TRANSMISSION OF HEAT

1. Coefficient of thermal conductivity

1) Depends upon Nature of the material of the Body

2) is independent of Dimensions of the body

3) both (1) and (2)

4) depends on temperture gradient

2. Which of the following properties would be most desirable for a cooking pot :

1) High specific heat and low thermal conductivity

2) Low specific heat and high thermal conductivity

3) High specific heat and high thermal conductivity

4) Low specific heat and low thermal conductivity

3. Thermal radiation belongs to

1) Visible region 2) Cosmic region 3) Ultra violet region 4) Infrared region

4. Spectrum of heat radiations obtained by

1) Flint glas prisms 2) Crown glass prisms 3) Rock salt prisms 4) Quartz prisms

5. Emissive power and Absorptive power of a body depend upon

1) Nature of the surface 2) Temperature of the body

3) Both 1 and 2 4) None of the above

6. In Fery's blackbody

1) Inner surface of inner wall is coated with lamp black and outer surface of outer wall is silver polished

2) Space between the two walls is evacuated to prevent heat losses due to conducion & convection

3) A conical projection is provided on the inner wall opposite to small hole

4) All the above

7. Blackbody Radiation is

1) Black 2) White

3) Colourless 4) None of the above

8. In a Thermos flask, heat losses due to

1) Conduction & Convection are minimized by creating vacuum between the two walls of the flask

2) Radiation is minimized by silver polishing both inner & outer surfaces

3) Both 1&2

4) None of the above

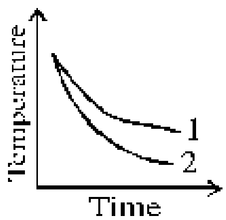
9. A beaker full of hot water is kept in a room. It cools from 80° C to 75° C in t_1 minutes, 75°C to 70°C in t_2 minutes and 70°C to 65°C in t_3 minutes in the same surroundings. Then

1) $t_1 = t_2 = t_3$ 2) $t_1 < t_2 < t_3$ 3) $t_1 > t_2 > t_3$ 4) $t_1 < t_2 = t_3$

10. Two spheres of radii r_1 and r_2 have densities and specific heats C_1 and C_2 respectively. If they are heated to same temperature, the ratio of their rates of fall of temperature in the same surroundings will be

1) $\frac{r_1\rho_1 c_1}{r_2\rho_2 c_2}$ 2) $\frac{r_1\rho_2 c_2}{r_2\rho_1 c_1}$ 3) $\frac{r_2\rho_1 c_1}{r_1\rho_2 c_2}$ 4) $\frac{r_2\rho_2 c_2}{r_1\rho_1 c_1}$

11. The cooling curves 1and 2 of two liquids of same mass, specific heats S_1 and S_2 are cooled under identical conditions as shown in the graph. Then



1) $S_1 = S_2$ 2) $S_1 < S_2$ 3) $S_1 > S_2$ 4) $S_1 \leq S_2$

12. Newton's law of cooling is applicable when

1) Temperature of every part of the body is same
2) Hot body is cooled in uniform streamlined flow of air (Forced convection)
3) Heat is lost only by radiation
4) Both 1 and 2

13. Newton's law of cooling is a special case of

1) Kirchoff's Law 2) Wien's Law
3) Plank's Law 4) Stefan -Boltzmann's Law

14. According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is difference of temperature of body and surroundings, and n is equal to

1) 1 2) 2 3) 3 4) 4

15. A. Natural convection can take place in gravity free region
B) Forced convection is the principle in maintaining constant temperature of our body.

1) A is correct, B is wrong 2) Both A & B are correct
3) A is wrong, B is correct 4) Both A & B are wrong

16. A spherical black body is of radius 'r'. Its radiating power is 'P' and its rate of cooling is R. Then

a) $P \alpha r$ **b)** $P \alpha r^2$ **c)** $R \alpha 1/r$ **d)None**

1) a only true 2) both b and c are true 3) a and c are true 4) b only true

17. A solid sphere of copper and a hollow sphere of same metal, same radius are with identical surfaces. They are heated to the same temperature and allowed to cool in the same environment.

