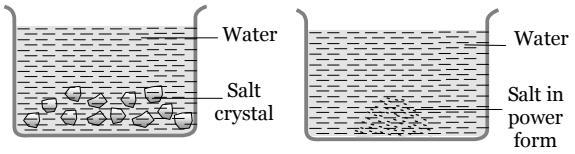
Thermometry, Thermal Expansion and Calorimetry

SET Self Evaluation Test - 12

1. Out of the following, in which vessel will the temperature of the solution be higher after the salt is completely dissolved.



(a) A
(b) B
(c) Equal in both
(d) Information is not sufficient

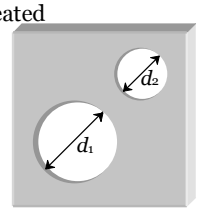
2. Fire is extinguished more effectively by
(a) Hot water (b) Cold water
(c) Equally by both (d) Ice

3. An ideal thermometer should have
(a) Large heat capacity (b) Medium heat capacity
(c) Small heat capacity (d) Variable heat capacity

4. A steel meter scale is to be ruled so that millimeter intervals are accurate within about 5×10^{-5} mm at a certain temperature. The maximum temperature variation allowable during the ruling is (Coefficient of linear expansion of steel $= 10 \times 10^{-6} K^{-1}$)
(a) $2°C$ (b) $5°C$
(c) $7°C$ (d) $10°C$

5. During illness an 80 kg man ran a fever of $102.2°F$ instead of normal body temperature of $98.6°F$. Assuming that human body is mostly water, how much heat is required to raise his temperature by that amount
(a) 100 $kcal$ (b) 160 $kcal$
(c) 50 $kcal$ (d) 92 $kcal$

6. Two holes of unequal diameters d_1 and d_2 $(d_1 > d_2)$ are cut in a metal sheet. If the sheet is heated



(a) Both d_1 and d_2 will decrease
(b) Both d_1 and d_2 will increase
(c) d_1 will increase, d_2 will decrease
(d) d_1 will decrease, d_2 will increase

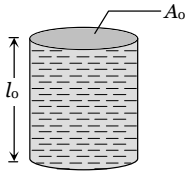
7. If earth suddenly stops rotating about its own axis, the increase in it's temperature will be
(a) $\frac{R^2\omega^2}{5Js}$ (b) $\frac{R^2\omega^2}{Js}$
(c) $\frac{Rm\omega^2}{5Js}$ (d) None of these

8. Latent heat of ice is 80 cal/gm. A man melts 60 g of ice by chewing in 1 $minute$. His power is
(a) 4800 W (b) 336 W
(c) 1.33 W (d) 0.75W

9. A faulty thermometer has its lower fixed point marked as $-10°C$ and upper fixed point marked as 110° and upper fixed point marked as 110°. If the temperature of the body shown in this scale is 62°, the temperature shown on the Celsius scale is
(a) 72° C (b) 82° C
(c) 60° C (d) 42° C

10. If there are no heat losses, the heat released by the condensation of x gm of steam at $100°C$ into water at $100°C$ can be used to convert y gm of ice at $0°C$ into water at $100°C$. Then the ratio $y : x$ is nearly
(a) 1 : 1 (b) 2.5 : 1
(c) 2 : 1 (d) 3 : 1

11. The figure shows a glass tube (linear co-efficient of expansion is α) completely filled with a liquid of volume expansion co-efficient γ. On heating length of the liquid column does not change. Choose the correct relation between γ and α



(a) $\gamma = \alpha$
(b) $\gamma = 2\alpha$
(c) $\gamma = 3\alpha$ **[EAMCET 2001]**
(d) $\gamma = \frac{\alpha}{3}$

12. Water falls from a height 500m. What is the rise in temperature of water at bottom if whole energy remains in the water **[AFMC 1997; DPMT 1997]**
(a) $0.96°C$ (b) $1.02°C$
(c) $1.16°C$ (d) $0.23°C$

13. A steel ball of mass 0.1 kg falls freely from a height of 10 m and bounces to a height of 5.4m from the ground. If the dissipated energy in this process is absorbed by the ball, the rise in its temperature is

(Specific heat of steel $= 460$ $Joule - kg^{-1}°C^{-1}$, $g = 10$ ms^{-2}) **[EAMCET (Med.) 2000]**
(a) $0.01°C$ (b) $0.1°C$
(c) $1°C$ (d) $1.1°C$

14. 1gm of ice at $0°C$ is mixed with 1gm of water at $100°C$ the resulting temperature will be **[AIIMS 1994]**
(a) $5°C$ (b) $0°C$
(c) $10°C$ (d) ∞

15. The amount of heat required to change 1 gm ($0°C$) of ice into water of $100°C$, is **[RPMT 1999]**
(a) 716 cal (b) 500 cal
(c) 180 cal (d) 100 cal

Answers and Solutions

(SET -12)

1. (b) When salt crystals dissolves, crystal lattice is destroyed. The process requires a certain amount of energy (latent heat) which is taken from the water.

