CBSE

THERMAL PROPERTIES OF MATTER WS 11

Class 11 - Physics

Section A

1. A black body at 1,227° C emits radiations with maximum intensity at a wavelength of 5000 $\overset{o}{A}$. If the temperature of the body is increased by 1,000 °C the maximum intensity will be observed at **[1]**

   a) 5000 $\overset{o}{A}$

   b) 4000 $\overset{o}{A}$

   c) 3000 $\overset{o}{A}$

   d) 6000 $\overset{o}{A}$

2. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be **[1]**

   a) 225

   b) 450

   c) 1800

   d) 1000

3. The unit of Stefan's constant is **[1]**

   a) $Nm^{-2}\ K^{-4}$

   b) WmK^{-4}

   c) $Wm^{-2}K^{-4}$

   d) $Wm^{-2}K^{-1}$

4. Two identical metallic balls, whose temperatures are 200°C and 400°C respectively, are placed in an enclosure at 27° C. The ratio of heat-loss of the balls will be **[1]**

   a) 1 : 4

   b) $\frac{(473)^4-(300)^4}{(673)^4-(300)^4}$

   c) 1 : 2

   d) $\frac{(200)^4-(27)^4}{(400)^4-(27)^4}$

5. A perfectly black body is one whose **[1]**

   a) absorptive power is 1

   b) absorptive power is 0

   c) absorptive power is 0.5

   d) emissive power is 1

6. If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum, then **[1]**

   a) $\lambda_m \propto T^4$

   b) λ_m is independent of temperature

   c) $\lambda_m \propto \frac{1}{T}$

   d) $\lambda_m \propto T$

7. Surface temperatures of stars A and B are 727°C and 327° C respectively. What is the ratio $H_A : H_B$ for the heat radiated per second by the two stars? **[1]**

   a) 125 : 27

   b) 625 : 81

   c) 5 : 3

   d) 25 : 9

8. A black body at a temperature of 2600 K has the wavelength corresponding to maximum emission 1200 $\overset{o}{A}$. Assuming the moon to be perfectly black body, the temperature of the moon, if the wavelength corresponding to **[1]**

maximum emission is 5000 $\overset{o}{A}$, is

a) 3640 K
b) 5240 K
c) 7800 K
d) 6240 K

9. For an enclosure maintained at 1,000 K, the maximum radiation occurs at wavelength λ_m. If the temperature is raised to 2,000 K, the peak will shift to **[1]**

a) $\frac{\lambda_m}{2}$
b) $\frac{3\lambda_m}{2}$
c) $\frac{5\lambda_m}{2}$
d) $\frac{7\lambda_m}{2}$

10. According to Wien's law **[1]**

a) $\frac{\lambda_m}{\sqrt{T}}$ = constant
b) $\frac{\lambda_m}{T}$ = constant
c) $\lambda_m T$ = constant
d) $\lambda_m \sqrt{T}$ = constant

11. Suppose the sun expands so that its radius becomes 100 times its present radius and its surface temperature becomes half of its present value. The total energy emitted by it then will increase by a factor of **[1]**

a) 625
b) 10^4
c) 16
d) 256

12. If temperature of a black body increases from 7°C to 287°C then the rate of energy radiation increases by **[1]**

a) 4
b) 2
c) 16
d) $(\frac{287}{7})^4$

13. Temperatures of two stars are in ratio 3 : 2. If wavelength of maximum intensity of first body is 4000 $\overset{o}{A}$, what is corresponding wavelength of second body? **[1]**

a) 2000 $\overset{o}{A}$
b) 8000 $\overset{o}{A}$
c) 6000 $\overset{o}{A}$
d) 9000 $\overset{o}{A}$

14. A black body radiates energy at the rate of $1 \times 10°$ J/sm^2 at a temperature of 227°C. The temperature to which it must be heated so that it radiates energy at rate of 1×10^9 J/sm^2 **[1]**

a) 5000°C
b) 5000 K
c) 500°C
d) 500 K

15. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature, are taken inside a dimly lit room, then **[1]**

a) blue shines like brighter red compared to the red piece
b) red looks brighter red and blue looks ordinary blue
c) the blue piece will look blue and red will look as usual
d) both the pieces will look equally red

16. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q? **[1]**

a) $\left(\frac{Q}{4\pi R^2 \sigma}\right)^{-1/2}$
b) $\left(\frac{Q}{4\pi R^2 \sigma}\right)^{1/4}$

c) $\left(\frac{4\pi R^2 Q}{\sigma}\right)^{1/4}$ d) $\frac{Q}{4\pi R^2 \sigma}$

17. On increasing the temperature of a substance gradually, its colour becomes **[1]**

a) green b) white

c) yellow d) red

18. Which of the following is best close to an ideal black body? **[1]**

a) black lamp b) a lump of charcoal heated to high temperature

c) cavity maintained at constant temperature d) platinum black

19. A black body is heated from 27^o C to 127^o C. The ratio of the energies of radiations emitted will be **[1]**

a) 3 : 4 b) 27 : 64

c) 81 : 256 d) 9 : 16

20. The emissive power of a black body is proportional (T = absolute temperature) to **[1]**

a) $E \propto T^4$ b) $E \propto T^2$

c) $E \propto T^2$ d) $E \propto T^0$

21. A black body, at a temperature of 227°C radiates heat at a rate of 20 cal $m^{-2}s^{-1}$. When its temperature is raised to 727°C heat radiated by it (in cal $m^{-2}s^{-1}$) will be closest to **[1]**

a) 320 b) 640

c) 40 d) 160

22. Temperature of a black body increases from 327°C to 927°C the initial energy possessed is 2 kJ. What is its final energy? **[1]**

a) 1200 kJ b) 120 kJ

c) 320 kJ d) 32 kJ

23. A metal rod at a temperature of 150°C radiates energy at a rate of 20 W. If its temperature is increased to 300°C then it will radiate energy at the rate of **[1]**

a) 17.5 W b) 68.3 W

c) 37.2 W d) 40.8 W

24. If σ is Stefan's constant and b is Wien's constant, then the dimensions of σb^4 are **[1]**

a) $[M^1 L^4 T^{-3}]$ b) $[M L^6 T^{-3}]$

c) $[M L^{-1} T]$ d) $[M^0 L^0 T^0]$

25. A black body is at a temperature of 500 K. It emits energy at a rate, which is proportional to **[1]**

a) $(500)^4$ b) 500

c) $(500)^3$ d) $(500)^2$

26. If wavelength at 4500 K is λ_m, the wavelength at 1500 K is **[1]**

a) $\frac{\lambda_m}{3}$ b) $9\lambda_m$

c) $\frac{\lambda_m}{9}$ d) $3\lambda_m$

27. Black holes in orbit around a normal star are detected from the earth due to the frictional heating of infalling gas into the black hole, which can reach temperatures greater than 106K. Assuming that the infalling gas can be modelled as a black body radiator, then the wavelength of maximum power lies **[1]**

a) in the visible region
b) in the X-ray region
c) in the microwave region
d) in the gamma-ray region of electromagnetic spectrum

28. A piece of iron is heated in a flame. It first becomes dull red, then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using **[1]**

a) Stefan' law
b) Newton' law of cooling
c) Wien' displacement law
d) Kirchoff's law

29. A copper ball 2 cm in radius is heated in a furnace at 327°C. If its emissivity is 0.3, at what rate does it radiate energy? **[1]**

a) 2.15 W
b) 11.0 W
c) 2.73 W
d) 1.72 W

30. A black body at 227°C radiates heat at the rate of 2 cal cm^{-2} s^{-1}. At a temperature of 727°C the rate of heat radiated in the same units will be **[1]**

a) 60
b) 50
c) 80
d) 112

31. A body at a temperature of 727° C and having surface area 5 cm^2, radiates 300 J of energy each minute. The emissivity (Given: Boltzmann constant = 5.67 $\times$ 10^{-8} $Wm^{-2}K^{-4}$) is **[1]**

a) e = 0.02
b) e = 0.2
c) e = 0.18
d) e = 0.15

32. **Assertion (A):** Blue star is at high temperature than red star. **[1]**
Reason (R): Wein's displacement law states that $T \propto (\frac{1}{\lambda_m})$.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

33. **Assertion:** For higher temperatures, the peak emission wavelength of a black body shifts to lower wavelengths. **[1]**
Reason: Peak emission wavelength of a black body is proportional to the fourth-power of temperature.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
c) Assertion is correct statement but reason is wrong statement.
d) Assertion is wrong statement but reason is correct statement.

