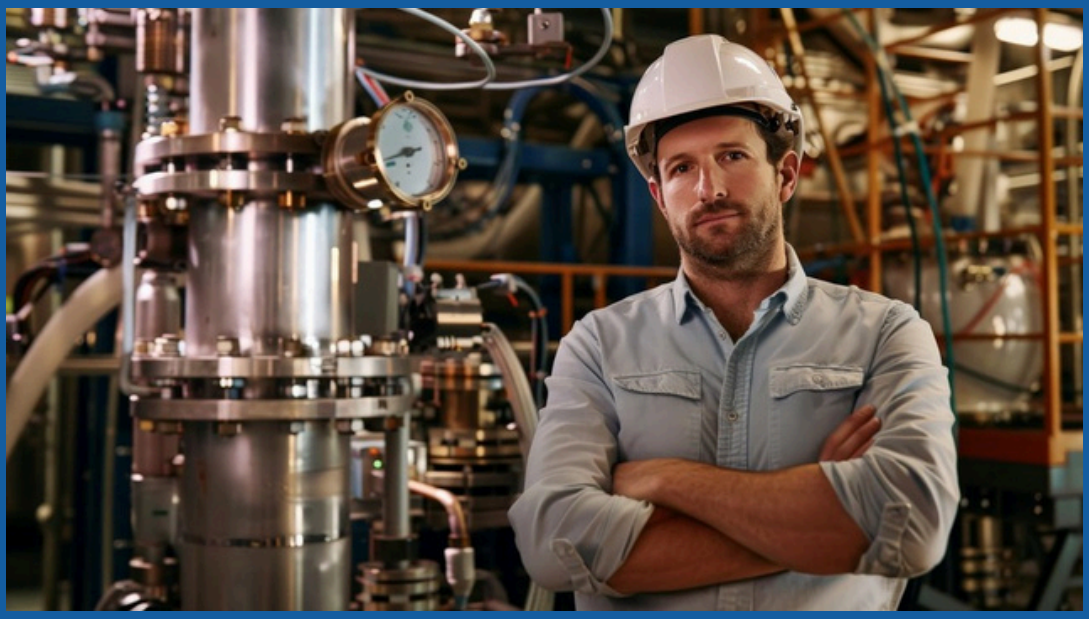
# Study Material For Boiler Operation Engineer (BOE) Exams



Theory, Numerical Problems, MCQs and Boiler Drawing Problems from BOE Exams

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SUDESH K JAIN

# GOVERNMENT OF INDIA
# MINISTRY OF COMMERCE AND INDUSTRY
# BOILER OPERATION ENGINEER'S EXAMINATION 2021

## PAPER-1

**Date : 11/12/2021** **Time : 09:30 to 12:30 Hrs.** **Max. Marks : 100**

**GENERAL INSTRUCTIONS :**

i. **This Question paper contains two parts, Section - A & B.**

ii. **Section - A contains 30 multiple choice questions (30 Marks)**

iii. **Section - B contains descriptive questions (70 Marks)**

**SECTION-A** **(30 X 1 = 30 Marks)**

1. For the same cross-sectional area and height, a beam of I-section takes more load than a beam of rectangular section because

   a) Section Modulus of I-beam is greater

   b) Maximum Bending stress induced in I-beam is greater

   c) Bending Moment induced in I-beam is less

   d) All of the above

2. The capacity of induced draft fan is higher than that of forced draft fan for a boiler using balanced draft because

   a) Specific Volume of flue gas is less than that of air

   b) Specific Volume of air is less than that of flue gas

   c) The load of forced draft fan is increased by primary air fan

   d) The load of induced draft fan is increased by Electrostatic precipitator

3. Bed coil tubes of a fluidized bed combustion boiler are studded

   a) To increase heat transfer

   b) To minimize erosion of tubes

   c) Both (a) and (b)

   d) None of the above

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4. Choose the fuel with the highest calorific value

