march 2013

3. (a) Define the coefficient of linear expansion. (2)

(b) A piston is required to have a diameter of 200 mm at a working temperature of 240°C.

Calculate the diameter to which it must be machined at an ambient temperature of 12°C. (6)

Note: for the piston $\propto = 0.00002/°C$

april 2014

GENERAL ENGINEERING SCIENCE II April 2014

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Name two devices used to counter the effect of expansion in long pipes due to temperature change. (2)

(b) A length of lead piping is 30 m long when measured at a temperature of 15°C. After hot water has been flowing through it, the temperature of the pipe is found to have been raised to 60°C.

Calculate the new length of the lead pipe. (5)

Note: the coefficient of linear expansion of lead = 0.000028/°C.

oct 2017

GENERAL ENGINEERING SCIENCE II October 2017

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Name a device used to counter the effect of expansion in long pipes due to temperature change. (2)

(b) A length of lead piping is 30 m long when measured at a temperature of 20°C. After hot water has been flowing through it, the temperature of the pipe is found to have been raised to 65°C.

Calculate the new length of the lead pipe. (5)

Note: the coefficient of linear expansion of lead = 0.000028/°C

dec 2015

GENERAL ENGINEERING SCIENCE II December 2015

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (2)

(b) A copper sphere has a diameter of 60 mm and is heated from 30°C to 520°C.

Calculate EACH of the following:

(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C.

dec 2013

GENERAL ENGINEERING SCIENCE II December 2013

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (3)

(b) A copper sphere has a diameter of 50 mm and is heated from 30°C to 515°C.

Calculate EACH of the following:

(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C

april 2016

6. An iron casting has a volume of 0.422 m^3 at 112°C. Its temperature falls to 10°C. Calculate EACH of the following:

(a) the final volume; (5)

(b) the percentage change in the volume. (3)

Note: the coefficient of linear expansion of cast iron = 0.000011/°C.

dec 2016

5. A mass of 1.1 tonne of copper drops in temperature by 86°C.

Calculate EACH of the following:

(a) the final volume; (5)

(b) the percentage reduction in volume. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C

Density of copper = 8800 kg/m³

july 2014

3. A glass thermometer at a temperature of 10°C contains a volume of 450 mm³ of a liquid.

Calculate the temperature required to increase the volume of the liquid by 15 mm³. The expansion of the glass may be neglected. (8)

Note: the coefficient of cubical expansion of the liquid = 1.8 x 10⁻⁴/°C

dec 2014

3. A container of mass 0.25 kg was completely filled with a mass of 0.4 kg of water at a temperature of 15°C and then heated to a temperature of 50°C during which time some of the water spilled out of the container.

   After they had cooled down to the original temperature, the container and water were re-weighed and found to have a mass of 0.645 kg.

   Calculate the coefficient of cubical expansion for the water, neglecting any expansion in the bottle. (8)

   Note: 1 kg of water has a volume of 1 litre at 15°C.

march 2015

GENERAL ENGINEERING SCIENCE II March 2015

Attempt ALL questions

Marks for each question are shown in brackets.

1. A container of mass 0.25 kg was completely filled with a mass of 0.4 kg of liquid at a temperature of 15°C and then heated to a temperature of 50°C during which time some of the liquid spilled out of the container. After they had cooled down to the original temperature the container and liquid were reweighed and found to have a mass of 0.645 kg.

   Calculate the coefficient of cubical expansion for the liquid, neglecting any expansion in the bottle. (10)

   Note: 1 kg of liquid has a volume of 0.99 litre at 15°C.

july 2017

4. A hydraulic system pipeline consists of a total length of 13.7 m of steel pipe with an internal diameter of 30 mm and is completely filled with oil. During working the temperature of the system rises by 27□C.

   Calculate the overflow volume of the oil in litres. (7)

   Note: *coefficient of linear expansion of steel* = 1.2×10^{-5} /□C
   coefficient of cubical expansion of oil = 9×10^{-4} /□C

july 2013

GENERAL ENGINEERING SCIENCE II July 2013

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (3)

(b) A copper sphere has a diameter of 50 mm and is heated from 30°C to 515°C.

