Thermodynamics and its Applications Test 3

Number of Questions 35 **Time:60 min.**

Direction for questions 1 to 35: Select the correct alternative from the given choices.

1. Which of the following are intensive properties?
(1) Energy (2) Volume
(3) Pressure (4) Specific enthalpy
(A) 1 and 2 (B) 2 and 3
(C) 3 and 4 (D) 1 and 4

2. Given P = Pressure, T = Temperature, v = Specific volume, which one of the following can be considered as a property of system?
(A) $\int pdv$ (B) $\int vdp$
(C) $\int\left(\frac{dT}{T}-\frac{Vdp}{T}\right)$ (D) $\int\left(\frac{dT}{T}+\frac{pdv}{T}\right)$

3. Match List – I with List – 2 and choose the correct answer from the code

	List – 1 (Laws of thermodynamics)		List – 2 (Defines)
P	First	1.	Absolute zero temperature
Q	Second	2.	Internal energy
R	Zeroth	3.	Temperature
S	Third	4.	Entropy

	P	*Q*	*R*	*S*
(A)	2,	4,	3,	1
(B)	1,	2,	3,	4
(C)	4,	3,	2,	1
(D)	2,	4,	1,	3

4. The work done by a closed system will increase when the value of the polytropic index n
(A) increases
(B) decreases
(C) first increases and then decreases
(D) first decreases and then increases

5. The ratio of the efficiency of Brayton cycle corresponding to maximum work done to the Carnot cycle efficiency operating between the temperature limits of 310 K and 1050 K is
(A) 0.65 (B) 0.75
(C) 0.85 (D) 0.95

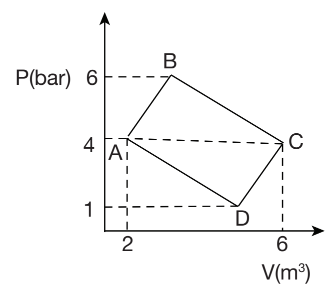
6. The air with enthalpy of 100 kJ/kg is compressed by an air compressor to a pressure and temperature at which its enthalpy becomes 200 kJ/kg. The loss of heat is 40 kJ/kg from the compressor as the air presses through it. Neglecting kinetic and potential energies the power required for an air mass flow of 0.5 kg/s is
(A) 30 kW (B) 50 kW
(C) 70 kW (D) 90 kW

7. The co–efficient of performance of a refrigerator working on a reversed Carnot cycle is 4. The ratio of the highest absolute temperature to the lowest absolute temperature is
(A) 1.2 (B) 1.25
(C) 3.33 (D) 4

8. In a reaction turbine the heat drop in fixed blade is 8 kJ/kg and the total heat drop per stage is 20 kJ/kg. The degree of reaction is
(A) 40% (B) 66.7%
(C) 60% (D) 25%

9. At a particular section of a reaction turbine the diameter of blade is 2 m, the velocity of flow of steam is 50 m/s and the quantity of steam flow is 5.4 m^3/s. The blade height at this section will be approximately.
(A) 1.5 cm (B) 1.7 cm
(C) 2 cm (D) 2.5 cm

10. The network done for the closed system shown in the given pressure-volume diagram is



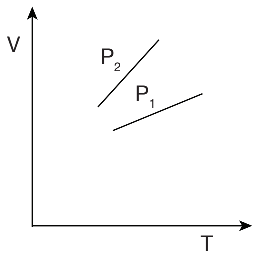
(A) 600 kN – m (B) 700 kN – m
(C) 900 kN – m (D) 1000 kN – m

11. A Carnot engine absorbs 300 J of heat from a reservoir at the temperature of the normal boiling point of water and rejects heat to a reservoir at the temperature of the tripple point of water. The work done by the engine is
(A) 80.38 J (B) 100.02 J
(C) 300 J (D) 320 J

12. During throttling process
(A) $\delta Q = 0$ (B) $\delta W = 0$
(C) $dH = 0$ (D) All of the above

13. Specific heats of a gas $C_p = C_V$, at
(A) absolute zero temperature
(B) critical temperature
(C) triple point temperature
(D) all temperature

14. The volume V versus temperature T graphs for a certain amount of a perfect gas at two pressure P_1 and P_2 are as shown in the figure. It can be concluded that



(A) The pressure P_1 is greater than the pressure P_2
(B) The Pressure P_2 is greater than the pressure P_1
(C) P_1 represents monoatomic gas and P_2 represents diatomic gas
(D) P_2 represents monoatomic gas and P_1 represents diatomic gas.

