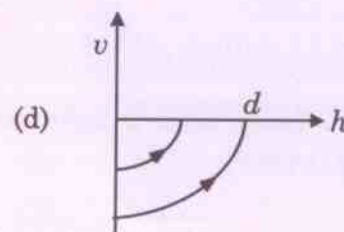
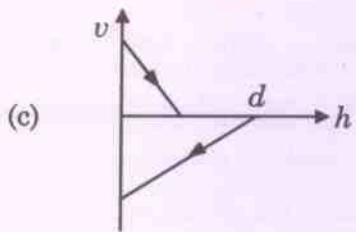
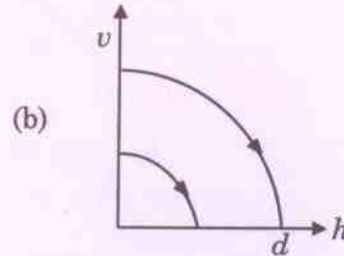
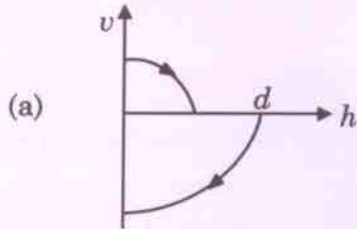
	INDIAN SPACE RESEARCH ORGANISATION	<b>SET A</b>
	MECHANICAL ENGINEERING	

- Starting from the same initial conditions, an ideal gas expands from volume  $V_1$  to  $V_2$  in three different ways, the work done by the gas is  $W_1$  if the process is purely isothermal,  $W_2$  if purely isobaric and  $W_3$  if purely adiabatic, then
  - $W_2 > W_1 > W_3$
  - $W_2 > W_3 > W_1$
  - $W_1 > W_2 > W_3$
  - $W_1 > W_3 > W_2$
- A beaker filled with hot water in a room cools from  $70^\circ\text{C}$  to  $65^\circ\text{C}$  in  $t_1$  minutes,  $65^\circ\text{C}$  to  $60^\circ\text{C}$  in  $t_2$  minutes and from  $60^\circ\text{C}$  to  $55^\circ\text{C}$  in  $t_3$  minutes. Then,
  - $t_1 > t_2 > t_3$
  - $t_1 = t_2 = t_3$
  - $t_1 < t_2 < t_3$
  - cannot be concluded
- A house refrigerator with its door open is switched on in a closed room. The air in the room is
  - cooled
  - remains at same temperature
  - heated
  - heated or cooled depending on atmospheric pressure
- An elevator has a mass of 5000 kg. When the tension in the supporting cable is 60 kN, the acceleration of the elevator is nearly
  - $8 \text{ m/s}^2$
  - $12 \text{ m/s}^2$
  - $-2 \text{ m/s}^2$
  - $2 \text{ m/s}^2$
- The piston of a steam engine moves with simple harmonic motion. The speed of rotation of crank is 120 rpm with a stroke of 2 m. What is the velocity of piston when it is 0.5 m from the centre?
  - $4\pi\sqrt{3}$
  - $\pi\sqrt{3}$
  - $2\pi\sqrt{3}$
  - $3\pi\sqrt{3}$

