Properties of Solids and Liquids JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Properties of Solids and Liquids

1. When M_1 gram of ice at $-10^{\circ}C$ (specific heat = $0.5\ cal\ g^{-1^{\circ}}C^{-1}$) is added to M_2 gram of water at $50^{\circ}C$, finally no ice is left and the water is at $0^{\circ}C$. The value of latent heat of ice, in cal g^{-1} is: **(+4, -1)**

[12 April 2019 I]

a. $\frac{5M_1}{M_2} - 50$

b. $\frac{50M_2}{M_1}$

c. $\frac{50M_2}{M_1} - 5$

d. $\frac{5M_2}{M_1} - 5$

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2. Two materials having coefficients of thermal conductivity '3K' and 'K' and thickness 'd' and '3d', respectively, are joined to form a slab as shown in the figure. The temperatures of the outer surfaces are $'\theta_2'$ and $'\theta_1'$ respectively, $(\theta_2 > \theta_1)$. The temperature at the interface is :- **(+4, -1)**

[9 April 2019 II]

a. $\frac{\theta_2+\theta_1}{2}$

b. $\frac{\theta_1}{10} + \frac{9\theta_2}{10}$

c. $\frac{\theta_1}{3} + \frac{2\theta_2}{3}$

d. $\frac{\theta_1}{6} + \frac{5\theta_2}{6}$

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3. When $100\,g$ of a liquid A at $100^{\circ}C$ is added to $50\,g$ of a liquid B at temperature $75^{\circ}C$, the temperature of the mixture becomes $90^{\circ}C$. The temperature of the mixture, if $100\,g$ of liquid A at $100^{\circ}C$ is added to $50\,g$ of liquid B at $50^{\circ}C$, will be : **(+4, -1)**

[11 Jan. 2019 II]

a. $80^{\circ}C$

b. $60^{\circ}C$

c. $70^{\circ}C$

d. $85^{\circ}C$

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4. $500\,g$ of water and $100\,g$ of ice at $0°C$ are in a calorimeter whose water equivalent is $40\,g$. $10\,g$ of steam at $100°C$ is added to it. Then water in the calorimeter is : (Latent heat of ice $= 80\,cal/g$, Latent heat of steam $= 540\,cal/g$) **(+4, -1)**

[**Online April 23, 2013**]

a. $580\,g$

b. $590\,g$

c. $600\,g$

d. $610\,g$

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5. A body takes 10 minutes to cool from $60°C$ to $50°C$. The temperature of surroundings is constant at $25°C$. Then, the temperature of the body after next 10 minutes will be approximately : **(+4, -1)**

[**Online April 15, 2018**]

a. $47°C$

b. $41°C$

c. $45°C$

d. $43°C$

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6. 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 $75°C$. T is given by : (Given : room temperature = $30°C$, specific heat of copper = $0.1\,cal\,g^{-1}\,^{\circ} C^{-1}$) **(+4, -1)**

[**2017**]

a. $800°C$

b. $885°C$

c. $1250°C$

d. $825°C$

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7. An external pressure P is applied on a cube at $0^{\circ}C$ 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 it. The temperature should be raised by : **(+4, -1)**

[2017]

a. $\frac{P}{3\alpha K}$

b. $\frac{P}{\alpha K}$

c. $\frac{3\alpha}{PK}$

d. $3PK\alpha$

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8. A mass of $50\,g$ of water in a closed vessel, with surroundings at a constant temperature takes 2 minutes to cool from $30^{\circ}C$ to $25^{\circ}C$. A mass of $100\,g$ of another liquid in an identical vessel with identical surroundings takes the same time to cool from $30^{\circ}C$ to $25^{\circ}C$. The specific heat of the liquid is: (The water equivalent of the vessel is $30\,g$.) **(+4, -1)**

[Online April 25, 2013]

a. 2.0 kcal/kg

b. 7 kcal/kg

c. 3 kcal/kg

d. 0.5 kcal/kg

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9. A faulty thermometer reads $5^{\circ}C$ in melting ice and $95^{\circ}C$ in stream.The correct temperature on absolute scale will be_____ K (when the faulty thermometer reads $41^{\circ}C$). **(+4, -1)**