15. $\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V$ is equal to
(A) Zero (B) 1
(C) –1 (D) Infinity

16. The capacity of the refrigerator (working on reversed cycle) is 250 tonnes when operating between –10 °C to 25 °C. The quantity of ice produced (in tonnes) with in 24 hours when water is supplied at 20 °C is
(A) 101 (B) 201
(C) 301 (D) 401

17. A piston–cylinder device with air at an initial temperature of 30°C undergoes an expansion process for which pressure and volume are related as given below.

$P(kP_a)$	100	37.9
$V(m^3)$	0.1	0.2

Calculate the work done by the system
(A) 2.3 kJ (B) 5.2 kJ
(C) 10.6 kJ (D) 15.52 kJ

18. A reversible engine, as shown in figure during a cycle of operations draws 5 MJ from the 400 K reservoir and does 840 kJ of work. The amount and direction of heat interatiction with other reservoirs are
(A) Q_2 = –820 kJ, Q_3 = 4980 kJ
(B) Q_2 = 820 kJ, Q_3 = – 4980 kJ
(C) Q_2 = 820 kJ, Q_3 = 4980 kJ
(D) Q_2 = –820 kJ, Q_3 = – 4980 kJ

19. A copper block of 600 g mass and with C_p of 150 J/K at 100°C is placed in a lake at 8°C. the entropy change of universe in J/K is
(A) 10.05 (B) 9.85
(C) 6.69 (D) 2.35

20. Which of the following is the correct expression for maximum work obtainable form two finite bodies at temperature T_1 and T_2.
(A) $C_P\left(\sqrt{T_1}+\sqrt{T_2}\right)^2$ (B) $C_V\left(\sqrt{T_1}+\sqrt{T_2}\right)^2$
(C) $C_P\left(\sqrt{T_1}-\sqrt{T_2}\right)^2$ (D) $C_V\left(\sqrt{T_1}-\sqrt{T_2}\right)^2$

21. 1.5 kg of liquid having a constant specific heat of 2.5 kJ/kg is stirred in a well insulated chamber causing the temperature rise by 15°C. The work transfer for this process is
(A) 20.56 kJ (B) –20.56 kJ
(C) 56.25 kJ (D) –56.25 kJ

22. Water at 80°C flowing at the rate of 2 kg/s mixes adiabatically with another stream of water at 20 °C flowing at the rate of 1 kg/s. The rate of energy loss due to mixing is (Take T_o = 300 K)
(A) 15.6 kW (B) 12.6 kW
(C) 10.6 kW (D) 8.5 kW

23. In certain scale say °X, the ice point temperature is 1000°X and steam point temperature is 3000°X. Then the value of 27 °C in °X scale is
(A) 1000 (B) 1250
(C) 1540 (D) 1800

24. In a closed vessel a gas undergoes reversible expansion from P_1V_1 to final pressure P_2, according to following laws
(i) Isothermal
(ii) Adiabatic
(iii) Polytropic ($n > \gamma$)
(iv) Polytropic ($n < \gamma$)
Arrange the above four process in the ascending order of their work done.
(A) (i) > (ii) > (iii) > (iv) (B) (iii) < (ii) < (i) < (iv)
(C) (iii) < (ii) < (iv) < (i) (D) (i) > (iii) > (iv) > (ii)

25. For an engine operating on air standard otto cycle, the clearance volume is 10% of the swept volume. The specific heat ratio of air is 1.4. The air standard cycle efficiency is
(A) 38.3% (B) 39.8%
(C) 60.2% (D) 61.7%

26. During a morse test on a 4-cylinder engine, the following measurements of brake power were taken at constant speed.
All cylinder firing 3037 kW
Number 1 cylinder not firing 2102 kW
Number 2 cylinder not firing 2102 kW
Number 3 cylinder not firing 2100 kW
Number 4 cylinder not firing 2098 kW
Then the mechanical efficiency of the engine is
(A) 91.53% (B) 85.07%
(C) 81.07% (D) 61.22%

