(*a*) Convection
(*b*) Conduction
(*c*) Radiation
(*d*) Conduction and convection

Sol. (*c*) In boiler, the energy from flame is transmitted mainly by radiation to water wall and radiant super heater.

68. Consider the following statements :

Blowdown is necessary on boilers, because

1. the boiler water level is lowered rapidly in case it accidentally rises too high.
2. the precipitated sediment or sludge is removed while the boiler is in service.
3. the concentration of suspended solids in the boiler is controlled.

Of these statements

(*a*) 1, 2 and 3 are correct
(*b*) 1 and 2 are correct
(*c*) 3 alone is correct
(*d*) 1 and 3 are correct

Sol (*b*) Statements 1 and 2 are correct.

69. A double acting steam engine with a cylinder diameter of 19 cm and a stroke of 30 cm has a cut-off of 0.35. The expansion ratio for this engine is nearly

(*a*) 1.05
(*b*) 2.85
(*c*) 6.65
(*d*) 10.05

Sol. (*b*) The expansion ratio $= \frac{1}{\text{cut off}} = \frac{1}{0 \cdot 35} = 2 \cdot 85$

70. Once through boiler is named as such because

(*a*) flue gas passes only in one direction
(*b*) there is no recirculation of water
(*c*) air is sent through the same direction
(*d*) steam is sent out only in one direction

Sol. (*b*) Once through boiler is named as such because there is no recirculation of water as in case of natural or forced circulation boiler.

71. In steam turbine terminology, diaphragm refers to

(*a*) separating wall between rotors carrying nozzles
(*b*) the ring of guide blades between rotors
(*c*) a partition between low and high pressure dies
(*d*) the flange connecting the turbine exit to the condenser

Sol. (*a*) Diaphragm in steam turbines is a separating wall between rotors carrying nozzles.

72. A three-stage Rateau turbine is designed in such a manner that the first two stages develop equal power with identical velocity diagram while the third one develops more power with higher blade speed. In such a multistage turbine, the blade ring diameter

(*a*) is the same for all the three stages
(*b*) gradually increases from the first to the third stage
(*c*) of the third stage is greater than that of the first two stages
(*d*) of the third stage is less than that of the first two stages

Sol. (*b*) In multistage steam turbines, the pressure drops in each stage and specific volume increases. To handle higher specific volume of steam, the blade size and accordingly the blade ring diameter has to gradually increase from the first to the third stage.

73. In a De Laval nozzle expanding superheated steam from 10 bar to 0.1 bar, the pressure at the minimum cross-section will be

(*a*) 3.3 bar (*b*) 5.46 bar

(*c*) 8.2 bar (*d*) 9.9 bar

Sol. **(b)** The isentropic index for superheated steam is 1.3 and throat pressure $p_2 = p_1\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$

$$= 10\left(\frac{2}{1\cdot3+1}\right)^{\frac{1\cdot3}{0\cdot3}} = 10\left(\frac{2}{2\cdot3}\right)^{4\cdot33}$$

$$= 10\times0\cdot869^{4\cdot33} = 10\times0\cdot546 = 5\cdot46 \text{ bar}$$

74. The effect of friction on flow of steam through a nozzle is to

(*a*) decrease the mass flow rate and to increase the wetness at the exit

(*b*) increase the mass flow rate and to increase the exit temperature

(*c*) decrease the mass flow rate and to decrease the wetness of the steam

(*d*) increase the exit temperature, without any effect on the mass flow rate

Sol. (*c*) The effect of friction of flow of steam through a nozzle is to decrease the mass flow rate and to decrease the wetness of the steam.

75. A single-stage impulse turbine with a diameter of 120 cm runs at 3000 rpm. If the blade speed ratio is 0.42, then, the inlet velocity of steam will be

(*a*) 79 m/s (*b*) 188 m/s

(*c*) 450 m/s (*d*) 900 m/s

Sol. (*c*) Blade speed ratio $= \dfrac{\text{blade speed}}{\text{velocity of steam at entry}}$

$$Vb = \frac{\pi DN}{60} = \frac{\pi\times1\cdot2\times3000}{60}\text{m/s.}$$

$\therefore$ Inlet velocity of steam $= \dfrac{\pi\times1\cdot2\times50}{0\cdot42} = 450\text{m/s}$

76. In an ideal impulse turbine, the

(*a*) absolute velocity at the inlet of moving blade is equal to that at the outlet

(*b*) relative velocity at the inlet of the moving blade is equal to that at the outlet

(*c*) axial velocity at the inlet is equal to that at the outlet

(*d*) whirl velocity at the inlet is equal to that at the outlet

Sol. (*b*) For an ideal impulse turbine, relative velocity at inlet of the moving blade is equal to that at the outlet.

77. For a Parsons' reaction turbine, if α_1 and α_2 are fixed blade angles at inlet and exit respectively and β_1 and β_2 are the moving blade angles at entrance and exit respectively, then

(*a*) $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$ (*b*) $\alpha_1 = \beta_1$ and $\alpha_2 = \beta_2$

(*c*) $\alpha_1 < \beta_1$ and $\alpha_2 > \beta_2$ (*d*) $\alpha_1 = \beta_2$ and $\beta_1 = \alpha_2$

Sol. (*d*) For a Parson's reaction turbine, fixed blade inlet angle α_1 = moving blade angle at exit and fixed blade exit angle α_2 = moving blade angle at inlet.

78. The isentropic enthalpy drop in moving blade is two-thirds of the isentropic enthalpy drop in fixed blades of a turbine. The degree of reaction will be

(*a*) 0.4 (*b*) 0.6

(*c*) 0.66 (*d*) 1.66

Sol. (*a*) Degree of reaction $= \dfrac{\Delta h \text{ (moving blade)}}{\Delta h \text{ (moving blade)} + \Delta h \text{ (fixed blade)}}$

$$= \frac{\frac{2}{3}\Delta h(\text{fixed blade})}{\frac{2}{3}\Delta h(\text{fixed blade})} = \frac{\frac{2}{3}}{1\frac{2}{3}} = \frac{2}{3} \times \frac{3}{5} = 0.4$$

79. Efficiency of nozzle governed turbine is affected mainly by losses due to

(*a*) partial admission (*b*) throttling

(*c*) interstage pressure drop (*d*) condensation in last stages

Sol. (*a*) Efficiency of nozzle governed turbine is affected mainly by losses due to partial admission because nozzle governing is accomplished by covering some of the nozzles and permitting entry through partial of the nozzles.