6. The sine of the angle between the two vectors  $a = 3i + j + k$  and  $b = 2i - 2j + k$  is
- (a)  $\sqrt{\frac{74}{99}}$  (b)  $\sqrt{\frac{25}{99}}$   
(c)  $\sqrt{\frac{37}{99}}$  (d)  $\sqrt{\frac{5}{51}}$
7. Equation of the line normal to function  $f(x) = (x - 8)^{2/3} + 1$  at  $P(0, 5)$  is
- (a)  $y = 3x - 5$  (b)  $3y = x - 15$   
(c)  $3y = x + 15$  (d)  $y = 3x + 5$
8. There are 20 locks and 20 matching keys. Maximum number of trials required to match all the locks is
- (a) 190 (b) 210  
(c) 400 (d) 40
9. If  $\phi(x, y, z)$  is a scalar function and if  $\nabla^2 \phi = 0$ , then  $\phi$  is
- (a) Irrational (b) Harmonic  
(c) Irrotational (d) Solenoidal
10. A and B are two candidates appearing for an interview by a company. The probability that A is selected is 0.5 and the probability that both A and B are selected is at most 0.3. The probability of B getting selected is
- (a) 0.9 (b)  $\leq 0.3$   
(c)  $\leq 0.6$  (d) 0.5
11. The reading of a spring balance is from 0 to 200 N and is 10 cm long. A body suspended from the spring balance is observed to oscillate vertically at 2 Hz. The mass of the body is nearly
- (a) 22.5 kg (b) 12.5 kg  
(c) 37 kg (d) 45 kg

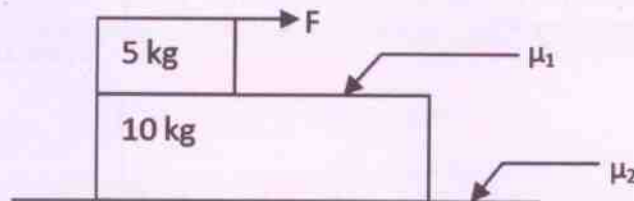
12. A ball is dropped vertically from a height  $d$  above the ground. It hits the ground and bounces up to a height  $d/2$ . Neglecting the subsequent motion and air resistance, its velocity ( $v$ ) varies with height ( $h$ ) above the ground as



13. A 10 kW drilling machine is used to drill a bore in a small aluminium block of mass 8 kg. How much is the rise in temperature of the block in 2.5 minutes, assuming 50% of power is used up in heating the block? (specific heat of aluminum :  $0.91 \text{ J}/(\text{g}^\circ\text{C})$ )

- (a)  $50^\circ\text{C}$  (b)  $206^\circ\text{C}$   
(c)  $103^\circ\text{C}$  (d)  $227^\circ\text{C}$

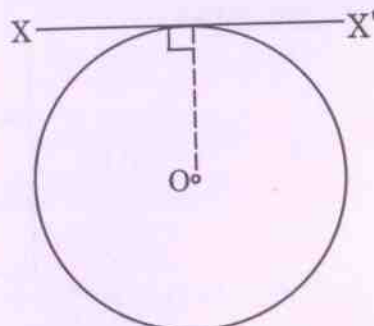
14. In the figure shown, the minimum ratio of  $\mu_1 / \mu_2$  so that the masses move together with the application of force  $F$  is



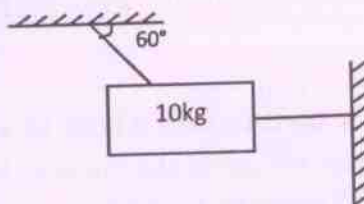
- (a) 5 (b) 2  
(c) 4 (d) 3



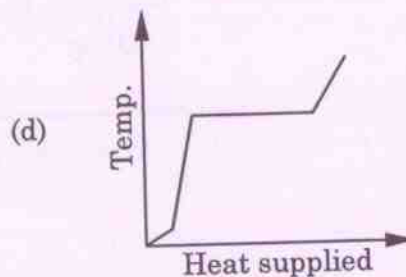
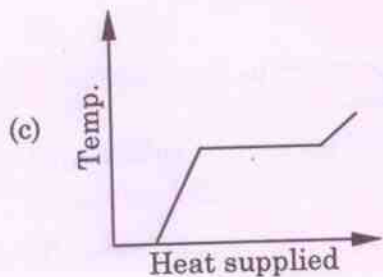
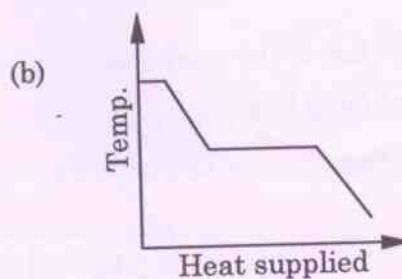
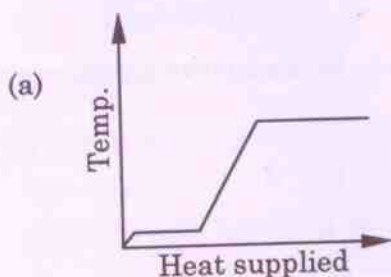
15. A thin wire of length  $L$  and uniform linear mass density  $\rho$  is bent into a circular loop with centre  $O$  as shown in figure. The moment of inertia of the loop about the axis  $XX'$  is