In vessel (*B*), a part of intermolecular bonds has already been destroyed in crushing the crystal. Hence less energy is require to dissolve the powder and the water will be at higher temperature.

2. (a) Fire is extinguished by the vaporisation do water which lowers the temperature of the burning body. Further, the water vapour envelops the body, keeping oxygen away. Hot water evaporates more than cold water as

3. (c) The thermometer has to attain the temperature of the body. To do this, it should draw as little heat from the body as possible, so that the existing temperature of the body is not disturbed.

4. (b) As we know $\alpha = \frac{\Delta L}{L_0 \Delta\theta} \Rightarrow \Delta\theta = \frac{\Delta L}{\alpha L_0} = \frac{5\times10^{-5}}{10\times10^{-6}\times1} = 5°C$

5. (b) Since $102.2°F \rightarrow 39°C$ and $98.6°F \rightarrow 39°C$

Hence ΔQ = m. s. ΔQ = 80 × 1000 × (39 – 37)

= 16 × 10^4 *cal* = 160 *kcal.*

6. (b) If the sheet is heated then both d_1 and d_2 will increase since the thermal expansion of isotropic solid is similar to true photographic enlargement.

7. (a) $W = JQ \Rightarrow \frac{1}{2} I\omega^2 = J(MS\Delta\theta) \Rightarrow \frac{1}{2}\left(\frac{2}{5}MR^2\right)\omega^2$

$= J(MS\Delta\theta) \Rightarrow \Delta\theta = \frac{R^2\omega^2}{5Js}$

8. (b) $W = JQ = J(mL) \Rightarrow P \times t = J(mL) \Rightarrow P = J\left(\frac{m}{t}\right)L$;

where $\frac{m}{t}$ = rate of melting of ice by chewing

$= \frac{60\ gm}{min} = \frac{1\ gm}{sec} \Rightarrow P = 4.2 \times 1 \times 80 = 336\ W.$

9. (c) $\frac{X-L}{U-L} = \frac{C}{100} \Rightarrow \frac{62-(10)}{110-(-10)} = \frac{C}{100}$ $(C = 60°C)$

10. (d) Heat released to convert *x gm* of steam at 100°*C* to water at 100°*C* is $x \times 540$ *cals*.

If *y gm* of ice is converted from 0°*C* to water at 100°*C* it requires heat $y \times 80 + y \times 1 \times 100 = 180\ y$

$\therefore\ x \times 540 = 180\ y$ or $\frac{y}{x} = \frac{540}{180} = \frac{3}{1}$

11. (b) When length of the liquid column remains constant, then the level of liquid moves down with respect to the container, thus γ must be less than 3α.

Now we can write $V = V_0(1 + \gamma\Delta T)$

Since $V = Al_0 = [A_0(1 + 2\alpha\Delta T)]l_0 = V_0(1 + 2\alpha\Delta T)$

Hence $V_0(1 + \gamma\Delta T) = V_0(1 + 2\alpha\Delta T) \Rightarrow \gamma = 2\alpha$.

12. (c) By using

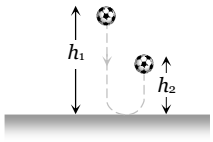
$\Delta\theta = 0.0023\ h = 0.0023 \times 500 = 1.15°C \approx 1.16°C$

13. (b) According to energy conservation, change in potential energy of the ball, appears in the form of heat which raises the temperature of the ball.

i.e. $mg(h_1 - h_2) = m.c.\Delta\theta$

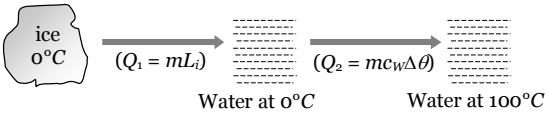
$\Rightarrow \Delta\theta = \frac{g(h_1 - h_2)}{c}$

$= \frac{10(10-5.4)}{460} = 0.1°C$



14. (c) $\theta_{mix} = \frac{\theta_w - \frac{L_i}{C_W}}{2} = \frac{100 - \frac{80}{1}}{2} = 10°C$

15. (c) Ice (0°*C*) converts into water (100°*C*) in following two steps.



Total heat required

$Q = Q_1 + Q_2 = 1 \times 80 + 1 \times 1 \times (100 - 0) = 180\ cal$

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