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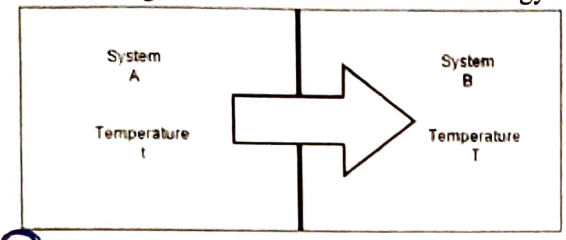
AME 365 QUIZ 1 SOLUTIONS

AME 365, 2021 QUIZ 1 - 2020/2021

Answer all questions on the question paper by placing a ring around the letter corresponding to the most appropriate option in pen.
In questions 25 and 28 you are required to show detailed working on the question paper to arrive at the answer before selecting the most appropriate option. Questions 25 and 28 will attract 3 marks each, while all other questions will attract one mark each.

1. Consider system A at uniform temperature t and system B at another uniform temperature T (t > T). Let the two systems be brought into contact and be thermally insulated from their surroundings but not from each other. Energy will flow from system A to system B because of



t > T ∴ flow of energy will be from A to B.
A higher temperature difference will result in a higher energy transfer

(a) Temperature difference
b) Energy difference
c) Mass difference
d) Volumetric difference

2. Unit of the rate of heat transfer is
a) Joule
b) Newton
c) Pascal
(d) Watt

Unit is energy per unit time i.e J/s = Watt (W)

3. The rate equation used to describe the mechanism of convection is called Newton's law of cooling. So rate of heat flow by convection doesn't depend on
a) Convective heat transfer coefficient ✓
b) Surface area through which heat flows ✓
(c) Time ✗
d) Temperature potential difference ✓

$\dot{Q}_{con} = f(A_s, h, \Delta T)$ — temp difference.
A_s: Surface area; h: Heat transfer coefficient

4. Thermal conductivity is maximum for which substance
a) Silver 410 W/mK
b) Ice 2.22 W/mK
c) Aluminum 204 W/mK
(d) Diamond 2300 W/mK

5. Which of the following is an example of forced convection?
a) Chilling effect of cold wind on a warm body — free convention
(b) Flow of water in condenser tubes involves use of pump to cause flow
c) Cooling of billets in the atmosphere — free convection
d) Heat exchange on cold and warm pipes — free convection.

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6. Which statement is true regarding steady state condition?
a) There is a variation in temperature in the course of time ✗
b) Heat exchange is constant ✓
c) It is a function of space and time coordinates ✗
d) Internal energy of the system changes ✗

7. Heat transfer in a long, hollow cylinder which is maintained at uniform but different temperatures on its inner and outer surfaces may be assumed to be taking place in which direction?
a) Axial only
b) Unpredictable
c) Radial only
d) No heat transfer takes place

8. Heat transfer takes place in liquids and gases is essentially due to
a) Radiation
b) Conduction
c) Convection
d) Conduction as well as convection

9. Identify the wrong statement
a) The process of heat transfer is an irreversible process ✓
b) For heat exchange, a temperature gradient must exist ✓
c) A material medium is not necessary for heat transmission ✓
d) Heat flow doesn't depend on temperature ✗

10. Most unsteady heat flow occurs
a) Through the walls of the refrigerator
b) During annealing of castings
c) Through the walls of the furnace
d) Through lagged pipe carrying steam

11. Fourier law of heat conduction is best represented by
a) $Q = -k A \, dt/dx$
b) $Q = k A \, dx/dt$
c) $Q = -k A$
d) $Q = k \, dt/dx$

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12. Consider the following statements:
The Fourier heat conduction equation
$Q = -k A \, dt/dx$
Presumes
i) Steady state conditions ✓
ii) Constant value of thermal conductivity ✗
iii) Uniform temperature at the wall surface ✓
iv) One dimensional heat flow ✓
Which of these statements are correct?
a) i, ii and iii
b) i, ii and iv
c) ii, iii and iv ✓
d) i, iii and iv ✗

c must be ii, iii and iv for
d to be i, iii and iv to be correct

13. Negative sign in Fourier heat conduction equation indicates
a) Heat always flow is in the direction of positive temperature gradient
b) Heat always flow in the direction of negative temperature gradient
c) No heat flow is there
d) Data is insufficient

$\dot{Q} = -kA\left(\frac{dt}{dx}\right)$ — This is negative value so -ve sign is inserted to make $\dot{Q}$ positive value.

