is a small observation hole in the wall of the furnace through which radiation escapes.



a) When the final temperature is achieved, someone looking through the observation hole can see the heater and one eighth of the surface area of the furnace. How much power is emitted from the observation hole? Explain your answer.

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____ [2]

b) If the observation hole is closed for a short time, what change will occur inside the furnace?

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____ [2]

c) A photon emitted from the heater is absorbed by the wall. Determine the time between emission and absorption of a photon.

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____ [1]

AS-2010 Q14 (continued)

d) If the heater emits radiation for the time period obtained in part (c), calculate the amount of this energy.

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____ [1]

e) Calculate the number n of photons emitted in this time if we assume that they have the average wavelength of 2900×10^{-9} m.

Planck's constant $h = 6.6 \times 10^{-34}$ Js

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____ [3]

f) In fact there are several orders of magnitude more photons in the furnace because the walls, with their large surface area, also radiate. The photons exert a pressure P on the furnace walls, which is given by $P = \frac{1}{3}U$, where U is the energy per unit volume of the radiation in the furnace. When it is at a steady temperature, the total radiation energy in the furnace is 2.5×10^{-5} J. Calculate the pressure P on the walls.

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____ [1]

g) If we used the energy emitted by the heater in a short time as in part (d), estimate how many orders of magnitude greater is the pressure of radiation in the furnace than that pressure which corresponds to the amount of energy in part (d).

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____ [1]

/11