80. Which one of the following pairs is correctly matched ?

(*a*) Stage efficiency — $\dfrac{\text{actual enthalpy drop}}{\text{isentropic enthalpy drop}}$

(*b*) Nozzle efficiency — $\dfrac{\text{work delivered}}{\text{isentropic enthalpy drop}}$

(*c*) Diagram efficiency — $\dfrac{\text{work delivered by blades}}{\text{isentropic enthalpy drop}}$

(*d*) Blade efficiency — $\dfrac{\text{work done on moving blades}}{\text{actual enthalpy drop}}$

Sol. (*a*) The correct matching is stage efficiency $= \dfrac{\text{actual enthalpy drop}}{\text{isentropic enthalpy drop}}$

81. Consider the following statements :

1. Reciprocating compressors are best suited for high pressure and low volume capacity.
2. The effect of clearance volume on power consumption is negligible for the same volume of discharge.

3. While the compressor is idling, the delivery valve is kept open by the control circuit.
4. Intercooling of air between the stages of compression helps to minimise losses.

Of these statements

(*a*) 1 and 2 are correct (*b*) 1 and 3 are correct

(*c*) 2 and 4 are correct (*d*) 3 alone is correct

Sol. (*b*) Statements 1 and 3 are correct and thus choice is (*b*).

82. The inlet and exit velocity diagrams of a turbomachine rotor are shown in the given figure. The turbomachine is

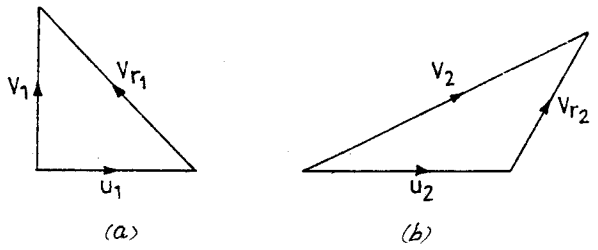


Fig. 11

(*a*) an axial compressor with backward curved blades
(*b*) a radial compressor with backward curved blades
(*c*) a radial compressor with forward curved blades
(*d*) an axial compressor with forward curved blades

Sol. (*c*) From inlet and outlet diagrams it will be seen the blade velocity $u_2 > u_1$, from which it is clear that it is radial compressor. For axial compressor, $u_2 = u_1$. Further in outlet velocity triangle, velocity Vr_2 is in the direction of u_2 which means blades are forward curved. In case of backward curved blades the direction of Vr_2 will be opposite to that of u_2, i.e. angle between Vr_2 & u_2 will be acute.

83. A multistage compressor is to be designed for a given flow rate and pressure ratio. If the compressor consists of axial flow stages followed by centrifugal instead of only axial flow stages, then the

(*a*) overall diameter would be decreased
(*b*) overall diameter would be increased
(*c*) axial length of the compressor would be increased
(*d*) axial length of the compressor would be decreased

Sol. (*b*) In case of axial flow stages, diameter will be less and same but in case of centrifugal compressor, the flow is radial at outlet and thus overall diameter will increase.

84. In air-craft gas turbines, the axial flow compressor is preferred because

(*a*) of high pressure rise (*b*) it is stall free

(*c*) of low frontal area (*d*) of higher thrust

Sol. (*c*) Axial flow compressor is preferred in aircraft gas turbines because of requirement of low frontal area.

85. In axial flow compressor, exit flow angle deviation from the blade angle is a function of

(*a*) blade camber (*b*) space-chord ratio

(*c*) both blade camber and space-chord ratio (*d*) blade camber and incidence angle

Sol. **(*c*)** (*c*) is the correct choice.

86. If the velocity of propagation of small disturbances in air at 27°C is 330 m/s, then at a temperature of 54°C, its speed would be

(*a*) 660 m/s (*b*) $330 \times \sqrt{2}$ m/s

(*c*) $330 / \sqrt{2}$ m/s (*d*) $330 \times \sqrt{\frac{327}{300}}$ m/s

Sol. **(*d*)** Velocity of propagation of small disturbance is proportional to $\sqrt{T}$,

$\therefore$ new velocity of propagation will be $330 \times \sqrt{\frac{327}{300}}$ *m/s*

87. For one-dimensional isentropic flow in a diverging passage, if the initial static pressure is P_1 and the initial Mach number is M_1 ($M_1 < 1$), then for the downstream flow

(*a*) $M_2 < M_1 ; p_1 < p_1$ (*b*) $M_2 < M_1 ; p_2 > p_1$

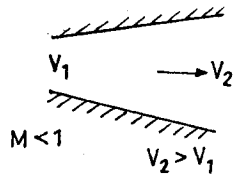
(*c*) $M_2 > M_1 ; p_2 > p_1$ (*d*) $M_2 > M_1 ; p_2 < p_1$

Sol. **(*a*)** For down stream flow, $M_2 < M_1$, and $p_2 < p_1$ for diverging section and subsonic flow conditions.

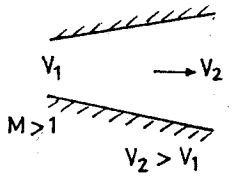
88. Which of the following diagrams correctly depict the behaviour of compressible fluid flow in the given geometries ?

Select the correct answer using the codes given below :

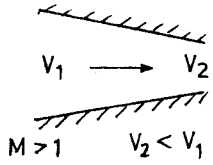
1.



2.



3.



4.

