VERY IMPORTANT PROBLEMS 02 (VIP 02 - HEAT TRANSFER/ICE/FUELS)

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

1. An Otto cycle has a compression ratio of 8. Find the pressure ratio during compression.
   A. 18.38 C. 14.38
   B. 16.38 D. 12.38
   Answer: A
2. A diesel cycle has a cut-off ratio of 2.5 and expansion ratio of 4. Find the clearance of the cycle.
   A. 9.11% C. 11.11%
   B. 5.55% D. 15.15%
   Answer: C
3. A dual cycle has an initial temperature of 30°C. The compression ratio is 6 and the heat addition at constant volume process is 600 kJ/kg. If cut-off ratio is 2.5, find the maximum temperature of the cycle.
   A. 3638.50°C C. 3565.50°C
   B. 3365.50°C D. 3965.50°C
   Answer: B
4. Determine the air-standard efficiency of an engine operating on the diesel cycle with clearance of 6% when the suction pressure is 99.97 kPa and the fuel is injected for 7% of the stroke. Assume k = 1.4.
   A. 62.11% C. 73.58%
   B. 51.20% D. 60.02%
   Answer: A
5. A certain coal has the following ultimate analysis:C = 69%N_2= 5%H_2= 2.5%S = 7%Determine the amount of oxygen if the heating value of fuel is 26,961.45 kJ/kg
   A. 1.5% C. 3.5% is the answer
   B. 2.5% D. 4.5%
   Answer: D
6. A diesel engine consumed 645 liters of fuel per day at 35°C. If the fuel was purchased at 15.5°C and 30°API at P29.00/li, determine the cost of fuel to operate the engine per day.
   A. P5677.50 C. P46,088.90
   B. P4577.50 D. P27,127.76
   Answer: D
7. A cylindrical tank 4 m long and 3 m diameter is used for oil storage. How many days can the tank Supply the engine having 27°API with fuel consumption of 60 kg/hr?
   A. 17.53 C. 12.84
   B. 5.84 D. 19.84
   Answer: A
8. The dry exhaust gas from oil engine has the following gravimetric analysis: CO_2 = 21.6%
   O_2 = 4.2% N_2 = 74.2%
   Specific heats at constant pressure for each component of the exhaust gas in Kcal/kg°C are CO_2 = 0.203 O_2 = 0.219N_2 = 0.248 Calculate the specific gravity if the molecular weight of air is 28.97 kg/kg-mol.
   A. 0.981 C. 1.055
   B. 1.244 D. 0.542
   Answer: C
9. A bituminous coal has the following composition: C = 71.5% H = 5.0%O = 7.0% N = 1.3% S = 3% Ash = 7.6% W = 3.4% Determine the theoretical weight of Nitrogen in lb/lb of coal.
   A. 2.870 C. 2.274
   B. 7.526 D. 6.233
   Answer: B
10. A gaseous fuel mixture has a molar analysis:H_2 = 14% CH_4 = 3% CO = 27% O_2 = 0.6% CO_2 = 4.5% N_2 = 50.9%
    Determine the air-fuel ratio for complete combustion on molar basis.
    A. 2.130 C. 1.233
    B. 3.230 D. 1.130
    Answer: C
11. A volumetric analysis of a gas mixture is as follows: CO_2 = 12%O_2 = 4%N_2 = 82%CO = 4%What is the percentage of CO_2 on a mass basis?
    A. 17.55% C. 12.73%
    B. 15.55% D. 19.73%
    Answer: A
12. An air standard engine has a compression ratio of 18 and a cut-off ratio of 4. If the intake air pressure and temperature are 100 kPa and 27°C, find the work in kJ per kg.
    A. 2976 C. 1582 is the answer
    B. 2166 D. 2751
    Answer: D
13. A Diesel cycle has a cut-off ratio of 2.20 and a compression ratio of 10. Find the cycle efficiency.
    A. 55.10% C. 59.735
    B. 52.23% D. 62.37%
    Answer: B
14. A Diesel cycle has an initial temperature of 27 °C. If the cut-off ratio is 2.50 and compression ratio is 12, find the maximum cycle temperature.
    A. 1634.4 °C C. 1753.44 °C
    B. 2010.3 °C D. 1983.4 °C
    Answer: C
15. A diesel engine which takes in air at 1 bar, 26 °C has a compression ratio of 19. Calculate the operating clearance in percent.
    A. 8.08 C. 8.56
    B. 7.52 D. 5.55
    Answer: D
16. An Otto cycle has an initial pressure of 100 kPa and has a pressure of 400 kPa after adiabatic compression. Find the cycle efficiency.
    A. 32.70% C. 34.70%
    B. 36.70% D. 38.70%
    Answer: A
17. An Otto cycle has a clearance of 8% and heat added of 1000 kJ. Find the heat rejected.
    A. 564 kJ C. 353 kJ
    B. 709 kJ D. 867 kJ
    Answer: C
18. An Otto cycle has a heat rejected of 300 kJ and work of 700 kJ. Find the cycle efficiency.
    A. 56% C. 60%
    B. 70% D. 50%
    Answer: B
19. An Otto cycle has a pressure ratio of 7. What is the cycle compression ratio?
    A. 5.18 C. 6.34
    B. 7.34 D. 4.01
    Answer: D
20. Find the power of a rotating shaft which develops a torque of 188 N-m at 1350 rpm.
    A. 101.54 hp C. 53.63 hp
    B. 63.35 hp D. 35.63 hp
    Answer: D
21. There are 18 kg of exhaust gas formed per kg of fuel oil burned in the combustion of diesoline $C_{16}H_{32}$. What is the excess air in percent?
    A. 28.4% C. 30.1%
    B. 21.5% D. 15.53%
    Answer: D
22. The specific gravity of oil tested at 24°C is 0.852. Find its API in degrees.
    A. 35.98 C. 37.62
    B. 32.98 D. 23.54
    Answer: B
23. An ideal gasoline engine operates with an initial cycle temperature of 48°C and exhaust temperature of 150°C. The change in temperature during combustion is 150°K. Calculate the ideal thermal efficiency.
    A. 32% C. 33%
    B. 34% D. 35%
    Answer: A
24. A spark ignition engine operates on an Otto cycle with a compression ratio of 9 and temperature limits of 30°C and 1000°C. If the power input is 500 kW. Calculate the mass flow rate of air.
    A. 1.99kg/s C. 2.19kg/s
    B. 2.99 kg/s D. 2.59 kg/s
    Answer: C
25. A 4m^2 asphalt pavement with emissive of 0.85 has a surface temperature of 50 deg C. Find the maximum rate of radiation that can be emitted from the surface.
    A.2,068.32 watts C.2,088.32 watts
    B.2,078.32 watts D.2,098.32 watts
    Answer: D
26. Consider a person standing in a breezy room at 20 deg C. Determine the total rate transfer from this person of the exposed surface area and the average outer surface temperature of the person are 1.6 m^2 and 29 deg C, respectively, and the convection heat transfer coefficient is 6 W/m^2 with emissivity of 0.95.

