ISRO

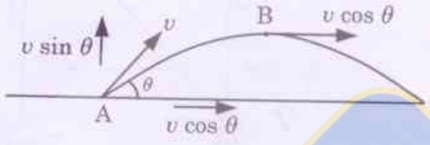
Previous Year Paper
Scientist ME 2015

1. The value of y as $t \to \infty$ for an initial value of $y(1)=0$, for the differential equation $(4t^2+1)\frac{dy}{dt}+8yt-t=0$, is

(a) 1 (b) 1/2

(c) 1/4 (d) 1/8

2. A shell is fired from a cannon with a speed 'v' at an angle θ with the horizontal direction as shown in the figure. At the highest point in its path, it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon. The speed of other piece immediately after the explosion is



(a) $3v\cos\theta$ (b) $2v\cos\theta$

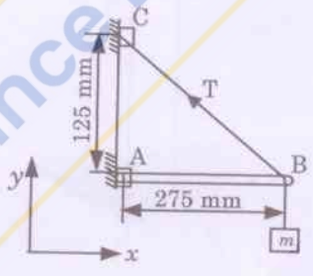
(c) $\frac{3}{2}v\cos\theta$ (d) $\sqrt{\frac{3}{2}}v\cos\theta$

3. The point of contraflexure is a point where

(a) Shear force changes sign (b) Bending moment changes sign

(c) Bending moment is maximum (d) None of the above

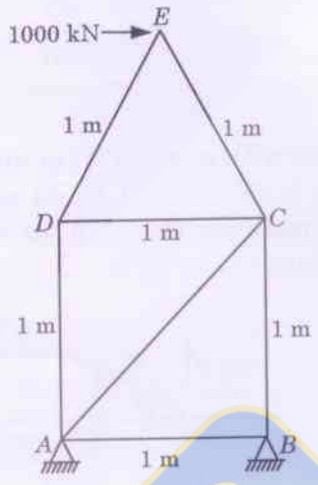
4. A mass of 35 Kg is suspended from a weightless bar AB which is supported by a cable CB and a pin at A as shown in the figure. The pin reactions at A on the bar AB are



(a) $R_x = 343.4\,N,\ R_y = 755.4\,N$ (b) $R_x = 343.4\,N,\ R_y = 0$

(c) $R_x = 755.4\,N,\ R_y = 343.4\,N$ (d) $R_x = 755.4\,N,\ R_y = 0$

5. A simple structure ABCDE is supported on a hinge at A and on rollers at B while it carries a horizontal force of 1000 KN at E as shown in the figure. Determine the force in member AC using the method of joints.

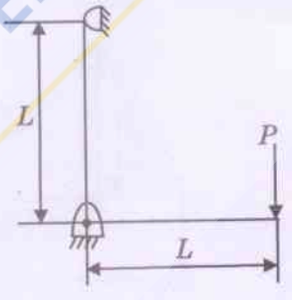


(a) 1500 KN (b) 1400 KN (c) 1314 KN (d) 1414 KN

6. A circular shaft subjected to torsion undergoes a twist of 1° in a length of 120 cm. If the maximum shear stress induced is limited to 1000 Kg/cm^2 and if the modulus of rigidity $G = 0.8 \times 10^6$, then the radius of the shaft should be

(a) $\pi/18$ (b) $\pi/27$ (c) $18/\pi$ (d) $27/\pi$

7. A frame of two arms of equal length L is shown in the figure. The flexural rigidity of each arm of the frame is EI. The vertical deflection at the point of application of load P is



(a) $\frac{PL^3}{3EI}$ (b) $\frac{2PL^3}{3EI}$

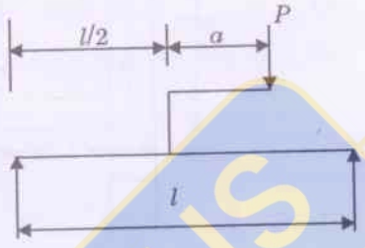
(c) $\frac{4PL^3}{3EI}$ (d) None of the above

