PRACTICE QUESTIONS

for SSC-JE : CBT-2

Power Plant Engineering

Mechanical Engineering

Q.1 Which of the following is correct about ORSAT apparatus?
(a) It is used to determine only wet constituents of combustion by volume.
(b) It is used to determine only dry constituents of combustion by volume.
(c) It is used to determine only dry constituents of combustion by weight.
(d) It is used to determine dry as well as wet constituents of combustion by volume.

Q.2 For an air standard Brayton cycle, increase in the maximum temperature of the cycle, while keeping the pressure ratio same would result in:
(a) increase in air standard efficiency.
(b) decrease in air standard efficiency.
(c) No change in air standard efficiency.
(d) increase in efficiency but reduction in work.

Q.3 Consider the following statements:
The Carnot cycle for refrigeration is ideal but non-practical because:
1. It is not possible to control condensation process is such a manner to get desired quality of steam.
2. It is not possible to add heat at constant temperature with decrease in pressure.
3. Pump work becomes negligible in it.
Which of the above statements are correct?
(a) 1 and 2   (b) 2 and 3
(c) 1 and 3   (d) 1, 2 and 3

Q.4 Which one of these does not take place due to reheating of steam?
(a) Specific output increases
(b) Cyclic efficiency may increase or decrease
(c) Dryness fraction decreases
(d) Blade erosion decreases

Q.5 Which one of the following ideal regenerative steam power cycle has the highest efficiency?
(a) Rankine cycle   (b) Carnot cycle
(c) Joule cycle   (d) Brayton cycle

Q.6 Enthalpies at various points in a Rankine cycle are as given below:
At turbine inlet 'h_1' = 2850 kJ/kg
At turbine exit 'h_2' = 1780 kJ/kg
At pump inlet 'h_3' = 187 kJ/kg
At pump exit 'h_4' = 212 kJ/kg
The work ratio of the cycle:
(a) 0.405   (b) 0.921
(c) 0.976   (d) 0.997

Q.7 Consider the following statements:
On increasing boiler pressure in Rankine cycle:
1. Cycle efficiency decreases.
2. The mean temperature of heat addition increases.
3. The mean temperature of heat rejection remains constant.
4. Pump work decreases.
Which of the above statements are correct?
(a) 1 and 2   (b) 2 and 3
(c) 2, 3 and 4   (d) 1 and 4

Q.8 Actual expansion process in a gas turbine is shown by the curve
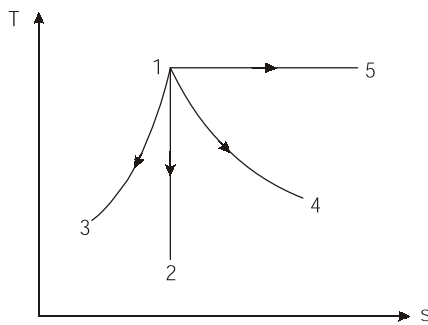
(a) 1-2   (b) 1-3
(c) 1-4   (d) 1-5

Q.9 What will be the thermal efficiency of ideal gas turbine cycle with regeneration if the maximum temperature is 777°C, minimum temperature is 27°C, pressure ratio is 8% and ratio of specific heats is 1.5?
(a) 28.33%   (b) 46.55%
(c) 42.85%   (d) 48.71%

Q.10 In coal gasification, to obtain medium heating value gas, a shift reaction is used to produce additional hydrogen, in this process which element is removed?
(a) H_2 (b) N_2
(c) O_2 (d) CO

Q.11 Which of the following combustion systems require maximum excess air?
(a) Pulverized coal combustion
(b) Oil burners
(c) Gas burners
(d) Chain grate stoker

Q.12 A boiler is generating steam at 5500 kg/hr. The maximum permissible limit of TDS in the boiler is 3500 ppm. If the made up water is 40% at TDS level of 3500 ppm, then the blowdown percentage and blowdown rates respectively, will be
(a) 60% and 320 kg/hr
(b) 30% and 280 kg/hr
(c) 8% and 250 kg/hr
(d) 4% and 220 kg/hr

Q.13 The low temperature carbonisation process:
(a) is mainly for producing the smokeless domestic coke.
(b) produces high quantity of gas than high temperature carbonisation.
(c) is meant for the production of metallurgical coke.
(d) produces less quantity of tar than high temperature carbonisation.

