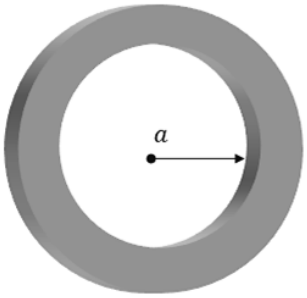
Chapter 18

Thermodynamics

Exercise

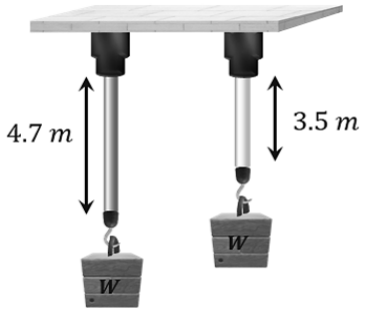
WORK SHEET

Q.1 The surface mass density of a disc of radius a varies with radial distance r as $\sigma = A + Br$ where A and B are positive constants. Then, moment of inertia of the disc about an axis passing through its centre and perpendicular to the plane (in kg m^2) is:



(A) $2\pi a^4\left(\frac{A}{4}+\frac{Ba}{5}\right)$ **(B)** $2\pi a^4\left(\frac{Aa}{4}+\frac{B}{5}\right)$ **(C)** $\pi a^4\left(\frac{A}{4}+\frac{Ba}{5}\right)$ **(D)** $2\pi a^4\left(\frac{A}{5}+\frac{Ba}{4}\right)$

Q.2 A steel wire of length 4.7 m and cross-sectional area $3.0 \times 10^{-5}\ m^2$ stretches by the same amount as a copper wire of length 3.5 m and cross-sectional area $4.0 \times 10^{-5}\ m^2$ under a given load. Find the ratio of the Young's modulus of steel to that of copper



(A) 1.5 : 2 **(B)** 1.8 : 2 **(C)** 1.5 : 1 **(D)** 1.8 : 1

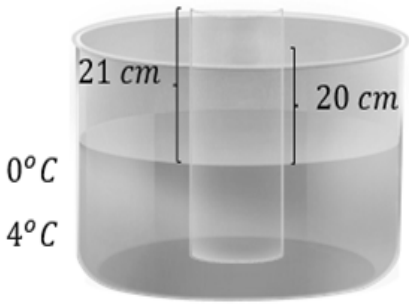
Q.3 One end of a steel wire is fixed to the ceiling of an elevator moving up with an acceleration 2 m/s^2 and a load of 10 kg hangs from another end. Area of cross-section of the wire is 2 cm^2. The longitudinal strain in the wire is ($g = 10\ m/s^2$ and $Y = 2 \times 10^{11}\ N/m^2$)

(A) 4×10^{-6} **(B)** 3×10^{-6} **(C)** 8×10^{-6} **(D)** 2×10^{-6}

Q.4 An ideal fluid is flowing in a pipe in a streamline flow. The pipe has a maximum and minimum diameter of 6.4 cm and 4.8 cm respectively. Find out the ratio of minimum to maximum velocity.

(A) $\frac{81}{256}$ **(B)** $\frac{9}{16}$ **(C)** $\frac{81}{256}$ **(D)** $\frac{3}{16}$

Q.5 A cylinder of height 1 m is floating in water at 0°C with 20 cm height in air. When the temperature of water is raised to 4°C, height of the cylinder in air becomes 21 cm. By assuming the expansion of the cylinder to be negligible and that the cylinder stays vertical, find the ratio of density of water at 4°C to density of water 0°C.

