

VERY IMPORTANT PROBLEMS 04 (VIP 04 - FLUID MECH/MACHINERIES)

INSTRUCTION: Solve or familiarize the answers of the following very probable problems.

1. The initial condition of air in an air compressor is 98 Kpa and 27°C and discharges air at 450 Kpa. The bore and stroke are 335 mm and 381 mm, respectively with percent clearance of 8% running at 300 rpm. Find the volume of air at suction.
 A. 541.62 m³/hr C. 561.62 m³/hr
 B. 551.62 m³/hr D. 571.62 m³/hr
 Answer: D
2. An air compressor has a suction volume of 0.35 m³/sec at 97 Kpa and discharges to 650 Kpa. How much power saved by the compressor if there are two stages?
 A. 18.27 KW C. 13.86 KW
 B. 16.54 KW D. 11.58 KW
 Answer: D
3. A two stages air compressor has an intercooler pressure of 4 kg/cm². What is the discharge pressure if suction pressure is 1 kg/cm²?
 A. 3 kg/cm² C. 12 kg/cm²
 B. 9 kg/cm² D. 16 kg/cm²
 Answer: D
4. A two- stage air compressor air at 100 Kpa and 22°C discharges to 750 Kpa. If intercooler intake is 105°C, determine the value of n.
 A. 1.400 C. 1.345
 B. 1.288 D. 1.326
 Answer: D
5. A single acting air compressor has a volumetric efficiency of 89%, operates at 500 rpm. It takes in air at 100 Kpa and 30°C and discharges it at 600 Kpa. The air handled is 8 m³/min measured at discharge condition. If compression is isentropic, find mean effective pressure in Kpa
 A. 233.34 C. 198.34
 B. 973.17 D. 204.82
 Answer: A
6. A water-jacketed air compressor handles 0.343 m³/s of air entering at 96.5 kpa and 21°C and leaving at 480 kpa and 132°C; 10.9 kg/h of cooling water enters the jacket at 15°C and leaves at 21°C. Determine the compressor brake power.
 A. 26.163 kw C. 34.44 kw
 B. 62.650 kw D. 19.33 kw
 Answer: B
7. A double suction centrifugal pumps delivers 20 ft³/sec of water at a head of 12 m and running at 650 rpm. What is the specific speed of the pump?
 A. 5014.12 rpm C. 2770.73 rpm
 B. 6453.12 rpm D. 9968.73 rpm
 Answer: C
8. Determine the number of stages needed for a centrifugal pump if it is used to deliver 400 gal/min of water and pump power of 15 Hp. Each impeller develops a head of 30 ft.
 A. 6 C. 5
 B. 7 D. 4
 Answer: C
9. The suction pressure of a pump reads 3 in. of mercury vacuum and discharge pressure reads 140 psi is use to deliver 120 gpm of water with specific volume of 0.0163 ft³/lb. Determine the pump work.
 A. 4.6 KW C. 7.4 KW
 B. 5.7 KW D. 8.4 KW
 Answer: C
10. A submersible pump delivers 350 gpm of water to a height of 5 ft from the ground. The pump were installed 150 ft below the ground level and a draw down of 8 ft during the operation. If the water level is 25 ft above the pump, determine the pump power.
 A. 7.13 KW C. 7.24 KW
 B. 4.86 KW D. 9.27 KW
 Answer: D
11. A vacuum pump is used to drain a flooded mine shaft of 20°C water. The pump pressure of water at this temperature is 2.34 Kpa. The pump is incapable of lifting the water higher than 16 m. What is the atmospheric pressure?
 A. 159.30 C. 198.22
 B. 132.33 D. 171.9
 Answer: A
12. A submersible, multi-stage, centrifugal deep well pump 260 gpm capacity is installed in a well 27 feet below the static water level and running at 3000 rpm. Drawdown when pumping at rated capacity is 10 feet. The pump delivers the water into a 25,000 gallons capacity overhead storage tank. Total discharge head developed by pump, including friction in piping is 243 feet. Calculate the diameter of the impeller of this pump in inches if each impeller diameter developed a head of 38 ft.
 A. 3.28 C. 3.71
 B. 5.33 D. 6.34
 Answer: C
13. A fan draws 1.42 m³ per second of air at a static pressure of 2.54 cm of water through a duct 300 mm diameter and discharges it through a duct of 275 mm diameter. Determine the static fan efficiency if total fan mechanical is 75% and air measured at 25°C and 760 mm Hg.
 A. 50.11% C. 65.67%
 B. 53.69% D. 45.43%
 Answer: B
14. Assume 8 ft³ of air at 100 psi, 100°F are compressed isothermally to a volume of 2 ft³. For each of end states the process, find the bulk modulus.
 A. 400 and 100 psi C. 400 and 120 psi
 B. 400 and 110 psi D. 400 and 130 psi
 Answer: A
15. A empty, open can is 30 cm high with a 15 cm diameter. The can, with the open end down, is pushed under water with a density of 1000 kg/m³. Find the water level in the can when the top of the can is 50 cm below the surface.
 A. 17.20 cm C. 4.20 cm
 B. 2.12 cm D. 5.87 cm
 Answer: B
16. A cylindrical pipe with water flowing downward at 0.03 m³/s having top diameter of 0.08, bottom diameter of 0.04 m and height of 1.5 m. Find the pressure between the pipe.
 A. 154.63 kpa C. 252.44 kpa
 B. 197.93 kpa D. 243.92 kpa
 Answer: C
17. Determine the size of pipe which will deliver 8 liters of medium oil ($\nu = 6.10 \times 10^{-6}$ m²/s) assuming laminar flow conditions.
 A. 622 mm C. 950 mm
 B. 754 mm D. 835 mm
 Answer: D
18. The type of flow occupying in a 1 cm diameter pipe which water flows at a velocity of 2.50 m/s. Use $\nu = 1.13 \times 10^{-6}$ m²/s of water.
 A. turbulent C. laminar
 B. constant D. none of these
 Answer: A
19. What force is exerted by water jet 60 mm diameter if it strikes a wall at the rate of 15 m/s?
 A. 636.17 N C. 764.23 N
 B. 4421.62 N D. 563.34 N
 Answer: A
20. A 300 mm diameter pipe discharges water at the rate of 200 li/s. Point 1 on the pipe has a pressure of 260