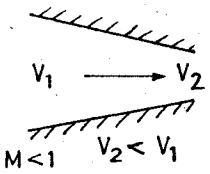


Fig. 12

Codes :

(*a*) 1 and 4 (*b*) 2 and 4

(*c*) 2 and 3 (*d*) 1 and 3

Sol. **(*c*)** Parts 2 and 3 of Fig. 12 represent correct behaviour of compressible fluid flow.

Thus code (*c*) is correct.

89. The given figure represents a schematic view of the arrangement of a supersonic wind tunnel section. A normal shock can exist without affecting the test conditions.

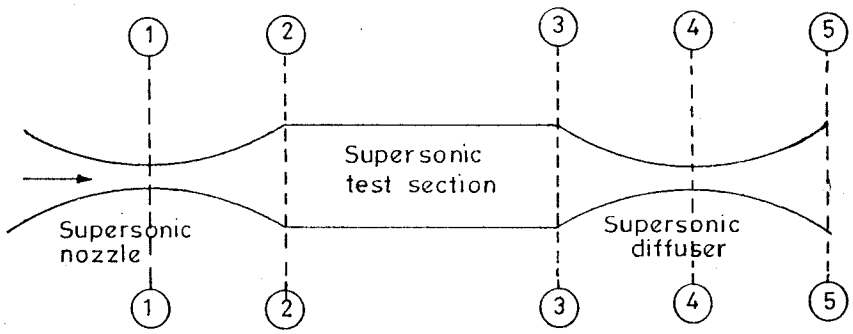


Fig. 13

(*a*) between sections 4 and 5 (*b*) at section 4

(*c*) between sections 4 and 3 (*d*) between sections 1 and 2

Sol. (*d*) A normal shock can exist between 1 and 2 without affecting the test conditions, as it can be swallowed through the second throat by making it larger than the first.

90. The thurst of a jet propulsion power unit can be increased by

(*a*) injecting water into the compressor

(*b*) burning fuel after gas turbine

(*c*) injecting ammonia into the combusition chamber

(*d*) all of the above

Sol. (*a*) The thrust of a jet propulsion power unit can be increased by injecting water into the compressor.

91. In a gas turbine cycle with two stages of reheating, working between maximum pressure P_1 and minimum pressure P_4, the optimum reheat pressures would be

(*a*) $(P_1P_4)^{1/3}$ and $(P_1P_4)^{2/3}$ (*b*) $(P_1^2P_4)^{2/3}$ and $(P_1P_4^2)^{1/3}$

(*c*) $\sqrt{P_1}P_4$ and $P_1\sqrt{P_4}$ (*d*) $(P_1P_4)^{1/2}$ and $(P_1P_4)^{2/3}$

Sol. (*a*) For single stage optimum reheat pressure is $\sqrt{P_1P_2}$ and for 2-stages of reheating, the optimum reheat pressures would be $\sqrt[3]{P_1P_4}$ and $\sqrt[3]{(P_1P_4)^2}$

92. Intercooling in gas turbines

(*a*) decreases net output but increases thermal efficiency

(*b*) increases net output but decreases thermal efficiency

(*c*) decreases both net ouput and thermal efficiency

(*d*) increases both net output and thermal efficiency

Sol. (*b*) Intercooling in gas turbine is used to compress air in two stages with intercooling. With intercooling the work to be done on compressor decreases and thus net output of turbine increases. However more heat has to be added in combustion chamber which results in decrease in thermal efficiency.

93. A furnace is made of a red brick wall of thickness 0.5 m and conductivity 0.7W/mK. For the same heat loss and temperature drop, this can be replaced by a layer of diatomite earth of conductivity 0.14 W/mK and thickness

(*a*) 0.05 m (*b*) 0.1 m
(*c*) 0.2 m (*d*) 0.5 m

Sol. **(*b*)** For thick place homogeneous wall, heat loss $= kA\frac{\Delta t}{\Delta x}$

$$= \left(0{\cdot}7 \times A \times \frac{\Delta t}{0{\cdot}5}\right)_{red\ brick} = \left(0{\cdot}14 \times A \times \frac{\Delta t}{\Delta x}\right)_{diatomite}$$

or $$\Delta x = \frac{0{\cdot}14}{0{\cdot}7} \times 0{\cdot}5$$
$$= 0{\cdot}2 \times 0{\cdot}5 = 0{\cdot}1\,\text{m}$$

94. Upto the critical radius of insulation

(*a*) added insulation will increase heat loss
(*b*) added insulation will decrease heat loss
(*c*) convection heat loss will be less than conduction heat loss
(*d*) heat flux will decrease

Sol. **(*b*)** Upto the critical radius of insulation, the added insulation will decrease heat loss and will have no effect beyond that.

95. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Dimensionless quantity)*	**List II** *(Application)*
A. Stanton number	1. Natural convection for ideal gases
B. Grashof number	2. Mass transfer
C. Peclet number	3. Forced convection
D. Schmidt number	4. Forced convection for small Prandtl number

Codes :	*A*	*B*	*C*	*D*
(*a*)	2	4	3	1
(*b*)	3	1	4	2
(*c*)	3	4	1	2
(*d*)	2	1	3	4

Sol. **(*b*)** The correct mathcing for various dimensionless quantites is provided by code (*b*)

96. A designer chooses the values of fluid flow ranges and specific heats in such a manner that the heat capacities of the two fluids are equal. A hot fluid enters the counterflow heat exchanger at 100°C and leaves at 60°C. The cold fluid enters the heat exchanger at 40°C. The mean temperature difference between the two fluids is temperature difference between the two fluids is :

(*a*) (100 +60 + 40)/3°C (*b*) 60°C
(*c*) 40°C (*d*) 20°C

Sol. **(d)** Mean temperature difference
= temperature of hot fluid at exit – temperature of cold fluid at entry
= 60° – 40° = 20°C.