Statement (A): The rate of loss of heat is same for both the spheres.

Statement (B): The rate of fall of temperature is more the hollow sphere.

1) A is true B is false 2) A is false B is true 3) A, B both are true 4) A, B both are false

18. Statement (A): Water can be boiled in a thin paper box without even charring the paper

Statement (B): In winter, woolen clothes keeps us warmer compared to cotten clothes.

1) A is true B is false 2) A is false B is true 3) A, B both are true 4) A, B both are false

19. (A): Stainless steel cooking pans are preferred with extra copper bottom.

(R): Thermal conductivity of copper is more than that of steel

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false 4) (A) is false but (R) is true

20. (A): Two layers of cloth of same thickness provide warmer covering than a single layer of cloth of double the thickness.

(R): Air layer trapped between two cloth layers acts as good insulator of heat.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false 4) (A) is false but (R) is true

21. (A): During solar eclipse, the solar spectrum is an emission spectrum

(R): During solar eclipse, the radiations from the elements in chromospheres are only received on earth.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false 4) (A) is false but (R) is true

22. (A): All black coloured objects are considered black bodies.

(R): Black colour is a good absorber of heat.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false 4) (A) is false but (R) is true

23. (A): 'Green houses' which are used to keep the plants in warm atmosphere in winter are built with glass.

(R): Glass has the property of tranmitting shorter wavelength heat radiations through it while reflecting longer ones.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false   4) (A) is false but (R) is true

24. (A): Animals curl into a ball, when they feel very cold.

(R): Animals by curling their body reduces the surface area and hence reduce the rate of loss of radiation.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false   4) (A) is false but (R) is true

25. Matching block type

List - I	**List - II**
a) Fraunhoffer lines	e) Prevost's theory of heat exchange.
b) Intensity of their mal radiation	f) Kirchhoff's law.
c) Rate of cooling	g) Inverse square law
d) Zero point energy	h) Newton's law of cooling

1) a - f   b - e   c - h   d – g   2) a - f   b - g   c - e   d - h

3) a - g   b - f   c - h   d - e   4) a - f   b - g   c - h   d – e

CONDUCTION

26. In steady state condition, the temperatures at the two ends of a metal rod of length 25 cm are 100°C and 0°C. Then temperature at a point 8cm from the hot end is

1) 68°C   2) 40°C   3) 32°C   4) 60°C

27. Four rods of same material but with different radii and lengths are used to connect two reservoirs of heat with the same temperature difference. Which one will conduct more heat

1) $r = 1cm, l = 1m$ 2) $r = 1cm, l = 2m$ 3) $r = 1cm, l = \frac{1}{2}m$ 4) $r = \frac{1}{2}cm, l = \frac{1}{2}m$

28. Two rods of same length having conductivities 60 $Wm^{-1}k^{-1}$, 40 $Wm^{-1}K^{-1}$ and areas 0.2 m^2, 0.3m^2 are connected in Parallel to each other. The effective conductivity of the combination is

1) 50 $Wm^{-1}K^{-1}$ 2) 45 $Wm^{-1}K^{-1}$ 3) 52 $Wm^{-1}K^{-1}$ 4) 48 $Wm^{-1}K^{-1}$

29. Equal temperature difference exists between the ends of two metallic rods 1 and 2 of equal length. Their thermal conductivities are K_1 *and* K_2 and cross sectional areas are respectively A_1 *and* A_2. The condition for equal rate of heat transfer will be

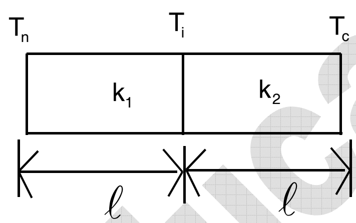
1) $K_1A_2 = K_2A_1$ 2) $K_1A_2^2 = K_2A_1^2$ 3) $K_1A_1 = K_2A_2$ 4) $K_1A_1^2 = K_2A_2^2$

30. A pond has an ice layer of thickness 3 cm. If K of ice is 0.005 CGS units, surface temperature of surroundings is -20^0C, density of ice is 0.9 gm/cc, the time taken for the thickness to increase by 1 cm is

1) 30 min. 2) 35 min. 3) 42 min. 4) 60 min.

