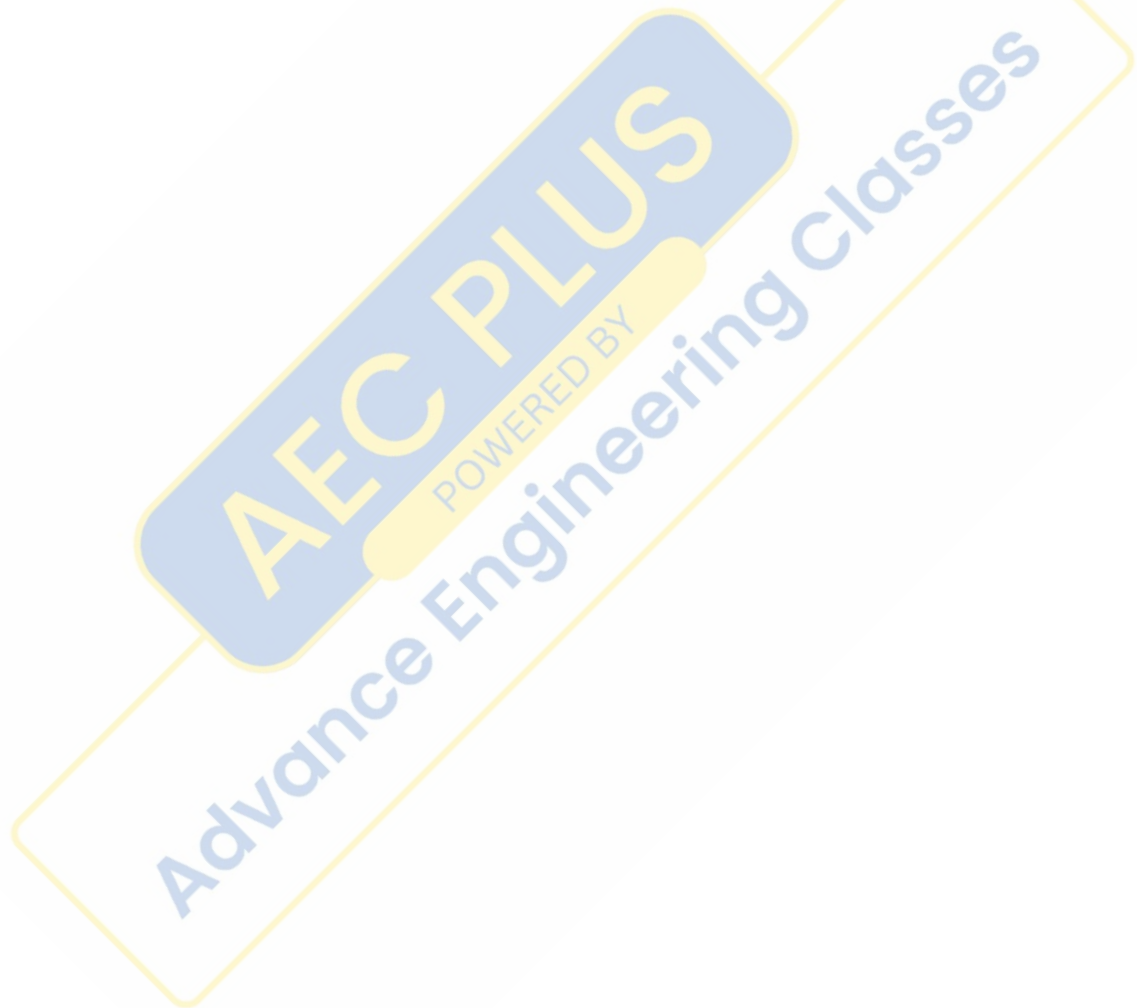


**ISRO**

**Previous Year Paper  
Refrigeration and  
Air Conditioning 2019**





GOVERNMENT OF INDIA :: DEPARTMENT OF SPACE  
**INDIAN SPACE RESEARCH ORGANISATION**

ISRO Centralised Recruitment Board

Recruitment Entrance Test for Scientist/Engineer 'SC' (CEPO) – 2019

Test Booklet		<b>REFRIGERATION &amp; AIR-CONDITIONING</b>	<b>B</b>
Date	:	March 10, 2019 (Sunday)	
Time	:	10.00 Hrs. to 11.30 Hrs.	
Test Duration (Minutes)	:	90	
No. of Questions	:	80	
No. of Pages (Other than cover sheet)	:	18	

