Exercise-1

Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

Section (A) : Calorimetry

A-1. The amount of heat required to change the state of 1 kg of substance at constant temperature is called
(1) kilocal (2) calorie (3) specific heat (4) latent heat

A-2. The water equivalent of a 400 g copper calorimeter (specific heat = 0.1 cal/g^{o}C)
(1) 40 g (2) 4000 g (3) 200 g (4) 4 g

A-3. Heat required to convert 1 g of ice at 0^{o}C into steam at 100^{o}C is
(1) 100 cal (2) 0.01 cal/^{o}C (3) 720 cal (4) 1 kilocal

A-4. The thermal capacity of 40 g of aluminium (specific heat = 0.2 cal/gm^{o}C)
(1) 40 cal/^{o}C (2) 160 cal/^{o}C (3) 200 cal/^{o}C (4) 8 cal/^{o}C

A-5. The boiling water is changing into steam. Under this condition, the specific heat of water is
(1) zero (2) one (3) infinite (4) less than one

A-6. One kg of ice at 0^{o}C is mixed with 1 kg of water at 10^{o}C. The resulting temperature will be
(1) between 0^{o}C and 10^{o}C (2) 0^{o}C
(3) less than 0^{o}C (4) greater than 0^{o}C

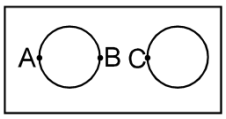
A-7. If 10g of ice at 0^{o}C is mixed with 10g of water at 40^{o}C, the final mass of water in the mixture is
(1) 10 g (2) 15 g (3) 18 g (4) 20 g

A-8. 540 g of ice at 0^{o}C is mixed with 540 g of water at 80^{o}C. The final temperature of the mixure is
(1) 0^{o}C (2) 40^{o}C (3) 80^{o}C (4) less than 0^{o}C

A-9. Steam at 100^{o}C is passed into 2.0 kg of water contained in a calorimeter of water equivalent 0.02 kg at 15^{o}C till the temperature of the calorimeter and its contents rise to 90^{o}C. The mass of steam condensed in kg is
(1) 0.301 (2) 0.280 (3) 0.60 (4) 0.02

Section (B) : Thermal Expansion

B-1. Two large holes are cut in a metal sheet. If this is heated, distances AB and BC, (as shown)



(1) both will increase (2) both will decrease
(3) AB increases, BC decreases (4) AB decreases, BC increases

B-2. Expansion during heating (generally)
(1) occurs only in a solid (2) increases the density of the material
(3) decreases the density of the material (4) occurs at the same rate for all liquids and solids.

B-3. Two bars of copper having same length but unequal diameter are heated to the same temperature. The change in length will be -
(1) More in thinner bar
(2) More in thicker bar
(3) Same for both the bars
(4) Determined by the ratio of length and diameter of the bars

B-4. A motallic bar is heated from 0^{o}C to 100^{o}C. The coefficient of linear expansion is $10^{-5}K^{-1}$. What will be the percentage increase in length
(1) 0.01% (2) 0.1% (3) 1% (4) 10%

B-5. A pendulum clock has an iron pendulum 1m long ($\alpha_{iron} = 10^{-5}/^oC$). If the temperature rises by 10ºC, the clock
(1) Will lose 8 seconds per day (2) Will lose 4.32 seconds per day
(3) Will gain 8 seconds per day (4) Will gain 4.32 seconds per day

B-6. Two rods of lengths ℓ_1 and ℓ_2 are made of materials whose coefficient of linear expansions are α_1 are α_2. If the difference between two lengths is independent of temperature -
(1) $\frac{\ell_1}{\ell_2} = \frac{\alpha_1}{\alpha_2}$ (2) $\frac{\ell_1}{\ell_2} = \frac{\alpha_2}{\alpha_1}$ (3) $\ell_2^2\alpha_1 = \ell_1^2\,\alpha_2$ (4) $\frac{\alpha_1^2}{\ell_1} = \frac{\alpha_2^2}{\ell_2}$