a) Coal
b) Bagasse
c) Lignite
d) Municipal Solid Waste

5. A boiler is permitted to operate at a maximum pressure of 17.5 kg/sq.cm. In an FPS standard pressure gauge fitted to the boiler, it corresponds to

a) 100 psi
b) 150 psi
c) 250 psi
d) 300 psi

6. Heat added to water in the economiser is

a) Sensible heat
b) Latent heat
c) Super heat
d) All of the above

7. The Power transmitted by a shaft in watt is given by

a) $P = 4 \pi NT/60$
b) $P = \pi NT/1000$
c) $P = 2 \pi NT/60$
d) $P = 4 \pi NT/3600$

8. Producer gas mainly contains

a) Carbon dioxide and steam
b) Carbon monoxide and Nitrogen
c) Methane, ethane, butane
d) Hydrocarbons

9. Cold End Corrosion in Boilers is mainly influenced by

a) Sulphur content in fuel
b) Moisture content in fuel
c) Ash content in fuel
d) All of the above

10. Which of the following property of Air does not increase with rise in temperature

a) Thermal conductivity
b) Density
c) Thermal diffusivity
d) Viscosity

11. The ideal shape of pressure vessel from stress consideration and minimum material is

a) Cylindrical
b) Spherical
c) Conical
d) Ellipsoidal

12. Reheater receives steam from

a) Superheater
b) Deaerator
c) Economizer
d) High pressure turbine outlet

13. Which of the following boilers is most efficient in combustion?

a) Fluidized bed combustion boiler
b) Lancashire boiler
c) Stoker fired boiler
d) Chain grate boiler

14. Power boiler is generally

a) Fire tube boiler
b) Water tube boiler
c) Mixed tube boiler
d) Both (a) and (b)

15. If the internal diameter of a cylindrical tank is d cms, height is *l* cms, the volume of water it can hold in litres is

a) $\frac{\pi d^3 l}{4000}$
b) $\frac{\pi d^2 l}{4}$
c) $\frac{\pi d^2 l}{4000}$
d) $\frac{\pi d^2 l}{40}$

16. Natural circulation is limited to

a) Subcritical boilers
b) Supercritical boilers
c) Both (a) and (b)
d) None of the above

17. The following type of pump is preferred as a feed pump in high pressure boilers

a) Reciprocating
b) Multistage Centrifugal
c) Both (a) and (b)
d) None of the above

18. Platen superheater absorbs heat mainly by

a) Convection

b) Radiation

c) Convection and conduction

d) Conduction and radiation

19. The critical pressure of steam is

a) 225 kg/m$^2$ b) 235 kg/cm$^2$

c) 325 kg/cm$^2$ d) 225 kg/cm$^2$

20. Which of the following is not a boiler mounting?

a) Steam stop valve b) Fusible plug

c) Safety valve d) Economiser

21. Type of valve used for isolation in steam or water piping

a) Gate valve b) Globe valve

c) Check valve d) None of the above

22. In a boiler, the setting of safety valve of a boiler drum compared to that of main steam line has

a) Same value

b) Higher value

c) Lower value

d) Higher or lower depending on steam flow

23. The point at which elongation of a material is quite large as compared to the increase in load is known as

a) Ultimate point b) Elastic limit

c) Yield point d) Rupture point

24. HP heaters are provided in the boiler for increasing

a) Cycle efficiency

b) The pressure of feed water

c) Temperature of feed water

d) Both (a) and (c)