**Instructions to the candidate**

1. The question paper is in the form of test booklet. All candidates will be assessed on identical questions.
2. A separate **OMR** answer sheet is provided to all candidates for answering.
3. Each objective question is provided with a text and/or figures wherever applicable with **multiple answer choices (a), (b), (c) and (d)**. Choose the most appropriate answer.
4. Read the instructions on the **OMR** sheet carefully. Use only **Blue or Black Ball Point Pen** for writing on OMR sheet and marking your answers.
5. All objective type questions carry equal marks of **THREE** for a correct answer, **ZERO** for no answer and minus **ONE** for a wrong answer.
6. **Multiple answers** for a question will be regarded as a wrong answer.
7. Although the test stresses on accuracy more than speed, it is important for you to use your time as effectively as possible.
8. Do not waste time on questions, which are too difficult for you. You can go on to other questions and come back to the difficult ones later.
9. Question booklets have been marked with **A** or **B** or **C** or **D** or **E** on the right hand top corner, which is mandatory to be written on the OMR sheet in the box and bubbled appropriately, failing which, the answer sheet will not be evaluated.
10. Space available in the booklet could be used for rough work, if required. No separate sheet will be provided.
11. Before signing the attendance sheet, the candidate should write the Booklet Code in the attendance sheet. Candidates should sign against THEIR names only.
12. **At the end of the test (1) Written Test Call Letter(s) with photograph pasted on it and (2) OMR Answer Sheet shall be returned to the Invigilator and shall not be carried by the candidate under any circumstances. Carbon copy of the OMR answer sheet may be retained by the candidate for future reference.**

\*\*\*

1. A diesel engine develops a Brake power of 4.5 kW. Its indicated thermal efficiency is 30% and the mechanical efficiency is 85%. Considering calorific value of the fuel as 40000 kJ/kg, the fuel consumption will be
 

(a) 2.1 kg/hr	(b) 3.9 kg/hr
(c) 1.6 kg/hr	(d) 4.6 kg/hr
  
2. A cycle consisting of two reversible isothermal processes and two reversible isobaric processes is known as
 

(a) Atkinson cycle	(b) Stirling cycle
(c) Brayton cycle	(d) Ericsson cycle
  
3. A large clearance volume in a reciprocating compressor results in
 

(a) Reduced volume flow rate	(b) Increased volume flow rate
(c) Lower suction pressure	(d) Lower delivery pressure
  
4. Two beams have the same length, same allowable stresses and the same bending moment. The cross sections of the beams are a square and a rectangle with depth twice that of width. The ratio of weight of square beam to the weight of rectangular beam is
 

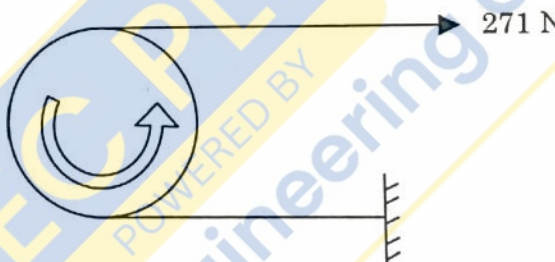
(a) 0.85	(b) 0.75
(c) 0.95	(d) 1.25
  
5. Two shafts A and B are made of same material. The diameter of shaft B is twice that of shaft A. The ratio of power which can be transmitted by shaft A to that of shaft B is
 

