MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF INSPECTOR OF FACTORIES UNDER LABOUR, EMPLOYMENT, SKILL DEVELOPMENT & ENTREPRENEURSHIP DEPARTMENT, GOVERNMENT OF MIZORAM, 2019

MECHANICAL ENGINEERING
PAPER - I

Time Allowed : 2 hours Full Marks : 200

All questions carry equal marks of 2 each.
Attempt all questions.

1. A closed system is one in which -
(a) both energy and mass cross the boundary of the system
(b) the mass does not cross the boundary, but energy interaction takes place
(c) neither mass nor energy cross the boundary of the system
(d) the mass crosses the boundary but energy does not

2. When two bodies are in thermal equilibrium with a third body, then they are in thermal equilibrium with each other. This statement is called -
(a) first law of thermodynamics (b) second law of thermodynamics
(c) third law of thermodynamics (d) zeroth law of thermodynamics

3. An adiabatic system is one in which -
(a) both energy and mass cross the boundary of the system
(b) the mass does not cross the boundary, but energy interaction takes place
(c) neither mass nor energy cross the boundary of the system
(d) mass crosses the boundary, heat energy does not cross the boundary of the system

4. Which of the following is an extensive property?
(a) Volume (b) Temperature
(c) Pressure (d) Density

5. The first law of thermodynamics deals with -
(a) heat and work (b) quality of energy
(c) balance of quantity of energy (d) measurement of energy transfer

6. The perpetual motion machine of the first kind is impossible according to the -
(a) zeroth law of thermodynamics (b) first law of thermodynamics
(c) second law of thermodynamic (d) third law of thermodynamics

7. The specific volume of water during freezing -
(a) Increases (b) remains constant
(c) decreases (d) none of these

8. In an isothermal process -
(a) temperature increases gradually (b) volume remains constant
(c) change in internal energy is zero (d) enthalpy change is maximum

9. In a reversible adiabatic process, the work transfer is equal to -

(a) decrease in enthalpy
(b) decrease in internal energy
(c) heat transfer
(d) the product of pressure and change in volume

10. A control volume refers to -

(a) a fixed region in space
(b) a fixed quantity of matter
(c) an isolated system
(d) a closed system

11. Steady flow occurs when -

(a) properties do not change with time
(b) the system is in equilibrium with its surroundings
(c) properties change with time
(d) when $\left(\frac{\partial v}{\partial t}\right)$ is constant

12. During a throttling process -

(a) internal energy remains constant
(b) enthalpy of fluid remains constant
(c) pressure remains constant
(d) temperature remains constant

13. The second law of thermodynamics deals with -

(a) direction of process and quality of energy
(b) energy balance
(c) balance of internal energy
(d) system efficiency

14. It is impossible to construct an engine which while operating in a cycle, produces no other effect except to extract the heat from a single-temperature reservoir and do equivalent amount of work -

(a) It refers to Clasius statement
(b) It refers to Kelvine–Planck's statement
(c) It refers to Carnot's theorem
(d) It refers to Clasius's theorem

15. A Carnot cycle comprises of -

(a) two isothermal and two isentropic processes
(b) two constant volume and two isentropic processes
(c) two constant pressure and two isentropic processes
(d) one constant volume, one constant pressure and two isentropic processes

16. In a thermal power plant, turbine does 10,000 kJ of work, pump consumes 10 kJ of work. The boiler receives 30,000 kJ of heat. Thermal efficiency of the plant is -

(a) 27%
(b) 33.3%
(c) 35%
(d) 40%

17. A heat engine receives heat from a source at 1000°C and rejects the waste heat to a sink at 50°C. If the heat is supplied to the engine at the rate of 100 kW. The maximum power output of this engine is-

(a) 25.48
(b) 55.44
(c) 74.62
(d) 79.85

18. Entropy is -

(a) an extensive property
(b) an abstract property
(c) a function of quality of heat
(d) all of these

