Properties of Solids and Liquids JEE Main PYQ - 3

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

Instructions

Instructions

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. In an experiment a sphere of aluminium of mass 0.20 kg is heated upto $150^{\circ}C$. Immediately, it is put into water of volume 150 cc at $27^{\circ}C$ kept in a calorimeter of water equivalent to 0.025 kg. Final temperature of the system is $40^{\circ}C$. The specific heat of aluminium is : (take 4.2 Joule=1 calorie) **(+4, -1)**

[Online April 8, 2017]

a. $378\,J/kg-^{\circ}C$

b. $315\,J/kg-^{\circ}C$

c. $476\,J/kg-^{\circ}C$

d. $434\,J/kg-^{\circ}C$

---

2. On a linear temperature scale Y, water freezes at $-160^{\circ}\ Y$ and boils at $-50^{\circ}\,Y$. On this Y scale, a temperature of $340\,K$ would be read as : (water freezes at $273\,K$ and boils at $373\,K$) **(+4, -1)**

[Online April 9, 2013]

a. $-73.7^{\circ}\,Y$

b. $-233.7^{\circ}\,Y$

c. $-86.3^{\circ}\,Y$

d. $-106.3^{\circ}\,Y$

---

3. Steam at 100 is passed into 1.1 of water contained in calorimeter of water equivalent 0.02 at 15 till the temperature of the calorimeter rises to 80^{0} . What is the mass of steam condensed? **(+4, -1)**

a. (A) 0.130

b. (B) 0.065

c. (C) 0.260

d. (D) 0.135

---

4. The height of liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is, $5cm$ If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of liquid column raised in liquid B would be $\_\_\_\_\_m$ **(+4, -1)**

[30-Jan-2023 Shift 1]

a. 0.20

b. 0.5

c. 0.10

d. 0.05

---

5. The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation $PT^2 =$ constant The volume expansion coefficient of the gas will be : **(+4, -1)**

a. $3T^2$

b. $\frac{3}{T^2}$

c. $\frac{3}{T^3}$

d. $\frac{3}{T}$

---

6. A $100\,m$ long wire having cross-sectional area $625 \times 10^{-4}\,m^2$ and Young's modulus is $10^{10} Nm^{-2}$ is subjected to a load of $250\,N$, then the elongation in the wire will be: **(+4, -1)**

[24-Jan-2023 Shift 1]

a. $6.25 \times 10^{-3} m$

b. $4 \times 10^{-3} m$

c. $4 \times 10^{-4} m$

d. $6.25 \times 10^{-6} m$

---

7. The temperature of the body drops from 60°C to 40°C in 7 min. The surrounding temperature is 10°C. The temperature of the body drops from 40°C to T°C in 7 min. Find the value of T **(+4, -1)**

[24-Jan-2023 Shift 2]

a. 16°C

b. 20°C

c. 28°C

d. 36°C

---

8. If an object cools down from 80°C to 60°C in 5 min in a surrounding of temperature 20°C. The time taken to cool from 60°C to 40°C will be (Assume Newton's law of cooling to be valid) **(+4, -1)**

[30-Jan-2023 Shift 1]

a. $\frac{25}{3}$ min

b. 5 min

c. $\frac{25}{4}$ min

d. 5 min

---

9. A wire of length 2 m, radius of cross-section 20 mm and Young's Modulus 2×10^{11} N/m is subjected to a force of 62.8 kN.The change in length of the wire is $p\times10^{-5}$ (in m). Find P. **(+4, -1)**

---

10. A wire of length L and radius r is clamped rigidly at one end When the other end of the wire is pulled by a force F, its length increases by $5\,cm$ Another wire of the same material of length $4L$ and radius $4r$ is pulled by a force $4F$ under same conditions The increase in length of this wire is _____cm **(+4, -1)**

Answers

1. **Answer: d**

Explanation:

Q given = Q used

$\Rightarrow m_1 C_1 \Delta T_1 = (m_2 + w)\, C_2 \Delta T_2$

$\Rightarrow 0.20 \times C_1 \times (150 - 40) = \left(150 \times 10^{-3}\right)$

$C_1 = 434\ ykg^{-1}k^{-1}$

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.