(a) 1/2	(b) 1/4
(c) 1/8	(d) 1/16

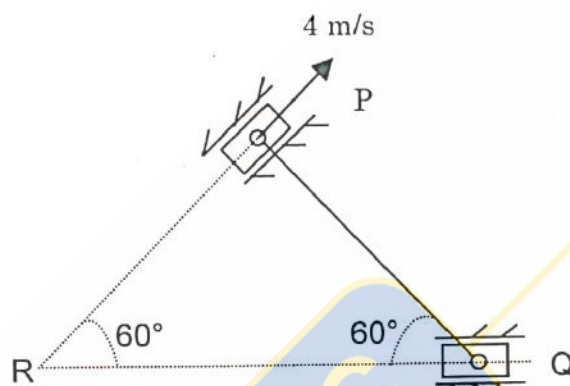


6. The value of maximum deflection for a cantilever beam of length  $l$  and carrying uniformly varying load from zero at free end to  $w$  per unit length at fixed end is
- (a)  $wl^3/8 EI$  (b)  $wl^3/16 EI$   
(c)  $wl^4/30 EI$  (d)  $wl^3/48 EI$
7. In a riveted joint, when the number of rivets decrease from the innermost row to outermost row, the joint is said to be
- (a) Chain rivetted (b) Zig-zag rivetted  
(c) Diamond rivetted (d) None of these
8. The process of reheating the martensitic steel to reduce its brittleness without any significant loss of hardness is called
- (a) normalising (b) tempering  
(c) annealing (d) quenching
9. 18/8 stainless steel contains
- (a) 18% steel, 8% chromium (b) 18% chromium, 8% nickel  
(c) 18% tungsten, 8% nickel (d) 18% tungsten, 8% chromium
10. Crowning of pulley is done to
- (a) Increase the tightness of the belt on the pulley  
(b) Prevent the belt running off the pulley  
(c) Increase the torque transmitted  
(d) Improve shape and strength of pulley
11. Flow of a liquid at a constant rate through a conical pipe is classified as
- (a) Unsteady, non uniform flow (b) Unsteady, uniform flow  
(c) Steady, non uniform flow (d) Steady, uniform flow

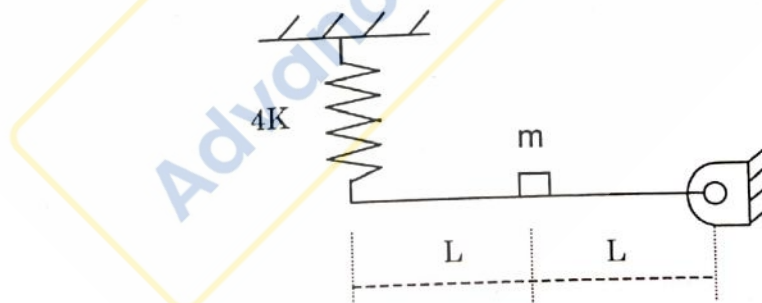
12. The comparison between pumps operating in series and in parallel is
- Pumps operating in series boost the head, whereas pumps in parallel boost the discharge
  - Pumps operating in series boost the discharge, whereas pumps in parallel boost the head
  - In both the cases there would be a boost in head only
  - In both the cases there would be a boost in discharge only
13. A jet of water issuing from a nozzle strikes a flat plate normally (plane of plate makes an angle  $90^\circ$  with the axis of the jet). The plate moves towards the nozzle with a velocity of 10 m/s while the jet issuing from the nozzle has a velocity of 15 m/s. The absolute velocity components of the jet (in m/s) as it leaves the vane, parallel ( $x$  component) and normal component ( $y$  component) to the undisturbed jet are. (Neglect friction on the surface).
- $V_x = 5, V_y = 5$
  - $V_x = -5, V_y = 5$
  - $V_x = 10, V_y = 10$
  - $V_x = -10, V_y = 25$
14. The overall heat transfer coefficient ( $U$ ) for a composite wall of thicknesses  $x_1, x_2, x_3$  and of corresponding thermal conductivities  $k_1, k_2, k_3$  is given by equation
- $1/U = k_1/x_1 + k_2/x_2 + k_3/x_3$
  - $U = k_1x_1 + k_2x_2 + k_3x_3$
  - $1/U = x_1/k_1 + x_2/k_2 + x_3/k_3$
  - $1/U = x_1/k_1 + x_2/k_2 + k_3/x_3$
15. Three metal walls of the same cross-sectional area having thermal conductivities in the ratio 1:2:4 transfers heat at the rate of 3000 kJ/hr. For the same wall thickness, the temperature drops will be in the ratio
- 1:2:4
  - 1:1/2:1/4
  - 1/4:1/2:1
  - 1:1:1
16. A electric heater of exposed surface area  $0.09 \text{ m}^2$  and output 600 watts is designed to operate fully submersed in water. When the water is at  $37^\circ\text{C}$  and the surface coefficient of heat transfer is  $285.3 \text{ W/m}^2\text{-deg C}$ , surface temperature of the heater will be
- $30.5^\circ\text{C}$
  - $60.5^\circ\text{C}$
  - $90.5^\circ\text{C}$
  - $120.5^\circ\text{C}$