B-7. If α, β, γ are linear, superficial and cubical expansivity of a solid, then -
(1) α : β : γ = 1 : 2 : 3 (2) α : β : γ = 3 : 2 : 1 (3) α : β : γ = 2 : 3 : 1 (4) α : β : γ = 3 : 1 : 3

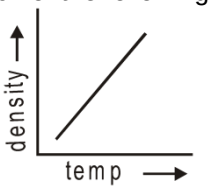
B-8. The coefficient of linear expansion of steel and brass are $11 \times 10^{-6}/^oC$ and $19 \times 10^{-6}/^oC$ respectively. If their difference in lengths at all temperatures has to be kept constant at 30cm, their lengths at 0ºC should be -
(1) 71.25 cm and 41.25 cm (2) 82 cm and 52 cm
(3) 92 cm and 62 cm (4) 62.25 cm and 32.25 cm

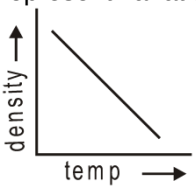
B-9. A solid ball of metal has a spherical cavity inside it . If the ball is heated, the volume of the cavity will -
(1) Increase (2) Decrease
(3) Remains unchanged (4) Have its shape changed

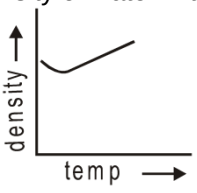
B-10. If the length of a cylinder on heating increases by 2%, the area of its base will increase by-
(1) 0.5% (2) 2% (3) 1% (4) 4%

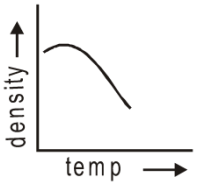
B-11. A uniform metal rod is used as a bar pendulum. If the room temperature rises by 10ºC, and the coefficient of linear expansion of the metal of the rod is 2×10^{-6}perºC, the period of the pendulum will have percentage increase of
(1) -2×10^{-3} (2) -1×10^{-3} (3) 2×10^{-3} (4) 1×10^{-3}

B-12. The volume of a solid decreases by 0.6% when it is cooled through 50ºC. Its coefficient of linear expansion is -
(1) $4 \times 10^{-6}K$ (2) $5 \times 10^{-5}K$ (3) $6 \times 10^{4}K$ (4) $4 \times 10^{-5}K$

B-13. Which of the following curve represent variation of density of water with temperature best -
(1) 

(2) 

(3) 

(4) 

B-14. A rectangular block is heated from 0ºC to 100ºC. The percentage increase in its length is 0.10% What will be the percentage increase in it volume ?
(1) 0.03 % (2) 0.10%
(3) 0.30% (4) none of these

B-15. A thin copper wire of ℓ length increases in lenth by 1% when heated from 0ºC to 100ºC. If a then cooper plate of area $2\ell \times \ell$ is heated from 0ºC to 100ºC, the percentage increase in its area will be
(1) 1% (2) 2% (3) 3% (4) 4%

Section (C) : Temperature

C-1. A difference of temperature of 25º C is equivalent to a difference of :
(1) 45º F (2) 72º F (3) 32º F (4) 25º F

C-2. What is the temperature at which we get the same reading on both the centigrade and Fahrenheit scales?
(1) – 40ºC or – 40ºF (2) – 30ºC or – 30º F (3) – 30ºC or – 40ºF (4) – 10ºC or – 10ºF

Exercise-2

Marked Questions can be used as Revision Questions.

PART - I : OBJECTIVE QUESTIONS

1. A small object is at just rest on the bottom surface of a container which is filled with liquid. Initially the object was completely submerged in the liquid and normal force by the bottom surface on the object is zero. The coefficient of volumetric expansion of the object is γ_0 and for liquid it is γ_L. When the temperature is decreased, it is found the object starts rising up. Then we can say that

(1) $\gamma_L > \gamma_0$ (2) $\gamma_0 > \gamma_L$ (3) $\gamma_L = \gamma_0$ (4) Cannot be decided

2. An ice block at 0°C is dropped from height 'h' above the ground. What should be the value of 'h' so that it just melts completely by the time it reaches the bottom assuming the loss of whole gravitational potential energy is used as heat by the ice ? [Given : L_f = 80 cal/gm]