Calculate EACH of the following:

(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C

march 2017

4. A copper sphere has a diameter of 50 mm at a temperature of 15°C. The sphere is heated until its temperature rises to 500°C and there are no heat losses.
Calculate EACH of the following:

(a) The increase in the surface area; (5)

(b) The specific heat added. (5)

Note: area of a sphere = $4\pi r^2$ specific heat capacity of copper = 0.394 kJ/kgK coefficient of linear expansion of copper = 0.000017/°C

march 2018

3. A copper sphere has a diameter of 49 mm at a temperature of 12°C. The sphere is heated until its temperature rises to 506°C and there are no heat losses.
Calculate EACH of the following:

(a) the increase in the surface area; (5)
(b) the specific heat added. (3)

Note: area of a sphere = $4\pi r^2$ specific heat capacity of copper = 0.395 kJ/kgK coefficient of linear expansion of copper = 0.000017/°C

july 2016

4. A solid cast iron sphere of 250 mm diameter has 2 MJ of heat energy transferred to it.

Calculate the increase in the diameter in mm. (9)

Note: for cast iron: density = 7200 kg/m^3 specific heat capacity = 0.54 kJ/kgK coefficient of linear expansion = 1.12 x 10^{-5}/ ^{o}C

volume of a sphere =□d^3/6

march 2013

0.01

3. (a) Define the coefficient of linear expansion. (2)

(b) A piston is required to have a diameter of 200 mm at a working temperature of 240°C.

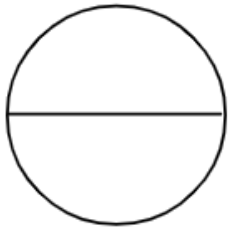
Calculate the diameter to which it must be machined at an ambient temperature of 12°C. (6)

Note: for the piston $\alpha = 0.00002/°C$

the factor by which the material expands for every degree increase in temeperature (Celcius or Kelvin)

$\Delta = 240 - 12$

$\alpha = 0.00002 / °C$



$O_{riginal} + (O_{riginal} \times \Delta temp \times \alpha) = New\ size$

$O_{riginal} + Expansion$

$x + (x \times 228 \times 0.00002) = 200$

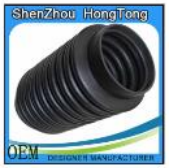
$(x + 0.00456x)$

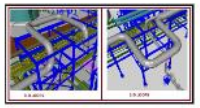
$x(1 + 0.00456) = 200$

$x(1.00456) = 200$

$x = \frac{200}{1.00456}$

$x = 199.0921\ mm$





april 2014

GENERAL ENGINEERING SCIENCE II April 2014

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Name two devices used to counter the effect of expansion in long pipes due to temperature change. (2)

(b) A length of lead piping is 30 m long when measured at a temperature of 15°C. After hot water has been flowing through it, the temperature of the pipe is found to have been raised to 60°C.

Calculate the new length of the lead pipe. (5)

Note: the coefficient of linear expansion of lead = 0.000028/°C.

L 30 m $t_1 = 15°C$ $t_2 = 60$ $\Delta t = 45°C$

$$L + (L \cdot \alpha \cdot \Delta t) = \text{New Length}$$

(expansion)

$$30 + (30 \times 0.000028 \times 45) = 30.0378 \text{ m}$$

oct 2017

GENERAL ENGINEERING SCIENCE II October 2017

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Name a device used to counter the effect of expansion in long pipes due to temperature change. (2)

(b) A length of lead piping is 30 m long when measured at a temperature of 20°C. After hot water has been flowing through it, the temperature of the pipe is found to have been raised to 65°C.

Calculate the new length of the lead pipe. (5)

Note: the coefficient of linear expansion of lead = 0.000028/ °C

$$L + (L \times \alpha \times \Delta t) = \text{New } L$$

$$30 + (30 \times 0.000028 \times 45)$$

dec 2015

GENERAL ENGINEERING SCIENCE II December 2015

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (2)

(b) A copper sphere has a diameter of 60 mm and is heated from 30°C to 520°C.

Calculate EACH of the following:

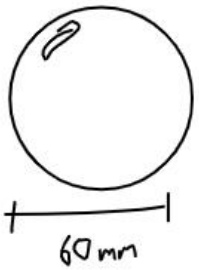
(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C.

a) the amount by which a surface area increases for every degree increase in the temp is approximatly 2 times the linear coeffcient of expansion

b)



diameter → 1 dimension

$L + (L \alpha \Delta t)$

Expansion

$(60 \times 0.000017 \times 490) = 0.4998$ mm

$\text{Percentage increase} = \frac{\text{Expansion}}{\text{Original}} \times 100$

$\frac{0.4998}{60} \times 100 = 0.833\%$

bii) Area

Surface Area $4\pi r^2$

$4\pi(30)^2 = 11309.73355\ mm^2$

Increase $= (SA \times 2\alpha \times \Delta t)$

$11309.73355 \times (2 \times 0.000017 \times 490 = \boxed{188.42\ mm^2}$

dec 2013

GENERAL ENGINEERING SCIENCE II December 2013

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (3)

(b) A copper sphere has a diameter of 50 mm and is heated from 30°C to 515°C.