31. Two bars of equal length and the same cross - sectional area but of different thermal conductivities, K_1 and K_2, are joined end to end as shown in Fig. One end of the composite bar is maintained at temperature T_h whereas the opposite end is held at T_c.

If there are no heat losses from the sides of the bars, the temperature T_j of the junction in steady state is given by



1) $\frac{k_2}{k_1}\frac{(T_h+T_c)}{2}$ 2) $\frac{k_2}{k_1+k_2}(T_h+T_c)$ 3) $\frac{k_1+k_2}{2}\frac{(T_h+T_c)}{2}$ 4) $\frac{(k_1T_h+k_2T_c)}{k_1+k_2}$

32. Two identical rods of a metal are welded in series then 20 cal of heat flows through them in 4 minute. If the rods are welded in parallel then the same amount of heat will flow in

1) 1 minute 2) 2 minute 3) 4 minute 4) 16 minute

33. A cylinder of radius R made of material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 3R made of material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

1) $K_1 + K_2$ 2) $\frac{K_2K_1}{K_1+K_2}$ 3) $\frac{8K_1+K_2}{9}$ 4) $\frac{K_1+8K_2}{9}$

34. Three rods A, B and C of the same length and cross-sectional area are joined in series as shown. Their thermal conductivities are in the ratio 1 : 2 : 1.5. If the open ends of A and C are at 200^0C and 18^0C, respectively, the temperature at the junction of A and B, in equilibrium, is 200^0C

1) 168°C 2) 140°C 3) 116°C 4) 160°C

RADIATION

35. If the temperature of a Black body increases by 50% then amount of radiation emitted by it in a given time interval will

1) Increase by 800% 2) Increase by 400% 3) Increase by 200% 4) Increase by 1600%

36. The rate of emission of radiation of a black body at temperature 27^oC is E_1. If its temperature is increased to 327^oC the rate of emission of radiation is E_2. The relation between E_1 and E_2 is

1) $E_2 = 24\,E_1$ 2) $E_2 = 16\,E_1$ 3) $E_2 = 8\,E_1$ 4) $E_2 = 4\,E_1$

37. The radiation emitted by a star "A" per second is 10,000 times that of the sun. If the surface temperatures of the sun and the star A are 6000K and 2000K respectively, the ratio of the radii of the star A and the sun is

1) 300:1 2) 600:1 3) 900:1 4) 1200:1

38. The rectangular surface of area 8cm x 4cm of a black body at a temperature of 127^0C emits energy at rate of E per second. If the length and breadth are reduced to half of its initial value and the temperature is raised to 327^0C, the rate of emission of energy will be

1) $\left(\frac{3E}{8}\right)$ 2) $\left(\frac{9E}{16}\right)$ 3) $\left(\frac{81E}{16}\right)$ 4) $\left(\frac{81E}{64}\right)$

39. Two objects A and B have same shape and area. The Emissivity of A is 0.2 and that of B is 0.8. Each radiates same power. The ratio of their absolute temperatures is

1) 2:1 2) 1:4 3) 1: $\sqrt{2}$ 4) $\sqrt{2}$:1

40. Two identical bodies have temperatures 277°C and 67°C. If the surrounding temperature is 27°C, the ratio of loss of heat of two bodies during the same interval of time is (approx).

1) 4 : 1 2) 8 : 1 3) 12 : 1 4) 16 : 1

41. A Black metal foil receives radiation of power P from a hot sphere at absolute temperature T, kept at a distance d. If the temperature is doubled and distance is halved, then Power will be

1) 64P 2) 16P 3) 4P 4) 8P

41. If wavelengths of maximum intensity of radiations emitted by the sun and the moon are 0.5 x 10^{-6} m and 10^{-4} m respectively, the ratio of their temperatures is

1) 1/100 2) 1/200 3) 100 4) 200

43. The wavelength of maximum energy released during an atomic explosion was 2.93 x 10^{-10} m. Given that Wien's constant is 2.93 x 10^{-3} m – K, the maximum temperature attained must be of the order of