34. **Assertion (A):** The earth without its atmosphere would be inhospitably cold. **[1]**
Reason (R): All heat would escape in the absence of atmosphere.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

35. **Assertion (A):** A body that is a good radiator is also a good absorber of radiation at a given wavelength. **[1]**

Reason (R): According to Kirchhoff's law the absorptivity of a body is equal to its emissivity at a given wavelength.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

36. **Assertion (A):** For higher temperatures the peak emission wavelength of a black body shifts to lower wavelengths. **[1]**

Reason (R): Peak emission wavelengths of a black body is proportional to the fourth-power of temperature.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

37. **Assertion (A):** A black body at higher temperature T radiates energy U. When temperature falls to one third, the radiated energy will be $\frac{U}{81}$. **[1]**

Reason (R): $U^2 \propto T^4$

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

38. **Assertion (A):** For higher temperatures, the peak emission wavelength of a black body shifts to lower wavelength. **[1]**

Reason (R): Peak emission wavelength of a black body is proportional to the fourth power of temperature.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

39. **Assertion:** A hallow metallic closed container maintained at a uniform temperature can act as a source of black body radiation. **[1]**

Reason: All metals act as black bodies.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

40. **Assertion (A):** A hollow metallic closed container maintained at a uniform temperature can act as a source of black body radiation. **[1]**

Reason (R): All metals act as black bodies.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

41. **Assertion:** The radiation from the sun's surface varies as the fourth power of its absolute temperature. **[1]**

Reason: Sun is not a black body.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

42. **Assertion:** Blue star is at higher temperature than red star. **[1]**

Reason: Wien's displacement law states that $T \propto \frac{1}{\lambda_m}$.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

43. A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, b = 2.88 $\times$ 10^6 nmK. Which of the following is correct? **[1]**

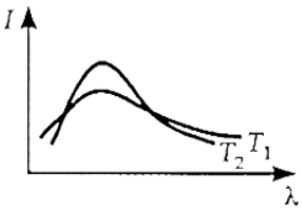
a) $U_1 > U_2$

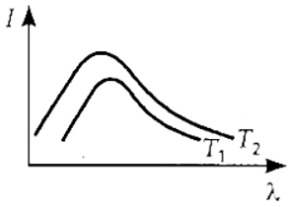
b) $U_1 = 0$

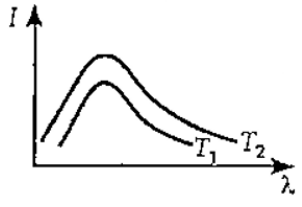
c) $U_3 = 0$

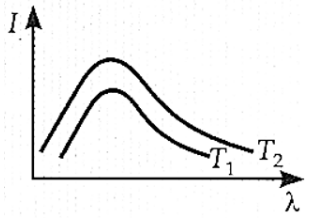
d) $U_2 > U_1$

44. Shown below are the black body radiation curves at temperatures T_1 and T_2 ($(T_2 > T_1)$. Which of the following plots is correct? **[1]**

a) 

b) 

c) 

d) 

45. Which of the following statements is wrong? **[1]**

i. Stefan's constant is same for all black bodies

ii. Thermal radiations travel with the speed of 3 $\times$ 10^8 m/s

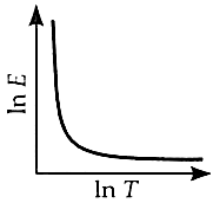
iii. Thermal radiations exhibit diffraction

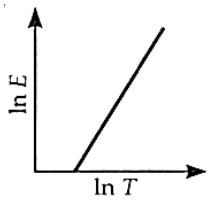
iv. Stefan's law is applicable for all heated bodies

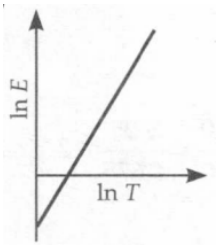
a) (iv) b) (ii)

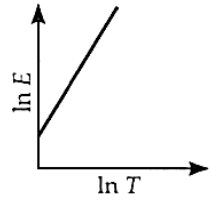
c) (iii) d) (i)

46. Which of the following graphs correctly represents the relation between E and T, where E is the amount of radiation emitted per unit time from unit area of body and T is the absolute temperature? **[1]**

a) 

b) 

c) 

d) 

