dec 2013

2. (a) Define the specific heat capacity of a substance and state the units of such. (4)

   (b) 6 MJ of heat energy are required to raise the temperature of 170 kg of copper by 90°C.

   Calculate the specific heat capacity of the copper. (4)

july 2014

4. A steel component, of mass 750 grammes, has its temperature raised from 17°C to 700 K in 5 minutes.

   Calculate the rate of energy input required. (6)

   Note: specific heat capacity of steel = 0.52 kJ/kgK

oct 2015

GENERAL ENGINEERING SCIENCE II October 2015

Attempt ALL questions

Marks for each question are shown in brackets.

1. A steel component, of mass 10 kg, is cooled from a temperature of 450°C by being completely immersed in a tank containing 4 kg of oil at a temperature of 15°C.

   Calculate the final temperature of the oil and the steel component, assuming that the heat losses are negligible. (8)

   Note: specific heat capacity of steel = 0.48 kJ/kgK
   specific heat capacity of oil = 1.8 kJ/kgK

December 18, Qu 1

A steel component of 30 kg mass and a temperature of 280°C is immersed in a bath of machine oil. The volume of the machine oil in the bath is 175 litres and the temperature is 16°C. The final temperature of the oil and the steel is 28°C. There are no heat losses to the surroundings.

Calculate the specific heat capacity of the oil. (8)

Note: specific heat capacity of the steel = 0.485 kJ/kgK density of machine oil = 880 kg/m³

October 18, Qu 1

(a) Define specific heat capacity, stating the SI unit. (3)

(b) Calculate the heat energy rejected when a mass of 5 kg of brass is cooled from a temperature of 215°C to 25°C. (4)

Note: for brass c = 0.393 kJ/kgK

april 2014

4. A mass of 0.4 kg of aluminium is heated to 200°C and then immersed in 1.6 kg of water contained in a copper vessel having a mass of 0.24 kg. The initial temperature of the water and copper is 12°C, the final temperature is 21.8°C and there are no heat losses.

Calculate the specific heat capacity of the aluminium. (9)

Note: the specific heat capacity of copper = 0.39 kJ/kgK
the specific heat capacity of water = 4.17 kJ/kgK

oct 2017

4. A mass of 0.4 kg of aluminium is heated to 198°C and then immersed in 1.55 kg of water contained in a copper vessel having a mass of 0.25 kg. The initial temperature of the water is 12.2°C, the final temperature is 22°C and there are no heat losses.

Calculate the specific heat capacity of the aluminium. (9)

Note: the specific heat capacity of copper = 0.39 kJ/kgK
the specific heat capacity of water = 4.17 kJ/kgK

dec 2016

4. An aluminium vessel has a mass of 10 kg and contains 6 kg of water at a temperature of 15°C. A mass of 5 kg of water at 35°C is added to the vessel and there are no heat losses.

Calculate the final temperature of the vessel and water. (8)

Note: the specific heat of aluminium = 0.95 kJ/kgK
the specific heat of water = 4.12 kJ/kgK

6. (a) Explain what is meant by EACH of the following terms:

(i) specific heat capacity; (3)

(ii) specific enthalpy of evaporation. (3)

(b) 6 kg of liquid at 20°C has 1240 kJ of heat transferred to it raising its temperature to 92°C.

Determine the specific heat capacity of the liquid. (3)

dec 2013

2. (a) Define the specific heat capacity of a substance and state the units of such. (4)

(b) 6 MJ of heat energy are required to raise the temperature of 170 kg of copper by 90°C.

Calculate the specific heat capacity of the copper. (4)

$$Q = mc\Delta t$$

Q = Energy = 6 MJ = 6×10^6 J

m = 170 kg

Δt = 90°

$$\frac{Q}{m\Delta t} = c$$

$$\frac{6,000,000}{(170 \times 90)} = c = 392.15686 \text{ J/kgK}^\circ$$

july 2014

4. A steel component, of mass 750 grammes, has its temperature raised from 17°C to 700 K in 5 minutes.

Calculate the rate of energy input required. (6)

Note: specific heat capacity of steel = 0.52 kJ/kgK = 520 J/kg K

700
17+273 = 290
410

Energy

$Q = mc\Delta t$

$= 0.75 \times 520 \times 410$

159900 Joules

$\text{Rate} = \frac{J}{s}$ $\frac{159900}{300} = $ **533 J/s** watts

oct 2015

GENERAL ENGINEERING SCIENCE II October 2015

Attempt ALL questions

Marks for each question are shown in brackets.