17. The highest value of thermal conductivity is expected for
- (a) Solid ice (b) Steam  
(c) Water (d) Superheated steam
18. The number of teeth of a spur gear is 30 and it rotates at 200 rpm. What will be its pitch line velocity if it has a module of  $(6/\pi)$  mm?
- (a) 600 mm/s (b) 300 mm/s  
(c) 191 mm/s (d) 164 mm/s
19. A force of 271 N is applied to the break drum of 2 m diameter in band brake system as shown in figure, where the wrapping angle is  $180^\circ$ . If the coefficient of friction between the drum and the band is  $7/22$ , the braking torque applied in Nm is
- 
- (a) 271 (b) 100  
(c) 171 (d) 371
20. Starting friction is low in which type of lubrication
- (a) Hydrostatic lubrication (b) Hydrodynamic lubrication  
(c) Mixed (semi fluid) lubrication (d) Boundary lubrication
21. A helical spring has  $N$  turns of coil diameter  $D$  and a second spring, made of same wire diameter and same material, has  $N/2$  turns of coil of diameter  $2D$ . If the stiffness of the first spring is  $k$ , then the stiffness of the second spring will be
- (a)  $k/4$  (b)  $k/2$   
(c)  $2k$  (d)  $4k$


22. A rigid rod PQ shown in Figure is connected to two sliders at each end through pins. The sliders can slide along PR and QR. If the velocity of the slider at P is 4 m/s, the velocity of the midpoint of the rod PQ at this instant is



- (a) 4 m/s                                      (b) 3 m/s  
(c) 2 m/s                                      (d) 1 m/s
23. A concentrated mass  $m$  is attached at centre of a rod of length  $2L$  as shown in figure. The rod is kept in a horizontal equilibrium position by a spring of stiffness  $4k$ . For very small amplitude of vibration, neglecting the weight of the rod and spring, the undamped natural frequency ( $\omega_n$ ) of the system is



- (a)  $\sqrt{2k/m}$                                       (b)  $\sqrt{4k/m}$   
(c)  $\sqrt{8k/m}$                                       (d)  $\sqrt{16k/m}$