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- kpa and 3.4 m below point 1 is point 2 with a pressure of 300 kpa. Compute the head loss between points 1 and 2.
 A. 4.29 m C. 6.32 m
 B. 2.59 m D. 1.87 m
 Answer: D
21. Water flowing at the rate of 10 m/s from an orifice at bottom of a reservoir. Find the pressure at the bottom of reservoir.
 A. 30 kpag C. 50 kpag
 B. 60 kpag D. 40 kpag
 Answer: C
22. Steam flows through a nozzle at 400°C and 1 Mpa ($h = 3263.9$ KJ/kg) with velocity of 300 m/s. Find the stagnation enthalpy.
 A. 3300 KJ/kg C. 3320 KJ/kg
 B. 3290 KJ/kg D. 3309 KJ/kg
 Answer: D
23. Air flows through a nozzle at a speed of 350 m/s. Find the stagnation temperature if entrance temperature is 200°C.
 A. 241.25°C C. 261.25°C
 B. 251.25°C D. 271.25°C
 Answer: C
24. Carbon dioxide flows through a nozzle with a speed of 00 m/s. Compute the dynamic temperature.
 A. 92.56°K C. 96.56°K
 B. 94.56°K D. 98.56°K
 Answer: B
25. Carbon dioxide flows through a nozzle with a speed of 380 m/s. The entrance condition of nozzle is 250°C and 1200 kpa. Find the stagnation pressure.
 A. 2,136.34 kpa C. 2,156.34 kpa
 B. 2,146.34 kpa D. 2,166.34 kpa
 Answer: A
26. Air enters a diffuser with a velocity of 200 m/s. Determine the velocity of sound if air temperature is 30°C.
 A. 349 m/s C. 369 m/s
 B. 359 m/s D. 379 m/s
 Answer: A
27. Air flows through a nozzle with temperature of entrance of 420°K stagnation temperature of 468°K. Find the mach number.
 A. 0.744 C. 0.764
 B. 0.754 D. 0.774
 Answer: B
28. Air at 10 deg C and 80 kpa enters a diffuser of a jet engine steadily with a velocity of 200 m/s. The inlet area of diffuser is 0.40 m². Determine the mass flow rate of air.
 A. 72.79 kg/s C. 76.79 kg/s
 B. 74.79 kg/s D. 78.79 kg/s
 Answer: D
29. Air pass thru a nozzle with efficiency of 90%. The velocity of air at the exit is 600m/s. Find the actual velocity at the exit.
 A. 382 m/s C. 458 m/s
 B. 540 m/s D. 568 m/s
 Answer: D
30. A small pump serving as model, when tested in laboratory using water at 3600 rpm, delivered 3.0 cfs at a head of 125 ft. If the efficiency of this model pump is 84%. Predict the horsepower input to the prototype pump if it is to develop the same head as model pump and the model pump has a scale ratio of 1:10. Assume the efficiency of the prototype pump is 90%.
 A. 50.6 hp C. 4730 hp
 B. 3740 hp D. 60.5 hp
 Answer: C
31. Pump at its best efficiency point (BEP) has a capacity of 10,500 gpm while developing a head of 60 ft at a rotative speed of 1450 rpm. What is the specific speed of the pump?
 A. 2760 C. 1450
 B. 2476 D. 6892
 Answer: D