Q.14 The combustible elements in coal and fuel oil are carbon, hydrogen and sulphur. Then theoretically air required for complete combustion of 1 kg fuel by the ultimate analysis is given by:

(a) $33.83\,C + 144.45\left(H + \dfrac{O}{8}\right) + 9.385$

(b) $33.83\,C + 144.45\left(H - \dfrac{O}{8}\right) - 9.385$

(c) $33.83\,C + 144.45\left(H - \dfrac{O}{8}\right) + 9.385$

(d) $33.83\,C - 144.45\left(H - \dfrac{O}{8}\right) + 9.385$

Q.15 In reaction turbines with reduction of inlet pressure.
(a) the blade heights increase as the specific volume of steam decreases.
(b) the blade heights increases as the specific volume of steam increases.
(c) the blade heights decrease as the specific volume of steam increases.
(d) the blade heights decrease as the specific volume of steam decreases.

Q.16 Match List-I with List-II and select the correct answer using the codes given below:
List-I
A. Stirling
B. Cochran
C. Lancashire
D. Benson
List-II
1. Bent water tube
2. Once through flow

3. Vertical fire tube
4. Incline water tube
5. Horizontal fire tube
   Codes:

	A	B	C	D
(a)	2	5	4	1
(b)	1	3	5	2
(c)	2	3	5	1
(d)	1	5	4	2

Q.17 Consider the following statements:
1. Induced draught fans require water cooled bearings.
2. For an induced draught fan installation, the fan size and power requirements are less than those of a forced draught fan installation.
Which of the following statements is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q.18 Economiser is generally placed in between:
(a) Convective superheater and radiant superheater.
(b) Radiant superheater and air preheater.
(c) Convective superheater and air preheater.
(d) Pendant superheater and air preheater.

Q.19 Consider the following statements with respect to condensers:
1. Spray condenser required high quality of cooling demineralized (DM) water.
2. Barometric condensers have tall structure (9-10 meters).
3. In case of Jet condensers, diffuser is provided instead of long tail pipes.
Which of these statement(s) is/are correct?
(a) 1 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Q.20 Consider the following statements with respect to regeneration of gas turbine (Brayton cycle):
1. In this, high temperature gas coming out of gas turbine is utilize to heat up the cold air coming out of compressor.
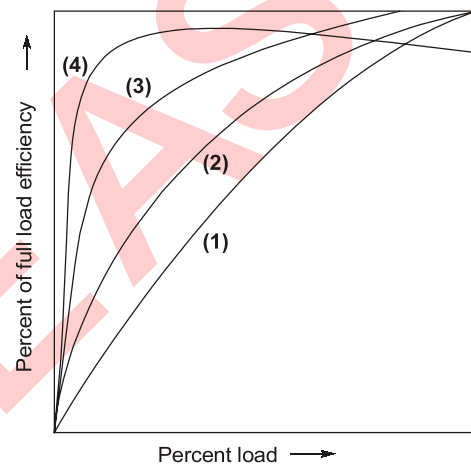
2. Regeneration increases the cycle efficiency.
3. Regenerator can work on any pressure ratio of compressor.
Which of the above statement(s) is/are correct?
(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1, 2 and 3 only

Q.21 Considering the part load efficiencies of different plants, match the correct process when plant is working with air as a working fluid:

A : Simple open cycle
B : Semi-closed cycle
C : Closed cycle with regenerator, intercooler and reheater
D : Open cycle with regenerator, intercooler and reheater
Codes:

|	A	B	C	D
(a)	4	1	2	3
(b)	4	1	3	2
(c)	1	4	3	2
(d)	1	4	2	3

Q.22 Consider the following statements with respect to regeneration of Rankine cycle:
1. In this, high temperature of steam is extracted from intermediate stages and it is utilized for feed water heating.
2. Regeneration increases cycle efficiency.
3. For same power output, smaller size/capacity boiler is required.

