# Heat – Temperature – Phase Change
# (Problems – Solutions)

**Note : 1** : No Phase change occurs if there is a change in Temperature.

Then Heat Lost/Gain by the bodies : $Q = m\ s\ \Delta T$

Here m = Mass of the body

S = Specific heat of the material of the body

$\Delta T$ = Difference in Temperature

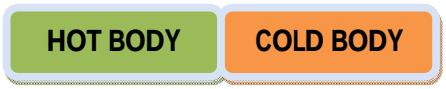
**Note : 2** : If there is a Phase change, then Temperature remains constant.

Then Heat Lost/Gain by the bodies : $Q = m\ L$

Here m = Mass of the body

L = Latent heat of fusion (or) Latent heat of vaporisation

**Note : 3** : If two bodies are kept in contact ...




Then

Heat lost by Hot Body = Heat gained by Cold Body

**Note : 4** : Observe these before solving the problems.

(i) Whether the given bodies made with same material or not ?

(ii) Whether the given bodies are in same phase or not ?

**Note : 5** : t – represents temperature in Celcius scale = $t^oC$

T – represents temperature in Kelvin scale = (t – 273)K

But the difference in temperature is same in both scales.

**Example-1 :**

5 g of water vapour at 100°C converted in to 5 g of water at 100°C. Calculate the heat energy released in this process ?

**Answer :**

Water vapour at 100°C converted in to water at 100°C

No change in temperature

Change in phase (Gaseous phase to Liquid phase)

Mass of the body (m) = 5 g

Latent heat of vaporization of water (L) = 540 cal/g

Heat Lost by the bodies : $Q = m\ L$

$= 5 \times 540$

$= 2700$ cal

**Example-2 :**

20 g of Spirit at 75°C converted in to 20 g of Spirit at 40°C. Calculate the heat energy released in this process ? (Specific heat of Spirit = 0.6 cal/g-°C)

**Answer :**

Spirit at 75°C converted in to Spirit at 40°C

No change in Phase

Change in Temperature (from 75°C to 40°C)

Mass of the body (m) = 20 g

Specific heat of spirit (s) = 0.6 cal/g-°C

Initial Temperature ($t_1$) = 75°C

Final Temperature ($t_2$) = 40°C

Difference in temperature ($\Delta T$) = 75°C – 40°C = 35°C

Heat Lost by the bodies : $Q = m\ s\ \Delta T$

$= 20 \times 0.6 \times 35$

$= 12 \times 35$

$= 420$ cal

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**Example-3 :**

**40 g of Water at 100°C converted in to 40 g of Water at 20°C. Calculate the heat energy released in this process ? (Specific heat of water = 1 cal/g-°C)**

**Answer :**

**Water at 100°C converted in to Water at 20°C**

**No change in Phase**

**Change in Temperature (from 100°C to 20°C)**

Mass of the body (m) = 40 g

Specific heat of spirit (s) = 1 cal/g-°C

Initial Temperature ($t_1$) = 100°C

Final Temperature ($t_2$) = 20°C

Difference in temperature ($\Delta T$) = 100°C – 20°C = 80°C

Heat Lost by the bodies : $Q = m\ s\ \Delta T$

$= 40 \times 1 \times 80$

$= 40 \times 80$

$= 3200$ cal

**Example-4 :**

**40 g of Water at 60°C is added to 60 g of water at 30°C. Find the resultant temperature ?**

**Answer :**

**Both substances are Same material .... Water**

**Both substances are in Same phase ..... liquid**

$m_1 = 40$ g $\quad T_1 = 60°C$

$m_2 = 60$ g $\quad T_2 = 30°C$

Resultant Temperature of Mixture $= \frac{m_1T_1+m_2T_2}{m_1+m_2}$

$= \frac{40\ X\ 60+60\ X\ 30}{40+60}$

$= \frac{2400+1800}{100}$

$= \frac{4200}{100}$

$= 42°C$



**Example-5 :**

**30 g of Spirit at 50°C is added to 50 g of Spirit at 40°C. Find the resultant temperature ?**

**Answer :**

**Both substances are Same material .... Spirit**

**Both substances are in Same phase ..... liquid**

$m_1 = 30$ g $\quad T_1 = 50°C$

$m_2 = 50$ g $\quad T_2 = 40°C$

Resultant Temperature of Mixture $= \frac{m_1T_1+m_2T_2}{m_1+m_2}$

$= \frac{30\ X\ 50+50\ X\ 40}{30+50}$

$= \frac{1500+2000}{80}$

$= \frac{3500}{80}$

$= 43.75°C$

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**Example-6 :**

**50 g of water at 80°C is added to 60 g of Kerosene at 40°C. Find the resultant temperature ? (Specific Heat of Kerosene = 0.5 cal/g-°C)**

**Answer :**

**Both substances are different material .... Water and Kerosene**

**Both substances are in Same phase ..... liquid**

| | | Specific heat |
|---|---|---|
| $m_w = 50$ g | $T_w = 80^oC$ | $s_w = 1$ cal/g-°C |
| $m_k = 60$ g | $T_k = 40^oC$ | $s_k = 0.5$ cal/g-°C |

Let the Resultant Temperature = $T_r$

Heat lost by Hot Body = Heat gained by Cold Body

$$m_w . s_w . \Delta T_w = m_k . s_k . \Delta T_k$$

$$50 \times 1 \times (80-T_r) = 60 \times 0.5 \times (T_r-40)$$

$$50 \times (80-T_r) = 30x (T_r-40)$$

$$4000 - 50\ T_r = 30\ T_r - 1200$$

$$4000 + 1200 = 30\ T_r + 50\ T_r$$

$$5200 = 80\ T_r$$

$$T_r = \frac{5200}{80}$$

$$T_r = 65^oC$$

**Example-7 :**

**60 g of water at 85°C is added to 40 g of Spirit at 30°C. Find the resultant temperature ? (Specific Heat of spirit = 0.6 cal/g-°C)**