---

2. Answer: c

Explanation:

The correct answer is (C) : -86.3°

$\frac{Reading\ on\ any\ scale - LFP}{UFP - LFP}$

= constant for all scales $\frac{340-273}{373-273} = \frac{^{\circ}y-(-160)}{-50-(-160)}$

$\Rightarrow \frac{67}{100} = \frac{y+160}{110}$

$\therefore \quad y = -86.3^{\circ}y$

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.

---

3. Answer: a

Explanation:

Explanation:
The amount of heat lost by the steam to condense into the water at 100° and in raising the temperature of water and calorimeter to 80° is $_1$ = + Δ wherem:
Mass of steam = 540 / Latent heat of vaporization of steam
Δ = 100 − 80 = 20 Decrease in temperature = 1 cal / Specific heat of waterNow, the amount of heat gained by water to increase its temperature from

15 to 80 is $_2 = 1.1 \times \times (80 - 15)$ $_2 = 1.1 \times 10^3 \times 1$ / $\times 65$ $_2 = 71500$ Again, the amount of heat gained by the calorimeter to increase its temperature from 15 to 80 is $_3 = 0.02 \times \times (80 - 15)$ $_3 = 0.02 \times 10^3 \times 1$ / $\times 65$ $_3 = 1300$ From the principle of calorimetry, we have $_1 = _2 + _3$ $+ (\times 20) = 71500$ $+ 1300$ 540 / $\times$ $+ (\times 1$ / $\times 20) = 72800$ 560 cal / $\times$ $= 72800$ $= \frac{72800}{560}$ $= 130$ $= 0.130$ Therefore, the mass of steam condensed is 0.130 .Hence, the correct option is (A).

---

4. Answer: d

Explanation:

$h = \frac{2S\cos\theta}{r\rho g}$
$\therefore \frac{h_1}{h_2} = \frac{S_1}{S_2}\frac{\rho_2}{\rho_1}$
$\frac{5}{h_2} = \left[\frac{1}{2}\right]\left[\frac{2}{1}\right] \Rightarrow h_2 = 5cm = 0.05m$
{Info about angle of contact not there so most appropriate is 3 }

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.

---

5. Answer: a

Explanation:

$PT^2 =$ constant, Using

$PV = nRT$

$P = \frac{nRT}{V}$

$PT^2 = \frac{nRT}{V} \times T^2 =$ constant

$\Rightarrow T^3 = KV$

So, $\frac{d}{dT}(KV) = 3T^2$

$\Rightarrow \frac{KdV}{dT} = 3T^2$

$\Rightarrow dV = \frac{3T^2}{K}dT$

$dV = V\gamma dT$

$\Rightarrow \gamma = \frac{3T^2}{KV^2} = \frac{3T^2}{T^3} = \frac{3}{T}$

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.

---

6. Answer: b

Explanation:

The correct answer is B:
Elongation in wire δ=Fl /AY
δ= $\frac{250\times100}{6.25\times10^{-4}\times10^{10}}$ \

δ=$4 \times 10^{-3}m$

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.

---

7. Answer: c

Explanation:

The correct option is (C) 28°C

$\frac{(60-40)}{7} = K(50-10)$

$\Rightarrow \frac{(40-T)}{7} = K([\frac{40+T}{2}]-10)$

$\Rightarrow \frac{20}{(40-T)} = \frac{(40\times 2)}{(T+20)}$

$\Rightarrow T+20 = 160-4T$

$\Rightarrow 5T = 140$

$T = \frac{140}{5}$

T = 28°C

Concepts:

1. Radiation:

Radiation is the energy or particles from a source that travels from one media to other. It travels through a medium after its emission from a source and is absorbed

by matter.

Forms of Radiation:

1. **Particle Radiation** includes the alpha (α), beta (β), and neutron radiations.
2. **Gravitational Radiation** includes the radiation that takes the form of gravitational waves or as ripples in the curvature of space-time.
3. **Acoustic Radiation** includes ultrasound, seismic and sound waves.
4. **Electromagnetic Radiation** is inclusive of radio waves, gamma radiation (γ), x-rays, and visible light.