97. For infinite parallel planes with emissivities ε_1 and ε_2, the interchange factor for radiation from surface 1 to surface 2 is given by

(*a*) $\dfrac{\varepsilon_1\varepsilon_2}{\varepsilon_1+\varepsilon_2-\varepsilon_1\varepsilon_2}$ (*b*) $\dfrac{1}{\varepsilon_1}+\dfrac{1}{\varepsilon_2}$

(*c*) $\varepsilon_1+\varepsilon_2$ (*d*) $\varepsilon_1\varepsilon_2$

Sol. **(*a*)** For infinite parallel planes with emissivities ε_1 and ε_2, the interchange factor or effective emissivity coefficient

$$= \frac{1}{\frac{1}{\varepsilon_2}+\frac{1}{\varepsilon_2}-1}$$

$$= \frac{\varepsilon_1\varepsilon_2}{\varepsilon_1+\varepsilon_2-\varepsilon_1\varepsilon_2}$$

98. A thin flat plate 2m by 2m is hanging freely in air. The temperature of the surroundings is 25°C. Solar radiation is falling on one side of the plate at the rate of 500 W/m². The temperature of the plate will remain constant at 30°C, if the convective heat transfer coefficient (in W/m²°C) is

(*a*) 25 (*b*) 50
(*c*) 100 (*d*) 200

Sol. **(a)** Heat transfer by convection $Q = hA\Delta t$

$$Q = 500\text{W/m}^2 \times \text{area} = 500 \times 2 \times 2\text{W}$$

or $$500\text{W/m}^2 \times 2 \times 2 = h \times 2 \times 2 \times (30-25)$$

or $$h = \frac{500}{5} = 100 W/\text{m}^2\text{°C}$$

99. Given the following data,
inside heat transfer coefficient = 25 W/m²°K
outside heat transfer coefficient = 25 W/m²°K
thermal conductivity of bricks (15 cm thick) = 0.15 W/mK,
the overall heat transfer coefficient (in W/m²K) will be closer to the

(*a*) inverse of heat transfer coefficient
(*b*) heat transfer coefficient
(*c*) thermal conductivity of bricks
(*d*) heat transfer coefficient based on the thermal conductivity of the bricks alone

Sol. **(*d*)** Overall coefficient of heat transfer U W/m²°K is expressed as

$$\frac{1}{U} = \frac{1}{h_i} + \frac{\Delta x}{k} + \frac{1}{h_o}$$
$$= \frac{1}{25} + \frac{0 \cdot 15}{0 \cdot 15} + \frac{1}{25}$$
$$= \frac{2}{25} = 1 = 1\frac{2}{25} = \frac{27}{25}$$

so $U = \frac{25}{27}$ which is closer to the heat transfer coefficient based on the bricks alone.

100. A heat exchanger with heat transfer surface area A and overall heat transfer co-efficient U handles two fluids of heat capacities C_{max} and C_{min}. The parameter NTU (number of transfer units) used in the analysis of heat exchanger is specified as

(*a*) $\frac{AC_{min}}{U}$ (*b*) $\frac{U}{AC_{min}}$

(*c*) AUC_{min} (*d*) $\frac{AU}{C_{min}}$

Sol. (*d*) $NTU = \frac{AU}{C_{min}}$

101. For evaporators and condensers, for the given conditions, the logarithmic mean temperature difference (LMTD) for parallel flow is

(*a*) equal to that for counterflow (*b*) greater than that for counterflow
(*c*) smaller than that for counterflow (*d*) very much smaller than that for counterflow

Sol. (*c*) The LMTD for paralled flow is smaller than for counterflow.

102. ε—NTU method is particularly useful in thermal design of heat exchangers when

(*a*) the outlet temperature of the fluid streams is not known as a priori
(*b*) outlet temperature of the fluid streams is known as a priori
(*c*) the outlet temperature of the hot fluid streams is known but that of the cold fluid streams is not known as a priori
(*d*) inlet temperatures of the fluid streams are known as a priori

Sol. (*a*) (*a*) is the correct choice.

103. The burnout heat flux in the nucleate boiling regime is a function of which of the following properties?

1. Heat of evaporation
2. Temperature difference.
3. Density of vapour.
4. Density of liquid.
5. Vapour-liquid surface tension.

Select the correct answer using the codes given below :

Codes :

(*a*) 1, 2, 4 and 5 (*b*) 1, 2, 3 and 5
(*c*) 1, 3, 4 and 5 (*d*) 2, 3 and 4

Sol. (*a*) Density of vapour affects the film boiling and does not have much role during nucleate boiling. Factors 1, 2, 4 and 5 come into picture for burnout heat flux in the nucleate boiling regime.

104. A composite slab has two layers of different materials with thermal conductivity K_1 and K_2. If each layer had the same thickness, the equivalent thermal conductivity of the slab would be

(*a*) $K_1 + K_2$ (*b*) $\dfrac{(K_1 + K_2)}{(K_1 K_2)}$

(*c*) $\dfrac{(2K_1 K_2)}{(K_1 + K_2)}$ (*d*) $K_1 K_2$

Sol. (*b*) The equivalent thermal conductivity of slab $= \dfrac{K_1 + K_2}{K_1 K_2}$

105. Thermal boundary layer is a region where

(*a*) inertia terms are of the same order of magnitude as convection terms
(*b*) convection terms are of the same order of magnitude as dissipation terms
(*c*) convection terms are of the same order of magnitude as conduction terms
(*d*) dissipation is negligible

Sol. (*b*) Statement at (*b*) provides correct choice.

106. The thickness of thermal and hydrodynamic boundary layer is equal if (Pr = Prandtl Number, Nu = Nusselt Number)

(*a*) $P_r = 1$ (*b*) $P_r > 1$
(*c*) $P_r < 1$ (*d*) $P_r = Nu$

Sol. (*d*) Thickness of thermal and hydrodynamic boundary layer is equal if Pr = Nu.

