

**POSTAL**  
**Book Package**

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**GATE • PSUs**

**PRODUCTION AND  
INDUSTRIAL ENGINEERING**

**Objective Practice Sets**

**General Engineering : Volume V**

**Basic Thermodynamics**



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Publications

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## Basic Thermodynamics

- Q.1** The correct sequence of the decreasing order of the value of characteristic gas constants of the given gases is
- hydrogen, nitrogen, air, carbon dioxide
  - carbon dioxide, hydrogen, nitrogen, air
  - air, nitrogen, carbon dioxide, hydrogen
  - nitrogen, air, hydrogen, carbon dioxide
- Q.2** Zeroth Law of thermodynamics states that
- two thermodynamic systems are always in thermal equilibrium with each other
  - if two systems are in thermal equilibrium, then the third system will also be in thermal equilibrium
  - two systems not in thermal equilibrium with a third system will also not be in thermal equilibrium with each other
  - when two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other
- Q.3** In new temperature scale say  $^{\circ}\rho$ , the boiling and freezing points of water at one atmosphere are  $100^{\circ}\rho$  and  $300^{\circ}\rho$  respectively. Correlate this scale with the Centigrade scale. The reading of  $0^{\circ}\rho$  on the Centigrade scale is
- $0^{\circ}\text{C}$
  - $50^{\circ}\text{C}$
  - $100^{\circ}\text{C}$
  - $150^{\circ}\text{C}$
- Q.4** Which one of the following is the characteristic equation of a real gas?
- $(p + a/v^2)(v - b) = RT$
  - $(p - a/v^2)(v + b) = RT$
  - $p v = RT$
  - $p v = nRT$
- Q.5** An ideal gas at  $27^{\circ}\text{C}$  is heated at constant pressure till its volume becomes three times. What would be then the temperature of gas?
- $81^{\circ}\text{C}$
  - $627^{\circ}\text{C}$
  - $543^{\circ}\text{C}$
  - $327^{\circ}\text{C}$
- Q.6** A closed system is one in which
- Mass does not cross boundaries of the system, though energy may do so.
  - Mass crosses the boundary but not the energy.
  - Neither mass nor energy cross the boundary of the system.
  - Both energy and mass cross the boundaries of the system.
- Q.7** Match **List-I** with **List-II** and select the correct answer using the code given below the lists:
- List-I**
- Interchange of matter is not possible in a system
  - Any processes in which the system returns to its original condition or state is called
  - Interchange of matter is possible in a
  - The quantity of matter under consideration in thermodynamic is called
- List-II**
- Open
  - System
  - Closed system
  - Cycle
- Codes:**
- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 4 | 3 |
| (b) | 3 | 1 | 4 | 2 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 3 | 4 | 1 | 2 |
- Q.8** A thermodynamic system is considered to be an isolated one if
- Mass transfer and entropy change are zero
  - Entropy change and energy transfer are zero
  - Energy transfer and mass transfer are zero
  - Mass transfer and volume change are zero
- Q.9** The constant volume gas thermometer works on the principle that

**Answers Basic Thermodynamics**

- |              |                |                |               |               |               |               |
|--------------|----------------|----------------|---------------|---------------|---------------|---------------|
| 1. (a)       | 2. (d)         | 3. (d)         | 4. (a)        | 5. (b)        | 6. (a)        | 7. (d)        |
| 8. (c)       | 9. (c)         | 10. (a)        | 11. (c)       | 12. (d)       | 13. (c)       | 14. (c)       |
| 15. (b)      | 16. (b)        | 17. (c)        | 18. (c)       | 19. (d)       | 20. (a)       | 21. (c)       |
| 22. (b)      | 23. (d)        | 24. (a)        | 25. (c)       | 26. (a)       | 27. (b)       | 28. (d)       |
| 29. (b)      | 30. (b)        | 31. (b)        | 32. (d)       | 33. (d)       | 34. (d)       | 35. (a)       |
| 36. (b)      | 37. (d)        | 38. (a)        | 39. (b)       | 40. (c)       | 41. (d)       | 42. (b)       |
| 43. (d)      | 44. (d)        | 45. (c)        | 46. (a)       | 17. (a)       | 48. (c)       | 49. (c)       |
| 50. (b)      | 51. (a)        | 52. (c)        | 53. (c)       | 54. (d)       | 55. (c)       | 56. (c)       |
| 57. (b)      | 58. (c)        | 59. (b)        | 60. (b)       | 61. (d)       | 62. (b)       | 63. (b)       |
| 64. (a)      | 65. (d)        | 66. (c)        | 67. (b)       | 68. (a)       | 69. (a)       | 70. (b)       |
| 71. (a)      | 72. (d)        | 73. (d)        | 74. (c)       | 75. (c)       | 76. (b)       | 77. (c)       |
| 78. (a)      | 79. (d)        | 80. (b)        | 81. (d)       | 82. (c)       | 83. (a)       | 84. (a)       |
| 85. (b)      | 86. (b)        | 87. (a)        | 88. (d)       | 89. (b)       | 90. (c)       | 91. (a)       |
| 92. (c)      | 93. (a)        | 94. (60)       | 95. (1320.6)  | 96. (c)       | 97. (c)       | 98. (d)       |
| 99. (a)      | 100. (a)       | 101. (5.7958)  | 102. (2568.4) | 103. (d)      | 104. (220.93) | 105. (a)      |
| 106. (c)     | 107. (a, b, c) | 108. (a)       | 109. (d)      | 110. (334.36) | 111. (c)      | 112. (b)      |
| 113. (a)     | 114. (6°C)     | 115. (b)       | 116. (c)      | 117. (d)      | 118. (a)      | 119. (c)      |
| 120. (a)     | 121. (4.56)    | 122. (1285.39) | 123. (2717)   | 124. (-55.45) | 125. (b)      | 126. (b)      |
| 127. (d)     | 128. (a)       | 129. (d)       | 130. (60%)    | 131. (a)      | 132. (c)      | 133. (d)      |
| 134. (a)     | 135. (b)       | 136. (d)       | 137. (c)      | 138. (a)      | 139. (a)      | 140. (1.5)    |
| 141. (d)     | 142. (a)       | 143. (c)       | 144. (a)      | 145. (d)      | 146. (c)      | 147. (525)    |
| 148. (b)     | 149. (b)       | 150. (73.83%)  | 151. (b)      | 152. (19.534) | 153. (0)      | 154. (203.96) |
| 155. (a)     | 156. (b)       | 157. (a)       | 158. (b)      | 159. (a)      | 160. (0)      | 161. (50)     |
| 162. (2)     | 163. (380)     | 164. (c)       | 165. (b)      | 166. (b)      | 167. (a)      | 168. (2.39)   |
| 169. (0.285) | 170. (0.030)   | 171. (15)      | 172. (c)      | 173. (d)      |               |               |