25. High percentage of CO in flue gas of the boiler indicates

a) Complete combustion

b) Good control of pollutants

c) Low excess air

d) High excess air

26. In a Boiler, the biggest heat loss is due to

a) Moisture in Fuel

b) Dry flue Gases

c) Radiation & convection

d) Unburnt Carbon

27. Reheating improves

a) Dryness fraction of steam entering last stages of turbine

b) Overall cycle efficiency

c) Both (a) and (b)

d) None of the above

28. Blowdown of the safety valve is

a) (Set pressure – reseating pressure)/ Set pressure

b) Reseating pressure / Lifting pressure

c) Lifting pressure / (Lifting pressure-reseating pressure)

d) None of the above

29. Axial flow pump is started with its delivery valve

a) Kept fully open

b) Kept fully closed

c) Kept partially open

d) None of the above

30. Increase of steam pressure has the following effects on steam

a) Steam temp. goes up and enthalpy of evaporation goes down

b) Specific volume goes down and enthalpy of evaporation goes up

c) Steam temp. goes up and enthalpy of evaporation goes up

d) Steam temp. and enthalpy of evaporation go down

## SECTION-B

**Q.1. Write short notes on any 5 of the following questions. (5 x 4 = 20 Marks)**

i. Bending and Torsional stresses

ii. Circulating Fluidized Bed Combustion

iii. Cavitation of Boiler Feed Pump

iv. Modes of Heat Transfer

v. Air Pre-Heater

vi. Effect of Silica in steam & its prevention

vii. Wet preservation of boiler

**Q.2. Attempt any 10 of the following questions. (10 x 2 = 20 Marks)**

i. What is the effect of soot deposit in the flue gas path of boiler?

ii. Why is the safety valve of a superheater set at a lower pressure than safety valve of a boiler drum?

iii. What is steam trap?

iv. Why is phosphate dozing required in boiler?

v. Why is hydrazine dozing required in boiler?

vi. What do you mean by 3 element control for a boiler?

vii. What are the advantages of water tube boiler over fire tube boiler?

viii. What do you mean by circulation ratio in boiler?

ix. What are the advantages of preheating the air in boiler?

x. Why is fusible plug used in fire tube boiler?

xi. What are the methods of varying ID fan output?

xii. What is superheating? What are the methods of controlling superheater steam temperature?

**Q.3. Boiler critical parameters, Fuel analysis & Flue gas analysis are given below.**

**(20 Marks)**

1. Boiler Capacity – 20 TPH
2. Steam Pressure – 66 $Kg/cm^2$
3. $O_2$ in flue gas – 9%
4. Average flue gas temp – 180°C
5. Air ambient temp – 29.3°C
6. Mass of Dry flue gas - 12.7 kg/ kg of coal

**Fuel Analysis –**

Carbon – 53.65%, Hydrogen – 3.25%, Nitrogen – 1.11%, Oxygen – 8.68%, Sulphur – 0.34%, Moisture – 14.43%, Ash content – 18.54%, GCV of coal – 4291 Kcal/Kg.

**Calculate –**

i. Theoretical air required for complete combustion. **(4 Marks)**

ii. Calculate % of Excess air supplied & actual mass of air. **(4 Marks)**

iii. Calculate % Heat loss in Dry flue gas. (Assume $C_p$ = 0.24 Kcal/Kg.°C) **(4 Marks)**

iv. % Heat loss due to $H_2$ in fuel. (Assume $C_p$ = 0.45 Kcal/Kg.°C) **(4 Marks)**

v. Boiler efficiency by indirect method, assuming the total of other losses like losses due to moisture in fuel & air, losses due to partial conversion of C to CO and losses due to unburnt in fly ash and bottom ash and losses due to radiation are approximately about 4%. **(4 Marks)**

**Q.4. Attempt any 2 of the following questions.** **(2 x 5 = 10 Marks)**

i. Explain the working principle of Ljungstrom air preheater

ii. What are the advantages of pulverized fuel firing?

iii. What is combustion of fuel and what are the requirements for combustion?