[30-Jan-2023 Shift2]

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10. The surface of water in a water tank of cross section area $750\,cm^2$ on the top of a house is hm above the tap level The speed of water coming out through the tap of cross section area $500mm^2$ is $30\,cm/s$ At that instant, $\frac{dh}{dt}$ is $x \times 10^{-3}\,m/s$ The value of x will be ____ **(+4, -1)**

[1-Feb-2023 Shift 2]

Answers

1. **Answer: c**

Explanation:

$$Heat\,lost = Heat\,gain$$
$$\Rightarrow\ M_2 \times 1 \times 50 = M_1 \times 0.5 \times 10 + M_1.L_f$$
$$\Rightarrow\ L_f = \frac{50M_2 - 5M_1}{M_1}$$
$$= \frac{50M_2}{M_1} - 5$$

Concepts:

1. Thermal Properties of Matter:

Anything that has mass or occupies space in the universe is commonly known as matter. There are five properties of matters namely chemical, mechanical, thermal, dimensional, and physical properties.

Read More: Thermal Properties of Matter

Heat Capacity:

The quantity of heat needed to change the temperature of the matter by 1° is known as the heat capacity of a material. The temperature is indicated in kelvin or Celsius and the amount of heat is shown in calories or joules. Specific heat capacity or molar heat capacity is used to calculate the heat capacity of the matter with the stated dimension.

Linear expansion is the situation when change takes place in one dimension or dimensional.

Thermal Expansion:

When heat is passed through the material, the change in the area, volume, and shape is recognized as the thermal expansion property of the material. The expansion of the railway tracks due to maximal heat which leads to accidents is an example of thermal expansion.

Thermal Conductivity:

This property is interconnected to the conductivity of heat. The amount of heat regulated by the material is directly proportional to the conductivity of the material. Not all objects have the capacity to conduct heat throughout their bodies. Insulators are such objects which do not have the property to conduct heat throughout their body.

Thermal Stress:

The stress due to thermal contraction or expansion of the body is known as thermal stress. The explosion of materials takes place due to thermal stress which is dangerous. The cracks on the truck tyres are caused by an outcome of thermal stress. Trucks at high speed generate heat which is caused by the friction of the truck tyres and the road surface.

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2. Answer: b

Explanation:

Let the temperature of interface be " θ "

$i_1 = i_2$ {Steady state conduction}

$\frac{3KA(\theta_2-\theta)}{d} = \frac{KA(\theta-\theta_1)}{3d}$

$\theta = \frac{9\theta_2}{10} + \frac{\theta_1}{10}$

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3. Answer: a

Explanation:

$100 \times S_A \times [100 - 90] = 50 \times S_B \times (90 - 75)$
$2S_A = 1.5S_B$
$S_A = \frac{3}{4}S_B$
Now , $100 \times S_A \times [100 - T] = 50 \times S_B\,(T - 50)$
$2 \times \left(\frac{3}{4}\right)(100 - T) = (T - 50)$
$300 - 3T = 2T - 100$

$400 = 5T$

$T = 80$

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4. **Answer: b**

Explanation:

The correct answer is (B) : 590 g
As $1\,g$ of steam at $100^{\circ}C$ melts $8g$ of ice at $0^{\circ}C$.
$10\,g$ of steam will melt $8 \times 10\,g$ of ice at $0^{?}C$
Water in calorimeter $= 500 + 80 + 10g = 590g$

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5. Answer: d

Explanation:

Time taken to cool from $60^{\circ}C$ to $50^{\circ}C = 10$ minutes
Temperature of surroundings $= 25^{\circ}C$ Temperature of body in next 10 minutes $= T$
Therefore, $\frac{60-50}{10\,\text{min}} = k_B\left[\frac{60+50}{2} - 25\right] \Rightarrow k_B 30 = 1 \quad (1)$
and $\frac{60-T}{20\,\text{min}} = k_B\left[\frac{60+T}{2} - 25\right] = k_B\left[\frac{60+T-50}{2}\right] \quad (2)$
Taking ratio of Eqs. (1) and (2), we get