**Explanations Basic Thermodynamics****1. (a)**

Characteristic gas constant,

$$R = \frac{\text{Universal gas constant}}{\text{Molecular weight}}$$

$$\text{Hence, } R \propto \frac{1}{\text{Molecular weight}}$$

Molecular weight of gases are

Hydrogen	: 2
Nitrogen	: 28
Air	: 29

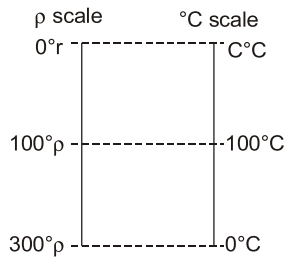
Carbon dioxide:44

$$\text{Hence } R_{H_2} > R_{N_2} > R_{Air} > R_{CO_2}$$

**2. (d)**

Zeroth law of thermodynamics states that when a body *A* is in thermal equilibrium with a body *B*, and also separately with a body *C*, then *B* and *C* will be in thermal equilibrium with each other. This is the basis of temperature measurement.

**3. (d)**



$$\frac{300 - 0}{300 - 100} = \frac{0 - C}{0 - 100}$$

$$\frac{3}{2} = \frac{C}{100}$$

$$C = 150^\circ\text{C}$$

**Alternate:**

Assume  $p = a + bC$

$$300 = a + b \times 0$$

$$a = 300$$

$$100 = a + b \times 100$$

$$\frac{100 - 300}{100} = b$$

$$b = -2$$

$$p = 300 - 2C$$

So, If  $p = 0$

$$300 - 2C = 0$$

$$C = 150^\circ\text{C}$$

**5. (b)**

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{V_1}{(273 + 27)} = \frac{3V_1}{T_2}$$

or  $T_2 = 300 \times 3 = 900 \text{ K} = 627^\circ\text{C}$

**6. (a)**

In a closed system, mass does not cross the boundary but the energy may cross the boundary. For example: Piston cylinder without valves.

**7. (d)**

Open system – Exchange of heat and mass with surroundings. Example: Compressor  
 Closed system – Exchange of heat and with surrounding. Example: Green House  
 Isolated system – Neither exchanger of heat nor exchange of mass with surroundings.  
 Example: Universe

**Interaction of thermodynamic system**

Type of system	Mass flow	Work	Heat
Open	Yes	Yes	Yes
Closed	No	Yes	Yes
Isolated	No	No	No

**Cyclic Processes:** A cyclic process is a process that can be repeated indefinitely often without changing the final state of the system in which the process occurs. The only traces of the effects of a cyclic process are to be found in the surroundings of the system or in other systems.

**8. (c)**

An isolated system is one in which there is no energy and mass transfer between the system and surrounding.  
*Examples :* Universe, coffee in thermo flask.

**9. (c)**

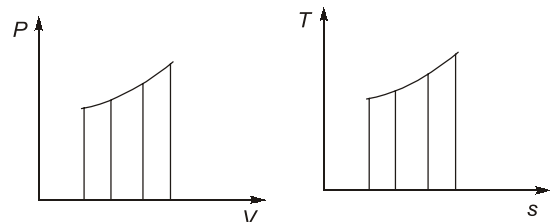
For a constant volume gas thermometer, pressure acts as thermometric property and at low pressure the gas behaves as ideal gas and follows ideal gas equation

$$pV = mRT$$

$\therefore$  for  $V = \text{constant}$  ( $m, R$  and also constant)

$$p \propto T$$

**11. (c)**



Area under curve on P-V represents work when projected on volume axis for closed system

Area under T-s diagram represents heat transfer for a reversible process

**12. (d)**

$$E = 25 + 0.25t$$

$$\frac{dE}{dt} = 0.25 \text{ kJ/}^\circ\text{C}$$

and  $\frac{dW}{dt} = 0.75 \text{ kJ/}^\circ\text{C}$

From the first law of thermodynamics

$$\delta Q = dE + \delta W$$

$$\delta Q = 0.25 + 0.75 = 1.00 \text{ kJ/}^\circ\text{C}$$