27. For two cycles coupled inseries, the topping cycle has an efficiency of 30% and the bottoming cycle has an efficiency of 20%. The overall combined cycle efficiency is
(A) 50% (B) 44%
(C) 38% (D) 55%

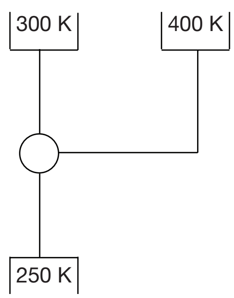
28. A rigid tank is connected through a valve to main supplying steam at 1 MPa, 427°C. Heat is transferred from the tank to the surroundings and the valve is closed when the total amount of cooling is 2500 kJ. The energy contained in the tank is the same before and after the process. Neglecting potential and kinetic energy changes, the mass of the steam that enters the tank is (take h_i = 4500 kJ/kg at (MPa = 427°C)

(A) 0.676 kg/s (B) 0.714 kg/s
(C) 6.76 kg/s (D) 7.14 kg/s

29. An ideal Brayton cycle, operating between the pressure limits of 1 bar and 6 bar, has minimum and maximum temperatures of 300 K and 1500 K. The ratio of specific heat of the working fluid is 1.4. The approximate final temperature in Kelvin at the end of the compression and expansion process are respectively.

(A) 400 K, 1600 K (B) 1600 K, 400 K
(C) 900 K, 500 K (D) 500 K, 900 K

30. A vapour absorption refrigeration system is a heat pump with three thermal reservoirs as shown in figure A refrigerator effect of 100 W is required at 250 K when the heat source available is at 400 K. Heat rejection occurs at 300 K. The minimum value of heat required (in W) is



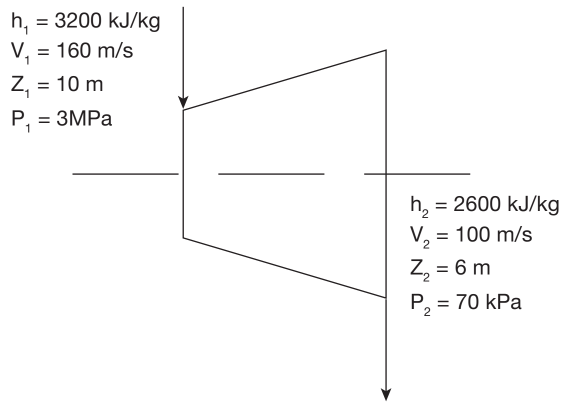
(A) 20 (B) 80
(C) 100 (D) 167

31. One kilomole of an ideal gas is throttle from an initial pressure of 0.6 MPa to 0.9 MPa. The initial temperature is 400 K. The entropy change of universe is

(A) 9.13 kJ/K (B) 2021.3 kJ/K
(C) 0.446 kJ/K (D) –0.446 kJ/K

Common Data for Questions 32 and 33:

The inlet and the outlet conditions of steam for an adiabatic steam turbine are as indicated in the notations are as usually followed.



32. If mass flow rate of steam through the turbine is 15 kg/s, the power output of the turbine is (in MW)

(A) 9.1 (B) 10.5
(C) 112 (D) 125

33. Assume the above turbine to be part of a simple Rankine cycle. The density of water at the inlet to the pump is 1000 kg/m^3. Ignoring kinetic and potential energy effects, the specific work (in kJ/kg) supplied to the pump is

(A) 0.293 (B) 0.351
(C) 2.930 (D) 3.510

Linked Answer for Questions 34 and 35:

A 250 mm diameter cylinder fitted with a friction less leak proof piston contains 0.02 kg of steam at pressure of 0.6 MPa and a temperature of 200°C. As the piston moves slowly outwards through a distance of 300 mm the steam undergoes a fully-resisted expansion during which the steam pressure p and the steam volume v are related by pv^n = constant, where n is index of the process.
(take v_1 = 0.352m^3/kg, h_1 = 2850.1 kJ/kg, at 0.6 MPa, 200°C)
The final pressure of the steam is 0.1MPa