47. Why a body with large reflectivity is a poor emitter? **[1]**

48. The surface temperature of a hot body is 1227^{o} C. Find the wavelength at which it radiates maximum energy. Given Wien's constant = 0.2898 cm K. **[1]**

49. What is the absorptivity of a perfect black body? **[1]**

50. If the temperature of a black body is increased from 300 K to 900 K, by what factor the rate of emission will increase? **[1]**

51. Suppose the surface area of a person's body is 1.8 m^2 and the room temperature is 20^{o} C. The skin temperature is 27^{o} C and the emissivity of the skin is about 0.97 for the relevant region of electromagnetic radiation. Estimate the rate of heat radiation from the body of the person. **[1]**

52. Why does a piece of red glass when heated and taken out glow with green light? **[1]**

53. The temperature of an ordinary electric bulb is around 3000 K. At what wavelength will it radiate maximum energy? Will this wavelength be within visible region? Given b = 0.288 cm K. **[1]**

54. Wavelength corresponding to E_{max} for the moon is 14 microns. Estimate the surface temperature of the moon, if $b = 2.884 \times 10^{-3}$ mK. **[1]**

55. A hole in the cavity of a radiator is a black body. Why? **[1]**

56. Draw energy distribution curves for a black body at two different temperatures T_1 and T_2 ($T_1 > T_2$). Write any two conclusions that can be drawn from these. **[1]**

57. The temperature of a body is 0°C. Is it radiating? **[1]**

58. A spherical body with radius 12 cm radiates 450 W power at 500 K. If the radius were halved and the temperature doubled, what would be the power radiated? **[1]**

59. At what temperature will the filament of 100 W lamp operate if it is supposed to be perfectly black body of area 1 cm^2? **[1]**

60. Calculate the temperature (in K) at which a perfect black body radiates energy at the rate of 5.67 W cm^{-2}. Given $\sigma = 5.67 \times 10^{-8}\,Wm^{-2}\,K^{-4}$. **[1]**

61. Is it necessary that all black coloured objects should be considered black bodies? **[1]**

62. The rate of dissipation of heat by a black body at temperature T is Q. What will be the rate of dissipation of heat by another body at temperature 2T and emissivity 0.25? **[1]**

63. Why is there the word displacement in Wien's displacement law? **[1]**

Section B

64. **State True or False:** **[2]**
    (a) A blackened platinum wire, when gradually heated, first appears dull red, then blue and finally white. **[1]**
    (b) All black-colored objects can be considered as black bodies. **[1]**

65. A black body initially at 27^oC is heated to 327^oC. How many times is total heat emitted at the higher temperature than that emitted at lower temperature? What is the wavelength of the maximum energy radiation at the higher temperature? Wien's constant = 2.898×10^{-3} mK. **[2]**

66. The spectral energy distribution of the sun has a maximum at 4753 $\overset{o}{A}$. If the temperature of the sun is 6050 K, what is the temperature of a star for which this maximum is at 9506 $\overset{o}{A}$? **[2]**

67. Discuss briefly energy distribution of black body radiation. Hence deduce Wien's displacement law. **[2]**

68. A blackened platinum wire, when gradually heated, first appears dull red, then blue and finally white. Explain why. **[2]**

69. Consider a filament which is indirectly heated. The radiating maximum energy having wavelength 3.4×10^{-5} cm. Determine the amount of heat energy lost per second per unit area if the temperature of surrounding air is 17^oC. **[2]**

    Given, $\sigma = 5.67 \times 10^{-8}$ Wm^{-2} K^{-4}, b = 2.9×10^{-3} mk

70. An indirectly heated filament is radiating maximum energy of wavelength 2.16×10^{-7}m. Find the net amount of heat energy lost per second per unit area, the temperature of surrounding air is 13^0C. Given b = 2.88 cm K, σ = 5.77×10^{-5} erg sec^{-1} cm^{-2} k^{-4}? **[2]**

Section C

71. **Fill in the blanks:** **[4]**
    (a) The wavelength corresponding to which the energy emitted by a black body is maximum is _____ proportional to its absolute temperature. **[1]**
    (b) Total heat energy emitted by a black body per second per unit area is directly proportional to the _____ power of the absolute temperature of its surface. **[1]**
    (c) A good emitter is a _____ reflector. **[1]**
    (d) A body that neither reflects nor transmits, but absorbs the whole of the radiation incident on it is called a _____. **[1]**