	INDIAN SPACE RESEARCH ORGANISATION	<b>SET B</b>
	REFRIGERATION AND AIR-CONDITIONING	

24. At the time of starting, idling and low speed operation, the carburetor supplies a mixture which can be termed as
- (a) lean (b) slightly leaner than stoichiometric  
(c) stoichiometric (d) rich
25. The crank radius of a single cylinder IC engine is  $(60/\pi)$  mm and diameter of the cylinder is 40 mm. The swept volume of the cylinder in  $\text{cm}^3$  is
- (a) 48 (b) 58  
(c) 68 (d) 78
26. For the same values of peak pressure, peak temperature and heat rejection, the correct order of efficiencies for Otto, Dual and Diesel cycles
- (a) Otto > Dual > Diesel (b) Dual > Diesel > Otto  
(c) Diesel > Dual > Otto (d) Diesel > Otto > Dual
27. For determining the ignition quality of compression ignition engine fuels, the reference fuels used are
- (a) Iso octane and  $n$  heptane (b) Cetane and  $\alpha$  methy naphthalene  
(c) Hexadecane and  $n$  heptanes (d) Cetane and iso octane
28. Air enters diesel engine with a density of  $1 \text{ kg/m}^3$ . The compression ratio is 21. At steady state, the air intake is  $21 \times 10^{-3} \text{ kg/s}$  and the network output is 20 kW. The Mean effective pressure (kPa) is
- (a) 500 (b) 1000  
(c) 1500 (d) 2000
29. The purpose of providing supercharging for engine is
- (a) to provide forced cooling air  
(b) to inject excess pressurized fuel  
(c) to raise exhaust pressure  
(d) to supply intake air at density higher than ambient air





30. While designing refrigeration system of an aircraft, the prime consideration is that
- (a) System has high COP
  - (b) Power per TR is low
  - (c) Mass of refrigerant circulated in the system is low
  - (d) Mass of refrigeration system is low
31. A good refrigerant should have
- (a) High latent of vaporization and low freezing point
  - (b) High operating pressures and low freezing point
  - (c) High specific volume and low latent heat of vaporization
  - (d) Low COP and low freezing point
32. The bypass factor of cooling coil
- (a) Decrease with increase in velocity of air passing through it
  - (b) Increase with increase in velocity of air passing through it
  - (c) Remains unchanged with increase in velocity of air passing through it
  - (d) May increase or decrease with increase in velocity of air passing through it depending upon the condition of air entering
33. The centrifugal compressors are generally used for refrigerants that require
- (a) Small displacements and low condensing pressures
  - (b) Large displacements and high condensing pressures
  - (c) Small displacements and high condensing pressures
  - (d) Large displacements and low condensing pressures
34. Equation of a line normal to  $f(x) = (x+4)^{\frac{1}{2}} + 1$  at Q(0,3) is :
- (a)  $y = 3 - 4x$
  - (b)  $y = 3 + 4x$
  - (c)  $4y = 12 + x$
  - (d)  $4y = 12 - x$

35. A box contains 2 blue, 3 black and 4 red balls. Balls are drawn from the box at random one at a time without replacement. The probability of drawing 2 blue balls first followed by 3 black balls and subsequently 4 red balls is
- (a)  $\frac{2}{350}$  (b)  $\frac{1}{629}$   
(c)  $\frac{1}{1260}$  (d)  $\frac{1}{24}$
36. Using trapezoidal rule and dividing the interval of integration into three equal sub intervals, the definite integral  $\int_{-1}^{+1} |x| dx$  is
- (a) 1.11 (b) 2.22  
(c) 3.33 (d) 4.44
37. A circular ring of radius 42 cm is cut and bent into the form of a rectangle whose sides are in the ratio of 6:5. The small side of the rectangle is
- (a) 80 cm (b) 30 cm  
(c) 120 cm (d) 60 cm
38. A tank is normally filled in 8 hours but takes 2 hours longer to fill because of a leak in the bottom. If the tank is full and due to leakage alone, the tank will get empty in \_\_\_\_\_ hours (Assume no further filling happens)
- (a) 20 (b) 40  
(c) 30 (d) 50
39. From a circular sheet of paper of radius 50 cm, a sector of 40% area is removed in the shape of an arc section. If the remaining part is used to make a conical surface, then the ratio of the radius to height of the cone is
- (a)  $\frac{4}{3}$  (b)  $\frac{5}{4}$   
(c)  $\frac{3}{4}$  (d)  $\frac{7}{8}$