$$N_s = \frac{N \sqrt{Q}}{H^{3/4}} = \frac{1450 \sqrt{10500}}{60^{3/4}} = 6892$$
32. A pump will be installed below the reservoir water surface with a required net positive suction head (NPSH_r) of 50 ft. The barometric pressure is 14.3 psia, and the vapor pressure is 0.5 psia. Assume friction losses in the intake piping are 5 ft. Find the maximum allowable elevation of the pump relative to the water surface intake to avoid cavitation.
 A. 45 ft C. 55 ft
 B. 18.2 ft D. 23.2 ft
 Answer: D
33. Centrifugal pump at best efficiency point (BEP). Assume the pump characteristic are head, $h = 7$ m, flow rate, $Q = 19$ liters/sec, and rotative speed $n = 1170$ rpm. Find the specific speed in SI units.
 A. 0.4 C. 0.71
 B. 10.41 D. 3.94
 Answer: C
34. A 15 in. diameter fan operates at 1600 rpm and develops a head of 6 in. of water and delivers 120 cfm. What volumetric capacity for geometrically similar fan that will develop 6 in. of water at 1300 rpm?
 A. 147.70 cfm C. 181.8 cfm
 B. 97.5 cfm D. 79.2 cfm
 Answer: C
35. A radial-flow pump operating at maximum efficiency at a specific speed of 2500 is to deliver 260 gpm against a head of 129 ft at a rotative speed of 2100 rpm. Find the required number of stages (i.e., impellers).
 A. 2 stages C. 3 stages
 B. 4 stages D. 5 stages
 Answer: B
36. A 26-hp pump delivers 475 gpm of gasoline ($\gamma = 42.5$ lb/ft³) at 20°C with 78% efficiency. What pressure rise result across the pump?
 A. 30.2 psi C. 32.7 psi
 B. 120.3 psi D. 73.2 psi
 Answer: D
37. A model pump delivering water at 180°F ($\gamma = 60.6$ lb/ft³; $\rho_{\text{water}} = 7.54$ psia) at 900 gpm and 2500 rpm begins to cavitate when the inlet pressure and velocity are 13 psia and 22 fps. Find the required NPSH of a prototype which is 4 times larger and runs at 1100 rpm.
 A. 63.5 ft C. 20.49 ft
 B. 6.61 ft D. 36 ft
 Answer: A
38. The diameter of the discharge pipe is 8 in. and that of the intake pipe is 10 in. The pressure gage at discharge reads 32 psi, and vacuum gage at the intake reads 12 in Hg. If the discharge flow rate = 4.0 ft³/s of water and the brake horsepower is 49.0, find the efficiency. The intake and the discharge are at the same elevation.
 A. 82.1% C. 80.9%
 B. 55.8% D. 58.46%
 Answer: A
39. A piston positive-displacement pump (PDP) has 6-in diameter and a 2.5-in. stroke. Its crankshaft rotates at 300 rpm. Calculate its output at 94 percent volumetric efficiency.
 A. 12.27 cfm C. 13.5 cfm
 B. 10 cfm D. 11.53 cfm
 Answer: D
40. A centrifugal pump (efficiency 88%) lifts water through a total height of 40m from reservoir to discharge. Pumping is through 300m of 75mm