A.86.40 watts C.198.1 watts
B.81.70 watts D.168.1 watts
Answer: D

27. Water is boiler in a pan on a stove at sea level. During 10 minutes of boiling, it is observed that 200 grams of water has evaporated. Then the rate of heat transfer to the water is:
A.0.84 KJ/min C.41.8 KJ/min
B.45.1 KJ/min D.53.5 KJ/min
Answer: B

28. An aluminum pan whose thermal conductivity is 237 W/m-C has a flat bottom whose diameter is 20 cm and thickness0.4 cm. Heat is transferred to boiling water in the pan through its bottom at a rate of 500 watts. If the inner surface of the bottom of the pan is 105 deg C, determine the temperature of the surface of the bottom of the pan.
A.95.27 deg C C.115.27 deg C
B.105.27 deg C D.125.27 deg C
Answer: B

29. For heat transfer purposes, a standing man can be modeled as a 30 cm diameter, 170 cm long vertical cylinder with bottom both the top and bottom surfaces insulated and with the side surface at an average temperature of 34 deg C. For a convection heat transfer coefficient is 15 W/m^2-C, determine the rate of the heat loss from this man by convection in an environment at 20 deg C.
A.316.46 watts C.336.46 watts
B.326.46 watts D.346.46 watts
Answer: C