107. A heat pump working on a reversed Carnot cycle has a C.O.P. of 5. If it works as a refrigerator taking 1 kW of work input, the refrigerating effect will be

(*a*) 1 kW (*b*) 2 kW
(*c*) 2 kW (*d*) 4 kW

Sol. (*d*)

$$\text{COP heat pump} = \frac{\text{heat rejected}}{\text{work done}}$$

or $\text{heat rejected} = 5 \times \text{work done}$

$\text{Also heat rejected} = \text{refrigeration effect} + \text{work input}$

or $5 \times \text{work input} - \text{work input} = \text{refrigeration effect}$

or $4 \times \text{work input} = \text{refrigeration effect}$

or $\text{refrigeration effect} = 4 \times 1\text{kW}$

$= 4\text{kW}$

108. A refrigerating system operating on reversed Brayton refrigeration cycle is used for maintaining 250K. If the temperature at the end of constant pressure cooling is 300 K and rise in the temperature of air in the refrigerator is 50 K, then the net work of compression will be (assume air as the working substance with c_p 1kJ per kg per°C)

(*a*) 250 kJ/kg (*b*) 200 kJ/kg
(*c*) 50kJ/kg (*d*) 25kJ/kg

Sol. (*d*) Fig. 13 shows the reversed Brayton refrigeration cycle.

Various values are shown.

Net work of compression = $(h_2 - h_1) - (h_3 - h_4)$

Now $$\frac{T_2}{T_1} = \frac{T_3}{T_4}$$

or $$T_2 = \frac{300}{200} \times 250 = 375$$

$\therefore$ Net work = $(375 - 250) - (300 - 200) = 25$

$\therefore$ Net work = $25 \times Cp = 25$ kJ/kg

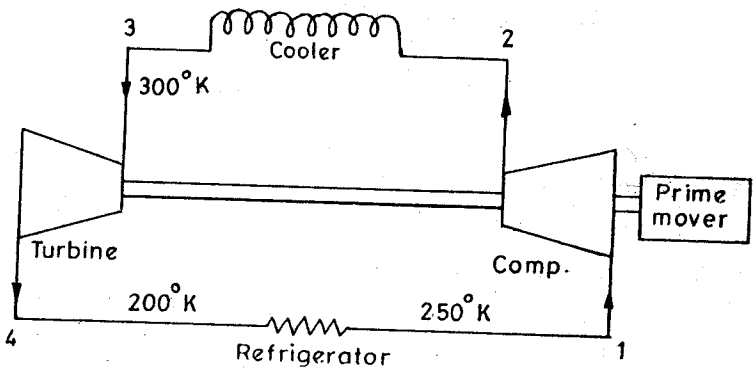


Fig. 13

109. In a vapour compression refrigeration plant, the refrigerant leaves the evaporator at 195 kJ/kg and the condenser at 65 kJ/kg. For every kg of refrigerant the plant can supply per second, a cooling load of,

(*a*) 70 kW (*b*) 100 kW
(*c*) 130 kW (*d*) 160 kW

Sol. (*c*) $h_1 = 195$ kJ/kg.

$h_3 = 65$ kJ/kg.

Since there is no heat transfer in throttling,

$h_3 = h_4$

Refrigeration effect = $h_1 - h_4$

$= 195 - 65 = 130$ kJ/kg.

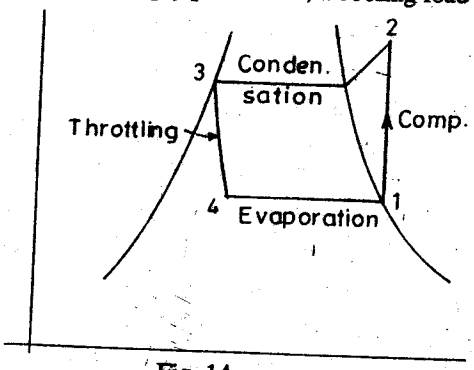


Fig. 14

110. While designing the refrigeration system of an aircraft prime consideration is that the

(*a*) system has high C.O.P.
(*b*) H.P./ton is low
(*c*) weight of refrigerant circulated in the system is low
(*d*) weight of the refrigeration equipment is low

Sol. (*d*) (*d*) is the correct choice.

111. A valve which maintains a constant degree of superheat at the end of the evaporator coil, is called

(*a*) automatic expansion valve
(*b*) high side float valve
(*c*) thermostatic expansion valve
(*d*) low side float valve

Sol. (*c*) (*c*) is the correct choice.

112. Which of the following statements are true for Ammonia as a refrigerant ?

1. It has higher compressor discharge temperature compared to fluorocarbons.
2. It is toxic to mucous membranes.
3. It requires larger displacement per TR compared to fluorocarbons.
4. It reacts with copper and its alloys.

Select the correct answer using the codes given below :

Codes :

(*a*) 1 and 2 (*b*) 1, 2 and 3
(*c*) 1, 2 and 4 (*d*) 2, 3 and 4

Sol. (*c*) Statements 1, 2 and 4 are correct.

113. Consider the following statements :

In chemical dehumidification process

1. dew point temperature decreases. 2. wet bulb temperature decreases.
3. dry bulb temperature increases.

Of these statements

(*a*) 1, 2 and 3 are correct (*b*) 1 and 2 are correct
(*c*) 2 and 3 are correct (*d*) 1 and 3 are correct

Sol. (*b*) Statements 1 and 2 are correct because dry bulb temperature remains constant in dehumidification process.

114. Moist air is a mixtue of dry air and water vapour. Hence three independent intrinsic thermodynamic properties are required to fix its thermodynamic state. While using psychrometric chart, however, only two thermodynamic properties are needed since, psychrometric chart

(*a*) is an approximation to actual properties
(*b*) assumes that both water vapour and dry air behave like perfect gases
(*c*) is drawn for actual properties of water vapour and dry air
(*d*) is drawn for a fixed pressure

Sol. (*d*) The psychrometric chart is drawn for a fixed pressure (standard atmospheric pressure) and thus only two thermodynamic properties are needed to fix thermodynamic state.