Which of the above statement(s) is/are correct?
(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1, 2 and 3 only

Q.23 Consider the following T-S diagram with respect to reheat Rankine cycle, thermal efficiency of the cycle is
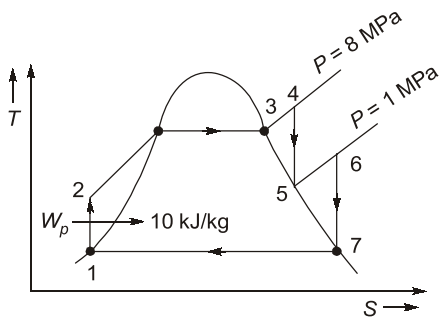
Stage	1	3	4	5	6	7
Enthalpy (kJ/kg)	175	3050	3348	2741	3328	2428

(a) 0.4018
(b) 0.3237
(c) 0.3992
(d) 0.4764

Q.24 Which of the following statement is correct regarding mercury as working fluid for binary vapour cycle?
(a) it can be used as topping unit
(b) it can be used as bottoming unit
(c) depends on pressure of gas
(d) depends on temperature of gas

Q.25 Which is the largest size valve fitted as mounting in steam boiler?
(a) Feed check valve
(b) Safety valve
(c) Steam stop valve
(d) None of these

Q.26 In a forced circulation boilers, about 80% of water is recirculated without evaporation, the circulation ratio is
(a) 9
(b) 8
(c) 5
(d) 3

Q.27 In centrifugal compressor, an increase in speed at given pressure ratio causes
(a) increase in flow and increase in efficiency.
(b) increase in flow and decrease in efficiency.
(c) decrease in flow and decrease in efficiency.
(d) decrease in flow and increase in efficiency.

Q.28 Consider the following statements with respect to reciprocating compressors:
1. Multi-staging becomes compulsory beyond a certain limit of pressure ratio.
2. For perfect intercooling, the pressure ratio is same for each stage.
3. For same volumetric efficiency and clearance ratio, different reciprocating compressor has

$P_1 D_1^3 L_1 = P_2 D_2^3 L_2 = P_3 D_3^3 L_3$ relationship.

Which of the above statement(s) is/are correct?
(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1, 2 and 3

Q.29 A simple impulse turbine of mean blade speed of 200 m/s. The nozzles are inclined at 30° to the plane of rotation of blades. The steam velocity from nozzle is 600 m/s. If the absolute velocity at exit is along axis of turbine, then diagram efficiency is
(a) 0.707
(b) 0.866
(c) 0.625
(d) 0.577

Q.30 Maximum work done corresponding to maximum blading efficiency for parson's turbine is

(a) V_{w1}^2
(b) uV_{w1}
(c) $24uV_{w1}$
(d) u^2

■■■■

1.	(b)	2.	(c)	3.	(a)	4.	(c)	5.	(b)	6.	(c)	7.	(b)
8.	(c)	9.	(c)	10.	(b)	11.	(d)	12.	(d)	13.	(a)	14.	(c)
15.	(b)	16.	(b)	17.	(a)	18.	(c)	19.	(d)	20.	(b)	21.	(c)
22.	(b)	23.	(c)	24.	(a)	25.	(c)	26.	(c)	27.	(b)	28.	(b)
29.	(d)	30.	(d)										

Detailed Solutions

1.   (b)

ORSAT apparatus is used to determine only dry constituents of flue gases on the volume basis. It does not measure H_2O, unburnt hydrocarbons and free hydrogen in the products. It uses a chemical absorption technique to determine mole fractions of CO_2, CO and O_2 in the exhaust product.

S.No.	Exhaust product	Absorbent gases
1.	CO_2	KOH
2.	O_2	Alkaline pyrogallic acid
3.	CO	Ammonical cuprous Chloride

2.   (c)

Air standard efficiency, $\quad \eta = 1 - \dfrac{1}{(r_p)^{\frac{\gamma-1}{\gamma}}}$
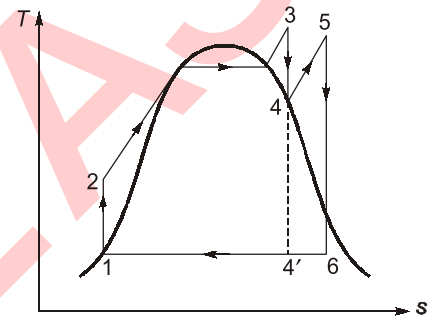
Since, pressure ratio for air standard cycle remains same, therefore there will not be any change in efficiency.