30. A 5 cm diameter spherical ball whose surface is maintained at a temperature of 70 deg C is suspended in the middle of a room at 20 deg C. If the convection heat transfer coefficient is 15 W/m^2-C and the emissivity of the surface is 0.8, determine the total heat transfer form the ball:
A.23.56 watts C.9.22 watts
B.32.77 watts D.43.45 watts
Answer: B

31. A frictionless piston-cylinder device and a rigid tank contain 1.2 kmol of a ideal gas at the same temperature, pressure, and volume. Now heat is transferred, and the temperature of both system is raised by 15 deg C. The amount of extra heat that must be supplied to the gas in the cylinder that is maintained at constant pressure.
A.0 C.100 KJ
B.50 KJ D.150 KJ
Answer: D

32. A 4m x 5m x 6m room is to be heated by a baseboard resistance wear. It is desired that the resistance heater be able to raise the air temperature in the room from 7 to 23 deg c within 15 minutes. Assuming no heat losses form the room and an atmospheric pressure of 100 kpa, determine the required power of the resistance heater. Assume constant specific heats at room temperature.
A.2.34 KW C.4.56 KW
B.1.91 KW D.6.34 KW
Answer: B

33. A student living in a 4 m x 6m x 6m dormitory room turns on her 150 watts fan before she leaves the room on a summer day, hoping that the room will be cooler when she comes back in the evening. Assuming all the doors and windows are tightly closed and disregarding any heat transfer through the walls and the windows, determine the temperature in the room when she comes back 10 hours later. Use specific heat value at room temperature, and assume the room to be at 100 kpa and 15 deg C in the morning when she leaves.
A.28.13 deg C C.48.13 deg C
B.38.13 deg C D.58.13 deg C
Answer: D

34. A piston-cylinder device whose piston is resisting on top of a set of stops initially contains 0.50 kg of helium gas at 100 kpa and 25 deg C. The mass of the piston is such that 500 kpa of pressure is required to raise it. How much heat must be transferred to the helium before the piston starts rising?
A.1557.13 KJ C.1757.13 KJ
B.1657.13 KJ D.1857.13 KJ
Answer: D

35. A tank contains liquid nitrogen at -190 deg C is suspected in a vacuum shell by three stainless steel rods 0.80 cm in diameter and 3 meters long with a thermal conductivity of 16.3 W/m^2-deg C. If the ambient air outside the vacuum shell is 15 deg C, calculate the magnitude of the conductive heat flow in watts along the support rods.
A.0.168 C.0.182
B.0.176 D.0.0587
Answer: A

36. Methyl alcohol (Ch_3OH) is burned with 25% excess air. How much unburned oxygen in kg-mol-oxygen/.kg-mol-fuel will there in the products if the combustion is complete?
A.0.35 C.0.37
B.0.45 D.0.65
Answer: C

37. A 4 liter (2-liter per revolution at standard pressure and temperature) spark ignition engine has a a compression ratio of 8 and 2200 KJ/kg heat addition by the fluid combustion. Considering a cold air-standard Otto cycle model, how much power will the engine produce when operating at 2500 rpm?
A.166.53 hp C.97.4 hp
B.73.12 hp D.148 hp
Answer: A

38. An ideal gas mixture consists of 2 kmol of N_2 and 6 Kmol of CO_2. The mass fraction of CO_2 is:
A.0.175 C.0.825
B.0.250 D.0.750
Answer: C

39. An ideal gas mixture consists of 2 kmol of N_2 and 6 kmol of Co_2. The apparent gas constant of mixture is:
A.0.208 C.0.531
B.0.825 D.0.231
Answer: A

40. Air in an ideal Diesel cycle is compressed from 3 L to 0.15 and then it expands during the constant pressure heat addition process to 0.3 L. Under cold air standard conditions, the thermal efficiency of this cycle is:
A.35 % C.65 %
D.70 % D.44 %
Answer: C

41. In an ideal Otto cycle, air is compressed from 1.20 kg/m^3 and 2.2 L to 0.26L and the net work output of the cycle is 440 KJ/kg. The mean effective pressure for the cycle is:
A.612 kpa C.528 kpa
B.599 kpa D.416 kpa
Answer: B