********** **End of the question Paper** **********

Regn. No. BOE - 2180

Name : ARUN KUMAR

(To be written by the candidate)

# GOVERNMENT OF INDIA
# MINISTRY OF COMMERCE AND INDUSTRY
# BOILER OPERATION ENGINEER'S EXAMINATION 2021

## PAPER-2

**Date : 11/12/2021** **Time : 14:00 to 17:00 Hrs.** **Max. Marks : 100**

**GENERAL INSTRUCTIONS :**

i. **This Question paper contains two parts, Section - A & B.**
ii. **Section - A contains 30 multiple choice questions (30 Marks)**
iii. **Section - B contains descriptive questions (70 Marks)**

**(30 X 1 = 30 Marks)**

**SECTION-A**

1. The following gas is used in tungsten inert gas welding process
   a) Acetylene
   b) Argon
   c) Oxygen
   d) Hydrogen

2. In a pulverised fuel fired boiler ash collection
   a) In bottom ash hopper is more than ESP hopper
   b) In ESP hopper is more than bottom ash hopper
   c) In ESP hopper is same as that of bottom ash hopper
   d) None of the above

3. In a top supported boiler
   a) The entire boiler expands upwards
   b) The entire boiler expands downwards
   c) The boiler does not expand
   d) None of the above

4. Natural draft is created by
   a) FD fan b) ID fan c) Chimney d) Furnace

5. Deaerators are provided in boiler

a) To remove hardness from feed water

b) To remove dissolved oxygen from feed water

c) To increase pH value of feed water

d) None of the above

6. Burner tilting is resorted to for the purpose of

a) Varying furnace pressure

b) Controlling reheat steam temperature

c) Improving combustion efficiency

d) None of the above

7. Draught in a boiler is necessary

a) To force adequate air through the combustion chamber to assist proper combustion of fuel

b) To draw out the resulting hot flue gas from the combustion chamber

c) To vent the products of combustion to atmosphere

d) All of the above

8. Modern ESPs have particulate removal efficiency of

a) More than 90%

b) Less than 90%

c) Less than 80%

d) 100%

9. Continuous blow down is resorted to

a) Maintain drum level

b) Maintain salt concentration of boiler water within permissible limits

c) Remove dissolved oxygen

d) None of the above

10. Chances of fire are more in APH

a) During start up and shutdown of boiler

b) During furnace wall blowing

c) During cutting in of coal burner

d) None of the above

11. Erosion due to ash in a P.F fired water tube boiler

a) Increases if the flue gas velocity increases

b) Decreases if the flue gas velocity increases

c) Remains unaffected due to velocity change

d) None of the above

12. SOx emissions in a FBC boiler fired with coal are controlled by adding ____to the bed

a) Magnesia b) Limestone

c) Sand d) Silica

13. Which data is not required to calculate boiler efficiency by the indirect method

a) Steam flow rate b) Stack gas temperature

c) Ambient temperature d) Energy content of fuel

14. Hydra-step is mounted on

a) Boiler drum b) Economizer

c) Re-heater d) Super heater

15. Superheating is a thermodynamic process of steam heating at

a) Constant Temperature b) Constant Pressure

c) Constant Volume d) None of the above

16. The Turndown ratio of oil burners in a boiler is the ratio of

a) Air to fuel

b) Maximum fuel input to actual fuel input

c) Maximum air input to minimum air input

d) Maximum fuel input to minimum fuel input

17. The rise in conductivity of boiler feed water indicates

a) Drop in the TDS of feed water

b) Thermal conductivity of water

c) Alkalinity of water

d) Rise in the TDS of feed water

18. Scaling in Boiler tube is not desired as it

a) Overheats the tube material and leads to failure

b) Causes obstruction of water circulation causing overheating of tube

c) Reduces heat transfer and hence, efficiency of the boiler

d) All of the above

19. Steam piping comes under the purview of I.B.R., if

a) Steam pressure exceeds 5.5 $Kg/cm^2$ or internal diameter exceeds 250mm.

b) Steam pressure exceeds 3.5 $Kg/cm^2$ or internal diameter exceeds 254mm.

c) Steam pressure exceeds 1.5 $kg/cm^2$ or internal diameter exceeds 25mm.

d) Steam pressure exceeds 3.0 $kg/cm^2$ or internal diameter exceeds 150mm.