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diameter pipe at the rate of 20 liter/sec. If pipe friction factor, $f = 0.025$, what horsepower is required?

- A. 28.4 kW
B. 25 kW
C. 32.2 kW
D. 9 Kw

Answer: C

41. In order to predict the behavior of a small oil pump, tests are to be made on a model using air. The oil pump is to be driven by a 1/20-hp motor at 1800 rpm and a 1/4-hp motor is available to drive the air pump at 600 rpm. Using specific gravity of oil at 0.912 and density of air constant at 0.076 lb/ft^3 , what size model should be built?

- A.) The model should be 2 times as large as the oil pump.
B.) The model should be 5 times as large as the oil pump.
C.) The model should be 8 time as large as the oil pump.
D.) The model should be 10 times as large as the oil pump.

Answer: D

42. What is the power ratio of a pump and its 1/5 scale model if the ratio of heads is 4 to 1?

- A. 20
B. 12.5
C. 200
D. 125

Answer: C

43. The speed of a centrifugal pump is doubled. By what factor does the pump head change?

- A. 0.125
B. 4
C. 0.25
D. 8

Answer: B

44. A pump in a municipality's water-supply system receives water from the filtration beds and pumps it up to the top of a water tower. The tower's height is 35 m, and the inlet piping to the pump is 2 m below the pump's intake. The water temperature is 20°C , measured at both the inlet and the discharge from the pump. The mass flow rate through the pump is 100 kg/s , the diameter of the inlet piping is 25 cm, and the diameter of the discharge piping is 15 cm. Determine the power required by the pump.

- A. 77.3 kW
B. 33.77 kW
C. 34.42 kW
D. 42.34 kW

Answer: B

45. A single acting air compressor with a clearance of 6% takes in air at atmospheric pressure and temperature of 85°F , and discharges it at a pressure of 85 psia. The air handled is 0.25 ft^3 / cycle measured at discharge pressure. If the compression is isentropic, find the piston displacement per cycle, if the compressor is running at 750 rpm.

- A. $0.0750 \text{ ft}^3/\text{cycle}$
B. $0.025 \text{ ft}^3/\text{cycle}$
C. $1.030 \text{ ft}^3/\text{cycle}$
D. $1.090 \text{ ft}^3/\text{cycle}$

Answer: C

46. A single acting air compressor with a clearance of 6% takes in air at atmospheric pressure and temperature of 85°F , and discharges it at a pressure of 85 psia. The air handled is 0.25 ft^3 / cycle measured at discharge pressure. If the compression is isentropic, find the air hp of the compressor if rpm is 750.

- A. 16 hp
B. 96 hp
C. 69 hp
D. 61 hp

Answer: B

47. A nozzle receives 0.5 kg/s of air at a pressure of 2700 kPa and a velocity of 30 m/s and with an enthalpy of 923 kJ/kg , and the air leaves at a pressure of 700 kPa and with an enthalpy of 660 kJ/kg . Determine the exit velocity from the nozzle.

- A. 923 m/s
B. 726 m/s
C. 700 m/s
D. 660 m/s

Answer: B

48. A two-stage, double-acting compressor is to deliver 90 lb/min of air from 14.3 psia and 90°F to a final

pressure of 185 psia. The normal barometer is 29.8 in-Hg and the temperature is 80°F . The pressure drop in the intercooler is 3 psi and the speed is 210 rpm and $pV^{1.34} = C$ during compression and expansion. The clearance is 5% for both cylinders. The temperature of the cooling water increase by 18°F . Find the volume of free air.