- (a)  $\rho L^3/16\pi^2$       (b)  $\rho L^3/8\pi^2$       (c)  $5\rho L^3/16\pi^2$       (d)  $3\rho L^3/8\pi^2$
16. A 10 kg mass is hung from 2 light, inextensible strings as shown. The tension in the horizontal string is nearly



- (a) 49 N      (b) 57 N      (c) 100 N      (d) 0 N
17. A block of ice at  $-10^\circ\text{C}$  is slowly heated and converted to steam at  $100^\circ\text{C}$ . Which of the following curves represent the phenomena qualitatively?






18. If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor of
- (a) 2 (b) 4  
(c) 8 (d) 16
19. The transmission of heat by molecular collision is called
- (a) Convection (b) Conduction  
(c) Radiation (d) Ionisation
20. If two ends of rods of length  $L$  and radius  $r$ , made of same material are kept at the same temperature difference, which of the following rods conduct most heat per unit time?
- (a)  $L = 50 \text{ cm}, r = 1 \text{ cm}$  (b)  $L = 2 \text{ cm}, r = 0.5 \text{ cm}$   
(c)  $L = 100 \text{ cm}, r = 2 \text{ cm}$  (d)  $L = 3 \text{ cm}, r = 1 \text{ cm}$
21. A thermometer works on the principle of
- (a) Law of stable equilibrium (b) Zeroth law of thermodynamics  
(c) First law of thermodynamics (d) Second law of thermodynamics
22. The working temperatures in evaporator and condenser coils of a refrigerator are  $-25^\circ\text{C}$  and  $30^\circ\text{C}$ , respectively. The COP of the refrigerator is 0.85 of the maximum COP for a power input of 2 kW. The refrigeration effect produced will be
- (a) 7.6 kW (b) 9 kW  
(c) 10.2 kW (d) 12 kW
23. A mercury thermometer was first placed in melting ice and the length of mercury column was observed to be 10 mm; when it was placed in steam, the length of the column was 250 mm. When placed in tap water, the length of the column was 58 mm. The temperature of the tap water is
- (a)  $24.2^\circ\text{C}$  (b)  $20^\circ\text{C}$   
(c)  $38.4^\circ\text{C}$  (d)  $4.14^\circ\text{C}$
24. The amount of steam (at  $100^\circ\text{C}$ ) required to raise the temperature of 200 g of water from  $60^\circ\text{C}$  to  $100^\circ\text{C}$  is
- (a) 10 g (b) 16.8 g  
(c) 20 g (d) 14.8 g



25. A engine works on Carnot cycle between  $727^{\circ}\text{C}$  and  $227^{\circ}\text{C}$ . The efficiency of the engine is
- (a) 50% (b) 75.4%  
(c) 31.2% (d) 68.8%
26. A steam thermal power plant works on
- (a) Brayton cycle (b) Rankine cycle  
(c) Carnot cycle (d) Otto cycle
27. A boat which has a speed of 5 km/h in still water crosses a river of width 1 km along the shortest path in 15 min. The velocity of the river in km/h is
- (a) 3 (b) 1  
(c) 4 (d)  $\sqrt{41}$
28. In 1s, a particle goes from point A to point B, moving in a semicircle (as shown in figure). The magnitude of the average velocity is