40. Triple point of a substance
- (a) Occurs in a mixture of two or more gases
  - (b) Is the point where three phases exists together
  - (c) Occurs in sublimation
  - (d) None of the above
41. A liquid is boiling in a airtight vessel. Using an exhaust tube the vapour is pumped out at a faster rate. What will happen to the liquid?
- (a) Temperature will go down but boiling will continue
  - (b) Temperature will rise and boiling will continue
  - (c) Boiling will stop
  - (d) Vapour starts condensing
42. The equivalent evaporation rate (kg/hr) of a boiler producing 2000 kg/hr of steam with enthalpy content of 2426 kJ/kg from feed water at temperature 40 deg. C (liquid enthalpy = 168 kJ/kg and enthalpy of vaporization of water at 100 deg. C = 2258 kJ/kg) is
- (a) 2000
  - (b) 2249
  - (c) 1658
  - (d) 1649
43. A cycle consisting of one constant pressure, one constant volume and two isentropic processes is known as
- (a) Carnot cycle
  - (b) Sterling cycle
  - (c) Otto cycle
  - (d) Diesel cycle
44. The maximum theoretical work obtainable, when a system interacts to equilibrium with a reference environment, is called
- (a) Entropy
  - (b) Enthalpy
  - (c) Exergy
  - (d) Rothalpy

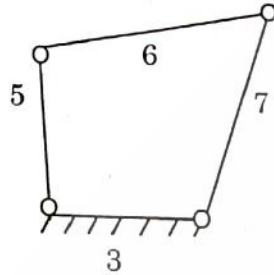
45. If a circular shaft is subjected to a torque  $T$  and a bending moment  $M$ , the ratio of the maximum shear stress to maximum bending stress is
- (a)  $2 M/T$  (b)  $T/2M$   
(c)  $2T/M$  (d)  $M/2T$
46. A simply supported beam of length 3 m carries a concentrated load of 12 kN at a distance of 1m from left support. The maximum bending moment in the beam is
- (a) 12 kNm (b) 24 kNm  
(c) 8 kNm (d) 16 kNm
47. A girder of uniform section and constant depth is freely supported over a span of 3 metres. The point load at the midpoint is 30 kN and Moment of inertia =  $15 \times 10^{-6} \text{ m}^4$  and youngs modulus =  $200 \text{ GN/m}^2$ . The deflection at centre will be
- (a) 6.6 cm (b) 8.6 cm  
(c) 5.6 mm (d) 6.6 mtr
48. A copper rod 3 mm in diameter when subjected to a pull of 495 N extends by 0.07 mm over a gauge length of 100 mm. The youngs modulus for copper will be
- (a)  $1 \times 10^5 \text{ N/mm}^2$  (b)  $1 \times 10^6 \text{ N/mm}^2$   
(c)  $7 \times 10^5 \text{ N/mm}^2$  (d)  $1 \times 10^7 \text{ N/mm}^2$
49. When a body is subjected to three mutually perpendicular stresses of equal intensity, the ratio of direct stress to the expanding volumetric strain is known as
- (a) Young's modulus (b) Modulus of rigidity  
(c) Bulk modulus (d) Poisson's ratio
50. The bending moment in the centre of a simply supported beam carrying a uniformly distributed load of  $w$  per unit length is
- (a) zero (b)  $wl^2/2$   
(c)  $wl^2/4$  (d)  $wl^2/8$