34. The value of index (n) is

(A) 1.2 (B) 1.3
(C) 1.4 (D) 1.5

35. The work done by the steam in kJ is

(A) 2.5 (B) 3.5
(C) 4.1 (D) 5.1

Answer Keys

1. C	**2.** C	**3.** A	**4.** B	**5.** A	**6.** C	**7.** B	**8.** C	**9.** B	**10.** D
11. A	**12.** D	**13.** A	**14.** A	**15.** C	**16.** D	**17.** D	**18.** A	**19.** C	**20.** C
21. D	**22.** A	**23.** C	**24.** C	**25.** D	**26.** C	**27.** B	**28.** B	**29.** D	**30.** B
31. A	**32.** A	**33.** C	**34.** D	**35.** C					

Hints and Explanations

2. $\int pdv, \int vdp, \left(\frac{dT}{T}\int + \frac{p}{T}dv\right)$

$\Rightarrow$ are inexact differentials $\left(\frac{dT}{T} - \frac{v}{T}dp\right)$ is an exact differential. Hence it is property. Choice (C)

5. $T_{min} = 310$ K, $T_{max} = 1050$ K

$$\eta_{Brayton} = 1 - \frac{1}{(r_p)^{\frac{\gamma-1}{\gamma}}} = 1 - \sqrt{\frac{T_{min}}{T_{max}}}$$

$$= 1 - \sqrt{\frac{310}{1050}} = 0.456$$

$$\eta_{carnot} = \sqrt{\frac{\text{min}}{\text{max}}}$$

$$= 1 - \sqrt{\frac{310}{1050}} = 0.704$$

$$\frac{\eta_{Brayton}}{\eta_{Carnot}} = \frac{0.456}{0.704} = 0.647$$

Choice (A)

6. $h_1 = 100$ kJ/kg, $h_2 = 200$ kJ/kg, $q = 40$ kJ/kg

According to steady flow energy equation.

$h_1 + q = h_2 + w_c$

$100 - 40 = 200 + w_c$

$w_c = -140$ kJ/kg

Power $= \dot{m} \times w_c = 0.5 \times 140 = 70$ kW

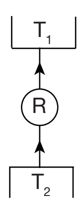
–ve sign shows that power is required to run the compressor. Choice (C)

7. $(\text{C. O. P})_R = 4$

$$\frac{T_2}{T_1 - T_2} = 4$$

$$\frac{T_1 - T_2}{T_2} = \frac{1}{4}$$

$$\frac{T_1}{T_2} = \frac{1}{4} + 1 = 1.25$$



Choice (B)

8. Degree of reaction $= \frac{(\Delta h)_{moving}}{(\Delta h)_{stage}}$

$$= \frac{20-8}{20} \times 100$$

$= 0.6 \times 100 = 60\%$ Choice (C)

9. $D = 2$ m

$V_f = 50$ m/s

$Q = 5.4$ m^3/s

$Q = \text{A V}_f = \pi Dh\, V_f$

$5.4 = \pi \times 2 \times 50 \times h$

$h = 1.7$ cm Choice (B)

10. Area under the curve = Δ^{le} Area of ABC + Δ^{le} Area of ADC

$$= \left(\frac{1}{2} \times 2 \times 4 + \frac{1}{2} \times 3 \times 4\right) \times 10^2$$

$= (4 + 6) \times 10^2 = 1000$ kN – m Choice (D)

11. $Q_1 = 300$ J at $T_1 = 373.15$ K

$T_2 = 273.16$ K

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$

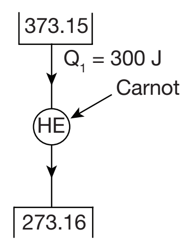
$$Q_2 = \frac{T_2}{T_1}.Q_1 = \frac{273.16}{373.15} \times 300$$

$= 219.61$ J

$W_{net} = Q_1 - Q_2$

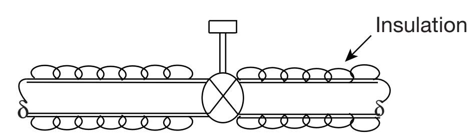
$= 300 - 219.61$

$= 80.38$ J



Choice (A)

12. Expansion of gases through porous plug is called throttling.



* $Q = 0$

* $\delta W = 0$

* $\delta H = 0$ Choice (D)

13 Choice (A)

14 Choice (A)

15 Choice (C)

16. $T_1 = 25°\text{C} = 298$ K

$T_2 = -10°\text{C} = 263$ K

Heat to be extracted per kg of water (to form ice at 0°C)

$= 4.18 \times 20 + 335 = 418.6$ kJ/kg

Heat extraction capacity of the refrigerator

= 250 tonnes

$= 250 \times 14000 = 3500{,}000$ kJ/h

Quantity of ice produced in 24 hours.