- A. 1282 CFM
B. 1230 CFM
C. 1320 CFM
D. 1822 CFM

Answer: B

49. A reciprocating compressor handles 1,400 cfm of air measured at intake where $p_1 = 18 \text{ psia}$ and $t_1 = 90^\circ\text{F}$. The discharge pressure is 92 psia. Calculate the work if the process of the compression is isothermal.

- A. -180.5 hp
B. -179.5 hp
C. -227.6 hp
D. -228.6 hp

Answer: B

50. A pump discharges 550 gpm of water to a height of 35 ft. With an efficiency of 80%, what is the power input?

- A. 6.09 hp
B. 6.32 hp
C. 4.74 hp
D. 4.94 hp

Answer: A

51. A centrifugal pump with a 3 ft. impeller diameter operates at 800 rpm. If the speed is to be increased to 1200 rpm, determine the impeller diameter that should be used so that the same shaft input power would be required.

- A. 5.32 ft.
B. 2.35 ft.
C. 5.23 ft.
D. 2.93 ft.

Answer: B

52. What is the power of the pump, HP, if it delivers 925 gal/min of water against a head of 15m?

- A. $P = 15.38 \text{ HP}$
B. $P = 10.5 \text{ HP}$
C. $P = 16.38 \text{ HP}$
D. $P = 11.5 \text{ HP}$

Answer: D

53. Kerosene is pumped into an aircraft fuel tank through a hose that has an inside diameter of 4cm. If the velocity of the kerosene is 8 m/s through the hose. Determine the mass flow rate. Assume that kerosene has a density of 800 kg/m^3

- A. 7.06 kg/s
B. 8.06 kg/s
C. 7.56 kg/s
D. 8.56 kg/s

Answer: B

54. An air compressor takes in 9 kg/min of air at 98 kPa; $v_1 = 0.125 \text{ m}^3/\text{kg}$ and discharges it at 680 kPa; $v_2 = 0.03 \text{ m}^3/\text{kg}$. The increase of internal energy is 93 kJ/kg and the work done on air is 163 kJ/kg; the change in potential and kinetic energy are neglected. How much heat is transferred per kg of air?

- A. 264.15 kJ/kg
B. 288.65 kJ/kg
C. 61.85 kJ
D. 78.15 kJ/kg

Answer: C

55. Water is flowing in a pipe with a radius of $10''$ at a velocity of 5 m/s. At the temperature in the pipe, the density and viscosity of the water are as follows:

$\rho = 997.9 \text{ kg/m}^3$ $\mu = 1.131 \text{ Pa.s}$. What is the Reynold's number for this situation?

- A. 44.1
B. 88.2
C. 1140
D. 2241

Answer: D

56. What is the flow rate through a pipe 4" in diameter carrying water at a velocity of 11 ft/sec?

- A. $27,200 \text{ cm}^3/\text{s}$
B. $726 \text{ cm}^3/\text{s}$
C. $993 \text{ cm}^3/\text{s}$
D. $19,200 \text{ cm}^3/\text{s}$

Answer: D

57. A surface tension force, σ , of water in air is approximately $0.00518 \text{ lb}_f/\text{ft}$. If the atmospheric pressure is 14.7 psia, what is the pressure inside a droplet $0.01''$ in diameter?