1) $10^{-7}K$ 2) $10^{7}K$ 3) $10^{-13}K$ 4) $5.86\times10^{7}K$

44. The wavelength of maximum emitted energy of a body at 700 K is 4.08μm. If the temperature of the body is raised to 1400 K, the wavelength of maximum emitted energy will be

1) $1.02\mu m$ 2) $16.32\mu m$ 3) $8.16\mu m$ 4) $2.04\mu m$

45. A sphere and a cube both made of copper have equal volumes and are blackened. These are heated to same temperature and are allowed to cool under same surroundings. The ratio of their rates of loss of heat is

1) 1 : 1 2) $(p/6)^{1/3}$ 3) $(6/p)^{1/3}$ 4) $(p/6)^{1/2}$

46. A metal ball of surface area 200 cm^2 and temperature 527^0C is surrounded by a vessel at 27^0C. If the emissivity of the metal is 0.4, then the rate of loss of heat from the ball is $\left(\sigma = 5.67\times10^{-8} J/m^2 - s - k^4\right)$

1) 108 joules approx 2) 168 joules approx

3) 182 joules approx 4) 192 joules approx

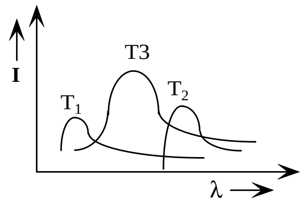
47. A spherical black body with a radius of 12 cm radiates 450 W power at 500 K. If the radius were halved and the temperature doubled, the power radiated by it in watt would be

1) 225 2) 450 3) 900 4) 1800

48. Three discs A, B and C having radii 2m 4m and 6 m respectively are coated with carbon black on their other surfaces. The wavelengths corresponding to maximum intensity are 300 nm, 400 nm and 500 nm, respectively. The power radiated by them is Q_a, Q_b and Q_c respectively

1) Q_a is maximum 2) Q_b is maximum 3) Q_c is maximum 4) $Q_a = Q_b = Q_c$

49. The plots of intensity versus wavelength for three black bodies at temperatures T_1, T_2 and T_3 respectively are as shown. Their temperature are such that



1) $T_1 > T_2 > T_3$ 2) $T_1 > T_3 > T_2$ 3) $T_2 > T_3 > T_1$ 4) $T_3 > T_2 > T_1$

50. The absolute temperature of a body A is four times that of another body B. For the two bodies, the difference in wavelengths, at which energy radiated is maximum is $3.0\mu m$**. Then the wavelength at which the body B radiates maximum energy, in micrometers is**

1) 2   2) 2.5   3) 4.00   4) 4.5

51. Two metallic spheres S_1 and S_2 made of same material have identical surface finish. The mass of S_1 is 3 times that of S_2. Both are heated to same temperature and are placed in same surroundings. Then ratio of their initial rates of fall of temperature will be

1) $\frac{1}{\sqrt{3}}$ 2) $\frac{1}{3}$ 3) $\left(\frac{1}{3}\right)^{\frac{1}{3}}$ 4) $\frac{\sqrt{3}}{1}$

52. The wavelength of maximum intensity of radiation emitted by a star is 289.8 nm. The radiation intensity for the star is

1) $5.67x10^8 Wm^{-2}$ 2) $5.67\times10^{12} Wm^{-2}$ 3) $10.67\times10^7 Wm^{-2}$ 4) $10.67\times10^{14} Wm^{-2}$

KEY

1) 3	2) 2	3) 4	4) 3	5) 3	6) 4	7) 2	8) 3	9) 2	10) 4	11) 3
12) 4	13) 4	14) 1	15) 3	16) 2	17) 3	18) 3	19) 1	20) 1	21) 1	22) 4
23) 1	24) 1	25) 4	26) 1	27) 3	28) 4	29) 3	30) 3	31) 4	32) 1	33) 4
34) 3	35) 2	36) 2	37) 3	38) 4	39) 4	40) 4	41) 1	42) 4	43) 2	44) 4
45) 2	46) 3	47) 4	48) 2	49) 2	50) 3	51) 3	52) 1			