3.   (a)
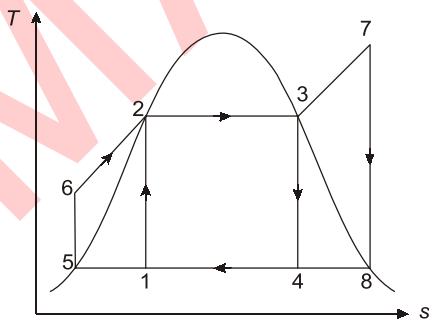
Process 1-2 shows pump work, which becomes very large in Carnot cycle and it also makes Carnot cycle impractical.

4.   (c)

Due to reheating:

* W_C = Remains same, W_T = Increases $\Rightarrow$ W_{net} = Increases.
*   Dryness fraction increases $\Rightarrow$ Blade erosion decreases.
* $\eta \propto T_{mA}$ (Mean temperature of heat addition)

5.   (b)

Ideally Carnot cycle has highest efficiency. If we use infinite number of feed water heaters in Rankine cycle then we can achieve carnot efficiency from Rankine cycle.

6.   (c)

Work ratio $= \left(\dfrac{W_T - W_P}{W_T} \right) = \dfrac{(h_1 - h_2) - (h_3 - h_4)}{(h_1 - h_2)}$

$\Rightarrow$ Work ratio $= \dfrac{(2850 - 1780) - (212 - 187)}{(2850 - 1780)}$

$= \dfrac{1045}{1070} = 0.9766$

7. (b)

On increasing boiler pressure cycle efficiency increases and moisture content also increases as dryness fraction decreases. Pump work increases by small amount and there will be greater increase in turbine work. Mean temperature of heat addition increases and mean temperature of heat rejection remains same.

9. (c)

Efficiency of ideal regenerative cycle,

$$\eta = 1 - \frac{T_{min}}{T_{max}}(r_p)^{\frac{k-1}{k}}$$

$$\Rightarrow \eta = 1 - \frac{27+273}{777+273} \times (8)^{\frac{1.5-1}{1.5}}$$

$$= 1 - \frac{300}{1050} \times (8)^{1/3}$$

$$\Rightarrow \eta = 1 - \frac{4}{7} = \frac{3}{7} = 42.85\%$$

10. (b)

Coal gasification is the process of reacting coal with oxygen, steam and carbon dioxide to form a product gas containing hydrogen and carbon monoxide. Gasification is essentially incomplete combustion. To obtain medium heating value gas, a shift reaction is used to produce additional hydrogen and nitrogen is removed.

$$CO + H_2O \rightarrow CO_2 + H_2$$
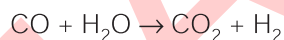
12. (d)

As permissible limit of TDS (Total dissolved solids) = 3500 rpm

$$\Rightarrow \text{Blowdown percentage} = \frac{350 \times 40}{3500} = 4\%$$

Blowdown rate = Steam generation rate × Blowdown percentage

= 5500 × 0.4 = 220 kg/hr

13. (a)

Carbonisation is the process used to convert an organic substance into carbon or carbon containing resistance through pyrolysis or destructive distillation.

15. (b)

With decrease in inlet pressure, specific volume of steam increases to accommodate higher volume, the blade height should increase so that there is more similar area for fluid expansion.

17. (a)

Fan size and power requirements for forced draught fan are less in comparison to induced draught fan.

18. (c)

Economiser is generally placed in between convective super heater and air preheater.

19. (d)

- Spray condensor has limitation, that it requires high amount of high quality cooling water or DM water.

- It barometric condensor, cooling water is made to fall in a series of baffles to expose large surface area for the steam fed from below to come in direct contact. The height of fail pipe required may vary from 9 to 10 m, which result in very fall structure, so not preferred.

- In Jet condensors, concade and diffuser is provided. Cascade is used to increase the surface area and to decrease the height of tail pipe diffuser is provided. Diffuser help to increase pressure in a short distance.

20. (b)

- In this, high temperature gas coming out of gas turbine is utilize to heat up the cold air coming out of compressor.