$= \frac{3500,000 \times 24}{418.6 \times 1000} = 200.66$ tonnes Choice (D)

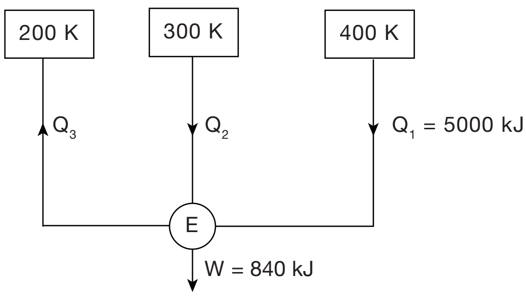
17. $P_1V_1^n = P_2V_2^n$

$$n = \frac{\ell n(P_1/P_2)}{\ell n(V_2/V_1)} = \frac{\ell n(100/37.9)}{\ell n(0.2/0.1)} = 1.4$$

$$\text{Work done} = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{100 \times 0.1 - 37.9 \times 0.1}{1.4 - 1}$$

$= 15.52$ kJ Choice (D)

18. Let Q_2 and Q_3 are rejected from the engine. (i.e both are negative)



$Q_1 = W + Q_2 + Q_3$; $Q_2 + Q_3 = 5000 - 840$

$Q_2 + Q_3 = 4160$ kJ $\rightarrow (1)$

From the Clausius inequality for reversible engine

$$\frac{\delta Q}{T} = 0$$

$$\frac{Q_1}{T_1} - \left(\frac{Q_2}{T_2} + \frac{Q_3}{T_3}\right) = 0$$

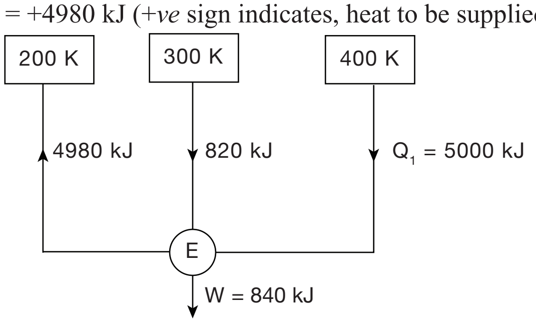
$$\frac{5000}{400} - \left(\frac{Q_2}{200} + \frac{Q_3}{300}\right) = 0$$

$$\frac{Q_2}{200} + \frac{Q_3}{300} = +\frac{5000}{400} \quad \rightarrow (2)$$

Solving (1) and (2) we get

$Q_2 = -820$ kJ (*–ve* sign indicates, heat to be rejected)

$Q_3 = +4980$ kJ (*+ve* sign indicates, heat to be supplied)



Choice (A)

19. Entropy change of block $= C_P \, \ell_n \left(T_f/T_i\right)$

$$= 150 \, \ell n\left(\frac{273+8}{273+100}\right)$$

$= -42.48$ J/K

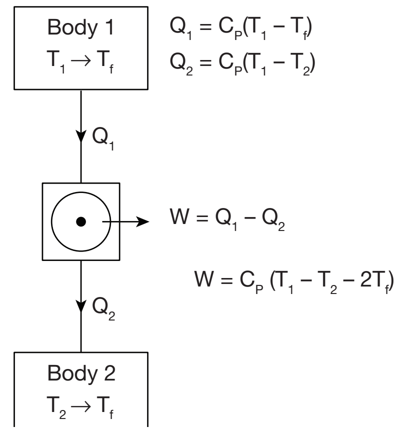
$$\text{Entropy change of lake} = \frac{C_P \Delta T}{T}$$

$$= \frac{150(100-8)}{281} = 49.110 \text{ J/K}$$

Entropy change of universe $= -42.48 + 49.110$

$= 6.63$ J/K Choice (C)