8. A thin cylindrical shell of diameter (d), length (l) and thickness (t) is subjected to an internal pressure (p). The ratio of the longitudinal strain to hoop strain is

(a) $\frac{m-2}{2m-1}$ (b) $\frac{2m-1}{m-2}$

(c) $\frac{m-2}{2m+1}$ (d) $\frac{m+2}{2m+2}$

9. A simply supported beam carries a load 'P' through a bracket as shown in the figure. The maximum bending moment in the beam is



(a) $\frac{Pl}{2}$ (b) $\frac{Pl}{2}+\frac{ap}{2}$

(c) $\frac{Pl}{2}+aP$ (d) $\frac{Pl}{2}-aP$

10. A vertical column has two moments of inertia I_{xx} and I_{yy}. The column will tend to buckle in the direction of the

(a) axis of load (b) perpendicular to the axis of load

(c) maximum moment of inertia (d) minimum moment of inertia

11. Which of the following is applied to brittle materials?

(a) maximum principal stress theory

(b) maximum principal strain theory

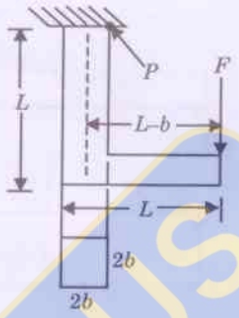
(c) maximum strain energy theory

(d) maximum shear stress theory

12. A moving fluid mass may be brought to a static equilibrium position by applying an imaginary inertia force of the same magnitude as that of the accelerating force but in the opposite direction. This is called

(a) Pascal's law
(b) Archimedes principle
(c) D-Alembert's principle
(d) None of the above

13. For the component loaded with a force F as shown in the figure, the axial stress at the corner point P is



(a) $\frac{F(3L-b)}{4b^3}$ (b) $\frac{F(3L+b)}{4b^3}$ (c) $\frac{F(3L+4b)}{4b^3}$ (d) $\frac{F(3L-2b)}{4b^3}$

14. When a body floating in a liquid is given a small angular displacement, it starts oscillating about a point known as

(a) centre of gravity
(b) centre of pressure
(c) metacenter
(d) centre of buoyancy

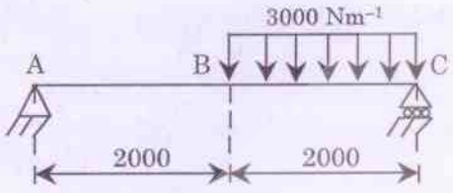
15. Bernoulli's equation is applied to

(a) venturimeter
(b) orifice meter
(c) pitot tube meter
(d) all of the above

16. A jet of water discharging from a 40 mm diameter orifice has minimum area at its vena contracta. The coefficient of contraction is

(a) 0.46
(b) 0.61
(c) 0.78
(d) 0.87

21. A massless beam has a loading pattern as shown in the figure. The beam is of rectangular cross section with a width of 30 mm and height of 100 mm. The maximum magnitude of bending stress (in MPa) is given by



(a) 60.0 (b) 67.5

(c) 200 (d) 225

22. What is the type of flow when a cylindrical vessel containing some liquid is rotated about its vertical axis?

(a) steady flow (b) turbulent flow

(c) vortex flow (d) non-uniform flow

23. Water at 25°C is flowing through a 1.0 Km long GI 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

24. The velocity at which the laminar flow stops is known as

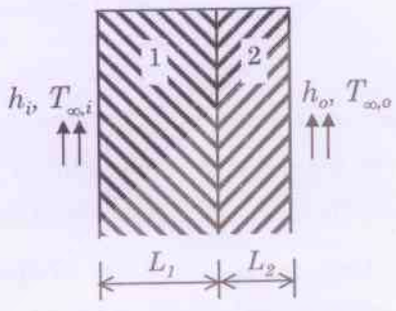
(a) velocity of approach

(b) lower critical velocity

(c) higher critical velocity

(d) none of the above

25. Consider steady state heat conduction across the thickness in a plane composite wall as shown in the figure exposed to convection conditions on both sides. Given : $h_i = 20\,W/m^2K$; $h_0 = 50\,W/m^2K$; $T_{\infty,i} = 20°C$; $T_{\infty,0} = -2°C$; $k_1 = 20$ W/mK ; $k_2 = 50$ W/mK ; $L_1 = 0.30$ m and $L_2 = 0.15\,m$. Assuming negligible contact resistance between the wall surfaces, the interface temperature, T (in °C) of the two walls will be