(1) 33.6 m (2) 33.6 km (3) 8 m (4) 8 km

3. Four cubes of ice at – 10°C each one gm is taken out from the refrigerator and are put in 150 gm of water at 20°C. The temperature of water when thermal equilibrium is attained. Assume that no heat is lost to the outside and water equivalent of container is 46 gm. (Specific heat capacity of water = 1 cal/gm-°C, Specific heat capacity of ice = 0.5 cal/gm-°C, Latent heat of fusion of ice = 80 cal/gm)

(1) 0°C (2) – 10°C (3) 17.9°C (4) None

4. A current of 2.50 A passing through a heating coil immersed in 180g of paraffin (specific heat capacity 2.00 J g^{-1} K^{-1}) contained in a 100 g calorimeter (specific heat capacity 0.400J g^{-1} K^{-1}) raises the temperature from 5ºC below room temperature to 5ºC above room temperature in 100 s. The reading of the voltmeter connected across the heating coil is

(1) 8.0 V (2) 16.0 V (3) 24.0 V (4) 32.0 V

5. A uniform steel rod has length ℓ at 0ºC. Now one of its end is kept in ice (0°C) and the other end is kept in steam (100ºC). If the coefficient of thermal expansion of the rod is α, how much is the thermal expansion of the rod at steady state?

(1) 50 $\alpha\ell$ (2) 100 $\alpha\ell$ (3) 200 $\alpha\ell$ (4) 150 $\alpha\ell$

6. Water of mass m_2 = 1 kg is contained in a copper calorimeter of mass m_1 = 1 kg. Their common temperature t = 10°C. Now a piece of ice of mass m_3 = 2 kg and temperature is –11°C dropped into the calorimeter. Neglecting any heat loss, the final temperature of system is. [specific heat of copper = 0.1 Kcal/ kg°C, specific heat of water = 1 Kcal/kg°C, specific heat of ice = 0.5 Kcal/kg°C, latent heat of fusion of ice = 78.7 Kcal/kg]

(1) 0°C (2) 4°C (3) – 4°C (4) – 2°C

7. An ice block at 0°C and of mass m is dropped from height 'h' such that the loss in gravitational potential energy of block is exactly equal to the heat required to just completely melt the ice. Taking latent heat of fusion of ice = 80 cal/gm, acceleration due to gravity = 10 m/s^2 and mechanical equivalent of heat = 4.2 J/ Cal. The value of 'h' is

(1) 8 m (2) 8 km (3) 33.6 m (4) 33.6 km

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

A-1. **STATEMENT-1 :** Gas thermometers are more sensitive than liquid thermometers
STATEMENT-2 : Coefficent of thermal expansion of gases is more then liquid.
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-2. **STATEMENT-1 :** Water is considered unsuitable for use in thermometers
STATEMENT-2 : This is due to small specific heat and high thermal conductivity.
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-3. **STATEMENT-1 :** When water is heated by a burner in metallic container its level first decreases then increases.
STATEMENT-2 : Thermal conductivity of metal is very large compared to water.
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2)Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

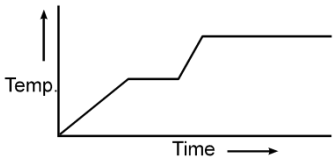
Section (B) : Match the column

B-1. In the following question column - I represents some physical quantities & column-II represents their units, match them

	Column I		**Column II**
(1)	Coefficient of linear expansion	(p)	Cal/°C
(2)	Water equivalent	(q)	gm
(3)	heat capacity	(r)	$(°C)^{-1}$
(4)	Specific heat	(s)	Cal/g°C

Section (C) : One or More Than One Options Correct

C-1. Heat is supplied to a certain homogeneous sample of matter at a uniform rate. Its temperature is plotted against time as shown in the figure. Which of the following conclusions can be drawn?



(1) its specific heat capacity is greater in the solid state than in the liquid state.
(2) its specific heat capacity is greater in the liquid state than in the solid state.
(3) its latent heat of vaporization is greater than its latent heat of fusion.
(4) its latent heat of vaporization is smaller than its latent heat of fusion.