- (a) 3.14 m/s (b) 1 m/s (c) 2 m/s (d) Zero
29. A block is made to slide down an inclined plane ( $30^{\circ}$  with horizontal) which is smooth. It starts sliding from rest and takes a time 't' to reach the bottom of the plane. An identical body is freely dropped from the same point. The time the body takes to reach the bottom is
- (a) t (b)  $\frac{t}{2}$   
(c)  $\frac{t}{3}$  (d)  $\frac{t}{4}$

	INDIAN SPACE RESEARCH ORGANISATION	<b>SET A</b>
	MECHANICAL ENGINEERING	

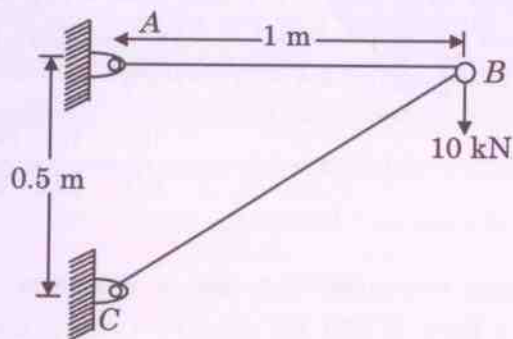
30. What parameter will remain constant in a throttling process?
- (a) Entropy (b) Temperature  
(c) Pressure (d) Enthalpy
31. The main objective of 'shot peening' is to improve which property of metal parts
- (a) Surface finish (b) Ductility  
(c) Fatigue strength (d) None of the above
32. When a material is strain hardened?
- (a) its yield strength reduces and ductility increases  
(b) its yield strength increases and ductility reduces  
(c) both yield strength and ductility increases  
(d) both yield strength and ductility reduces
33. Which thread is more suited in power screw to take load on both directions?
- (a) Acme thread (b) Square thread  
(c) Buttress thread (d) None of these
34. A hole is specified as  $\phi 50^{(+0.050/-0.000)}$  mm. The mating shaft has a clearance fit with minimum clearance of 0.02 mm. The tolerance on the shaft is 0.03 mm. Maximum clearance between hole and shaft is
- (a) 0.100 mm (b) 0.030 mm  
(c) 0.080 mm (d) 0.070 mm
35. In a cutting operation the cutting speed was reduced by 20%. Assuming  $n = 0.5$  and  $C = 350$  in Taylor's equation, the increase in tool life is
- (a) 46% (b) 48%  
(c) 59% (d) 56%
36. Mass production of seamless tubes is by the process of
- (a) Rolling (b) Spinning  
(c) Welding (d) Extrusion



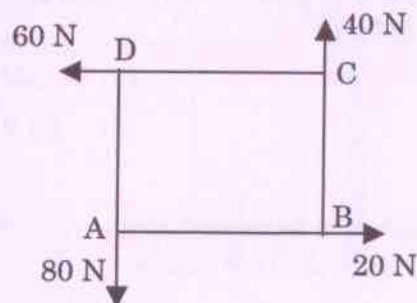
37. Misrun is a casting defect which occurs due to
- (a) Very high pouring temperature of metal (b) Absorption of gases by liquid metal  
(c) Insufficient fluidity of molten metal (d) Improper alignment of mould flasks
38. A simple steam power cycle receives 100,000 kJ/min as heat transfer from hot combustion gases and rejects 66,000 kJ/min as heat transfer to the environment. If the pump power required is 1400 kJ/min, the thermal efficiency of the cycle and turbine power output is
- (a) 51.5% and 590 kW (b) 34% and 590 kW  
(c) 51.5% and 566.6 kW (d) 34% and 566.6 kW
39. Air at 100 kPa, 2°C occupies a 10 liter piston-cylinder device that is arranged to maintain constant air pressure. This device is now heated until its volume is 20 liters. The work produced by the air is
- (a) 20 kJ (b) 10 kJ  
(c) 2 kJ (d) 1 kJ
40. A heat engine working with a thermal efficiency of 35% receives 2 kW of heat from a furnace. The waste heat rejected from the engine is
- (a) 0.7 kW (b) 0.35 kW  
(c) 1.3 kW (d) 1.65 kW
41. Joule-Thompson coefficient for an ideal gas is
- (a) higher than zero (b) less than zero  
(c) zero (d) 1
42. Air is heated from 0°C to 100°C in a sealed metal container. Its density
- (a) Increases slightly (b) Decreases slightly  
(c) Remains the same (d) Change cannot be predicted
43. If a certain mass of moist air in an air tight vessel is heated to a higher temperature, then
- (a) Specific humidity of the air increases (b) Specific humidity of the air decreases  
(c) Relative humidity of the air increases (d) Relative humidity of the air decreases