42. An Otto cycle operates on 0.1 lb/s of air from 13 psia and 130^{0}F at the beginning of compression. The temperature at the end of combustion is 5000^{0}R; compression ratio is 5.5; hot-air standard, k = 1.3. Find the horsepower of the engine.
A. 51.99 hp C. 54.1 hp
B. 53.1 hp D. 55.1 hp
Answer: A

43. Determine the air-fuel ratio on a molar basis for the complete combustion of octane, with theoretical amount of air.
A. 59.5 kg_{air} / kg_{fuel} C. 69.5 kg_{air} / kg_{fuel}
B. 95.5 kg_{air} / kg_{fuel} D. 49,5 kg_{air} / kg_{fuel}
Answer: A

44. During a steady state operation, a gearbox receives 60 kW through the input shaft and delivers power through the output shaft. For the gearbox as the system, the rate of energy transfer is by convection. h = 0.171 kW/m^2-K is the heat transfer coefficient, A = 1.0 m^2 is the outer surface area of the gearbox, T_b = 300^{0}K (27^0) is the temperature at the outer surface, T_f = 293^{0}K (20^{0}C) is the temperature of the surroundings away from the immediate vicinity of the gearbox. Determine the power delivered to the output shaft in kW if the heat transfer rate is -1.2 kW.
A. 98.8 kW C. 68.8 kW
B. 78.8 kW D. 58.8 Kw
Answer: D

45. A 3.0 liter, 5-cylinder, 4-stroke cycle SI engine, with a volumetric efficiency of 82%, operates at 3000 RPM using gasoline with a λ = 0.91. Bore and stroke are related as S = 1.08B. At a certain point in the engine cycle, the gas temperature in the combustion chamber is T_g = 2100^{0}C while the cylinder wall temperature is T_w = 190^{0}C. Viscosity, and Thermal conductivity, of gases (air at 1145^{0}C) $\dot{u}_g = 5.21 \times 10^{-5}$ kg/m-sec, k_g = 0.090 W/m-K are respectively. Convective heat transfer coefficient of c_1 = 0.035 and c_2 = 0.08. Calculate the approximate convection heat transfer rate to the cylinder wall at this instant.
A. 54.32 kW/m^2 C. 35.42 kW/m^2
B. 32. 54 kW/m^2 D. 45.44 kW/m^2
Answer: A

46. The fuel oil has the ff. analysis:
C= 89% N_2= 2% H_2= 8% S= 1%With 3% excess air, what is the actual amount of air needed to burn the fuel oil?
A. 13.17 kg_{air}/kg_{fuel} C. 14.47 kg_{air}/kg_{fuel}
B. 13.47 kg_{air}/kg_{fuel} D. 14.17 kg_{air}/kg_{fuel}
Answer: D

47. A car engine with a power output of 65 hp has a thermal efficiency of 24%. Determine the fuel consumption rate of this car if the fuel has a heating value of 19,000 Btu/lb_m.
A. 36.28 lb/hr C. 37.28 lb/hr
B. 37.28 lb/hr D. 35.30 lb/hr
Answer: A

48. A slab of iron with temperature, $T_{i1} = 48°C$ is used to heat a flat glass plate that has an initial temperature of $T_{g1} = 18°C$. Assuming no heat is lost to the environment, and the masses are $m_i = 0.40kg$ for the slab and $m_g = 310g$ for the plate, what is the amount of heat transferred when the two have reached equal temperatures? Assume $c_i = 0.11$ kcal/kg.°C for iron. And $c_g = 0.20$ kcal/kg.°C for glass.
A. 860 cal C. 53 kcal
B. 32 kcal D. 320 kcal
Answer: A

49. Calculate the energy transfer rate across a 6" wall of firebrick with a temperature difference across the wall of 50 °C. The thermal conductivity of firebrick is 0.65 BTU/hr-ft-°F at the temperature of interest.
A. 112 W/m² C. 369 W/m²
B. 285 W/m² D. 429 W/m²
Answer: C

50. A house has brick walls 15 millimeters thick. On a cold winter day, the temperature of the inner and outer surfaces of the walls are measured and found to be 20 °C and -12 °C, respectively. If there is 120 m² of exterior wall space, and the thermal conductivity of bricks is 0.711 J/m.s.°C, how much heat is lost through the walls per hour?
A. 182 J C. 655 kJ
B. 12.5 kJ D. 655 MJ
Answer: D