Types of Radiation:

- **Ionizing Radiation -** It carries more than 10 eV, that is enough to ionize atoms and molecules and break chemical bonds.
- **Non-ionizing Radiation –** It consists of alpha particles, beta particles, and gamma particles, whereas ionizing radiation consists of microwave radiation, infrared radiation and radio waves.

Read More: Types of Radiation

---

8. **Answer: a**

Explanation:

The correct option is (A): $\frac{25}{3}$ min

$$\frac{20}{5} = K(70-20) \quad \ldots(1)$$

$$\text{also } \frac{20}{t} = K(50-20) \quad \ldots(2)$$

from (1) and (2)

$$t = \frac{25}{3} \text{ minutes}$$

Concepts:

1. Radiation:

Radiation is the energy or particles from a source that travels from one media to other. It travels through a medium after its emission from a source and is absorbed by matter.

Forms of Radiation:

1. **Particle Radiation** includes the alpha (α), beta (β), and neutron radiations.
2. **Gravitational Radiation** includes the radiation that takes the form of gravitational waves or as ripples in the curvature of space-time.
3. **Acoustic Radiation** includes ultrasound, seismic and sound waves.

4. **Electromagnetic Radiation** is inclusive of radio waves, gamma radiation (γ), x-rays, and visible light.

Types of Radiation:

- **Ionizing Radiation -** It carries more than 10 eV, that is enough to ionize atoms and molecules and break chemical bonds.
- **Non-ionizing Radiation –** It consists of alpha particles, beta particles, and gamma particles, whereas ionizing radiation consists of microwave radiation, infrared radiation and radio waves.

Read More: Types of Radiation

---

9. **Answer: 50 - 50**

Explanation:

The correct answer is **50**.

$\Delta L = \frac{FL}{AY} = \frac{62.8 \times 1000 \times 2}{3.14 \times 20 \times 20 \times 10^{-6} \times 2 \times 10^{11}} = 50 \times 10^{-5} m$

Hence, the value of P= 50

Concepts:

1. Mechanical Properties of Solids:

Mechanical properties of solids intricate the characteristics such as the resistance to deformation and their strength. Strength is the ability of an object to resist the applied stress, to what extent can it bear the stress.

Therefore, some of the mechanical properties of solids involve:

- **Elasticity:** When an object is stretched, it changes its shape and when we leave, it retrieves its shape. Or we can say it is the property of retrieving the original shape once the external force is removed. For example Spring
- **Plasticity:** When an object changes its shape and never attains its original shape even when an external force is removed. It is the permanent deformation property. For example Plastic materials.
- **Ductility:** When an object is been pulled in thin sheets, wires or plates, it will be assumed that it has ductile properties. It is the property of drawing into thin

wires/sheets/plates. For example Gold or Silver

- **Strength:** The ability to hold out applied stress without failure. Many types of objects have higher strength than others.

---

10. Answer: 5 - 5

Explanation:

The correct answer is 5

$\Delta l_1 = \frac{Fl}{AY} = \frac{Fl}{\pi r^2 Y}$ = 5cm

$\Delta l_2 = \frac{4F4l}{\pi 16 r^2 Y} = \frac{Fl}{\pi r^2 Y}$ = 5cm

Concepts:

1. Mechanical Properties of Solids:

Mechanical properties of solids intricate the characteristics such as the resistance to deformation and their strength. Strength is the ability of an object to resist the applied stress, to what extent can it bear the stress.

Therefore, some of the mechanical properties of solids involve:

- **Elasticity:** When an object is stretched, it changes its shape and when we leave, it retrieves its shape. Or we can say it is the property of retrieving the original shape once the external force is removed. For example Spring
- **Plasticity:** When an object changes its shape and never attains its original shape even when an external force is removed. It is the permanent deformation property. For example Plastic materials.
- **Ductility:** When an object is been pulled in thin sheets, wires or plates, it will be assumed that it has ductile properties. It is the property of drawing into thin wires/sheets/plates. For example Gold or Silver
- **Strength:** The ability to hold out applied stress without failure. Many types of objects have higher strength than others.