RACE # 68 (RADIATION) PHYSICS

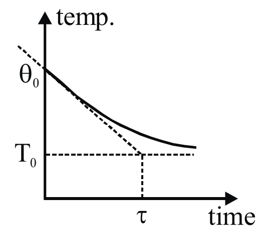
1. The cylindrical filament of an incandescent lamp of power 64 W is made of Tungsten. The operation temperature of the lamp is 2000K. Consider the filament a black body and find its radius (in mm).

[Given : $\sigma = 6 \times 10^{-8}$ W/m^2 & length of filament is $\frac{10}{3\pi}$cm]

2. A long solid cylinder is radiating power. It is remolded into a number of smaller cylinders, each of which has the same length as original cylinder. Each small cylinder has the same temperature as the original cylinder. The total radiant power emitted by the pieces is twice that emitted by the original cylinder. How many smaller cylinders are there? Neglect the energy emitted by the flat faces of cylinder.

3. End A of a rod AB of length L = 1.5 m and of uniform cross-sectional area is maintained at some constant temperature. The heat conductivity of the rod is k = 17 J/s-m°K. The other end B of this rod is radiating energy into vacuum and the wavelength with maximum energy density emitted from this end is $\lambda_0 = 75000$ Å . The emissivity of the end B is e = 1. If the temperature of the end A (in K) is 66α. Then find the value of α. (Assuming that except the ends, the rod is thermally insulated)
(Take b = 3×10^{-3} SI units, $\sigma = 17/3 \times 10^{-8}$ SI units)
(A) 2 (B) 4 (C) 8 (D) 10

4. A body at temperature θ_0 having Newton's cooling constant K is placed in a surrounding having temperature T_0 at time t = 0. The graph of temperature of the body as a function of time t is shown in the adjacent figure. A tangent on the curve is drawn at t = 0 as shown in the figure. Find the value of τ.



(A) K (B) 1/K
(C) K(θ_0–T_0) (D) data insufficient

5. There are two solar energy collectors made up of thin aluminium sheet. They are flat and uncoated. Collector 'A' is rectangular measuring 20 cm long and 15 cm wide. Collector 'B' is circular having 20cm diameter. If they are kept under mid-day sun for long time then.
(A) both the collectors A and B will show nearly the same temperature
(B) collector A will show higher temperature than B
(C) collector B will show higher temperature than A
(D) there will be no rise in the temperature of the two collectors, as they are uncoated

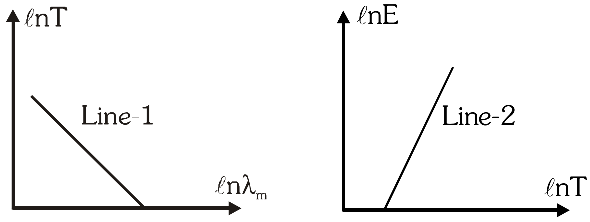
6. A metal cylinder of mass 0.5 kg is heated electrically by a 12 W heater in a room at 15ºC. The cylinder temperature rises uniformly to 25ºC in 5 min and finally becomes constant at 45ºC. Assuming that the rate of heat loss is proportional to the excess temperature over the surroundings
(A) The rate of loss of heat of the cylinder to surrounding at 20ºC is 2 W
(B) The rate of loss of heat of the cylinder to surrounding at 45ºC is 2 W
(C) Specific heat capacity of metal is $\frac{240}{\ell n(3/2)}$ J/kgºC
(D) None of these

7. A heated body maintained at T K emits thermal radiation of total energy E with a maximum intensity at frequency ν. The emissivity of the material is 0.5. If the temperature of the body be increased to and maintained at temperature 3T K, then :-
(A) The maximum intensity of the emitted radiation will occur at frequency $\nu/3$
(B) The maximum intensity of the emitted radiation will occur at frequency 3ν.
(C) The total energy of emitted radiation will become 81 E
(D) The total energy of emitted radiation will become 27 E

8. The total energy of a blackbody radiation source is collected for one minute and used to heat water. The temperature of the water increases from 20 °C to 21 °C. If the absolute temperature of the blackbody is doubled and the experiment repeated, which of the following statements would be most nearly **CORRECT**?
(A) The temperature of the water would increases from 20°C to a final temperature of 28°C
(B) The temperature of the water would increases from 20°C to a final temperature of 36°C
(C) Rate of heat emission by the body will increase 8 times
(D) Rate of heat emission by the body will increase 16 times

Paragraph for Question 9 to 11

The variation of the ℓnT versus $\ln\lambda_m$ and ℓnE versus ℓnT are shown in figure. T is the temperature of the body in Kelvins, λ_m is the wavelength corresponding to maximum spectral radiant energy and E is the energy emitted by the body per second. The intercept made by the line 1 on the y–axis is A.



9. What is the slope of line–1?
(A) –2 (B) –4 (C) –1 (D) –0.5

10. What is the slope of line–2?
(A) –2 (B) 4 (C) 1 (D) 0.5

11. What is the value of Wein's displacement constant?
(A) e^A (B) $\frac{1}{e^A}$ (C) ℓnA (D) $\frac{1}{\ell nA}$

12. A solid sphere of diameter 0.1 cm is at 227°C and is kept in an enclosure at 27°C. Its rate of temperature change is α K/sec. Fill 100 α in OMR sheet.
(Stefan's constant : 6×10^{-8} W/m^{2}K^4, emissivity of the surface 0.7, specific heat 0.1 kcal/kg K, density = 8×10^3 kg/m^3, J = 4200 J/k cal.)

13. Solar constant is the amount of energy received by the earth on a unit area per second. Its values is nearly 1.75×10^3 watt. A solar cooker used for heating water has solar panel of effective area 1 m^2. Only 10 % of the energy received by the solar panel is utilized for heating the contents. If time taken by this solar cooker to heat 1 litre of water from 30°C to 80°C is nearly 5x minutes then x is.

14. A solid sphere of diameter 0.1 m is at 427°C and is kept in an enclosure at 27°C. Take Stefan's constant = $\frac{20}{3} \times 10^{-8}$ W/m^{2}K^4, emissivity of the surface 0.84, specific heat 0.1 kcal/kg K, density = 9280 kg/m^3, J = 4200 J/k cal. If rate of decrease of temperature of the sphere is $N \times 10^{-3}$ °C/s, find $\frac{N}{40}$.

15. Wavelength associated with maximum spectral emissive power of two black spheres A and B are λ_1 and λ_2 respectively. Radius of sphere A and B are r_A and r_B and both spheres are made by same material. Both spheres are kept in surrounding of temperature of 0K. If ratio of initial rate of cooling of sphere A and B is $\frac{60}{n}$ then value of n is. (Given $\frac{r_B}{r_A} = 3; \frac{\lambda_2}{\lambda_1} = \sqrt{2}$)

N_Race # 68			Answer key
1. Ans. 1	2. Ans. 4	3. Ans. (C)	4. Ans. (B)
5. Ans. (A)	6. Ans. (A, C)	7. Ans. (B,C)	8. Ans. (B,D)
9. Ans. (C)	10. Ans. (B)	11. Ans. (A)	12. Ans. 408
13. Ans. 4	14. Ans. 5	15. Ans. 5	