$\frac{20}{60-T} = \frac{30k_B}{k_B\left(\frac{10+T}{2}\right)}$

$\Rightarrow \frac{20}{60-T} = \frac{30}{5+T/2}$

$\Rightarrow 20\left(5+\frac{T}{2}\right) = 30(60-T)$

$\Rightarrow 100 + T\,10 = 1800 - 30\,T$

$\Rightarrow 1800 - 100 = 30\,T + 10\,T$

$\Rightarrow 1700 = 40\,T$

$\Rightarrow T = \frac{1700}{40} = 42.5^{\circ}C - 43^{\circ}C$

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6. **Answer: b**

Explanation:

$$100 \times 0.1 \times (t - 75) = 100 \times 0.1 \times 45 + 170 \times 1 \times 45$$
$$10t - 750 = 450 + 7650$$
$$10t = 1200 + 7650$$
$$10t = 8850$$
$$t = 885^{\circ}C$$

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7. Answer: a

Explanation:

$K = \frac{\Delta P}{\left(-\frac{\Delta V}{V}\right)}$
$\frac{\Delta V}{V} = \frac{P}{K}$
$\therefore V = V_0\left(1 + \gamma \Delta t\right)$
$\frac{\Delta V}{V_0} = \gamma \Delta t$
$\therefore \frac{P}{K} = \gamma \Delta t$
$\Rightarrow \Delta t = \frac{P}{\gamma K} = \frac{P}{3\alpha K}$

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8. **Answer: d**

Explanation:

As the surrounding is identical, vessel is identical time taken to cool both water and liquid (from $30?C$ to $25?C$ is same 2 minutes, therefore

$\left(\frac{dQ}{dt}\right)_{water} = \left(\frac{dQ}{dt}\right)_{liquid}$

$or,\ \frac{(m_w C_w + W)\Delta T}{t} = \frac{(m_\ell C_\ell + W)\Delta T}{t}$

(W = water equivalent of the vessel)

$or,\ m_w C_w = m_\ell C_\ell$

$\therefore$ Specific heat of liquid, $C_\ell = \frac{m_w C_w}{m_\ell}$

$= \frac{50 \times 1}{100} = 0.5\, kcal\, kg$

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9. **Answer: 313 - 313**

Explanation:

The correct answer is 313.

$\frac{41^\circ-5^\circ}{95^\circ-5^\circ} = \frac{C-0^\circ}{100^\circ-0^\circ}$

$\Rightarrow C = \frac{36}{90} \times 100 = 40^\circ C = 313\,K$

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10. Answer: 2 - 2

Explanation:

The correct answer is 2.

$A_1V_1 = A_2V_2$

$750 \times 10^{-4}V_1 = 500 \times 10^{-6} \times 0.3$

$V_1 = \frac{500 \times 3 \times 10^{-3}}{750} m/s$

$= 2 \times 10^{-3} m/s$

$\frac{dh}{dt} = -2 \times 10^{-3} m/s$

Concepts:

1. Mechanical Properties of Fluid:

The science of the mechanical properties of fluids is called Hydrostatics. A fluid is a substance that relents to the slightest pressure. Fluids are categorized into two classes famed by the names of liquids, and elastic fluids or gases, which later comprehend the air of the atmosphere and all the different kinds of air with which chemistry makes us acquainted.

Streamline Flow:

A streamline is a curve the tangent to which at any point provides the direction of the fluid velocity at that point. It is comparable to a line of force in an electric or magnetic field. In steady flow, the pattern of the streamline is motionless or static with time, and therefore, a streamline provides the actual path of a fluid particle.

Tube of Flow:

A tubular region of fluid enclosed by a boundary comprises streamlines is called a tube of flow. Fluid can never cross the boundaries of a tube of flow and therefore, a tube of flow acts as a pipe of the same shape.

Surface Tension and Viscosity:

The surface tension of a liquid is all the time a function of the solid or fluid with which the liquid is in contact. If a value for surface tension is provided in a table for oil, water, mercury, or whatever, and the contacting fluid is unspecified, it is safe to consider that the contacting fluid is air.