14. Which one is not the unit of thermal conductivity?
a) kcal/m hr K
b) KJ/m hr K
c) W/m s K
d) Cal/cm s K
15. Which of the following is the unit of thermal resistance?
a) degree/kcal
b) hour degree
c) s degree/kcal
d) degree/W
16. Mark the matter with least value of thermal conductivity
a) Air 0.024 W/mK
b) Water 0.6071 W/mK
c) Ash 0.55–0.70 W/mK; 0.52–0.64 for $\varepsilon = 0.29$
d) Window glass 0.78 W/mK
17. The average thermal conductivities of water and air conform to the ratio
a) 50:1
b) 25:1
c) 5:1
d) 15:1

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18. Most metals are good conductor of heat because of
a) Transport of energy
b) Free electrons and frequent collision of atoms
c) Lattice defects
d) Capacity to absorb energy

19. The heat energy propagation due to conduction heat transfer will be minimum for
a) Lead
b) Water
c) Air
d) Copper

20. Choose the false statement
a) For pure metal thermal conductivity is more ✓ (increases)
b) Thermal conductivity decreases with increase in the density of the substance ✗
c) Thermal conductivity of dry material is lower than that of damp material ✓
d) Heat treatment causes variation in thermal conductivity ✓

21. The thermal conductivity and the electrical conductivity of a metal at absolute temperature are related as
a) $k/\sigma T$
b) k/σ
c) $k\,\sigma/T$
d) k/T

$L_o = \frac{K}{\sigma T}$ is called the Lorenz number
its value is $2.4 \times 10^{-8}\ W\Omega/K^2$

22. The unit of thermal diffusivity is
a) $m^2/hr\text{-}K$
b) $kcal/m^2\text{-}hr$
c) m^2/hr
d) $m/hr\text{-}K$

$\nabla^2 T = 0$ Laplace Equation

$\nabla^2 T + \dot{q}_g = 0$ Poisson Equation

$\nabla^2 T + \dot{q}_g = \frac{1}{\alpha} \frac{dT}{dt}$ Diffusion Equation.

23. The diffusion equations
$\nabla^2 t + q_g = (1/\alpha)\,(d\,t/d\,r)$
Governs the temperature distribution under unsteady heat flow through a homogeneous and isotropic material. The Fourier equation follows from this expression when
a) Temperature doesn't depends on time
b) There is no internal heat generation
c) Steady state conditions prevail
d) There is no internal heat generation but unsteady state condition prevails

24. The temperature distribution in a large thin plate with uniform surface temperature will be (Assume steady state condition)
a) Logarithmic
b) Hyperbolic
c) Parabolic
d) Linear

σ electrical resistivity
K – thermal conductivity.
L_o is constant b/n −100°C and 100°C

L_o (Lorenz number, applicable for metals only b/n −100°C and 100°C

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25. The interior of an oven is maintained at a temperature of 850 degree Celsius by means of a suitable control apparatus. The oven walls are 500 mm thick and are fabricated from a material of thermal conductivity 0.3 W/m degree. For an outside wall temperature of 250 degree Celsius, workout the resistance to heat flow

$R_t = \frac{L}{KA} = \frac{1}{A}\frac{0.5m}{0.3 W/m^\circ C} = 1.667\ ^\circ C/W$

Assume $A = 1\ m^2$.