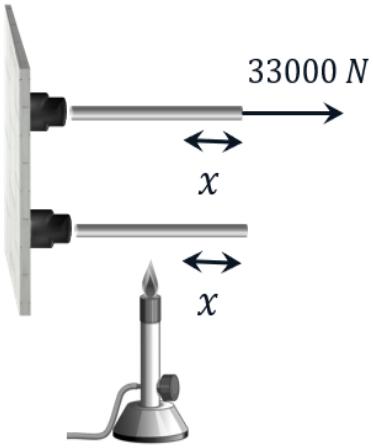


(A) 1.01 **(B)** 1.03 **(C)**2.01 **(D)** 1.04

Q.6 A solid sphere of density $\rho = \rho_0\left(1 - \frac{r^2}{R^2}\right)$, $0 < r \leq R$ (where r is the distance from the center of the sphere) just floats in a liquid. Then, density of the liquid is -

(A) $\frac{2Po}{5}$ **(B)** $\frac{4Po}{5}$ **(C)** $\frac{2Po}{7}$ **(D)** Po

Q.7 There is some change in length when a 33,000 N tensile force is applied on a steel rod of area of cross-section 10^{-3} m^2. The change of temperature required to produce the same elongation, if the steel rod is heated is – [Take modulus of elasticity Y = 3×10^{11} N/m^2 and the coefficient of linear expansion of steel is $\alpha = 1.1 \times 10^{-5}$/°C]

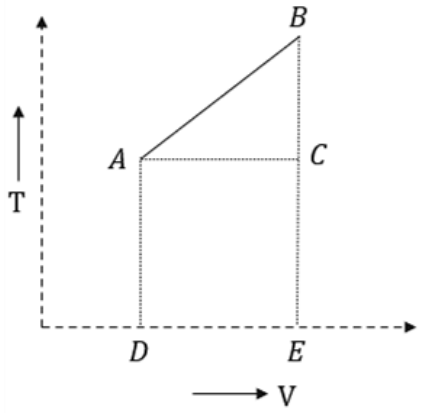


(A)20°C **(B)** 15°C **(C)** 10°C **(D)** 0°C

Q.8 The temperature of an ideal gas is increased from 27°C to 127°C. Then, percentage increase in V_{rms} is

(A)37% **(B)**11% **(C)**33% **(D)** 15.5%

Q.9 From the following $V - T$ indicator diagram, which of the following options is true about pressure?



(A) $P_1 < P_2$ **(B)** $P_1 > P_2$ **(C)** $P_1 = P_2$ **(D)** cannot predict

Q.10 For two bodies (which are in contact with each other) to be in thermal equilibrium, they must be separated by:

(A) An adiabatic wall **(B)** A diathermic wall
(C) Both A and B **(D)** None of the above

Q.11 The first law of thermodynamics
1. Is a re-statement of the law of conservation of energy when applied to thermodynamic systems.
2. Is the basis for the definition of internal energy.
3. Is basis for the definition of temperature.

(A) 1 and 2 are correct **(B)** Only 1 is correct
(C) Only 2 is correct **(D)** Both 2 and 3 are correct

Q.12 In which process does P – V indicator diagram show a straight line parallel to the volume axis?

(A) Isochoric **(B)** Isobaric **(C)** Isothermal **(D)** Adiabatic

Q.13 The change in internal energy of a system that has absorbed 2 kcal of heat and does 500 J of work is

(A) 6400 J **(B)** 5400 J **(C)** 7800 J **(D)** 8900 J

Q.14 A gas expands with temperature according to the relation $V = kT^{2/3}$. What is the work done, when the temperature changes by 30°C?

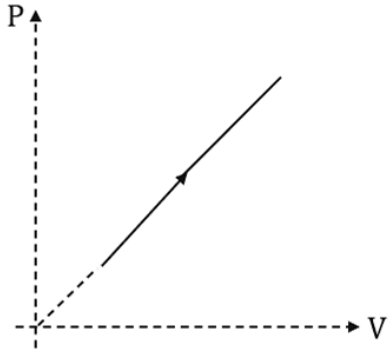
(A) 10 R **(B)** 20 R **(C)** 30 R **(D)** 40 R

Q.15 A sample of 0.1 g of water at 100°C and normal pressure (1.03×10^5 Nm^{-2}) requires 54 cal of heat energy to convert to steam at 100°C. If the volume of the steam produced is 167.1 cc, the change in

internal energy of the sample is A gas expands with temperature according to the relation $V = kT^{2/3}$. What is the work done, when the temperature changes by 30°C?