(a) 0.5 (b) 2.75 (c) 3.75 (d) 4.5

26. For the matrix $\begin{bmatrix} 4 & 1 \\ 1 & 4 \end{bmatrix}$, the eigen values are

(a) 3 and –3 (b) –3 and –5 (c) 3 and 5 (d) 5 and 0

27. Solution for the following differential equation with boundary conditions,

$y(0) = 2$ and $y(1) = -3$ is $\frac{d^2y}{dx^2} = 3x - 2$

(a) $y = \frac{x^3}{3} - \frac{x^2}{2} + 3x - 6$ (b) $y = 3x^3 - \frac{x^2}{2} - 5x + 2$

(c) $y = \frac{x^3}{2} - x^2 - \frac{5x}{2} + 2$ (d) $y = x^3 - \frac{x^2}{2} + 5x + \frac{3}{2}$

28. $\frac{PL^3}{3EI}$ is the deflection under the load P of a cantilever beam (Length-L, modulus of elasticity-E, moment of inertia-I). The strain energy due to bending is

(a) $\frac{P^2L^3}{3EI}$ (b) $\frac{P^2L^3}{6EI}$

(c) $\frac{P^2L^3}{4EI}$ (d) $\frac{P^2L^3}{48EI}$

29. For which value of x, will the matrix $\begin{bmatrix} 8 & x & 0 \\ 4 & 0 & 2 \\ 12 & 6 & 0 \end{bmatrix}$ become singular ?

(a) 4 (b) 6

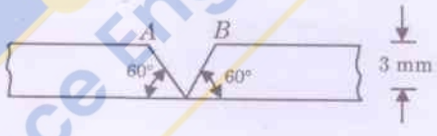
(c) 8 (d) 12

30. A coolant fluid at 30° C flows over a heated flat plate maintained at a constant temperature of 100°C. The boundary layer temperature distribution at a given location on the plate may be approximated as $T = 30 + 70\exp(-y)$, where y is the distance normal to the plate in meters and T is in °C. If thermal conductivity of the fluid is 1.0 W/mK, then the local convective heat transfer coefficient in W/m²K at that location will be

(a) 0.2 (b) 1

(c) 5 (d) 10

31. In a butt welding process using arc welding, the arc power is found to be 2.5 KVA. The process is used to weld two steel plates each of 3 mm thickness as shown in the figure. Determine maximum possible welding speed. It is assumed that the metal transfer is of short circuit type and the arc is on for 85% of the total time. Take $\alpha_{steel} = 1.2\times10^{-5}$ m²/s, $k_{steel} = 43.6$ W/m°C, melting point of steel = 1530 °C and ambient temperature = 30°C.



(a) 0.035 m/s (b) 0.0146 m/s (c) 0.02 m/s (d) 0.0156 m/s

32. The effective number of lattice points in the unit cell of simple cubic, body centered cubic and face centered cubic space lattices, respectively are