51. In an air standard Otto cycle, the clearance volume is 12 % of the displacement volume. What is the thermal efficiency?
a) 57 % c) 59 %
b) 58 % d) 60 %
Answer: C

52. Determine the critical radius in cm for an asbestos-cement covered pipe [k_{asb} = 0.208 W/m-°K]. The external heat-transfer coefficient is 1.5 Btu/h-ft²-°F.
a. 2.44 cm c. 2.55 cm
b. 2.66 cm d. 2.22 cm
Answer: A

53. A certain coal has the following ultimate analysis by weight. C = 67 %, Ash = 5 %, Moisture = 8 %, N = 6 %, H = 3 %, Sulfur = 7 %, O = 4 %. Calculate the higher heating value in Btu/lb.
a) 15 179 c) 11 579
b) 17 519 d) 19 517
Answer: C

54. Determine the heating value of a certain fuel with a SG = 0.997.
a) 42 975 kJ/kg c) 42 597 kJ/kg
b) 42 795 kJ/kg d) 42 579 kJ/kg
Answer: A

55. Calculate the energy transfer rate across 6" wall of firebrick with a temperature difference across of 50 °C. the thermal conductivity of the firebrick is 0.65 Btu/hr-ft-°F.
a) 369 W/m² c) 369 Btu/hr-Ft²
b) 639 W/m² d) 639 Btu/hr-Ft²
Answer: A

56. What is the specific gravity of a fuel at 28° Baume?
a) 0.868 c) 0.688
b) 0.886 d) 0.986
Answer: B

57. A steam generator burns fuel oil with 25 % excess air. Fuel may be represented by $C_{14}H_{30}$. Calculate the actual-air fuel ratio.
a) 17.63 c) 18.63
b) 16.63 d) 15.63
Answer: C

58. Heat is transferred from hot water to an oil in a double-pipe counter-flow heat exchanger. Water enters the outer pipe at 120 °C and exits at 55 °C while the oil enters the inner pipe at 26 °C and exits at 65 °C. What is the log-mean temperature difference (LMTD)?
a) 42.60 °C c) 40.62 °C
b) 46.20 °C d) 42.06 °C
Answer: C

59. Determine the equivalence ratio of the following mixture: 4 grams of butane, C_4H_{10}, and 75 grams of air.
a) 0.72 c) 0.92
b) 0.62 d) 0.82
Answer: D

60. The combustion gases of a furnace are separated from its surrounding or ambient air which is 29 °C. The brick wall is 130 mm and has a thermal conductivity of 1.23 W/m-°C with a surface emissivity of 0.81. The outer surface temperature of the wall is 130 °C and with surface air conductance of 15 W/m²-°C. For steady state conditions, what is the total heat transmitted for a surface area of 30 m²?
a) 70.33 kW c) 73.30 kW
b) 33.07 kW d) 37.30 kW
Answer: A

61. The forced convective heat transfer coefficient for a hot fluid flowing over a cold surface is 225 W/m².°C for a particular problem. The fluid temperature upstream of the cold surface is 120 °C, and the surface is held at 10 °C. Determine the heat transfer rate per unit surface from the fluid to the surface.
a. 24 570 W/m² c. 52.470 W/m²
b. 24 700 W/m² d. 24 750 W/m²
Answer: D

62. A gaseous mixture of propane (C_3H_8), methane (CH_4), and ethane (C_2H_6) have partial pressure 50 kPa, 95 kPa, and 115 kPa respectively. Determine the mass percentage of propane.
a) 30.68 % c) 28.68 %
b) 21.68 % d) 32.68 %
Answer: A

63. Calculate the thermal efficiency of an air standard diesel cycle engine operating at a volumetric compression ratio of 23:1 with a cut-off ratio of 2.25.
a) 62.6% c) 60.6%
b) 65.6% d) 67.6%
Answer: B

64. There are 20 kg of exhaust gas formed per kg of fuel oil burned in the combustion of diesoline $C_{16}H_{32}$. What is the excess air percent?
a) 30.1 % c) 29.16 %
b) 21.5 % d) 30.6 %
Answer: C

NOTE: STUDY PROBLEMS AND ELEMENTS IN POWER PLANT ENGG AVAILABLE IN THE OFFICE.

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