20.



$$\text{For body 1, } \Delta S_1 = \int_{T_1}^{T_f} C_P \frac{dT}{T} = C_p \ell n\left(\frac{T_f}{T_2}\right)$$

$$\text{For body 2, } \Delta S_2 = \int_{T_2}^{T_f} C_P \frac{dT}{T} = C_p \ell n\left(\frac{T_f}{T_2}\right)$$

$(\Delta S)_{Univ} \geq 0$

$$C_p \ell_n \left(\frac{T_f}{T_1}\right) + C_p \ell_n \left(\frac{T_f}{T_2}\right) \geq 0$$

$$C_p \ell_n \frac{T_f^2}{T_1 T_2} \geq 0$$

The lowest attainable final temperature T_f corresponds to the delivery of the largest possible amount of work, and is associated with a reversible process

$(\Delta S)_{Univ} = 0$ for reversible process

$$C_p \ell_n \frac{T_f^2}{T_1 T_2} = 0 = \ell_n(1)$$

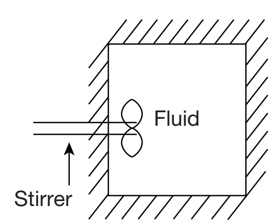
$$\frac{T_f^2}{T_1 T_2} = 1; \; T_f = \sqrt{T_1 T_2}$$

$$\therefore \quad W_{max} = C_P \left(T_1 + T_2 - 2\sqrt{T_1 T_2}\right)$$

$$= C_p \left(\sqrt{T_1} - \sqrt{T_2}\right)^2$$

Choice (C)

21.



$dT = 15$ °C
$m = 1.5$ kg
$C = 2.5$ kJ/kg K
Since container is insulated $\delta Q = 0$
$\therefore \quad \delta Q = dE + \delta W$
$\delta Q = 0, \delta Q = -dE$
Raise in internal energy $dE = mC\,dT$
$= 1.5 \times 2.5 \times 15 = 56.25$ kJ
$\therefore \quad$ Work transfer $= -56.25$ kJ Choice (D)

22. $\dot{m} = \dot{m}_1 + \dot{m}_2 = 2 + 1 = 3$ kg/s

$$X = \frac{\dot{m}_1}{\dot{m}} = \frac{2}{3} = 0.67$$

$$\tau = \frac{T_2}{T_1} = \frac{293}{353} = 0.83$$

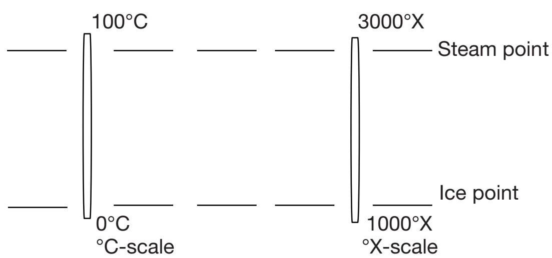
$$\dot{S}_{gen} = \dot{m}\,C_p \ell_n \left(\frac{x + \tau(1-x)}{\tau^{1-x}} \right)$$

$$= 3 \times 4.187 \ell n \left(\frac{0.67 + 0.83 \times 0.33}{(0.83)^{0.33}} \right)$$

$$= 12.561 \ell_n \left(\frac{0.9439}{0.940} \right) = 0.052 \text{ kW}/K$$

Rate of energy loss due to mixing
$\dot{I} = T_o \dot{S}_{gen}$
$= 300 \times 0.052 = 15.60$ kW Choice (A)

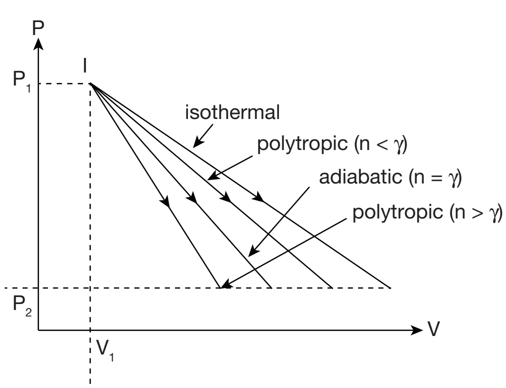
23.



$$\frac{0 - °C}{0 - 100} = \frac{1000 - °X}{1000 - 3000}$$

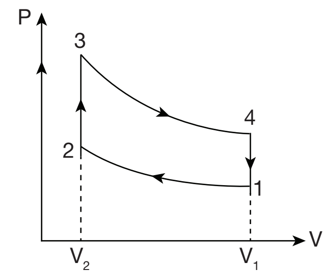
$T°X = 20(T°C) + 1000$
At 20°C, $T°(x) = 20(27) + 1000$
$= 540 + 1000 = 1540°X$ Choice (C)

24.