1. A steel component, of mass 10 kg, is cooled from a temperature of 450°C by being completely immersed in a tank containing 4 kg of oil at a temperature of 15°C.

Calculate the final temperature of the oil and the steel component, assuming that the heat losses are negligible. (8)

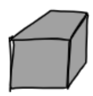
Note: specific heat capacity of steel = 0.48 kJ/kgK
specific heat capacity of oil = 1.8 kJ/kgK

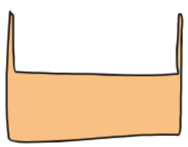
Steel

$Q = mc\Delta t$

Oil

$Q = mc\Delta t$





	starting	Find	ΔT
Steel	$m = 10$ $c = 480$ J $T_1 = 450$	$T_2 = x$	$T_2 - T_1$ $\Delta T = 450 - x$
Oil	$m = 4$ $c = 1800$ $T_1 = 15$	$T_2 = x$	$T_2 - T_1$ $\Delta T = x - 15$

$Q_1 = mc\Delta t$

$Q = 10 \cdot 480 \cdot (450 - x)$

$Q_2 = mc\Delta t$

$Q = 4 \times 1800 \times (x - 15)$

Energy Lost by Steel = Energy Gained Oil

$10 \cdot 480 \cdot (450 - x) = 4 \times 1800 \times (x - 15)$

$4800(450 - x) = 7200(x - 15)$

$2160000 - 4800x = 7200x - 108000$

$2268000 = 12000x$

$189 = x$

December 18, Qu 1

A steel component of 30 kg mass and a temperature of 280°C is immersed in a bath of machine oil. The volume of the machine oil in the bath is 175 litres and the temperature is 16°C. The final temperature of the oil and the steel is 28°C. There are no heat losses to the surroundings. Calculate the specific heat capacity of the oil. (8)

Note: specific heat capacity of the steel = 0.485 kJ/kgK density of machine oil = 880 kg/m³

Oil = 175 Litres
0.175 m³

$\text{Density} = \frac{\text{mass}}{\text{vol}}$

mass = D × V = 880 × 0.175 = 154 kg

$Q = mc\Delta t$

Energy lost by steel = Energy gain by oil

	Starting	Final		
steel	m = 30 c = 485 t = 280	t = 28	Δt = 252	$Q = mc\Delta t$ $Q = 30 \times 485 \times 252 = 3,666,600$
Oil	m = 154 c = x t = 16	t = 28	Δt = 12	$Q = mc\Delta t$ $3,666,600 = 154 \times 12 \times c$ **c = 1984 J/kgK**

October 18, Qu 1

(a) Define specific heat capacity, stating the SI unit. (3)

(b) Calculate the heat energy rejected when a mass of 5 kg of brass is cooled from a temperature of 215°C to 25°C. (4)

Note: for brass c = 0.393 kJ/kgK

specific heat capacity, c [J/kg K] or [kJ/kg K]

the amount of heat energy it takes to change the temperature of 1 kg of the material by 1 K (or 1˚C)

b) $Q = mc\Delta t$

$= 5 \times 393 \times 190$

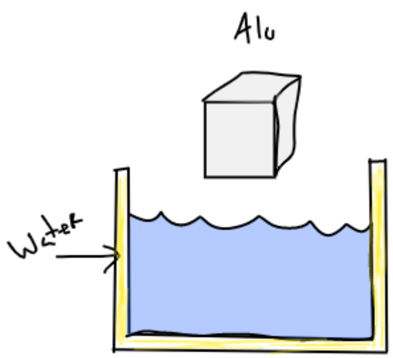
373350 J

april 2014

4. A mass of 0.4 kg of aluminium is heated to 200°C and then immersed in 1.6 kg of water contained in a copper vessel having a mass of 0.24 kg. The initial temperature of the water and copper is 12°C, the final temperature is 21.8°C and there are no heat losses.