Calculate EACH of the following:

(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C

$d = 50\,mm \qquad t_1 = 30 \qquad t_2 = 515$

$\Delta t = 485°C$

$\alpha = 0.000017$

$$\frac{\text{increase}}{\text{original}} = \frac{(d \cdot \alpha \cdot \Delta t)}{\text{original}}$$

$= 0.8245\%$

Area $4\pi r^2$

bii) $A = 4\pi(25)^2 = 7853.981634$

$$\text{increase} = (A \times 2\alpha \times \Delta t) = 19.5\,mm^2$$

april 2016

6. An iron casting has a volume of 0.422 m^3 at 112°C. Its temperature falls to 10°C. Calculate EACH of the following:

(a) the final volume; (5)

(b) the percentage change in the volume. (3)

Note: the coefficient of linear expansion of cast iron = 0.000011/°C.

a) $V = 0.422\ m^3$ $t_1 = 112$ $t_2 = 10$

$\Delta t = -102$

$$V + (V \cdot 3\alpha \cdot \Delta t)$$

original change

$$0.422 + (0.422 \times 3 \times 0.000011 \times (-102)) =$$

$$0.422 + (-1.42 \times 10^{-3}) = 0.4205795\ m^3$$

b) $\frac{\text{Change}}{\text{Original}} \times 100 = \text{Percent change}$

0.3366%

dec 2016

5. A mass of 1.1 tonne of copper drops in temperature by 86°C.

Calculate EACH of the following:

(a) the final volume; (5)

(b) the percentage reduction in volume. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C
Density of copper = 8800 kg/m³

$m = 1100\,kg$ copper

$\Delta t = -86\,^{\circ}C$

$d = \frac{m}{V}$ $\qquad 8800 = \frac{1100}{V}$

$V = \frac{1100}{8800} = 0.125\,m^3$

a) $Vol + (Vol \times 3\alpha \times \Delta t) = New\ volume$

$0.125 + (0.125 \times 3 \times 0.000017 \times (-86)) =$

$0.125 - (5.4825 \times 10^{-4}) = 0.12465175\,m^3$

b) $\frac{5.4825 \times 10^{-4}}{0.125} \times 100 = 0.4386\ \%$

july 2014

3. A glass thermometer at a temperature of 10°C contains a volume of 450 mm^3 of a liquid.

Calculate the temperature required to increase the volume of the liquid by 15 mm^3. The expansion of the glass may be neglected. (8)

Note: the coefficient of cubical expansion of the liquid = 1.8 x 10^{-4}/°C — 1.8×10^{-4}

$V_{01} = 450\,mm^3$ $\Delta t = x$

$\alpha = 1.8\times10^{-4}$

increase

$(V \times \alpha \times \Delta t) = 15$

$450 \cdot 1.8\times10^{-4} \cdot x = 15$

$x = \dfrac{15}{450\times1.8\times10^{-4}} = 185.185$

Find temp $= 185.185\,^{\circ}C$

dec 2014

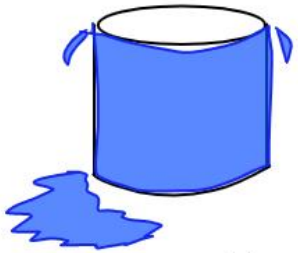
3. A container of mass 0.25 kg was completely filled with a mass of 0.4 kg of water at a temperature of 15°C and then heated to a temperature of 50°C during which time some of the water spilled out of the container.

After they had cooled down to the original temperature, the container and water were re-weighed and found to have a mass of 0.645 kg.

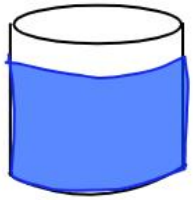
Calculate the coefficient of cubical expansion for the water, neglecting any expansion in the bottle. (8)

Note: 1 kg of water has a volume of 1 litre at 15°C.