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

33. Thermosetting plastics have in general

(a) molecular chains that slip past one

(b) be a ceramic since all ceramics are glass and glass is a kind of ceramic

(c) have a monolithic crystal structure

(d) have no long range crystalline lattice structure

34. Silicon steel is widely used in

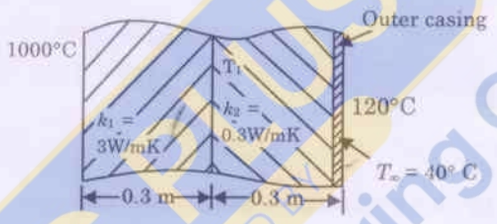
(a) cutting tools

(b) dies and punches

(c) electrical industry

(d) chemical industry

35. A furnace wall is constructed as shown in the figure. The interface temperature T_1 will be



(a) 560° C

(b) 200° C

(c) 920° C

(d) 1120° C

36. Which bond gives the softest bond?

(a) silicate bond

(b) shellac bond

(c) vitrified bond

(d) all of equal strength

37. An eutectoid steel consists of

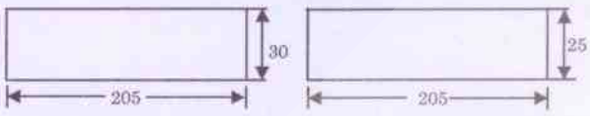
(a) wholly pearlite

(b) wholly austenite

(c) pearlite and ferrite

(d) pearlite and cementite

38. Fifty flat pieces of 1 mm thick and initial dimensions as shown in the figure (a) to be milled in a single cut to the final dimensions shown in figure (b) using end milling. The cutter of diameter 25 mm has 10 teeth and rotates at 100 rpm. Horizontal feed of the table is 10 mm/min. Assuming single tooth in contact, the material removal rate will be



(a) (b)

(a) 35.7 mm^3/s (b) 37.7 mm^3/s

(c) 41.7 mm^3/s (d) 47.7 mm^3/s

39. German silver contains

(a) 12.5% silver (b) 5% silver

(c) 1% silver (d) None of the above

40. Addition of coal dust to the green moulding sand is to improve

(a) permeability (b) surface finish

(c) mouldability (d) green strength

41. Slush casting process is used to produce

(a) hollow castings (b) intricate castings

(c) large size castings (d) thin walled castings

42. Two castings of the same metal have the same surface area. One casting is in the form of a sphere and the other is a cube. What is the ratio of the solidification time for the sphere to that of the cube?

(a) 3/4 (b) $6/\pi$

(c) $5/4\pi$ (d) $3\pi/8$

43. Plug gauge is used to measure

(a) Taper bores

(b) Cylindrical bores

(c) Spherical holes

(d) None of the above

44. Resistance spot welding is performed on two plates of 1.5 mm thickness with 6 mm diameter electrode using 15000 A current for a time duration of 0.25 seconds. Assuming the interface resistance to be 0.0001 Ω, the heat generated to form the weld is

(a) 5625 W-sec

(b) 8437 W-sec

(c) 22500 W-sec

(d) 33750 W-sec

45. Pre-heating before welding is done to

(a) make the steel softer

(b) burn away oil, grease, etc. from the plate surface

(c) prevent cold cracks

(d) prevent plate distortion

46. The velocity of tool along the tool face is known as

(a) Shear velocity

(b) Chip velocity

(c) Cutting velocity

(d) Mean velocity

47. A milling cutter having 8 teeth is rotating at 150 RPM. If the feed per tooth is 0.1, the table speed in mm per minute is

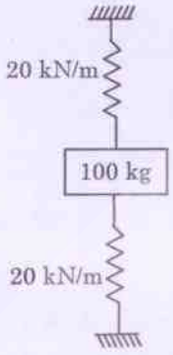
(a) 120

(b) 187

(c) 125

(d) 70

48. As shown in the figure a mass of 100 kg is held between two springs. The natural frequency of vibration of the system in cycle/s is



(a) $1/2\pi$ (b) $5/\pi$

(c) $10/\pi$ (d) $20/\pi$

49. In ultrasonic machining process, the material removal rate would

(a) increase (b) decrease

(c) increase and then decrease (d) decrease and then increase

50. Tool life of 10 hrs is obtained when cutting with single point tool at 63 m/min. If Taylor's constant $C = 257.35$, tool life on doubling the velocity will be

(a) 5 hrs (b) 25.7 min

(c) 38.3 min (d) No change

51. 3-2-1 method of location in a jig or fixture would collectively restrict the work piece in 'n' degrees of freedom where the value of 'n' is

(a) 6 (b) 8

(c) 9 (d) 1

52. During orthogonal machining with a HSS tool, the rake angle is 5°, un-deformed chip thickness is 0.25 mm and width of cut is 4 mm. Assuming shear strength of work material to be 350 N/mm^2 and coefficient of friction as 0.5, determine cutting and thrust force.