20. Main advantage of waste heat recovery in Industry is

a) Reduction in pollution. b) Increase in Efficiency

c) Both (a) and (b) d) None of the above

21. Bimetallic strip is used in which of the following Steam Traps?

a) Inverted Bucket b) Thermostatic

c) Float Trap d) Thermodynamic

22. Which type of valve causes more pressure drop across?

a) Gate valve b) Globe valve

c) Butterfly valve d) Safety valve

23. Attemperation is done to

a) Control of Steam pressure b) Control of Steam Temperature

c) Control of Feed water Silica d) None of the above

24. Scale is formed on Heat transfer surface when

a) Water is acidic

b) Water is alkaline

c) Water contains dissolved Calcium & Magnesium salts

d) Both (b) and (c)

25. Chemical dozing pump for a boiler is of _____ type

a) Centrifugal
b) Axial Flow
c) Propeller
d) Reciprocating

26. Boiler Buckstays are used to

a) Provide foundation of Boiler
b) Provide top support for Boiler
c) Prevent flat surfaces from tearing apart
d) None of the above

27. For flash steam calculation, flash steam quantity available depends upon

a) Condensate pressure & flash steam pressure
b) Pressure of steam in Boiler
c) Steam Enthalpy at atmospheric pressure
d) Total heat of flash steam

28. Drain pockets are provided in a steam line for

a) Storage of flash steam
b) Storage of condensate
c) Checking of steam line
d) Effective removal of condensate from the line

29. In solar thermal conversion systems, the solar heat is transferred to

a) Water-steam
b) Molten salts
c) Both (a) and (b)
d) None of the above

30. Manganese is added to steel primarily to increase

a) Tensile strength
b) Fatigue strength
c) Ductility
d) Malleability

## SECTION-B

**Q.1. Attempt any 1 of the following questions.** **(1 X 20 = 20 Marks)**

i. Explain the step-by-step procedure of starting any one type of water tube boiler from cold condition up to synchronization.

ii. Explain the balanced draft system of a boiler with a schematic sketch representing pressure variations in air and flue gas circuits.

**Q.2. Attempt any 10 of the following questions.** **(10 X 2 = 20 Marks)**

i. Give major reasons for boiler tube failure

ii. What is excess air?

iii. What is meant by residence time of fuel particle in a pulverized fuel fired furnace?

iv. Mention two major differences between Indian coal and imported (Indonesian / South African) coal?

v. What is emergency blowdown?

vi. What are the reasons for 'drum level low' in an operating boiler?

vii. what is the basic difference between Pipe and Tube?

viii. Which two elements of a fuel have same percentage in proximate and ultimate analysis

ix. Why are boiler feed water tanks and deaerators, feeding to boiler feed pumps always kept at an elevated position?

x. Write any four drum water parameters along with its range being tested in water quality lab in power plant

xi. Name three pollution control equipments used in boiler?

xii. What is steam test and when it is carried out?

**Q.3. Attempt any 4 of the following questions.** **(4 X 5 = 20 Marks)**

i. State the causes of boiler trip in a high-pressure boiler with protection and interlocks.

ii. Explain the working of Steam soot blower & its purpose

iii. What is Wet mode operation of supercritical boiler

iv. What is priming and foaming in a boiler? How can these be prevented?

v. Write short notes on remnant life assessment study on boilers?

**Q.4. Attempt any 1 of the following questions.** **(1 X 10 = 10 Marks)**

i. Draw a schematic line diagram of water treatment plant for treating boiler water and explain?

ii. Explain the Difference between AFBC, PFBC and CFBC with regard to fluidized bed technology.