Container
0.25kg



Water 0.4kg



Water = 0.395

total weight = 0.645
container − 0.25
water 0.395

Δ water = 0.005 kg = 5×10^{-6} m^3

Δ t = 35

$$\text{density} = \frac{\text{mass}}{\text{Vol}}$$

0.4 kg = 400ml = 0.4 Litres = 0.0004 m^3

$$(V \times \alpha \times \Delta t) = \text{expansion vol}$$

$$0.0004 \cdot x \cdot 35 = 5 \times 10^{-6}$$

$$x = \frac{5 \times 10^{-6}}{35 \times 0.0004}$$

$$\alpha = 0.000357142 \, / ^{\circ}C$$

march 2015

GENERAL ENGINEERING SCIENCE II March 2015

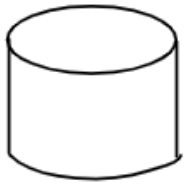
Attempt ALL questions

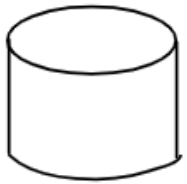
Marks for each question are shown in brackets.

1. A container of mass 0.25 kg was completely filled with a mass of 0.4 kg of liquid at a temperature of 15°C and then heated to a temperature of 50°C during which time some of the liquid spilled out of the container. After they had cooled down to the original temperature the container and liquid were reweighed and found to have a mass of 0.645 kg.

   Calculate the coefficient of cubical expansion for the liquid, neglecting any expansion in the bottle. (10)

   Note: 1 kg of liquid has a volume of 0.99 litre at 15°C.





1 kg = 0.5 Litre

Contain 0.25

Wtr 0.4 kg × 0.99 = 0.396 = 3.96×10^{-4}

totd 0.65 kg

totd = 0.645 kg

Δ liquid = 0.005 kg

↓

× 0.99

0.00495 Litres =

4.95×10^{-6}

Δ temp = 35

= water lost

$V \times \alpha \times \Delta t$ = Expansion

$(V \times \alpha \times \Delta t) =$ Expansion

$3.96 \times 10^{-4} \times \alpha \times 35 = 4.95 \times 10^{-6}$

$$\alpha = \frac{4.95 \times 10^{-6}}{(3.96 \times 10^{-4} \times 35)}$$

$0.000357142 8 /^{\circ}C$

july 2017

4. A hydraulic system pipeline consists of a total length of 13.7 m of steel pipe with an internal diameter of 30 mm and is completely filled with oil. During working the temperature of the system rises by 27°C.

Calculate the overflow volume of the oil in litres. (7)

Note: *coefficient of linear expansion of steel* = 1.2×10^{-5} /°C
coefficient of cubical expansion of oil = 9×10^{-4} /°C

cylinder internal vol

$\pi r^2 h$

$\pi (0.015)^2 (13.7) = 9.683959 \times 10^{-3}$ m^3

30 mm $\Delta 27$

13.7m

r 0.015m

Cold system Hot system

length of pipe 13.7 m

$L + (L \times \alpha \times \Delta t) =$

$13.7 + (13.7 \times 1.2 \times 10^{-5} \times 27) = 13.7044388 = h$

Volume of pipe when hot

$\pi r^2 h = 9.693375213 \times 10^{-3}$ m^3

diameter of pipe = 0.03 m

$d + (d \times \alpha \times \Delta t)$

$0.03 + (0.03 \times 1.2 \times 10^{-5} \times 27) = 0.03000972 = d$

(cold) Vol of oil = 9.683959×10^{-3} m^3

Hot

$V + (V \times \alpha \times \Delta t)$

$9.683959 \times 10^{-3} + (9.683959 \times 10^{-3} \times 9 \times 10^{-4} \times 27)$ = $9.919279204 \times 10^{-3}$ m^3

2.3532×10^{-4}

$9.91 \times 10^{-3} - 9.69 \times 10^{-3}$

Overflow = $2.259039907 \times 10^{-4}$ m^3

0.2259 Litres

july 2013

GENERAL ENGINEERING SCIENCE II July 2013

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) Define the coefficient of superficial expansion. (3)

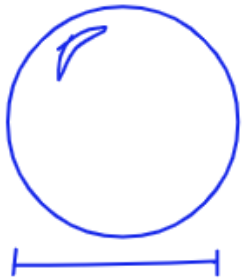
(b) A copper sphere has a diameter of 50 mm and is heated from 30°C to 515°C.