115. In a saturated air-water vapour mixture, the

(*a*) dry bulb temperature is higher than the wet bulb temperature
(*b*) dew point temperature is lower than the wet bulb temperature
(*c*) dry bulb, wet bulb and dew point temperatures are the same
(*d*) dry bulb temperature is higher than the dew point temperature

Sol. (*c*) In a saturated air-water vapour mixture, the dry bulb, wet bulb and dew point temperatures are the same.

116. Effective temperature is that temperature of saturated air which gives the same degree of comfort as the air at given

(*a*) DBT, WBT and incidental solar radiation
(*b*) WBT, incidential solar radiation and air flow rate
(*c*) DBT, sol-air temperature and air flow rate
(*d*) DBT, WBT and air flow rate

Sol. (*d*) Choice (*d*) is correct.

117. A human body feels comfortable when the heat produced by the metabolism of human body is equal to the

(*a*) heat dissipated to the surroundings
(*b*) heat stored in the human body
(*c*) sum of (*a*) and (*b*)
(*d*) difference of (a) and (*b*)

Sol. (*a*) Choice (*a*) is correct.

118. In the case of sensible cooling of air, the coil efficiency is given by (BPF = Bypass factor)

(*a*) *BPF*—1 (*b*) 1—*BPF*

(*c*) $\frac{1}{BPF}$ (*d*) 1 + *BPF*

Sol. (*b*) Coil efficiency in the sensible cooling is = 1 – *BPF*

119. In a spray washing system, if the temperature of water is higher than the dry bulb temperature of entering air, then the air is

(*a*) heated and dehumidified (*b*) heated and humidified
(*c*) cooled and humidified (*d*) cooled and dehumidified

Sol. (*b*) Choice (*b*) is correct.

120. In a psychrometric process, the sensible heat added is 30 kJ/sec and the latent heat added is 20 kJ/sec. The sensible heat factor for the process will be

(*a*) 0.3 (*b*) 0.6
(*c*) 0.67 (*d*) 1.5

Sol. (*b*) Sensible heat factor $= \frac{\text{sensible heat}}{\text{sensible heat + latent heat}}$

$= \frac{30}{30+20} = \frac{3}{5} = 0 \cdot 6$

Engineering Service Examination

MECHANICAL ENGINEERING—1993

PAPER–II

1. *This Test Booklet contains 120 items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose ONLY ONE response for each item.*
2. *You have to mark all your responses ONLY on the separate Answer Sheet provided. See directions in the Answer Sheet.*
3. *All items carry equal marks. Attempt all items. Your total marks will depend only on the number of correct responses marked by you in the Answer Sheet.*

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1. If the chip-tool contact length is reduced slightly by grinding the tool face, then

(*a*) both cutting force and interface temperature would decrease
(*b*) both cutting force and interface temperature would increase
(*c*) the cutting force would decrease but the interface temperature would increase
(*d*) the cutting force would increase but the interface temperature would decrease

Sol. (*c*) As the chip-tool contact length is reduced, it results in excessive stress concentration and greater heat generation. However, cutting force is less due to lesser contact area.

Thus cutting force is reduced and interface temperature would increase.

Thus (*c*) is the correct choice.

2. Tool life in the case of a grinding wheel is the time

(*a*) between two successive regrinds of the wheel
(*b*) taken for the wheel to be balanced
(*c*) taken between two successive wheel dressings
(*d*) taken for a wear of 1 mm on its diameter

Sol. (*a*) The tool life of a grinding wheel is the time between two successive regrinds of the wheel.

3. For achieving a specific surface finish in single point turning the most important factor to be controlled is

(*a*) depth of cut
(*b*) cutting speed
(*c*) feed
(*d*) tool rake angle

Sol. (*c*) Surface roughness is directly dependent on square of feed.

Slow cutting results in formation of built-up edge, but after certain speed the finish remains same.

Rake angle has noticeable effect at slow speeds, but its effect is small at speeds, used for finish machining.

Depth of cut does not have much influence till it is large enough to cause chatter.

Thus feed is the most important factor to be controlled for achieving a specific surface finish.

4. In ASA System, if the tool nomenclature is 8-6-5-5-10-15-2-mm, then the side rake angle will be

(*a*) 5° (*b*) 6°

(*c*) 8° (*d*) 10°

Sol. **(b)** The second item is the side rake angle. Thus 6° is the ride rake angle.

5. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Cutting tool Material)*	**List II** *(Major characteristic constituent)*
A. High speed steel	1. Carbon
B. Stellite	2. Molybdenum
C. Diamond	3. Nitride
D. Coated carbide tool	4. Columbium
	5. Cobalt

Codes :	A	B	C	D
(*a*)	2	1	3	5
(*b*)	2	5	1	3
(*c*)	5	2	4	3
(*d*)	5	4	2	3

Sol. **(b)** High speed steel, in addition to W, Cr & V, has Mo as the most influencing constituent. Thus A matches with 2.

Non ferrous alloys (stellites) are high in cobalt. Thus B matches with 5.

The major constituent of diamond is carbon. Thus C matches with 1.

Coated carbide tools are treated by nitriding.Thus D matches with 3.

All these choices are give in (*b*).

6. Consider the following parameters :

1. Grinding wheel diameter.
2. Regulating wheel diameter.
3. Speed of the grinding wheel.
4. Speed of the regulating wheel.
5. Angle between the axes of grinding and regulating wheels.

Among these parameters, those which influence the axial feed rate in centreless grinding would include

(*a*) 2, 4 and 5 (*b*) 1, 2 and 3

(*c*) 1, 4 and 5 (*d*) 3, 4 and 5

Sol. (*a*) The rate of longitudinal feed = $\pi \times$ diameter of regulating wheel $\times$ rpm of regulating wheel $\times$ sin (angle of inclination of regulating wheel)

Thus parameters 2, 4 and 5 given in (*a*) influence the axial feed rate in centreless grinding.