19. Entropy of water at 0°C is assumed to be -

(a) 0
(b) 1
(c) –1
(d) none of these

20. Entropy is a function of -

(a) work transfer
(b) volume
(c) temperature
(d) pressure

21. The available energy is -

(a) high-grade energy
(b) portion of energy as useful work
(c) theoretical maximum amount of work
(d) none of these

22. The degradation of energy is responsible for -

(a) entropy generation within the system
(b) decrease of entropy within the system
(c) maximum work done by the system
(d) none of these

23. Maxwell's Thermodynamic relations are valid for -

(a) all processes
(b) a closed system
(c) a thermodynamic system in equilibrium
(d) an open system

24. A relation of vapour pressure to enthalpy of vaporisation is expressed in -

(a) van der waals equation
(b) Maxwell's relations
(c) Carrier's equation
(d) Clausius–Claypeyron equation

25. Which statement is true for Otto cycle?

(a) Heat addition at constant volume and heat rejection at constant volume
(b) Heat addition at constant volume and heat rejection at constant pressure
(c) Heat addition at constant pressure and heat rejection at constant volume
(d) Heat addition at constant pressure and heat rejection at constant pressure

26. Air standard Diesel cycle consists of -

(a) two isothermal and two constant-volume processes
(b) two isentropic and two constant-pressure processes
(c) two isentropic and two constant-volume processes
(d) none of these

27. The efficiency of air standard Otto cycle depends on -

(a) pressure ratio in the cycle
(b) temperature ratio in the cycle
(c) Compression ratio in the cycle
(d) mean effective pressure

28. Which one of the following is part of air standard Atkinson cycle?

(a) Isothermal heat addition
(b) Constant-volume heat rejection
(c) Constant-volume heat addition
(d) Constant-pressure heat addition

29. Which one of the following is part of air standard Brayton cycle?

(a) Polytropic compression
(b) Isochoric heat addition
(c) Isobaric heat addition
(d) Isochoric and isobaric heat addition

30. The main constituents of a fuel are -

(a) hydrogen and oxygen
(b) carbon and hydrogen
(c) sulphur and hydrogen
(d) sulphur and oxygen

31. Stoichiometric air–fuel ratio of petrol is roughly -

(a) 50 : 1
(b) 25 : 1
(c) 15 : 1
(d) 1 : 1

32. In a two-stroke engine, one power stroke is obtained in -

(a) one revolution of the crank shaft
(b) two revolutions of the crank shaft
(c) four revolutions of the crank shaft
(d) none of these

33. In a Diesel engine, fuel consumption against brake power is -

(a) parabolic (b) linear

(c) hyperbolic (d) non-predictable

34. By use of cooling, which efficiency of an IC engine decreases -

(a) volumetric efficiency (b) mechanical efficiency

(c) charging efficiency (d) thermal efficiency

35. Which one of following is a governing method used on petrol engines?

(a) Quality governing (b) Quantity governing

(c) Injection governing (d) Hit and miss governing

36. Increase in compression ratio in an Otto cycle engine may cause -

(a) misfiring (b) detonation

(c) knocking (d) longer ignition delay

37. In a gas turbine plant, the intercooler is used in between -

(a) air compressor and regenerator (b) air compressor and combustion chamber

(c) combustion chamber and turbine (d) LP compressor and HP compressor

38. The function of regenerator in a gas turbine plant is -

(a) to heat the compressed air from the compressor

(b) to heat the gas before inlet to gas turbine

(c) to exchange the heat from hot gases from combustion chamber to exhaust gases of the turbine

(d) to heat the compressed air in between the stages

39. Thermal efficiency of an IC engine indicates percentage of -

(a) BP converted into IP (b) heat converted into work

(c) IP converted into BP (d) heat lost into exhaust

40. A rocket engine receives oxygen for combustion of fuel from -

(a) oxidizer on board (b) compressed atmospheric air

(c) surrounding air (d) none of the above

41. The absorptivity of thermal radiation by a solid surface can be enhanced -

(a) by polishing the surface (b) by roughening the surface

(c) by increasing the surface area (d) by decreasing the surface area

42. Transient heat conduction means -

(a) conduction when the temperature at a point varies with time

(b) heat conduction for a short time

(c) very little heat transfer

(d) heat conduction with a very small temperature difference

43. For a balanced counter flow heat exchanger, the temperature profiles of the two fluids along the length of the heat exchanger -