********** **End of the question Paper** **********

# GOVERNMENT OF INDIA
# MINISTRY OF COMMERCE AND INDUSTRY
# BOILER OPERATION ENGINEER'S EXAMINATION 2021

## PAPER-3

**Date : 12/12/2021** **Time : 09:30 to 12:30 Hrs.** **Max. Marks : 100**

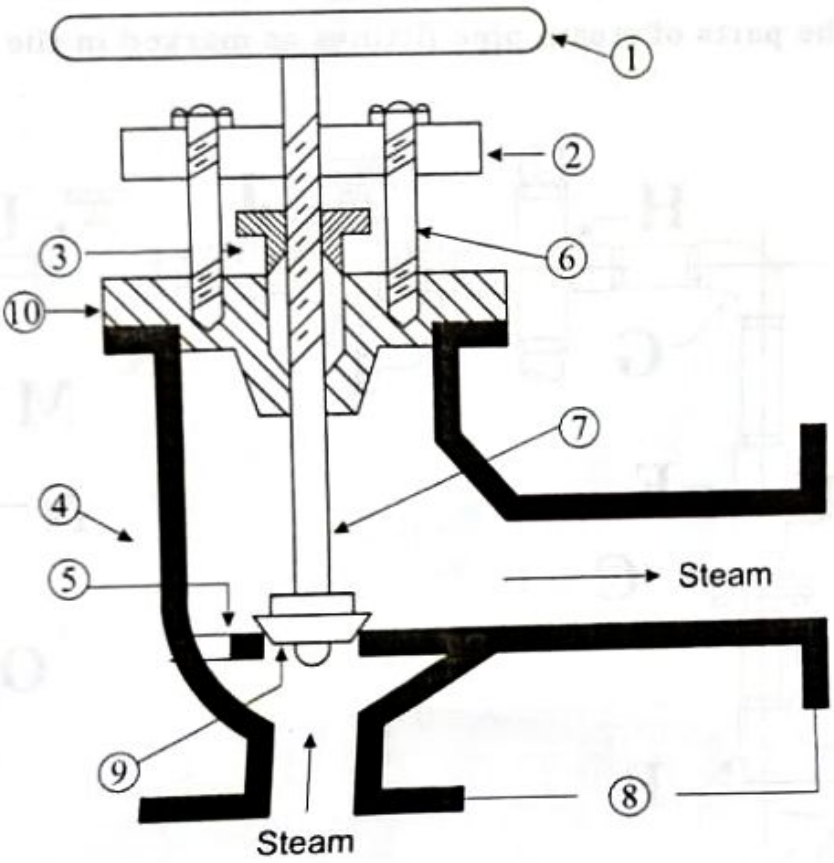
**GENERAL INSTRUCTIONS :**

i. There is no requirement for the use of Mini drafter/Drafter in the examination.

ii. Free-hand sketch/drawing would be sufficient.

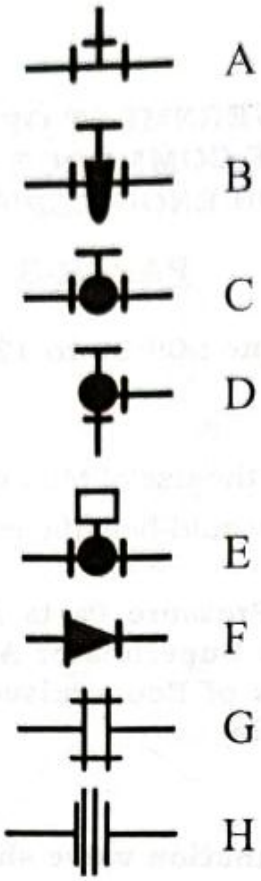
**Q.1. Draw a neat sketch of Pressure Parts Arrangement of a bi-drum water tube boiler with Primary Superheater Assembly, Secondary Superheater Assembly and two banks of Economiser Assembly, and mark the major boiler components therein.** **(20 Marks)**