a) 0.667 degree/W
b) 1.667 degree/W
c) 2.667 degree/W
d) 3.667 degree/W

26. The rate of heat transfer for a plane wall of homogenous material with constant thermal conductivity is given by

a) $Q = kA\ (t_1 - t_2)/\delta$
b) $Q = 2kAx/\ \delta$
c) $Q = 2kA\delta x$
d) $Q = 2k/\delta\ x$

27. The rate of convective heat transfer between a solid boundary and adjacent fluid is given by

a) $Q = h\ A\ (t_s - t_f)$
b) $Q = h\ A$
c) $Q = (t_s - t_f)$
d) $Q = h\ (t_s - t_f)$

28. A rod of 3 cm diameter and 20 cm length is maintained at 100 degree Celsius at one end and 10 degree Celsius at the other end. These temperature conditions are attained when there is heat flow rate of 6 W. If cylindrical surface of the rod is completely insulated, determine the thermal conductivity of the rod material

$\delta = 0.2m$
$A_c = 0.000706 m^2$

$Q = kA_c\frac{(t_2 - t_1)}{\delta} = 6$ Find k

$k = 6x$

$A_c = \frac{\pi \times 0.03^2}{4} = 0.000706 m^2$

$\delta = (r_2 - r_1)$.

$\frac{k(0.000707)(100-10)}{0.20} = 0.31815k = 6$

$k = 6/0.318275$

$K = 18.86\ W/m\ degree$

a) 21.86 W/m degree
b) 20.86 W/m degree
c) 19.86 W/m degree
d) 18.86 W/m degree

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29. Three metal walls of the same thickness and cross-sectional area have thermal conductivities k, 2k and 3k respectively. The temperature drop across the walls (for same heat transfer) will be in the ratio

$\delta_1 = \delta_2 = \delta_3 \quad A_1 = A_2 = A_3 = A \quad \delta t = \frac{Q\delta}{KA}$

$\dot{Q} = KA\frac{\delta t}{\delta x}$

(a) 3:2:1
b) 1:1:1
c) 1:2:3
d) Given data is insufficient

30. Let us say thermal conductivity of a wall is governed by the relation $k = k_0(1+\alpha t)$. In that case the temperature at the mid-plane of the heat conducting wall would be

a) Av. of the temperature at the wall faces
(b) More than average of the temperature at the wall faces
c) Less than average of the temperature at the wall faces
d) Depends upon the temperature difference between the wall faces

α is positive so it is more than the ave temp at the faces

31. "Radiation cannot be affected through vacuum or space devoid of any matter". True or false

a) True
(b) False

32. A composite wall of a furnace has two layers of equal thickness having thermal conductivities in the ratio 2:3. What is the ratio of the temperature drop across the two layers?

a) 2:3
(b) 3:2
c) 1:2
d) $\log_e 2 : \log_e 3$

$\dot{Q} = KA\frac{\delta t}{dx}$

$\frac{\delta t_1}{\delta t_2} = \frac{1/K_1}{1/K_2} = \frac{K_2}{K_1}$

From the question. $K_1 : K_2 = 2:3 \quad dt \propto 1/K$

$\therefore \frac{dt_1}{dt_2} = \frac{K_2}{K_1} = \frac{3}{2}$

$\delta t_1 = \frac{\dot{Q}\,\delta t_1}{K_1 A_1}$

$\delta t_1 = \frac{Q\delta t_1}{KA}$

$\delta t_2 = \frac{\dot{Q}\,\delta t_2}{K_2 A_2}$

$\frac{\delta t_1}{\delta t_2} = 2:1$

$\delta t_2 = \frac{\dot{Q}\,\delta t_2}{2KA}$

$\delta t_3 = \frac{\dot{Q}\,\delta t_2}{K_3 A_2}$

$\frac{\delta t_1}{\delta t_3} = 3:1 \quad \delta t_3 = \frac{Q\delta t_3}{3KA}.$

$\delta t_1 : \delta t_2 : \delta t_3$

$\Rightarrow$

3 : 2 : 1