HINTS

26. $\frac{100-0}{25}=\frac{100-\theta}{8}$

$32 = 100-\theta$

$\theta = 68^0C$

27. $\frac{\theta}{t}=\frac{kA(\theta_1-\theta_2)}{l}$

$\frac{\theta}{t}\propto\frac{r^2}{l}$

1) $\frac{r^2}{l}\rightarrow\frac{1^2}{1}=1$

2) $\frac{r^2}{l}\rightarrow\frac{1^2}{2}=0.5$

3) $\frac{r^2}{l}\rightarrow\frac{1^2}{(1/2)^2}=2$

4) $\frac{r^2}{l}\rightarrow\frac{(1/2)^2}{(1/2)^2}=0.5$

28. $k_p=\frac{k_1A_1+k_2A_2}{A_1+A_2}$

$=\frac{60\times0.2+40\times0.3}{0.2+0.3}$

$=\frac{12+12}{0.5}=48wm^{-1}k^{-1}$

29. $\frac{Q}{t}=\frac{kA(\theta_2-\theta_2)}{l}$

$k_1A_1= k_2A_2$

30. $t = \frac{S.L}{2k\theta}(x_2^2 - x_1^2)$

$= \frac{0.9 \times 80}{2(0.005) \times 20}(4^2 - 3^2)$

$= \frac{72}{2 \times 0.1}(16 - 9)$

$= \frac{720}{2} \times 7 = 2520 = 42\,\text{min}$

31. $\frac{k_1(T_n - T_i)}{l} = \frac{k_2(T_i - T_c)}{l}$

$T_i = \frac{k_1T_n + k_2T_c}{k_1 + k_2}$

32. $\theta_{t_1} = \frac{kA(\theta_1 - \theta_2 0}{2l}$

$\theta_{t_2} = \frac{k(2A)(\theta_1 - \theta_2)}{l}$

$\frac{4}{t_2} = \frac{4}{1}$

t_2 = 1 min

33. $k_p = \frac{k_1A_1 + k_2A_2}{A_1 + A_2}$

$= \frac{k_1\pi R^2 + k_2\pi(9R^2 - R^2)}{\pi R^2 + \pi(9R^2 - R^2)}$

$k_p = \frac{k_1 + 8k_2}{9}$

34. $\frac{3}{k_s}=\frac{1}{k}+\frac{1}{2k}+\frac{2}{3k}$

$k_s=\frac{18}{13}k$

$\left(\frac{\theta}{t}\right)_{combined}=\left(\frac{\theta}{t}\right)_A$

$\frac{18k}{13}\frac{A(200-18)}{3l}=\frac{kA(200-\theta)}{l}$

θ = 116^0C

35. $T_2=\frac{3}{2}T_1 \in \propto T^4$

$\frac{E^1-E}{E}\times 100=\frac{(3/2)^4-1}{1}\times 100$

$=\left(\frac{81}{16}-1\right)\times 100$

= (5 - 1) x 100

= 400 % Increases

36. $\frac{E_1}{E_2}=\left(\frac{27+273}{327+273}\right)^4$

$\frac{E_1}{E_2}=\left(\frac{300}{600}\right)^4$ E_2 = 16 E_1

37. $R_{st}^2(2000)^4=10,000R_s^2(6000)^4$

$\left(\frac{R_{st}}{R_s}\right)^2=3^4\times 10^4$

$\frac{R_{st}}{R_s}=900:1$

38. $\frac{E}{E^1}=\frac{8\times 4\times (400)^4}{4\times 2(600)^4}$

$\frac{E}{E^1}=4\times\left(\frac{2}{3}\right)^4=\frac{64}{81}$ $\quad E^1=\frac{81}{64}E$