(a) linear (b) parallel

(c) linear and parallel (d) parabolic

44. A heat pipe is used to transfer heat from the source to the sink by a fluid by means of

(a) conduction (b) evaporation

(c) condensation (d) evaporation and condensation

45. Gases have poor -

(a) tranmissitivity (b) absorptivity

(c) reflectivity (d) emissivity

46. COP of a Carnot refrigeration cycle is greater than -

(a) vapour compression cycle (b) reversed Brayton cycle

(c) vapour absorption cycle (d) all the above

47. In an ideal vapour compression refrigeration cycle, the refrigerant is in the form of superheated vapour before entering into -

(a) condenser (b) throttle valve

(c) evaporator (d) compressor

48. Heat is absorbed by a refrigerant during a refrigerant cycle -

(a) condenser (b) throttle valve

(c) evaporator (d) compressor

49. A zeotropes are mixture of -

(a) primary and secondary refrigerant (b) Ammonia and water

(c) CFCs and HFCs (d) HCFCs and HFCs

50. Subcooling of refrigerant in vapour compression refrigeration cycle -

(a) decreases COP (b) increases COP

(c) decrease refrigerating effect (d) increases work input

51. In a forced vortex

(a) the fluid velocity is inversely proportional to the radius

(b) the fluid rotates without any relative velocity

(c) the rise depends on the specific weight

(d) the rise is proportional to the cube of angular velocity

52. The centre of pressure of a rectangular plane with height of liquid h m from base -

(a) h/2 m from bottom

(b) h/3 m from top

(c) h/3 m from bottom

(d) can be determined only if liquid specific weight is known

53. The location of the centre of pressure over a surface immersed in a liquid is -

(a) always above the centroid

(b) will be at the centroid

(c) will be below the centroid

(d) for higher densities it will be above the centroid and for lower densities it will be below the centroid

54. If a body is in stable equilibrium the metacentric height should be -

(a) zero (b) positive

(c) negative (d) depends on the fluid

55. When a ship leaves a river and enters the sea -

(a) It will rise a little (b) It will sink a little

(c) There will be no change in the draft (d) It will depend on the type of the ship

56. The continuity equation is the result of application of the following law to the flow field -

(a) First law of thermodynamics
(b) Conservation of energy
(c) Newton's second law of motion
(d) Conservation of mass

57. The stream function is -

(a) constant along an equipotential line
(b) along a stream line
(c) defined only in irrotational flow
(d) defined only for incompressible flow

58. Bernoulli equation is applicable for -

(a) steady rotational flow
(b) steady rotational compressible flow
(c) steady irrotational incompressible flow
(d) unsteady irrotational incompressible flow

59. In a flow along a varying flow cross section, as the area decreases -

(a) the energy line will slope up
(b) the hydraulic gradient line will slope up
(c) the hydraulic gradient line will slope down
(d) the energy line will slope down

60. In steady flow in a varying section pipe if the diameter is doubled the kinetic energy will -

(a) be doubled
(b) increase 4 times
(c) increase 8 times
(d) decrease to one sixteenth

61. Reynolds number signifies the ratio of -

(a) gravity forces top viscous forces
(b) inertial forces to viscous forces
(c) inertia forces to gravity forces
(d) buoyant forces to inertia forces

62. The entry length in pipe flow will be higher for -

(a) highly viscous fluids
(b) low viscosity fluid
(c) high velocity of flow
(d) small diameters

63. In fully developed turbulent flow, if the diameter is halved without changing the flow rate, the frictional drop will change by the factor -