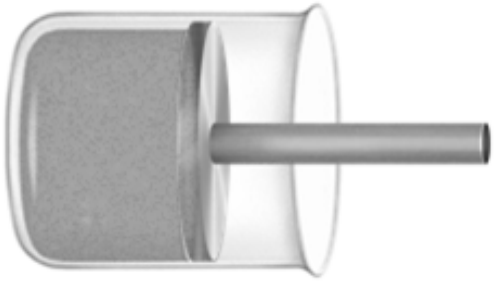
(A) +104.4 J **(B)** +208.8 J **(C)** −84.5 J **(D)** −242.6 J

Q.16 During the thermodynamic process shown in figure for an ideal gas.



(A) $\Delta T = 0$ **(B)** $\Delta Q = 0$ **(C)** $W = 0$ **(D)** $\Delta U = 0$

Q.17 n moles of a gas filled in a container is in thermodynamic equilibrium initially at temperature T. If the gas is compressed quasi-statically and isothermally to half its initial volume, the work done by the atmosphere on the piston is:



(A) $\frac{n\,RT}{2}$ **(B)** $-\frac{n\,RT}{2}$ **(C)** $nRT\,(In2 - \frac{1}{2})$ **(D)** nRTIn 2

Q.18 Work done by 0.1mole of a gas at 27°C to double its volume at constant pressure is [Take $R = 2$ cal $mol^{-1}K^{-1}$]

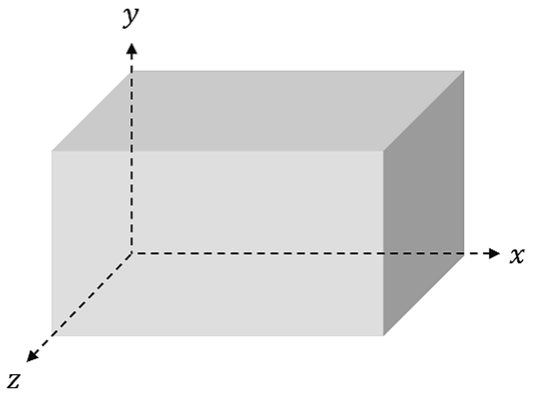
(A) 54 cal **(B)** 600 cal **(C)** 60 cal **(D)** 546 cal

Q.19 In an isothermal reversible expansion, if the volume of 96 g of oxygen at 27°C is increased from 70 liters to 140 liters, then the work done by the gas will be

(A) $300\ R \log_{10} 2$ **(B)** $2.3 \times 900\ R \log_{10} 2$

(C) $600\ R \log_{10} 2$ **(D)** $2.3 \times 300\ R \log_{10} 2$

Q.20 An anisotropic solid metal cube has coefficients of linear expansion $5 \times 10^{-5}/^{o}C$ along the x – axis and $5 \times 10^{-6}/^{o}C$ along y – axis and z – axis. If the coefficient of volume expansion of the solid is $n \times 10^{-6}/^{o}C$, then the value of n is



Q.21 An ideal gas is taken through a quasi-static process described by $P = \alpha V^2$, with $\alpha = 5.00\ atm/m^6$ The gas is expanded to twice its original volume of 1.00 m^3. How much work is done by the gas (in MJ) during expansion in this process

ANSWER KEY

WORK SHEET										
Q.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Sol.	(A)	(D)	(B)	(B)	(A)	(A)	(C)	(D)	(A)	(B)
Q.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Sol.	(A)	(B)	(C)	(B)	(B)	(D)	(D)	(C)	(B)	()
Q.	**21**									
Sol.										