7. It is required to cut screw threads of 2 mm pitch on a lathe. The lead screw has a pitch of 6 mm. If the spindle speed is 60 rpm, then the speed of the lead screw will be

(*a*) 10 rpm (*b*) 20 rpm
(*c*) 120 rpm (*d*) 180 rpm

Sol. **(b)**

$$\frac{\text{Pitch to be cut}}{\text{Pitch of lead screw}} = \frac{\text{rpm of lead screw } (N_l)}{\text{rpm of spindle}}$$

or $$\frac{2}{6} = \frac{N_l}{60},$$

or $$N_l = 20 \text{ rpm}.$$

Thus (*b*) is the correct choice.

8. A 'Dynamometer' is a device used for the measurement of

(*a*) chip thickness ratio (*b*) forces during metal cutting
(*c*) wear of the cutting tool (*d*) deflection of the cutting tool

Sol. **(*b*)** Dynamometer is a device used for the measurement of forces during metal cutting.

9. The main purpose of boring operation, as compared to drilling is to :

(a) drill a hole (*b*) finish the drilled hole
(c) correct the hole (*d*) enlarge the existing hole

Sol. **(*d*)** The main purpose of boring operation is to enlarge the existing hole.

10. Climb milling is chosen while machining because

(*a*) the chip thickness increases gradually
(*b*) it enables the cutter to dig in and start the cut
(*c*) the specific power consumption is reduced
(*d*) better surface finish can be obtained

Sol. **(*d*)** The main advantage of climb milling is better surface finish

11. Internal gears can be made by

(*a*) hobbing (*b*) shaping with pinion cutter
(*c*) shaping with rack cutter (*d*) milling

Sol. **(b)** Internal gears can be made by shaping with pinion cutter.

12. A moving mandrel is used in

(*a*) wire drawing (*b*) tube drawing
(*c*) metal cutting (*d*) forging

Sol. **(*b*)** A moving mandrel is used in tube drawing.

13. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Equipments)*	**List II** *(Functions)*
A. Hot chamber machine	1. Cleaning
B. Muller	2. Core making
C. Dielectric Baker	3 Die casting
D. Sand blasting	4 Annealing
	5 Mixing

Codes :

	A	*B*	*C*	*D*
(*a*)	3	5	2	1
(*b*)	4	2	5	3
(*c*)	4	2	3	1
(*d*)	3	5	1	2

Sol. **(*a*)** Hot chamber machine is associated with die casting, muller with mixing of sand, dielectric baker with core making and sand blasting with cleaning.

Thus right code is (*a*).

14. Electron beam welding can be carried out in

(*a*) open air
(*b*) a shielding gas environment
(*c*) a pressurised inert gas chamber
(*d*) vacuum

Sol. **(*d*)** Electron beam welding is carried out in vacuum.

15. In sheet metal work, the cutting foce on the tool can be reduced by

(*a*) grinding the cutting edges sharp
(*b*) increasing the hardness of tool
(*c*) providing shear angle on tool
(*d*) increasing the hardness of die

Sol. **(*c*)** In sheet metal work, the cutting force on the tool can be reduced by providing shear angle on tool.

16. Tandem drawing of wires and tubes is necessary because

(*a*) it is not possible to reduce at one stage
(*b*) annealing is needed between stages
(*c*) accuracy in dimensions is not possible otherwise
(*d*) surface finish improves after every drawing stage

Sol. **(*a*)** Tandem drawing of wires and tubes is necessary because it is not possible to reduce at one stage.

17. In order to get uniform thickness of the plate by rolling process, one provides

(*a*) camber on the rolls
(*b*) offset on the rolls
(*c*) hardening of the rolls
(*d*) antifriction bearings

Sol. **(*a*)** In order to get uniform thickness of the plate by rolling process, one provides camber on the rolls to take care of unavoidable tool bending. Cylindrical rollers would result in production of plate with convex surface.

18. The blank diameter used in thread rolling will be

(*a*) equal to minor diameter of the thread
(*b*) equal to pitch diameter of the thread
(*c*) a little large than the minor diameter of the thread
(*d*) a little larger than the pitch diameter of the thread

Sol. (*b*) The blank diameter used in thread rolling is equal to pitch diameter of the thread.

19. Which one of the following manufacturing processes requires the provision of 'gutters' ?

(*a*) Closed die forging
(*b*) Centrifugal casting
(*c*) Investment casting
(*d*) Impact extrusion

Sol. (*a*) Closed die forging requires the provision of flash gutters to provide space for excess material and ensure complete and defect free forged part.

20. A hole of 30 mm diameter is to be produced by reaming. The minimum diameter permissible is 30.00 mm while the maximum diameter permissible is 30.05 mm. In this regard, consider the following statements about the reamer size :

1. The minimum diameter of the reamer can be less than 30 mm.
2. The minimum diameter of the reamer cannot be less than 30 mm.
3. The maximum diameter of the reamer can be more than 30.05 mm.
4. The maximum diameter of the reamer must be less than 30.05 mm.

Of these statements

(*a*) 1 and 4 are correct
(*b*) 1 and 3 are correct
(*c*) 2 and 3 are correct
(*d*) 2 and 4 are correct

Sol. (*a*) Since hole has to lie between 30.00 mm and 30.05 mm, the reamer size can be less than 30 mm and maximum diameter must be less than 30.05 mm.This is possible with statements 1 and 4 and thus correct choice is (*a*).

21. In centreless grinding, the work piece centre will be

(*a*) above the line joining the two wheel centres
(*b*) below the line joining the two wheel centres
(*c*) on the line joining the two wheel centres
(*d*) at the intersection of the line joining the wheel centres with the work plate plane.

Sol. (*a*) In centreless grinding, the workpiece centre will be above the line joining the two wheel centres. (Usually about half the diameter of workpiece).

22. A 'block' of informaiton in N.C. machine program means

(*a*) one row on tape
(*b*) a word comprising several rows on tape
(*c*) one complete instruction
(*d*) one complete program for a job

Sol. (*c*) A 'block' of information generally transmits one complete instruction for a designated machine movement.