39. $0.2T_1^4 = 0.8T_2^4$

$\left(\frac{T_1}{T_2}\right)^4 = 4$

$\frac{T_1}{T_2} = \sqrt{2}:1$

40. $\frac{E_1}{E_2} = \frac{600^4 - 300^4}{340^4 - 300^4}$

$\frac{E_1}{E_2} = \frac{6^4 - 3^4}{3.4^4 - 3^4} = \frac{1215}{63} \simeq 16:1$

41. $P \propto \frac{T^4}{d^2}$

$\frac{P_1}{P_2} = \left(\frac{T_1}{T_2}\right)^4 \times \left(\frac{d_2}{d_1}\right)^2$

$= \left(\frac{T_1}{2T}\right)^4 \times \left(\frac{1}{2}\right)$

$P_2 = 64$ P

42. $\lambda_1 T_1 = \lambda_2 T_2$

$\frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1} = \frac{10^{-4}}{0.5\times10^{-6}}$

$\frac{T_1}{T_2} = \frac{100}{0.5} = \frac{200}{1}$

43. $\lambda.T = b$

T. 2.93 x 10^{-10} = 2.93 x 10^{-3}

T = 10^7K

44. $\lambda_1 T_1 = \lambda_2 T_2$

4.08 x 700 = λ_2 x 1400

$\lambda_2 = \frac{4.08\times700}{1400}$ = 2.04 μm

45. $Q = \sigma\ At(T^4 - T_0^4)$

$$\frac{Q_{sphere}}{Q_{cube}} = \frac{A_{sphere}}{A_{cube}} = \frac{4\pi r^2}{6a^2}$$

Given $\frac{4}{3}\pi r^3 = a^3$

$$a = \left(\frac{4}{3}\pi\right)^{1/3}.r$$

$$\frac{Q_{sphere}}{Q_{cube}} = \frac{4\pi r^2}{6\left(\left(\frac{4}{3}\pi\right)^{1/3}.r\right)^2} = \left(\frac{\pi}{6}\right)^{1/3}:1$$

46. Rate of loss of heat

$$E = \sigma e A(T^4 - T_0^4)$$

$= 5.67 \times 10^{-8} \times 0.4 \times 200 \times 10^{-4} \times (800^4 - 300^4)$

$= 180$ J/s

47. $P = A\ \sigma\ T^4$

$$p \propto r^4 T^4$$

$$\frac{P_1}{P_2} = \left(\frac{r_1}{r_2}\right)^2 \left(\frac{T_1}{T_2}\right)^4$$

$$\frac{440}{p_2} = \left(\frac{12}{6}\right)\left(\frac{500}{1000}\right)^4$$

$P_2 = 1800$ w

48. $p = Ae\sigma\ T^4$

$$p \propto A\ T^4$$

$$\lambda.T = const \quad T \propto \frac{1}{\lambda}$$

$$p \propto \frac{r^2}{\lambda^4} \quad Q_A : Q_B : Q_c = \frac{2^2}{300^4} : \frac{4^2}{400^4} : \frac{6^2}{500^4}$$

Q_B will maximum

49. $\lambda.T = const$

$\lambda_{max} \propto \frac{1}{T}$

$(\lambda_1) < (\lambda_3) < (\lambda_2)$

$T_1 > T_3 > T_2$

50. $T_A = 4T \;\; T_B = T$

$\lambda_1 T_1 = \lambda_2 T_2$

$\therefore \lambda_2 = 4(1) = 4\mu m$

51. $R = \frac{4\theta}{t} = \frac{Ae\,\sigma\,(T^4 - T_0^4)}{m.s}$

$R \propto \frac{A}{m} \propto \frac{area}{vol} \propto \frac{r^2}{r^3} \propto \frac{1}{r}$

$R \propto \frac{1}{r} \propto \frac{1}{m^{1/3}}$

$\frac{R_1}{R_2} = \left(\frac{m_2}{m_1}\right)^{1/3} = \left(\frac{1}{3}\right)^{1/3}$

52. $\lambda.T = 2.89 \times 10^{-3}$

$T = \frac{2.89 \times 10^{-3}}{289.8 \times 10^{-9}}$

$T = 10^4$

$E = \sigma\, T^4 = 5.67 \times 10^{-8} \,(10^4)^4 = 5.67 \times 10^8 \frac{w}{m^2}$