- A. 14.53 psia
B. 14.70 psia
C. 14.87 psia
D. 14.78 psia

Answer: C

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58. What is the pressure at point A in the tank if $h = 2$ feet? ($g = 32.3 \text{ ft/sec}^2$, and $\rho = 1.94 \text{ slug/ft}^3$)
 A. 75 lbf/ft^2
 B. 85 lbf/ft^2
 C. 100 lbf/ft^2
 D. 125 lbf/ft^2
 Answer: D
59. Determine the average velocity through a circular section in which the velocity distribution is given as $v = v_{\max} \left[1 - \left(\frac{r}{r_o} \right)^2 \right]$. The distribution is symmetric with respect to the longitudinal axis, $r = 0$. r_o is the outer radius, v_{\max} is the velocity along the longitudinal axis.
 A. $\frac{v_{\max}}{4}$
 B. $\frac{v_{\max}}{3}$
 C. $\frac{v_{\max}}{2}$
 D. v_{\max}
 Answer: C
60. A pipe has a diameter of 4" at section AA, and a diameter of 2" at section BB. For an ideal fluid flow, the velocity is given as 1 ft/sec at section AA. What is the flow velocity at section BB?
 A. 4 ft/sec
 B. 0.5 ft/sec
 C. 1.0 ft/sec
 D. 2.0 ft/sec
 Answer: A
61. A mixing tank mixes two inlet streams containing salt. The salt concentration in stream 1 is 5% by weight, and stream 2 it is 15% by weight. Stream 1 flows at 25 kg/s, and stream 2 flows at 10 kg/s. There is only one exit stream. Find the salt concentration in the exit stream.
 A. 5%
 B. 8%
 C. 11%
 D. 13%
 Answer: B
62. Water is pumped at $1 \text{ m}^3/\text{s}$ to an elevation of 5 meters through a flexible hose using a 100% efficient pump rated at 100 kilowatts. Using the same length of hose, what size motor is needed to pump $1 \text{ m}^3/\text{s}$ of water to a tank with no elevation gain? In both cases both ends of the hose are at temperature pressure. Neglect kinetic energy effects.
 A. 51 kW
 B. 22 kW
 C. 36 kW
 D. 43 kW
 Answer: A
63. What is the actual volumetric flow rate for the discharge of the tank shown? The coefficient of contraction for the orifice is 0.61, and the coefficient of velocity is 0.98.
 A. $6.78 \text{ ft}^3/\text{sec}$
 B. $6.92 \text{ ft}^3/\text{sec}$
 C. $9.79 \text{ ft}^3/\text{sec}$
 D. $11.34 \text{ ft}^3/\text{sec}$
 Answer: A
64. The upper plate is fixed, while the lower plate moves in the positive x direction at 0.5 m/s. The plate separation is 0.001 m, the fluid viscosity is 0.7cp, and the velocity profile is linear. Calculate the shear stress, τ_{xy} , in the moving fluid.
 A. 0.05 Pa
 B. 0.15 Pa
 C. 0.25 Pa
 D. 0.35 Pa
 Answer: D
65. Calculate the Reynolds number, Re , for water at 20°C flowing in an open channel. The water flowing at a volumetric rate of 200 gal/sec. The channel has a height of 4 feet and a width of 8 feet. At this temperature, water has a kinetic viscosity of $1.104 \times 10^{-5} \text{ ft}^2/\text{sec}$.
 A. 600,000
 B. 800,000
 C. 1.0×10^6
 D. 1.2×10^6
 Answer: A
66. A fluid with a kinetic viscosity of $2.5 \times 10^{-5} \text{ ft}^2/\text{sec}$ is flowing at 0.1 ft/sec from an orifice 3" in diameter. How can the fluid be described?