(a) 1029.4 N, 406.8 N (b) 1000 N, 500 N

(c) 1110.5 N, 425.8 N (d) 1025.4 N, 410.8 N

53. The probability that a teacher will give an unannounced test during any class is 1/5. If a student is absent twice, then probability that misses atleast one test is

(a) 2/3 (b) 4/5 (c) 7/25 (d) 9/25

54. The difference between two specific heats, $C_p - C_v = \frac{R}{J}$. This relation is valid for

(a) any gas (b) perfect gases
(c) real gases (d) pure gases

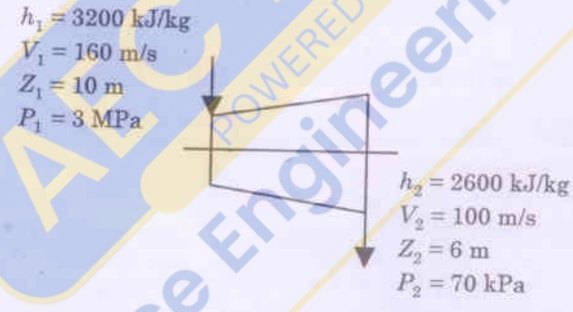
55. A process in which no heat is supplied or rejected from the system and entropy is not constant is known as

(a) isothermal (b) isentropic
(c) polytropic (d) hyperbolic

56. Carnot cycle has maximum efficiency for

(a) petrol engine (b) diesel engine
(c) reversible engine (d) irreversible engine

57. The inlet and outlet conditions of steam for an adiabatic steam turbine are as indicated in the figure. The notations are as usually followed. If the mass rate of steam through the turbine is 20 Kg/s, the power output of the turbine is



(a) 12.157 MW (b) 12.941 MW
(c) 168.001 MW (d) 168.785 MW

58. A solar energy based heat engine which receives 80 KJ of heat at 100 deg C and rejects 70 KJ of heat to the ambient at 30 deg C is to be designed. The thermal efficiency of the heat engine is

(a) 70% (b) 1.88%
(c) 12.5% (d) None of the above

59. A carnot cycle refrigerator operates between 250 K and 300 K. Its coefficient of performance is

(a) 6.0 (b) 5.0 (c) 1.2 (d) 0.8

60. A large diesel engine runs on a stroke cycle at 2000 rpm. The engine has a displacement of 25 litre and a brake mean effective pressure of 0.6 MN/m^2. It consumes 0.018 Kg/s of fuel (calorific value = 42000 KJ/Kg). Determine the brake power.

(a) 250 KW (b) 225 KW

(c) 275 KW (d) none of the above

61. A gas having a negative Joule-Thompson effect ($\mu<0$), when throttled will

(a) become cooler

(b) become warmer

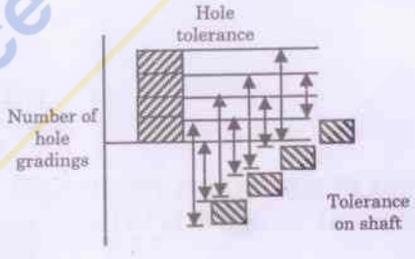
(c) remain at the same temperature

(d) either be cooler or warmer depending on the type of gas

62. The pressure 'p' of an ideal gas and its mean kinetic energy E per unit volume are related by the relation

(a) $p=\frac{4}{3}E$ (b) $p=\frac{3E}{2}$ (c) $p=\frac{E}{3}$ (d) $p=\frac{2E}{3}$