- Regeneration increases the cycle efficiency.

- Regenerator becomes ineffective, beyond a certain pressure ratio of compressor.

21. (c)
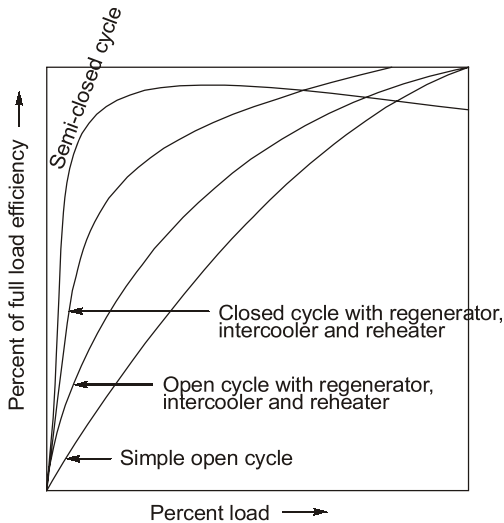
22. (b)

- In regeneration high temperature of steam is extracted from intermediate stages and utilized for feed water heating.
- Regeneration, increases cycle efficiency.
- For same power output, steam flow rate required increases, thus bigger size/capacity boiler required.

23. (c)

$$\eta = \frac{W_T - W_P}{Q_S} = \frac{\left\{(h_4 - h_5) + (h_6 - h_7)\right\} - 10}{(h_4 - h_2) + (h_6 - h_5)}$$

$$\eta = \frac{(3348 - 2741) + (3328 - 2428) - 10}{\{3348 - (175 + 10)\} + \{3328 - 2741\}} = 0.3992$$

24. (a)

- In a binary vapour cycle, two different working fluids are put together, one is high temperature region and the other in low temperature region.
- Mercury has high critical temperature and low critical pressure which makes a suitable working fluid will act as high temperature cycle (Toppling cycle) and steam cycle will act as low temperature cycle.
- In the low temperature range, mercury is

unsuitable because its saturation pressure becomes exceedingly low, and it would not be practical to maintain such high vacuum in condenser.

25. (c)

For steam boiler mounting:

Largest size valve: steam stop valve.

26. (c)

$$CR = \frac{m_s + m_l}{m_s} = 1 + \frac{m_l}{m_s} = 1 + \frac{0.8}{0.2}$$

$$CR = 5$$

27. (b)

- By increase in speed at a given pressure ratio, mass flow rate increases but efficiency decreases due to various frictional losses.

28. (b)

- Multistaging becomes compulsory beyond certain pressure ratio because volumetric efficiency decreases rapidly.
- For perfect intercooling, the pressure ratio is same for each stage.
- For same volumetric efficiency and clearance ratio, different reciprocating compressor has

$P_1 D_1^2 L_1 = P_2 D_2^2 L_2 = P_3 D_3^2 L_3$ relationship.
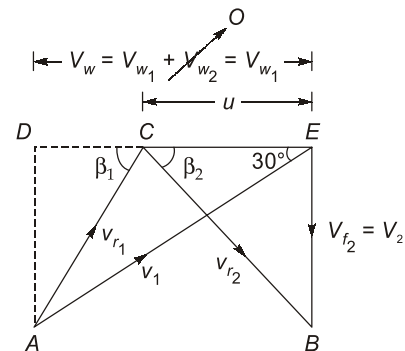
29. (d)

$$\eta_{\text{Diagram}} = \frac{2uV_w}{V_1^2} = \frac{2(200)(V_1\cos\alpha)}{V_1^2}$$

$$= \frac{2(200)(600\cos30°)}{(600)^2}$$

$$\eta_{\text{Diagram}} = \frac{1}{\sqrt{3}} = 0.577$$

30. **(d)**

$$W = V_1^2\left[2\rho\cos\alpha_1 - \rho^2\right]$$

For maximum efficiency,

$$\rho = \cos\alpha_1$$

$$W = V_1^2\left[2\rho\cdot\rho - \rho^2\right]$$

$$W = V_1^2\cdot\rho^2 = V_1^2\times\left(\frac{u}{V_1}\right)^2$$

$$W_{\text{max}} = u^2$$