 A. The fluid is completely turbulent.
 B. The fluid is laminar.
 C. The fluid is in transition zone.
 D. Turbulent cannot be calculated; it must be measured
 Answer: B
67. The Reynolds number of a sphere falling in air is 1×10^6 . If the sphere's radius is 1 ft, what is its velocity? ($\rho_{\text{air}} = 0.00234 \text{ slug/ft}^3$, $\mu_{\text{air}} = 3.8 \times 10^{-7} \text{ lbf-sec/ft}^2$)
 A. 2.5 ft/sec
 B. 5.1 ft/sec
 C. 40.6 ft/sec
 D. 81.2 ft/sec
 Answer: D
68. From the Blasius solution for laminar boundary layer flow, the average coefficient of skin friction is $C_f = \frac{1.328}{\sqrt{Re}}$. If air flowing past a 33 feet long plate at a velocity of 100 ft/sec, what is the force on the plate?
 A. 0.00114 lbf
 B. 0.00344 lbf
 C. 0.086 lbf
 D. 0.114 lbf
 Answer: D
69. The flow rate of water through a cast iron is 5000 gallons per minute. The diameter of the pipe is 1 foot, and the coefficient of friction is $f = 0.0173$. What is the pressure drop over a 100 foot length of pipe?
 A. 21.078 lbf/ft^2
 B. 23.78 lbf/ft^2
 C. 337.26 lbf/in^2
 D. 337.26 lbf/ft^2
 Answer: D
70. A cast iron pipe of equilateral triangular cross section with side length of 20.75" has water flowing through it. The flow rate is 6000 gallons per minute, and the friction factor for the pipe is $f = 0.017$. What is the pressure drop in a 100 foot section?
 A. 24.3 lbf/ft^2
 B. 48.7 lbf/ft^2
 C. 178.5 lbf/ft^2
 D. 309.7 lbf/ft^2
 Answer: C
71. A circular cylinder 4 feet long and 3 feet in diameter is in air stream. The flow velocity is 5 ft/sec perpendicular to the axis of the cylinder. Given that the coefficient of drag, C_D , on the cylinder is 1.3, and the density of air is $0.00234 \text{ slug/ft}^3$, what is the force on the cylinder?
 A. 0.09 lbf
 B. 0.11 lbf
 C. 0.46 lbf
 D. 0.91 lbf
 Answer: C
72. Air flows past a 2" diameter sphere at 100 ft/sec. What is the drag force experienced by the sphere given that it has a coefficient of drag of 0.5 and that the density of the air is $0.00234 \text{ slug/ft}^3$?
 A. 0.041 lbf
 B. 0.064 lbf
 C. 0.128 lbf
 D. 0.244 lbf
 Answer: C
73. A cylinder 10 feet long and 2 feet in diameter is suspended in air flowing at 8 ft/sec. The density of air $0.00234 \text{ slug/ft}^3$, and the coefficient of drag of the sphere is 1.3. What is the drag on the cylinder?
 A. 0.311 lbf
 B. 0.39 lbf
 C. 1.95 lbf
 D. 3.89 lbf
 Answer: C
74. A coil has an inlet temperature of 70°F and outlet of 80°F . If the mean temperature of the coil is 130°F , find the bypass factor of the coil.
 A. 0.28
 B. 1.20
 C. 0.82
 D. 0.83
 Answer: D
75. Compute the pressure drop of 35°C air flowing with a mean velocity of 5 m/s in a circular sheet-metal duct 400 mm in diameter and 25 m long. Use a friction factor, $f = 0.04$, and $\rho_{\text{air}} = 1.3799 \text{ kg/m}^3$.
 A. 431.22 Pa
 B. 221.34 Pa
 C. 312.24 Pa
 D. 422.31 Pa
 Answer: A