C-2. A metal of length L whose coefficient of linear expansion $\alpha = 10^{-3}$ /°C is heated such that it's temperature changes by 1000K. Assuming its α is constant during the temperature change. [Take $e \approx 2.7$]

(1) Final length of the rod is greater than 2L
(2) Final length of the rod is greater than 2.5L
(3) Final length of the rod is greater than 3L
(4) Increase in the length due to heating is L

Exercise-3

Marked Questions can be used as Revision Questions.

*** Marked Questions may have more than one correct option.**

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. Heat given to a body which raises its temperature by 1°C is : **[AIEEE 2002, 3/300]**
(1) water equivalent (2) thermal capacity (3) specific heat (4) temperature gradient

2. If mass – energy equivalence is taken into account, when water is cooled to form ice, the mass of water should: **[AIEEE 2002, 3/300]**
(1) increase (2) remain unchanged
(3) decrease (4) first increase then decrease

3. Time taken by a 836 W heater to heat one liter of water from 10ºC to 40ºC is : **[AIEEE 2004; 4/120, –1]**
(1) 50 s (2) 100 s (3) 150 s (4) 200 s

4. The specific heat capacity of a metal at low temperature (T) is given as : **[AIEEE 2011, 11 April; 4/120, –1]**

$C_p\ (kjK^{-1}\ kg^{-1}) = 32\left(\frac{T}{400}\right)^3$

A 100 gram vessel of this metal is to be cooled from 20K to 4K by a special refrigerator operating at room temperature (27ºC). The amount of work required to cool the vessel is :
(1) greater than 0.148 kJ (2) between 0.148 kJ and 0.028 kJ
(3) less than 0.028 kJ (4) equal to 0.002 kJ

5. A metal rod of Young's modulus Y and coefficient of thermal expansion α is held at its two ends such that its length remains invariant. If its temperature is raised by tºC, the linear stress developed in its is : **[AIEEE 2011, 11 April; 4/120, –1]**

(1) $\frac{Y}{\alpha t}$ (2) Yαt (3) $\frac{1}{(Y\alpha t)}$ (4) $\frac{\alpha t}{Y}$

6. An aluminium sphere of 20 cm diameter is heated from 0ºC to 100ºC. Its volume changes by (given that coefficient of linear expansion for aluminium $\alpha_{Al} = 23 \times 10^{-6}$/ºC) **[AIEEE 2011, 11 April; 4/120, –1]**
(1) 2.89 cc (2) 9.28 cc (3) 49.8 cc (4) 28.9 cc

7. A wooden wheel of radius R is made of two semicircular parts (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than 2πR. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surroundifng temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α, and its Young's modulus is Y, the force that one part of the wheel applies on the other part is : **[AIEEE 2012 ; 4/120, –1]**

(1) 2πSYαΔT (2) SYαΔT
(3) π SYαΔT (4) 2SYαΔT

8. A pendulum clock lose 12 s a day if the temperature is 40°C and gains 4 s a day if the temperature is 20°C. The temperature at which the clock will show correct time, and the co-efficient of linear expansion (α) of the metal of the pendulum shaft are respectively : **[JEE(Main)-2016; 4/120, –1]**
(1) 60°C ; $\alpha = 1.85 \times 10^{-4}$/°C (2) 30°C ; $\alpha = 1.85 \times 10^{-3}$/°C
(3) 55°C ; $\alpha = 1.85 \times 10^{-2}$/°C (4) 25°C ; $\alpha = 1.85 \times 10^{-5}$/°C

9. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is

found to be 75º C. T is given by : (Given : room temperature = 30ºC, specific heat of copper = 0.1 cal/gmºC) **[JEE(Main)-2017; 4/120,–1]**

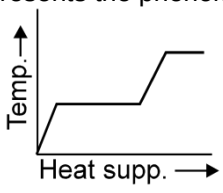
(1) 825º C (2) 800ºC (3) 885ºC (4) 1250ºC