44. Air is accelerated isentropically from 100 m/s to 300 m/s in a nozzle. If the temperature at the inlet is  $127^{\circ}\text{C}$ , the inlet Mach number is (take  $R = 287\text{J}/(\text{kg K})$  and specific heat ratio = 1.4)
- (a) 0.249 (b) 0.442  
(c) 0.747 (d) 0.333
45. Two equal forces are acting at a point with an angle of  $60^{\circ}$  between them. If the resultant force is equal to  $60\sqrt{3}$ , what is the magnitude of each force?
- (a) 30 (b) 50  
(c) 40 (d) 60
46. A two member truss ABC is configured as shown in figure. The force in the member AB is



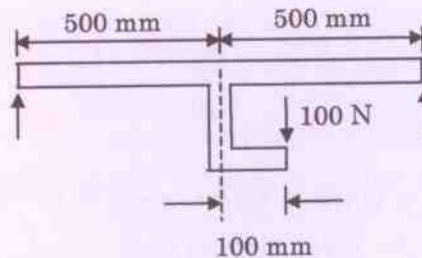
- (a) 15 kN (b) 30 kN  
(c) 20 kN (d) 5 kN
47. Four forces of magnitudes 20 N, 40 N, 60 N and 80 N are acting respectively along the four sides of a square ABCD as shown in figure. The magnitude of resultant is




- (a)  $40\sqrt{2}\text{ N}$  (b)  $50\sqrt{2}\text{ N}$   
(c)  $45\sqrt{2}\text{ N}$  (d)  $60\sqrt{2}\text{ N}$



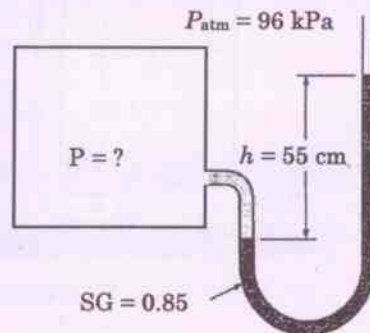
48. In a simply supported beam loaded as shown in figure, the maximum bending moment in Nm is



- (a) 25 (b) 30  
(c) 35 (d) 60
49. Two steel rails each of 12 m length are laid with a gap of 1.5 mm at ends at a temperature of 24°C. The thermal stress produced at a temperature of 40°C is (take  $E = 2 \times 10^5 \text{ N/mm}^2$ , coefficient of thermal expansion =  $12 \times 10^{-6} / ^\circ\text{C}$ )
- (a) 10.5 N/mm<sup>2</sup> (b) 12.5 N/mm<sup>2</sup>  
(c) 13.4 N/mm<sup>2</sup> (d) 15.5 N/mm<sup>2</sup>
50. An aluminum tensile test specimen has a diameter,  $d_o = 25 \text{ mm}$  and a gauge length of  $L_o = 250 \text{ mm}$ . If a force of 175 kN elongates the gauge length by 1.25 mm, the modulus of elasticity of the material is nearly
- (a) 71 GPa (b) 71 MPa  
(c) 142 GPa (d) 142 MPa
51. A tubular shaft, having an inner diameter of 30 mm and an outer diameter of 40 mm, is to be used to transmit 80 kW of power. The speed of rotation of the shaft so that the shear stress will not exceed 50 MPa is
- (a) 29.6 rpm (b) 3557.4 rpm  
(c) 1778.7 rpm (d) 59.2 rpm
52. A cantilever beam of length  $L$  is subjected to a concentrated load  $P$  at a distance of  $L/3$  from the free end. The deflection at the free end is
- (a)  $\frac{1}{3} \frac{PL^3}{EI}$  (b)  $\frac{14}{81} \frac{PL^3}{EI}$   
(c)  $\frac{7}{18} \frac{PL^3}{EI}$  (d)  $\frac{1}{2} \frac{PL^3}{EI}$