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76. A 29.53" x 39.37" pressure vessel contains ammonia with $f = 0.041$. Compute the minimum required discharge capacity of the relief device in kg/hr.
 A. 106.71 kg/hr C. 110.71 kg/hr
 B. 108.71 kg/hr D. 112.71 kg/hr
 Answer: C
77. Compute the maximum length of the discharge pipe installed on the outlet of a pressure-relief device in feet for internal pipe diameter of 0.5 inch and rated discharge capacity is 8 lb/min of air. The rated pressure of relief valve is 16 psig.
 A. 0.286 ft C. 0.486 ft
 B. 0.386 ft D. 0.586 ft
 Answer: A
78. A thermal power plant has a heat rate of 11,363 Btu/kW-hr. Find the thermal efficiency of the plant.
 A. 28% C. 34%
 B. 30% D. 40%
 Answer: B
79. Find the loss of head in the pipe entrance if speed of flow is 10 m/s.
 A. 5.10 m C. 17.4 m
 B. 10.2 m D. 2.55 m
 Answer: D
80. An air compressor consumed 1200 kw-hr per day of energy. The electric motor driving the compressor has an efficiency of 80%. If indicated power of the compressor is 34 kW, find the mechanical efficiency of the compressor.
 A. 117.65% C. 85%
 B. 75% D. 90%
 Answer: C
81. An air compressor has a power of 40 kW at 4% clearance. If clearance will increase to 7%, what is the new power?
 A. 70 kW C. 53 kW
 B. 40 kW D. 60 kW
 Answer: B
82. A three stages air compressor air from 100 kPa to 1000 kPa. Find the intercooler pressure between the first and second stage.
 A. 505.44 kPa C. 316.23 kPa
 B. 108.44 kPa D. 215.44 kPa
 Answer: D
83. A 10-stages air compressor compresses air from 100 kPa to 800 kPa. Find the intercooler pressure between the first and second stage.
 A. 282.84 kPa C. 123.11 kPa
 B. 113.21 kPa D. 333.51 kPa
 Answer: C
84. A 3-stages air compressor compresses air from 100 kPa to 700 kPa. Find the intercooler pressure between the 2nd and 3rd stage.
 A. 365.88 kPa C. 385.88 kPa
 B. 375.88 kPa D. 395.88 kPa
 Answer: A
85. The barometer of a mountain hiker reads 930 mbars at the beginning of a hiking trip and 780 mbars at the end. Neglecting the effect of altitude on local gravitational acceleration determine the vertical distance climbed. Assuming $g = 9.7 \text{ m/s}^2$.
 A. 1274.21 m C. 1267.34 m
 B. 1289.00 m D. 1583.34 m
 Answer: B
86. The lower half of a 10 m high cylindrical container is filled with water and the upper half with oil that has SG = 0.85. Determine the pressure difference between the top and bottom of the cylinder.
 A. 90.74 kPa C. 83.38 kPa
 B. 92.74 kPa D. 96.10 kPa
 Answer: A
87. A 200 mm x 250 mm, 8-cylinder, 4-stroke diesel engine has a brake power of 150 kW. The mechanical efficiency is 80%. If two of the cylinders were accidentally cut off, what will be the new friction power?
 A. 31.50 kW C. 35.50 kW
 B. 33.50 kW D. 37.50 kW
 Answer: D
88. A hiker carried an Aneroid barometer from the foot of Mount Banahaw to the camp of the NPA leader Ka Roger. On the foot of the mountain, the barometer reads 30.150 inches of Hg, and on the camp, which is nearly at the top of the mountain it reads 28.607 inches of Hg. Assume that the average air density (atmospheric) was 0.075 pcf, estimate the height of the mountain, in ft.
 a) 1455.54 c) 1545.54
 b) 1554.54 d) 1455.55
 Answer: A
89. Find the air Hp of an industrial fan that delivers 25 m³/s of air through a 900 mm by 1200 mm outlet. Static pressure is 127 mm of water gage and air density is 1.18 kg/m³.
 a) 52.3 Hp c) 35.2 Hp
 b) 42.3 Hp d) 34.2 Hp
 Answer: A
90. A Pelton wheel has a capacity of 25 000 kW with head of 290 m. What is the number of jet needed for this turbine if the jet if the nozzle jet diameter is 200 mm.
 a) 3 c) 4
 b) 2 d) 1
 Answer: C
91. A standard 25-mm outside diameter steel tube (with wall thickness of 1.65 mm) is carrying 0.34 lps of oil. Determine the velocity of flow of oil inside the tube.
 a) 191 fpm c) 181 fpm
 b) 171 fpm d) 161 fpm
 Answer: C
92. If the velocity of discharge from a fire hose is 15 m/s and the hose is oriented 45° from the horizontal. Disregarding air friction, determine the maximum range of the discharge.
 a) 14 m c) 33 m
 b) 24 m d) 23 m
 Answer: D
93. A full cylindrical tank 12 m high has a constant diameter of 6 m. The tank has a 100 mm diameter hole in its bottom. The coefficient of discharge for the hole is 0.98. How long will it take for the water level to drop from 12 m to 6 m?
 a) 16 minutes c) 20 minutes
 b) 24 minutes d) 28 minutes
 Answer: B
94. A pump delivering 230 lps of water whose absolute viscosity is 0.0114 poise has a 300 mm diameter suction pipe and 254 mm diameter discharge pipe. Determine the friction factor in the suction line if the pipe material is a cast iron.
 a) 0.02068 c) 0.0199
 b) 0.2013 d) 0.0299
 Answer: C

NOTE: STUDY PROBLEMS AND TERMS AVAILABLE IN THE OFFICE.

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