Calculate EACH of the following:

(i) the percentage increase in the diameter; (3)

(ii) the increase in the area. (3)

Note: the coefficient of linear expansion of copper = 0.000017/°C



Expansion

a) $\frac{(d \cdot \alpha \Delta t)}{d} \times 100 = 0.8245\%$

b) Area $\times 2\alpha \times \Delta t =$ 129.51 mm^2

Area $= 4\pi r^2$ $r = 25\ mm = 0.025\ m$

SA: Original $4\pi r^2 = 4\pi(0.025)^2 = 7.85 \times 10^{-3}$

Expansion $(SA \times 2\alpha \times \Delta t) =$ $1.2951 \times 10^{-4}\ m^2$

$7.85 \times 10^{-3} \times 2 \times 0.000017 \times 485 =$

march 2017

4. A copper sphere has a diameter of 50 mm at a temperature of 15°C. The sphere is heated until its temperature rises to 500°C and there are no heat losses. Calculate EACH of the following:

(a) The increase in the surface area; (5)

(b) The specific heat added. (5)

Note: area of a sphere = $4\pi r^2$ (specific heat capacity of copper = 0.394 kJ/kgK)
coefficient of linear expansion of copper = 0.000017/°C

a) Surface Area $4\pi r^2$ $r = 0.025\,m$

$4\pi (0.025)^2 = 7.8539 \times 10^{-3}$

Expansion $= \left(7.8539 \times 10^{-3} \times 2 \times 0.000017 \times 485\right)$

$= 1.295 \times 10^{-4}\ m^2$

b) $Q = m c \Delta t$

energy = mass × Specific heat capacity × change in temp

$m = 1$

$c = 0.394\,kJ = 394\,J/kgK$

$\Delta t = 500 - 15 = 485\,°C$

$Q = 1 \times 394 \times 485 = 191090\,J$

$191.09\,kJ$

march 2018

3. A copper sphere has a diameter of 49 mm at a temperature of 12°C. The sphere is heated until its temperature rises to 506°C and there are no heat losses. Calculate EACH of the following:

(a) the increase in the surface area; (5)
(b) the specific heat added. (3)

Note: area of a sphere = $4\pi r^2$ specific heat capacity of copper = 0.395 kJ/kgK coefficient of linear expansion of copper = 0.000017/°C

$\Delta t = 506 - 12 = 494$

a) $SA = 4\pi r^2$

$r = \frac{49}{2} \div 1000 = 0.0245$ m

$4\pi(0.0245)^2 = 7.542983961 \times 10^{-3}$ m^2

increase $= (SA \times 2\alpha \times \Delta t)$

increase $= (7.542983961 \times 10^{-3} \times 2 \times 0.000017 \times 494)$

$= 1.266916 \times 10^{-4}$

b) $Q = mc\Delta t$

$= 1 \times 395 \times 494 = 195130$ J

195.13 kJ

july 2016

4. A solid cast iron sphere of 250 mm diameter has 2 MJ of heat energy transferred to it.

Calculate the increase in the diameter in mm. (9)

Note: for cast iron: density = 7200 kg/m³ specific heat capacity = 0.54 kJ/kgK coefficient of linear expansion = 1.12 x 10^{-5}/°C

volume of a sphere = $\pi d^3/6$

$Q = mc\Delta t$

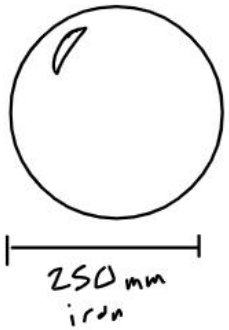
$Q = 2,000,000$ J

$m = 58.9$

$C = 0.54$ kJ/kg k

540 J/kg k

$\Delta t = x$



$r = 125$ mm

0.125 m

Mass r =

$Vol = \frac{4}{3}\pi r^3$

$\frac{4}{3}\pi(0.125)^3 = 8.18123 \times 10^{-3}$ m³

$Density = \frac{Mass}{Vol}$

$M = D \times V$

$Mass = 8.18123 \times 10^{-3} \times 7200$

$= 58.90486225$ kg

$\Delta t = 62.876$ °C

increase in diameter

$$(d \times \alpha \times \Delta t)$$

$$250 \times 1.12 \times 10^{-5} \times 62.87$$

$$0.176 \text{ mm}$$