Area under the curve represents work done during the expansion process.
$\therefore \quad$ (iii) < (ii) < (iv) < (i) Choice (C)

25.



$$\frac{C_p}{C_v} = 1.4 = \gamma \text{ r}$$

$$V_2 = \frac{10}{100}(V_1 - V_2)$$

$$10 = \left(\frac{V_1}{V_2} - 1 \right)$$

Compression ratio $r = \dfrac{V_1}{V_2} = 11$

$$\eta_{otto} = 1 - \frac{1}{(r)^{\gamma-1}} = 1 - \frac{1}{(11)^{1.4-1}}$$

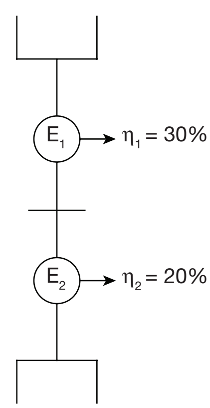
$= 0.616 = 61.7\%$ Choice (D)

26. When cylinder 1 is not firing then power is 2102 kW
When all cylinders are firing then power is 2037 kW
Power supplied by engine 1 = 3037 – 2102 = 935 kW
Power supplied by engine 2 = 3037 – 2012 = 935 kW
Power supplied by engine 3 = 3037 – 2100 = 937 kW
Power supplied by engine 4 = 3037 – 2098 = 939 kW
Total indicated power = 935 + 935 + 937 + 939 = 3746 kW

Mechanical efficiency $= \dfrac{B.P}{I.P} = \dfrac{3037}{3746} = 0.81073$

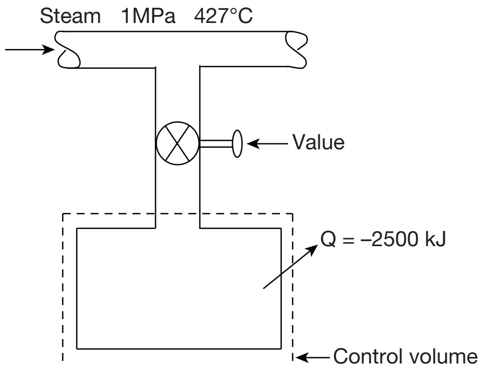
$= 81.073\%$ Choice (C)

27.



Overall efficiency $\eta_0 = \eta_1 + \eta_2 - \eta_1 \eta_2$
$= 0.3 + 0.2 - 0.3 \times 0.2 = 44\%$ Choice (B)

28.



$\frac{dU}{dt} = 0$

$\dot{W} = 0$

$m\,e\,he = 0$

$\frac{du}{dt} = mI\,hi + Q^\circ - m^\circ e\,he - w^\circ$

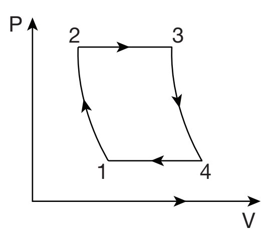
$0 = mhi + Q^\circ - 0 - 0$

$m\,hi = -Q$

$m\,(3500) = 2500$

$m = \frac{2500}{3500} = 0.714\text{kh}$ Choice (B)

29.