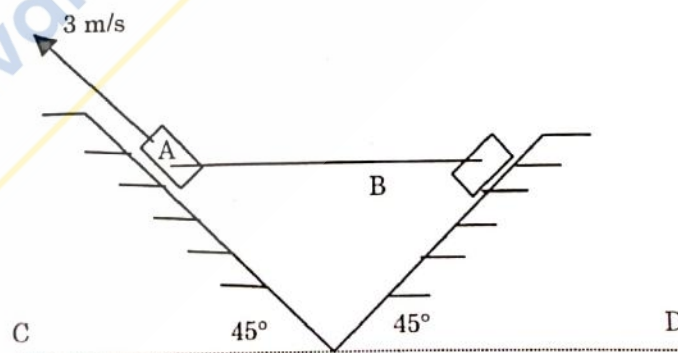
51. A uniform wooden cylinder has a specific gravity of 0.5. Find the ratio of diameter to length of the cylinder so that it will just float upright in a state of neutral equilibrium in water
- (a)  $\sqrt{2}$  (b)  $\sqrt{3}$   
(c) 2 (d) 3
52. In a siphon, the summit is 3 m above the water level in the reservoir from which the flow is being discharged. If the head loss from the inlet of the siphon to the summit is 1.5 m and the velocity head at the summit is 0.5 m, the absolute pressure at the summit is
- (a) 5.3 m of water (b) 9.3 m of water  
(c) 6.3 m of water (d) 5 m of water
53. Two pipe lines of equal length and diameters of 10cm and 40cm are connected in parallel between two reservoirs. If friction factor  $f$  is same for both the pipes, the ratio of the discharges in the larger to the smaller pipe is
- (a) 4 (b) 16  
(c) 32 (d) 64
54. The fluid property responsible for the problem of water hammer is
- (a) viscosity (b) density  
(c) elasticity (d) surface tension
55. Within a boundary layer
- (a) The order of viscous force is much higher than that of the inertia force  
(b) The order of viscous force is equal to that of the inertia force  
(c) The order of viscous force is much less than that of the inertia force  
(d) Both the forces are zero

56. The values of enthalpy of steam at inlet and outlet of a steam turbine in a Rankine cycle are 2800 kJ/kg and 1800 kJ/kg respectively. Neglecting pump work, the specific steam consumption in kg/kW-hour is
- (a) 3.60 (b) 0.36  
(c) 0.06 (d) 0.01
57. A pump handling a liquid raises its pressure from 1 bar to 30 bar. Take the density of liquid as 990 kg/m<sup>3</sup>. The isentropic specific work done by the pump in kJ/kg is
- (a) 3.93 (b) 1.93  
(c) 4.93 (d) 2.93
58. A heat engine using lake water at 12°C as source and the surrounding atmosphere at 2°C as sink executes 1080 cycles per min. If the amount of heat drawn per cycle is 57 J, then the output of the engine will be
- (a) 66 W (b) 46 W  
(c) 56 W (d) 36 W
59. The unit of Stefan Boltzmann constant is
- (a) Watt/cm<sup>2</sup>K (b) Watt/cm<sup>4</sup>K  
(c) Watt/cmK<sup>4</sup> (d) Watt/cm<sup>2</sup>K<sup>4</sup>
60. In a furnace, the wall thickness is 60 cm and is 100 cm wide by 150 cm height made of material with thermal conductivity 0.4 W/mK. The temperature inside and outside are 1000°C and 4°C respectively. The thermal resistance is
- (a) 1 K/W (b) 2 K/W  
(c) 18 K/W (d) 15 K/W
61. The rate of heat flow through a composite wall of three layers of thickness 0.3 m, 0.2 m, 0.15 m and of corresponding thermal conductivities 1.2, 0.8 and 0.6 kJ/hr-m°C is 1280 kJ/hr. If the surface area normal to the direction of heat flow is 1 sq.mtr. and inner surface temperature is 1000°C, then the interface temperature at the end of first layer will be
- (a) 700°C (b) 680°C  
(c) 500°C (d) 360°C

62. For the four link mechanism with the dimensions of the links indicated in standard units of length, choose the type of mechanism from the given options



- (a) crank rocker  
(b) double crank  
(c) double rocker  
(d) rocker
63. Operating pressure angle for involute gear teeth is
- (a) Maximum at engagement of teeth  
(b) Minimum at engagement of teeth  
(c) Same at all points of contact  
(d) Vary uniformly at all points of contact
64. For the position of the mechanism shown in Figure, find the velocity of the slider B for the given configuration if the velocity of the slider A is 3 m/s. Consider AB as a rigid link and is parallel to CD at this instant.