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	MECHANICAL ENGINEERING	

53. What is the common surface hardening treatment in steel?
- (a) Carburizing (b) Tempering  
(c) Quenching (d) None of the above
54. Which of the following order of crystal structure will match with metals Iron – Copper – Zinc in that order?
- (a) BCC – HCP – FCC (b) FCC – BCC – HCP  
(c) HCP – FCC – BCC (d) BCC – FCC – HCP
55. A resistance spot-welding operation is performed on two pieces of 1.5 mm thick sheet steel using 12000 amps current for a duration of 0.20 second. The electrodes are 6 mm in diameter at the contacting surfaces. Resistance is assumed to be 0.0001 ohms and the resulting weld nugget is 6 mm in diameter and 2.5 mm thick. The unit melting energy for the metal is  $12 \text{ J/mm}^3$ . What portion of heat generated was used to form the weld?
- (a) 29.4% (b) 70.6%  
(c) 58.8% (d) 41.2%
56. A manometer is used to measure the pressure of a gas in a tank. The fluid used has a specific gravity of 0.85 and the manometer column height is 55 cm, as shown in figure. If the local atmospheric pressure is 96 kPa, what is the absolute pressure in the tank?



- (a) 4.6 kPa (b) 98.6 kPa  
(c) 100.6 kPa (d) 200 kPa



57. A crane is used to lower weights into the sea (sea water density =  $1025 \text{ kg/m}^3$ ) for an underwater construction project. What is the percentage reduction in the tension in the rope of the crane due to a rectangular  $0.4 \text{ m} \times 0.4 \text{ m} \times 3 \text{ m}$  concrete block (density =  $2300 \text{ kg/m}^3$ ) when it is completely immersed in water compared to the tension in the rope when it was suspended in air

- (a) 45% (b) 55%  
(c) 65% (d) 75%

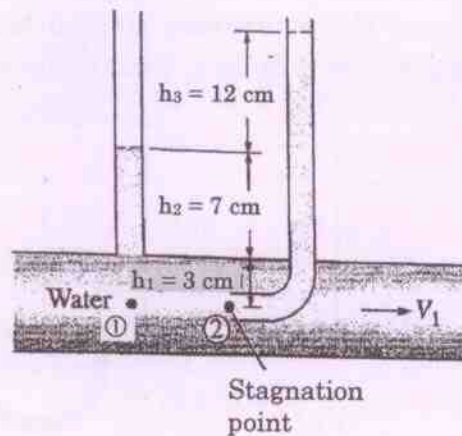
58. A steady, incompressible, two-dimensional velocity field is given by,

$$\vec{V} = (u, v) = (0.5 + 0.8x)\vec{i} + (1.5 - 0.8y)\vec{j}$$

The number of stagnation points there in the flow field is

- (a) zero (b) many  
(c) 1 (d) 2

59. A piezometer and a Pitot tube are tapped into a horizontal water pipe, as shown in figure. The velocity of water at the center of the pipe is



- (a) 2.4 m/s (b) 1.53 m/s  
(c) 2.07 m/s (d) 1.93 m/s