Calculate the specific heat capacity of the aluminium. (9)

Note: the specific heat capacity of copper = 0.39 kJ/kgK
the specific heat capacity of water = 4.17 kJ/kgK



loss = gain

$Q_{Alu} = Q_{water} + Q_{copper}$

	start	Find	Δt	$Q = mc\Delta t$
Alu	$m = 0.4$ $c = x$ $t = 200$	$t = 21.8$	178.2 °C	$Q_{Alu} = 0.4x(178.2)$ $= 71.28x$ J
Copper	$m = 0.24$ $c = 390$ $t = 12$	$t = 21.8$	9.8	$Q_{cop} = 0.24 \times 390 \times 9.8$ $= 917.28$ J
Water	$m = 1.6$ $c = 4170$ $t = 12$	$t = 21.8$	9.8	$Q_{wa} = 1.6 \times 4170 \times 9.8$ $= 65385.8$ J

$$71.28x = 65385.8 + 917.28$$

$$x = 930.2 \text{ J/kgK}$$

oct 2017

4. A mass of 0.4 kg of aluminium is heated to 198°C and then immersed in 1.55 kg of water contained in a copper vessel having a mass of 0.25 kg. The initial temperature of the water is 12.2°C, the final temperature is 22°C and there are no heat losses.

Calculate the specific heat capacity of the aluminium. (9)

Note: the specific heat capacity of copper = 0.39 kJ/kgK
the specific heat capacity of water = 4.17 kJ/kgK

Loss/Gain		Start	Find	Change	$Q = mc\Delta t$
L	Alu	$m = 0.4$ $c = x$ $t = 198$	$t = 22$	$\Delta t = 176$	$Q = 0.4 \times 176$ $70.4x$
G	Water	$m = 1.55$ $c = 4170$ $t = 12.2$	$t = 22$	$\Delta t = 9.8$	$Q = 1.55 \times 4170 \times 9.8$ 63342.3
G	Copper	$m = 0.25$ $c = 390$ $t = 12.2$	$t = 22$	$\Delta t = 9.8$	$Q = 0.25 \times 390 \times 9.8$ 955.5

Loss = Gain

$$70.4x = 63342.3 + 955.5$$

$$x = 913.32 \text{ J/kgK}$$

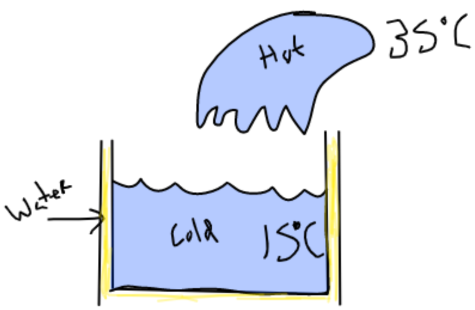
dec 2016

4. An aluminium vessel has a mass of 10 kg and contains 6 kg of water at a temperature of 15°C. A mass of 5 kg of water at 35°C is added to the vessel and there are no heat losses.

Calculate the final temperature of the vessel and water. (8)

Note: *the specific heat of aluminium = 0.95 kJ/kgK*
the specific heat of water = 4.12 kJ/kgK

gains = losses



Loss/gain	Name	initial	Final	Δt	$Q = mc\Delta t$
L	Hot water	m = 5 C = 4120 t = 35	t = x	35 − x	$Q = 5 \cdot 4120 (35 - x)$ $721000 - 20600x$
g	Cold water	m = 6 c = 4120 t = 15	t = x	x − 15	$Q = 6 \cdot 4120 (x - 15)$ $24720x - 370800$
g	Alu	m = 10 c = 950 t = 15	t = x	x − 15	$Q = 10 \cdot 950 (x - 15)$ $9500x - 142500$

Loss = gains

$$(721000 - 20600x) = (24720x - 370800) + (9500x - 142500)$$

$$721000 - 20600x = 34220x - 513300$$

$$1234300 = 54820x$$

$$\frac{1234300}{54820} = x$$

$$22.5155\ ^\circ C$$

$$\boxed{22.516\ ^\circ C}$$