- (a) 3 m/s  
(b)  $3\sqrt{2}$  m/s  
(c)  $3/\sqrt{2}$  m/s  
(d) 1.5 m/s

65. The device used to heat feed water by utilizing the heat of the exhaust flue gases before leaving through the chimney is called
- (a) Super heater (b) Economizer  
(c) Air preheater (d) Evaporator
66. The power consumed by a reciprocating air compressor will be minimum, if the compression follows the following thermodynamic process
- (a) isothermal (b) isentropic  
(c) adiabatic (d) polytropic
67. In an impulse reaction turbine stage, the heat drop in fixed and moving blades are 20 kJ/kg and 30 kJ/kg respectively. The degree of reaction for this stage will be
- (a)  $3/5$  (b)  $5/3$   
(c)  $2/5$  (d)  $5/2$
68. Which among the following automobile exhaust gas pollutants is a major cause of photochemical smog?
- (a) CO (b) CO<sub>2</sub>  
(c) NO<sub>2</sub> (d) SO<sub>2</sub>
69. In a two stage reciprocating air compressor with a suction pressure of 4 bar and delivery pressure of 16 bar, the ideal intercooler pressure will be
- (a) 10 bar (b) 8 bar  
(c) 32 bar (d) 20 bar
70. In PERT chart, the activity time distribution is
- (a) Normal (b) Poisson  
(c) Binomial (d) Beta

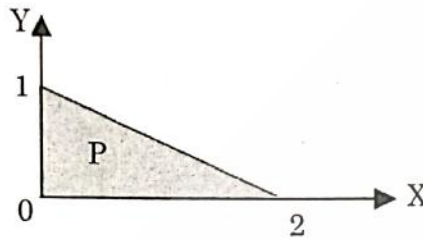




71. Dew point temperature lines on the psychometric chart are
- (a) Horizontal
  - (b) Vertical
  - (c) Curved
  - (d) Straight inclined slopping downward to the right
72. The lowest temperature during the cycle in a vapour compression system occurs after
- (a) Compression
  - (b) Expansion
  - (c) Condensation
  - (d) Evaporation
73. The principle of vapour compression system is that fluids absorb heat while changing from a
- (a) Vapour phase to liquid phase and give up heat in changing from liquid phase to vapour phase
  - (b) Liquid phase to vapour phase and give up heat in changing from a vapour phase to liquid phase
  - (c) Vapour phase to liquid phase only
  - (d) Liquid phase to solid state phase and give up heat in changing from a solid state to liquid phase
74. Sensible heat factor is defined as the ratio of
- (a) Latent heat to sensible heat
  - (b) Sensible heat to latent heat
  - (c) Latent heat to total heat
  - (d) Sensible heat to total heat
75. In vapour compression refrigeration system, heat rejected as compared to heat absorbed is
- (a) More
  - (b) Less
  - (c) Equal
  - (d) Depends on the refrigerant used
76. As warm air cools, it's relative humidity
- (a) Increases
  - (b) Decreases
  - (c) Remains same
  - (d) Depends on wet bulb temperature

77. Consider the shaded triangle region P shown in the figure

What is  $\iint_P xy dx dy$ ?



- (a) 1/6 (b) 2/9  
(c) 1/7 (d) 1

78. Distance between origin and the point nearest to it on the surface  $z^2 = 1 + xy$  is :

- (a)  $\frac{\sqrt{3}}{2}$  (b) 1  
(c)  $\sqrt{3}$  (d) 2

79. At  $x = 0$ , the function  $f(x) = |x|$  has

- (a) A maximum (b) A point of inflection  
(c) A minimum (d) Neither maximum nor minimum

80. General solution of differential equation  $\frac{dy}{dx} = \cos(x + y)$  is

- (a)  $\tan\left(\frac{x+y}{2}\right) = y + c$  (b)  $\sin\left(\frac{x+y}{2}\right) = y + c$   
(c)  $\cos\left(\frac{x+y}{2}\right) = x + c$  (d)  $\tan\left(\frac{x+y}{2}\right) = x + c$