23. The floating position of the holding fixture in a rotary transfer device is used to

(*a*) improve the accuracy of location
(*b*) reduce the tendency to over index
(*c*) reduce the cycle time
(*d*) improve upon the acceleration and deceleration characteristics

Sol. **(*a*)** The floating position of the holding fixture in a rotary transfer device is used to improve the accuracy of location.

24. When supported on three points, out of the 12 degrees of freedom the number of degrees of freedom arrested in a body is

(*a*) 3 (*b*) 4
(*c*) 5 (*d*) 6

Sol. **(*d*)** When supported on three points, following six degrees of freedom are arrested (two line movements along y-axis, two rotational movements each along x-axis and z-axis.)

25. A diamond locating pin is used in jigs and fixtures because

(*a*) diamond is very hard and wear resistant
(*b*) it occupies very little space
(*c*) it helps in assembly with tolerance on centre distance
(*d*) it has a long life

Sol. **(*c*)** A diamond locating pin is used in jigs and fixtures because it reduces time taken to load/unload the tool. Diamond pin prevents the movement around the pin and thus helps in assembly with tolerance on centre distance.

26. Process capability of a machine is defined as the capability of the machine to

(*a*) produce a definite volume of work per minute
(*b*) perform definite number of operations
(*c*) produce job at a definite spectrum of speed
(*d*) hold a definite spectrum of tolerances and surface finish

Sol. **(*d*)** Process capability of a machine is defined as the capability of the machine to hold a definite spectrum of tolerances and surface finish.

27. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Mech. property)*	**List II** *(Related to)*
A. Malleability	1. Wire drawing
B. Hardness	2. Impact loads
C. Resilience	3. Cold rolling
D. Isotropy	4. Indentation
	5. Direction

Codes :	*A*	*B*	*C*	*D*
(*a*)	4	2	1	3
(*b*)	3	4	2	5
(*c*)	5	4	2	3
(*d*)	3	2	1	5

Sol. **(b)** The correct matching is given by code (*b*) since malleability is related to cold rolling, hardness to indentation, resilience to impact loads, and isotropy to direction.

28. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Steel type)*	**List II** *(Product)*
A. Mild steel	1. Screw driver
B. Tool steel	2. Commercial beams
C. Medium carbon steel	3. Crane hooks
D. High carbon steel	4. Blanking dies

Codes :	*A*	*B*	*C*	*D*
(*a*)	1	4	3	2
(*b*)	2	4	1	3
(*c*)	1	3	4	2
(*d*)	2	4	3	1

Sol. **(*d*)** The correct choice is (*d*).

29. Which of the following statements are true of annealing of steels ?

1. Steels are heated to 500 to 700°C.
2. Cooling is done slowly and steadily.
3. Internal stresses are relieved.
4. Ductility of steel is reduced.

Select the correct answer using the codes given below :

Codes :

(*a*) 2, 3 and 4 (*b*) 1, 3 and 4
(*c*) 1, 2 and 4 (*d*) 1, 2 and 3

Sol. **(*a*)** Code (*a*) is right because statements 2, 3 and 4 are true for annealing.

30. Duralumin Alloy contains aluminium and copper in the ratio of

%Al	%Cu
(*a*) 94	4
(*b*) 90	8
(*c*) 88	10
(*d*) 86	12

Sol. **(*a*)** Duralumin alloy contains aluminium and copper in the ratio of 94% aluminium and 4% copper.

31. Eutectic reaction for iron-carbon system occurs at

(*a*) 600°C (*b*) 723°C
(*c*) 1147°C (*d*) 1493°C

Sol. **(*b*)** Eutectic reaction for iron-carbon system occurs at 723°C.

32. The blade of a power saw is made of

(a) boron steel (*b*) high speed steel
(c) stainless steel (*d*) malleable cast iron

Sol. **(b)** The blade of a power saw is made of high speed steel.

33. Which of the following pairs are correctly matched ?

1. Cellulose nitrate.....Table tenis ball.
2. Phenol furfurol..... Brake linings.
3. Epoxies..... Jigs and fixtures.

Select the correct answer using the codes given below :

Codes :

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

Sol. **(a)** Parts (1) & (2) are correctly matched.

34. Quartz is a

(a) ferroelectric material (b) ferromagnetic material
(c) piezoelectric material (d) diamagnetic material

Sol. **(c)** Quartz is a piezoelectric material.

35. A diagram showing the path followed by men and materials while performing a task is known as

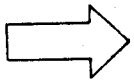
(a) String Diagram (b) Flow Process Chart
(c) Travel Chart (d) Flow Diagram

Sol. **(b)** A diagram showing the path followed by men and materials while performing a task is known as flow process chart.

36. Match List I with List II and select the correct answer using the codes given below the lists :

List I *(Activity)*		**List II** *(Symbol)*
A. A man is doing some productive work	1.	
B. A load is moving from one place to another	2.	

C. A hand is not accomplishing any thing and is waiting 3. 

D. A hand is holding an object 4. 

5. 

Fig. 1.

Codes :	A	B	C	D
(a)	1	4	3	5
(b)	1	3	4	5
(c)	3	2	1	4
(d)	3	4	5	2

Sol. (a) Code (a) provides correct answer.

37. The following data pertain to a worker :

Base rate = Rs. 20 per hour.

Time taken for completing the job = 2 hours.

Standard time = 3 hours.

Under Halsey plan, the total earning of the worker is

(a) Rs. 36.67 (b) 40.67

(c) Rs. 46.67 (d) Rs. 56.67

Sol. Under Halsey Plan

$$W = HA + \left(\frac{S-A}{2}\right)H$$

Where W = wage, H = base rate = Rs. 20/hrs.

A = actual time = 2 hrs.

S = standard time = 3 hrs.

$$\therefore \quad W = 20 \times 2 + \frac{(3-2)20}{2} = \text{Rs. } 50.$$