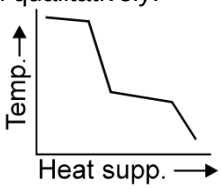
10. An external pressure P is applied on a cube at 0°C so that it is equally compressed from all sides. K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by : **[JEE(Main)-2017; 4/120,–1]**

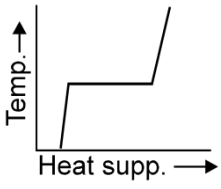
(1) $3PK\alpha$ (2) $\frac{P}{3\alpha K}$ (3) $\frac{P}{\alpha K}$ (4) $\frac{3\alpha}{PK}$

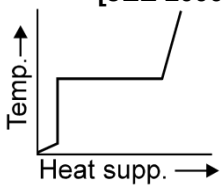
PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. A block of ice at –10ºC is slowly heated and converted to steam at 100ºC. Which of the following curves represents the phenomenon qualitatively: **[JEE 2000, 1/35]**

(A) 

(B) 

(C) 

(D) 

2. Two rods , one of aluminium of length ℓ_1 having coefficient of linear expansion α_a and other of steel is having coefficient of linear expansion α_s and length ℓ_2 are joined end to end . The expansion in both the rods is same for same variation of temperature . Then the value of $\frac{\ell_1}{\ell_1+\ell_2}$ is **[JEE Scr.'2003, 3/84,–1]**

(A) $\frac{\alpha_s}{\alpha_a}$ (B) $\frac{\alpha_a}{\alpha_s}$ (C) $\frac{\alpha_s}{\alpha_a+\alpha_s}$ (D) $\frac{\alpha_a}{\alpha_a+\alpha_s}$

3. 2 litre water at 27°C is heated by a 1 kW heater in an open container. On an average heat is lost to surroundings at the rate 160 J/s. The time required for the temperature to reach 77°C is **[JEE Scr. 2005, 3/84, –1]**

(A) 8 min 20 sec (B) 10 min (C) 7 min (D) 14 min

4. The ends Q and R of two thin wires, PQ and RS, are soldered (joined) together. Initially each of the wires has a length of 1m at 10 °C. Now the end P is maintained at 10 °C, while the end S is heated and maintained at 400 °C. The system is thermally insulated from its surroundings. If the thermal conductivity of wire PQ is twice that of the wire RS and the coefficient of linear thermal expansion of PQ is 1.2×10^{-5} K^{-1}, the change in length of the wire PQ is. **[JEE Advanced 2016; P-2, 3/62, –1]**

(A) 0.78 mm (B) 0.90 mm (C) 1.56 mm (D) 2.34 mm

Answers

EXERCISE # 1

Section (A)

A-1.	(4)	**A-2.**	(1)	**A-3.**	(3)
A-4.	(4)	**A-5.**	(3)	**A-6.**	(2)
A-7.	(2)	**A-8.**	(1)	**A-9.**	(2)

Section (B)

B-1.	(1)	**B-2.**	(3)	**B-3.**	(3)
B-4.	(2)	**B-5.**	(2)	**B-6.**	(2)
B-7.	(1)	**B-8.**	(1)	**B-9.**	(1)
B-10.	(4)	**B-11.**	(4)	**B-12.**	(4)
B-13.	(4)	**B-14.**	(3)		
B-15.	(2)				

Section (C)

C-1.	(1)	**C-2.**	(1)

EXERCISE #2

PART - I

1.	(1)	**2.**	(2)	**3.**	(3)
4.	(2)	**5.**	(1)	**6.**	(1)
7.	(4)				

PART - II

Section (A)

A-1.	(1)	**A-2.**	(3)	**A-3.**	(2)

Section (B)

B-1. (1) – (r) ; (2) – (q) ; (3) – (p) ; (4) – (s)

Section (C)

C-1.	(1,3)	**C-2.**	(1,2)

EXERCISE # 3

PART - I

1.	(2)	**2.**	(1)	**3.**	(3)
4.	(2)	**5.**	(2)	**6.**	(4)
7.	(4)	**8.**	(4)	**9.**	(3)
10.	(2)				

PART - II

1.	(A)	**2.**	(C)	**3.**	(A)
4.	(A)				