**Q.2. Name the parts of the Junction valve shown in figure below:** **(10 Marks)**

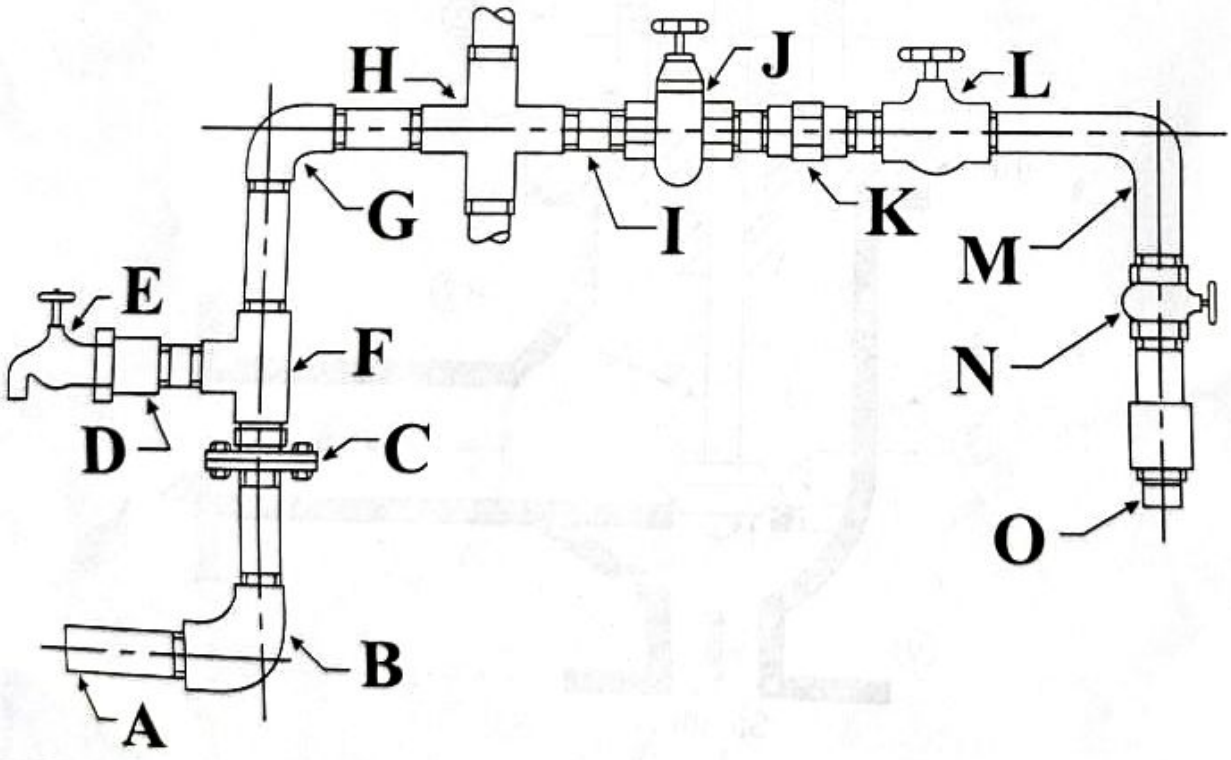


**Q.3. Attempt all questions:** **(20 Marks)**

**a. Name any 5 of the steam pipe fittings which are symbols of single line piping showing in figure below:** **(5 Marks)**




**b. Name the parts of steam pipe fittings as marked in the figure below:** **(15 Marks)**



**Draw free hand drawing for any 10 of the following type of Welded Joints:** **(10 x 3 = 30 Marks)**

I. Fillet

II. Square Butt

III. Single V-Butt

IV. Double V-Butt

V. Single U-Butt

VI. Double U-Butt

VII. Single Bevel Butt

VIII. Double Bevel Butt

IX. Single J-Butt

X. Seam

XI. Edge

XII. Spot

**Draw a neat sketch of Quick Closing Non-Return Valve and mark the major components therein.** **(20 Marks)**

********** **End of the question Paper** **********