**(Note : Consider the spirit as non volatile substance at particular temperature)**

**Answer :**

**Both substances are different material .... Water and Spirit**

**Both substances are in Same phase ..... liquid**



| | | Specific heat |
|---|---|---|
| $m_w = 60$ g | $T_w = 85^oC$ | $s_w = 1$ cal/g-°C |
| $m_s = 40$ g | $T_s = 30^oC$ | $s_s = 0.6$ cal/g-°C |

Let the Resultant Temperature = $T_r$

Heat lost by Hot Body = Heat gained by Cold Body

$$m_w . s_w . \Delta T_w = m_s . s_s . \Delta T_s$$

$$60 \times 1 \times (85-T_r) = 40 \times 0.6 \times (T_r-30)$$

$$60 \times (85-T_r) = 24x (T_r-30)$$

$$5100 - 60\ T_r = 24\ T_r - 720$$

$$5100 + 720 = 24\ T_r + 60\ T_r$$

$$5820 = 84\ T_r$$

$$T_r = \frac{5820}{84}$$

$$T_r = 69.3^oC$$

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**Example-8 :**

**10 g of Ice at -10°C is added to 50 g of water at 60°C. Find the resultant temperature of the mixture ?**

**Answer :**

**Both substances are .... Ice , Water**

**Both substances are in different phase ..... Solid , liquid**

**Let the resultant temperature = T**

**Case(i) 10 g of Ice at -10°C convert in to 10 g of Ice at 0°C**

**No change in Phase**

**Change in Temperature (from -10°C to 0°C)**

Mass of the body (m) = 10 g

Specific heat of spirit (s) = 0.5 cal/g-°C

Initial Temperature ($t_1$) = -10°C

Final Temperature ($t_2$) = 0°C

Difference in temperature ($\Delta T$) = 0°C – (-10)°C = 10°C

Heat Gain by the bodies : $Q = m\ s\ \Delta T$

$= 10 \times 0.5 \times 10$

$= 50$ cal

**Case(ii) 10 g of Ice at 0°C convert in to 10 g of Water at 0°C**

**No change in temperature**

**Change in phase (Solid phase to Liquid phase)**

Mass of the body (m) = 10 g

Latent heat of fusion of Ice (L) = 80 cal/g

Heat Gained by the Ice : $Q = m\ L$

$= 10 \times 80$

$= 800$ cal



**Case(iii) 10 g of water at 0°C convert in to 10 g of water at T°C**

**No change in Phase**

**Change in Temperature (from 0°C to T°C)**

Mass of the body (m) = 10 g

Specific heat of water (s) = 1 cal/g-°C

Initial Temperature ($t_1$) = 0°C

Final Temperature ($t_2$) = T°C

Difference in temperature ($\Delta T$) = T°C – 0°C = T°C

Heat Gain by the bodies : $Q = m\ s\ \Delta T$

$= 10 \times 1 \times T$

$= 10\ T$ cal

**Case(iv) 50 g of water at 60°C convert in to 50 g of water at T°C**

**No change in Phase**

**Change in Temperature (from 60°C to T°C)**

Mass of the body (m) = 10 g

Specific heat of water (s) = 1 cal/g-°C

Initial Temperature ($t_1$) = 60°C

Final Temperature ($t_2$) = T°C

Difference in temperature ($\Delta T$) = 60°C – T°C = (60-T)°C

Heat Lost by the bodies : $Q = m\ s\ \Delta T$

$= 50 \times 1 \times (60-T)$

$= 50\ (60-T)$

$= (3000 - 50\ T)$ cal

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**Formula for method of mixtures:**

Heat lost by hot body = heat gained by cold body

Heat lost by hot water = heat gained by cold Ice

$3000 - 50\,T = 50 + 800 + 10\,T$

$3000 - 50\,T = 850 + 10\,T$

$3000 - 850 = 10\,T + 50\,T$

$2150 = 60\,T$

$T = \frac{2150}{60}$

$T = 35.83^{o}C$

**Example-9 :**

**10 g of Ice at $0^{o}C$ is added to 10 g of water at $60^{o}C$. Find the resultant temperature ?**

**Answer :**

**Case(i) 10 g of Ice at $0^{o}C$ convert in to 1 g of water at $0^{o}C$**

**No change in temperature**

**Change in phase (Solid phase to Liquid phase)**

Mass of the body (m) = 10 g

Latent heat of fusion of Ice (L) = 80 cal/g

Heat Gained by the Ice : Q = m L

= 10 x 80

= 800 cal

**Case(ii) 10 g of water at $60^{o}C$ convert in to 10 g of water at $0^{o}C$**

**No change in Phase**

**Change in Temperature (from $60^{o}C$ to $0^{o}C$)**

Mass of the body (m) = 10 g

Specific heat of spirit (s) = 1 cal/g-$^{o}C$

Initial Temperature ($t_1$) = $60^{o}C$

Final Temperature ($t_2$) = $0^{o}C$

Difference in temperature ($\Delta T$) = $60^{o}C - 0^{o}C = 60^{o}C$

Heat Lost by the bodies : Q = m s $\Delta T$

= 10 x 1 x 60

= 600 cal

**It means the heat lost by the water is insufficient to melt the Ice.**

The amount of Ice melts with 800 cal = 10 g

The amount of Ice melts with 600 cal = $\frac{600}{800}$ x 10 = $\frac{60}{8}$ = 7.5 g

So Finally 7.5 g of Water and 2.5 g of Ice remains in the Mixture.

Resultant temperature is $0^{o}C$.



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