(a) 32 times
(b) 16 times
(c) 8 times
(d) 4 times

64. The velocity profile in turbulent flow is -

(a) parabolic
(b) logarithmic
(c) 2^{nd} degree polynomial
(d) 4th degree polynomial

65. A pitot static tube is used to measure -

(a) Stagnation pressure
(b) Static pressure
(c) Dynamic pressure
(d) Difference between the static pressure and dynamic pressure

66. Rotameter is used to measure -

(a) Viscosity
(b) Flow
(c) Density
(d) Pressure

67. Coefficient of discharge is the ratio of -

(a) Actual flow/Theoretical flow
(b) Theoretical flow/Actual flow
(c) Actual velocity/Theoretical velocity
(d) Theoretical velocity/Actual velocity

68. Slip in the case of a centrifugal pump.

(a) Reduces the flow rate
(b) Reduces the energy transfer
(c) Reduces the speed
(d) Increases cavitation

69. A low specific speed Francis turbine is -

(a) Axial flow turbine (b) tangential flow turbine

(c) Mixed flow turbine (d) radial flow turbine

70. Example of a pure reaction turbine is -

(a) Francis turbine (b) Propeller turbine

(c) Kaplan turbine (d) Lawn sprinkler

71. Pelton turbine is a -

(a) Reaction turbine (b) Impulse turbine

(c) Radial flow turbine (d) Axial flow turbine

72. In a normal shock taking place in a gas -

(a) the velocity, pressure and density increase across the shock

(b) the entropy remains constant

(c) the entropy decreases across the shock

(d) the entropy increases across the shock

73. The function of superheated is to -

(a) Superheat the steam (b) Extinguish the fire

(c) Maintain constant temperature (d) Preheat the feed water

74. Which one of the following is the correct sequence of accessories in a boiler plant?

(a) Boiler-economiser-superheater-chimney (b) Economiser-boiler-superheater-chimney

(c) Economiser-air preheater-superheater-chimney (d) Economiser-boiler-preheater-chimney

75. The draught in a boiler is provided to -

(a) force the air on the furnace (b) force the hot gases on superheater

(c) discharge the fiue gases through chimney (d) all of these

76. The equivalent evaporation is defined a -

(a) steam generated at 100°C

(b) dry and saturated steam generated at 100°C from feed water at 100°C

(c) steam generated at 1 bar and at 100°C

(d) none of these

77. A fiuid is a compressible fiuid when its density -

(a) decreases with pressure (b) increases with pressure

(c) increases with temperature (d) both (a) & (b)

78. A nozzle is designed for -

(a) maximum pressure at outlet

(b) minimum pressure at outlet

(c) maximum discharge at outlet

(d) maximum discharge and maximum pressure at outlet

79. Nozzle efficiency is defined as the ratio of -

(a) actual enthalpy drop to isentropic enthalpy drop

(b) isentropic enthalpy drop to actual enthalpy drop

(c) product of isentropic enthalpy drop and actual enthalpy drop

(d) square root of isentropic enthalpy drop to actual enthalpy drop

80. When a fiuid is coming out of a duct at a higher pressure than it enters, the duct is called a/an -

(a) orifice (b) nozzle

(c) diffuser (d) venturi

81. Presence of frictional effect during fiow through the nozzle -

(a) reduces the exit velocity (b) increases the exit velocity

(c) has no effect on exit velocity (d) none of these

82. The shear stress in turbulent flow is:

(a) Linearly proportional to the velocity gradient

(b) Proportional to the square of the velocity gradient

(c) Dependent on the mean velocity of flow

(d) Due to the exchange of energy between the molecules

83. Water at 25°C is flowing through a 1.0 km long G.I. pipe of 200 mm diameter at the rate of $0.07 m^3/s$. If value of Darcy friction factor for this pipe is 0.02 and density of water is 1000 kg/m^3, the pumping power (in kW) required to maintain the flow is:

(a) 1.8 (b) 17.4

(c) 20.5 (d) 41.0

84. A pipeline is said to be equivalent to another, if in both -

(a) Length and discharge are the same

(b) Velocity and discharge are the same

(c) Discharge and frictional head loss are the same

(d) Length and diameter are the same

85. Subsonic and supersonic diffusers have the following geometry -

(a) Divergent and convergent respectively (b) Both divergent

(c) Both convergent (d) Convergent and divergent respectively

86. Cavitation in a hydraulic turbine is most likely to occur at the turbine -

(a) Entry (b) Exit

(c) Stator exit (d) Rotor exit

87. Euler equation for water turbine is derived on the basis of -

(a) Conservation of mass (b) Rate of change of linear momentum

(c) Rate of change of angular momentum (d) Rate of change of velocity

88. Consider the following statements:

1. Pelton wheel is a tangential flow impulse turbine

2. Francis turbine is an axial flow reaction turbine

3. Kaplan turbine is a radial flow reaction turbine

Which of the above statements is/ are correct?

(a) 1 and 3 (b) 1 alone

(c) 2 alone (d) 3 alone

89. The ratio of work-done per cycle to the stroke volume of the compressor is known as -

(a) Compressor capacity (b) Compression ratio

(c) Compressor efficiency (d) Mean effective pressure

90. A Pelton wheel is ideally suited for

(a) High head and low discharge
(b) High head and high discharge
(c) Low head and low discharge
(d) Medium head and medium discharge

91. Thermal diffusivity of a substance is:

(a) Inversely proportional to thermal conductivity
(b) Directly proportional to thermal conductivity
(c) Directly proportional to the square of thermal conductivity
(d) Inversely proportional to the square of thermal conductivity

92. In which one of the following materials, is the heat energy propagation minimum due to conduction heat transfer?

(a) Lead
(b) Copper
(c) Water
(d) Air

93. Assertion (A) : The leakage heat transfer from the outside surface of a steel pipe carrying hot gases is reduced to a greater extent on providing refractory brick lining on the inside of the pipe as compared to that with brick lining on the outside.

Reason (R) : The refractory brick lining on the inside of the pipe offers a higher thermal resistance.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually 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

94. Two insulating materials of thermal conductivity K and 2K are available for lagging a pipe carrying a hot fluid. If the radial thickness of each material is the same.

(a) Material with higher thermal conductivity should be used for the inner layer and one with lower thermal conductivity for the outer.
(b) Material with lower thermal conductivity should be used for the inner layer and one with higher thermal conductivity for the outer.
(c) It is immaterial in which sequence the insulating materials are used.
(d) It is not possible to judge unless numerical values of dimensions are given.

95. Upto the critical radius of insulation:

(a) Added insulation increases heat loss
(b) Added insulation decreases heat loss
(c) Convection heat loss is less than conduction heat loss
(d) Heat flux decreases

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

List-I	**List-II**
A. Momentum transfer	**1.** Thermal diffusivity
B. Mass transfer	**2.** Kinematic viscosity
C. Heat transfer	**3.** Diffusion coefficient

(a) A-2, B-3, C-1
(b) A-1, B-3, C-2
(c) A-3, B-2, C-1
(d) A-1, B-2, C-3

97. A copper block and an air mass block having similar dimensions are subjected to symmetrical heat transfer from one face of each block. The other face of the block will be reaching to the same temperature at a rate:

(a) Faster in air block
(b) Faster in copper block
(c) Equal in air as well as copper block
(d) Cannot be predicted with the given information

98. A bomb calorimeter is used to determine -

(a) higher calorific value of solid or liquid fuel
(b) lower calorific value of solid or liquid fuel
(c) higher calorific value of gaseous fuel
(d) lower calorific value of gaseous fuel

99. The gas having higher calorific value is -

(a) water gas
(b) coke-oven gas
(c) blast-furnace gas
(d) producer gas

100. A good fuel has -

(a) low ignition point and high calorific value
(b) low ignition point and low calorific value
(c) high ignition point and high calorific value
(d) high ignition point and low calorific value

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