63. The figure shows the principle of



(a) traceability (b) interchangeability

(c) matched fits (d) selective assembly

64. Your finger sticks to an ice tray just taken from the refrigerator. Which factor has more effect on this phenomenon?

(a) The inside temperature of the freezer

(b) The humidity of the air

(c) The heat capacity of both your finger and the tray

(d) The thermal conductivity of the tray

65. Wet clothes are hung on a clothesline outdoors in sub-zero weather. After a day, the clothes are brought into the house and observed to be dry. The process of drying is best explained as

(a) vaporization (b) sublimation

(c) melting (d) condensation

66. A 10 Kg solid at 100°C with a specific heat of 0.8 KJ/Kg °C is immersed in 40 Kg of 20°C liquid with a specific heat of 4.0 KJ/Kg °C. Estimate the temperature after a long time if the container is insulated (Specific heat of water = 4.18 KJ/Kg).

(a) 30°C (b) 28°C

(c) 26°C (d) 24°C

67. For a current wire of 20 mm diameter exposed to air ($h = 20$ W/m^{2}K), maximum heat dissipation occurs when thickness of insulation ($k = 0.5$ W/mK) is

(a) 20 mm (b) 25 mm

(c) 10 mm (d) none of the above

68. A steel ball of mass 1 Kg and specific heat 0.4 KJ/Kg is at a temperature of 60°C. It is dropped into 1 Kg water at 20°C. The final steady state temperature of water is

(a) 23.5°C (b) 30°C

(c) 35°C (d) 40°C

69. It is proposed to coat a 1 mm diameter wire with enamel paint ($k = 0.1$ W/mK) to increase the heat transfer with air. If the air side heat transfer coefficient is 100 W/m^{2}K, the optimum thickness of enamel paint should be

(a) 0.25 mm (b) 0.5 mm

(c) 1 mm (d) 2 mm

70. In a pulverized fuel fired large power boiler, the heat transfer from the burning fuel to the walls of the furnace is

(a) by conduction only
(b) by convection only
(c) by conduction and convection
(d) predominantly by radiation

71. Three metal walls of the same cross sectional area having thermal conductivities in the ratio 1:2:4 transfer heat at the rate of 6000 KJ/hr. For the same wall thickness, the temperature drops will be in the ratio

(a) 1:2:4
(b) 1:1/2:1/4
(c) 1/4 : 1/2 :1
(d) 1:1:1

72. A basic hole is one whose

(a) lower deviation is zero
(b) upper deviation is zero
(c) lower and upper deviations are zero
(d) none of the above

73. As per IT 5, standard tolerance unit (i) is equal to

(a) $0.002 + 0.8\ D$
(b) $0.8 + 0.002\ D$
(c) $0.45\sqrt[3]{D} + 0.001\ D$
(d) $0.001\ \sqrt[3]{D} + 0.45\ D$

74. Circular shapes appear in this fashion when viewed at an angle other than 90 degrees

(a) Circular
(b) Elliptical
(c) Lengthened
(d) Angular

75. Starting friction is low in

(a) Hydrostatic lubrication
(b) Hydrodynamic lubrication
(c) Mixed lubrication
(d) Boundary lubrication

76. Which one of the following is trapezoidal thread?

(a) Acme
(b) Square
(c) Buttress
(d) All of the above

77. If the ratio of the diameter of rivet hole to the pitch of rivets is 0.25, then the tearing efficiency of the joint is

(a) 50%
(b) 75%
(c) 25%
(d) 87%

78. The life of a ball bearing at a load of 10 KN is 8000 hours. If the load is increased to 20 KN, keeping all other conditions the same, then its life in hours is

(a) 4000
(b) 2000
(c) 1000
(d) 500

79. A drawing which shows the product with its components in their correct physical relationship is called

(a) Part drawing
(b) Layout drawing
(c) Assembly drawing
(d) Fabrication drawing

80. Which one of the following is a solid state joining process?

(a) Gas tungsten arc welding
(b) Resistance spot welding
(c) Friction welding
(d) Submerged arc welding