$\frac{cp}{cv} = 1.4$

$T_1 = 300$ ϒK

$T_2 = 1500$ ϒK

$T_2 = ?\ T_4 = ?$

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\Upsilon-1}{\Upsilon}} = \left(\frac{6}{1}\right)^{\frac{0.4}{1.4}} = 1.6685$

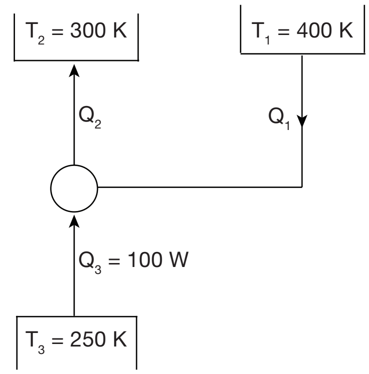
$T_2 = 1.6685 \times 300 = 500.5\text{K}$

$\frac{T_3}{T_4} = \left(\frac{P_3}{P_1}\right)^{\frac{Y-1}{Y}} = \left(\frac{6}{1}\right)^{\frac{Y-1}{Y}} = 1.665$

$T_4 = \frac{1500}{1.66} = 903.61$ K Choice (D)

30. $Q_1 = ?$

$Q_2 = Q_1 + 100$

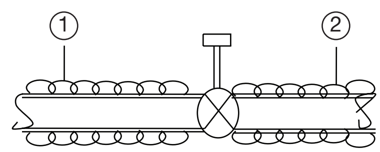


And also $\frac{\delta Q}{T} = 0,\ \frac{Q_1}{T_1} + \frac{Q_3}{T_3} - \frac{Q_2}{T_2} = 0$

$$\frac{Q_1}{400} + \frac{100}{250} - \frac{(Q_1 + 100)}{300} = 0$$

$Q_1 = \frac{1200}{15} = 80$ W Choice (B)

31.



$T_1 = 400$ K

$(ds)_{univ} = (ds)_{system} + (ds)_{surv}$

$(ds)_{sur} = 0$, since no heat transferred to the surroundings.

$(ds)_{system} = C_{P\,mol}\,\ell_n\left(\frac{T_2}{T_1}\right) - n\bar{R}\ell_n\left(\frac{P_2}{P_1}\right)$

For throttling process $T_1 = T_2$

$\therefore\ (ds)_{system} = n\bar{R}\ell_n\left(\frac{P_1}{P_2}\right) = 1 \times 8.314\,\ell n\left(\frac{0.6}{0.2}\right)$

$= 9.13$ kJ/K

Choice (A)

32. $h_1 + \frac{V_1^2}{2} + Z_1 g + q = h_2 + \frac{V_2^2}{2} + Z_2 g + w$

$3200 \times 100 + \frac{160^2}{2} + 10 \times 9.81 + 0$

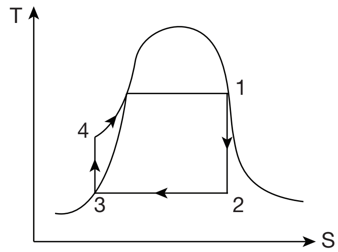
$= 260 \times 1000 + 6 \times 9.81 + \frac{100^2}{2} + w$

$w_T = 0.607$ MJ/kg

$\therefore$ Power output = 15 × 6.07 = 9.11 MW

Choice (A)

33.



Work supplied to pump = $\int vdp = v(p_1 - p_2)$

$= \dfrac{p_1 - p_2}{\rho}$

$= \dfrac{3000 - 70}{1000}$

= 2.93 kJ/kg Choice (C)

34. $PV^n = C$

$P_1V_1^n = P_2V_2^n$

$n = \dfrac{\ell_n(P_1/P_2)}{\ell_n(V_2/V_1)}$

Given $v_1 = 0.352$ m^3/ kg

∴ Total volume $v_1 = 0.02\ 0.352 = 0.00704$ m^3

Displaced volume $= \dfrac{\pi}{4}d^2\ell$

$= \dfrac{\pi}{4}(0.25)^2 \times (0.300) = 0.0147$ m^3

Total volume after expansion = 0.0147 + 0.00704 = 0.02174m^3

$$n = \frac{\ell_n\left(\frac{0.6}{0.1}\right)}{\ell_n\left(\frac{0.02174}{0.00704}\right)} = \frac{\ell_n(6)}{\ell_n(3.08)} = 1.5$$

Choice (D)

35. Work done by the steam

$= \int_{V_1}^{V_2} pdv = \dfrac{P_1V_1 - P_2V_2}{n-1}$

$= \dfrac{0.6\times1000\times0.00704 - 0.1\times1000\times0.02174}{1.5-1}$

= 4.1 kJ Choice (C)