Date : 10-10-2022 **RPSC (A.En.) Test Series – 2022**

Answer + Solution

Test ID - 004

Hydraulic Machine

1. (b)

Unit power $(P_u) = \frac{P}{(H)^{3/2}}$

2. (b)

In single suction pump, fluid is admitted from the suction pipe on one side of impleller hence there is an axial thrust. However, in double suction pump liquid enters from both side of impeller and hence axial thrust in neutralised and also larger quantity of water can be pumped.

3. (b)

$$P = T\omega$$

$$2515 \times 10^3 = T \times \frac{2\Pi \times 240}{60}$$

$$T = 100068.6705 \text{ Nm}$$

$$= 100.068 \text{ kNm}$$

4. (c)

Water hammer :- Occurs when a valve is closed quickly or pump shuts down and causes the water pressure twice and fall rapidly. Sounds like some hammering on pipe can damage pipes, causing them burst.

5. (b)

Specific speed of pump is given by -

$$N_S = \frac{N\sqrt{Q}}{H^{3/4}} \quad ....(1)$$

For half discharge i.e. $\frac{Q}{2}$, the specific speed is -

$$N_S' = \frac{N\sqrt{\frac{Q}{2}}}{H^{3/4}} \quad ....(2)$$

From eq. (1) & (2)

Specific speed i.e. $N_S' = \frac{N_S}{\sqrt{2}}$

6. (a)

Gross head required

$= 10 + 5 = 15\text{m}$

$Q = 0.1 \text{ m}^3/\text{s}$

Power required, $P = \rho QgH$

$P = (1000\times0.1\times9.81\times15)\times10^{-3}$

$P = 14.715 \text{ kW}$

7. (a)

8. (c)

9. (b)

10. (c)

11. (a)

$V = 8$ m/s, $f = 120$ N

Power transmitted,

$$P = F.V$$
$$= 120 \times 8 = 960 \text{ watt}$$
$$P = 0.96 \text{ kW}$$

12. (d)

The main function of surge tank are

- When the load decreases, the water moves backward and gets stored in it.
- When the load increases, an additional supply of water will be provided by the surge tank.
- In short, the surge tank mitigates pressure variations due to rapid changes in the velocity of the water and protects the pipe line against water hammers.

13. (a)

$V = 14$ m/s, $A = 10$ mm^2

Total force on plate $= \rho A V^2$

$$= 1000 \times (10 \times 10^{-6}) \times 14^2$$
$$F = 1.96 \text{ N}$$

14. (c)

15. (b)

16. (b)

17. (d)

18. (a)

19. (b)

As we know

$$1 \text{ HP} = 746 \text{ Watt}$$

So
$$30 \text{ HP} = 746 \times 30 \text{ watt}$$
$$= 22380 \text{ Watts}$$

20. (a)

$$N_S = \frac{N\sqrt{P}}{H^{5/4}}$$

Dimension of specific speed

$$N_S = \frac{\sqrt{ML^2T^{-3}}}{L^{5/4}T} = M^{1/2}L^{-1/4}T^{-3/2}$$
$$= M^{1/2}L^{-1/4}T^{-5/2}$$

$$\text{Now}, F = MLT^{-2}$$
$$\Rightarrow \quad M = FL^{-1}T^2$$
$$\therefore [N_S] = F^{1/2}L^{-3/4}T^{-3/2}$$

21. (a)

22. (b)

Speed ratio varies from 0.43 to 0.48.

23. (b)

Given

Power = 10,000 hp

N = 500 rpm

Head = 81 m

A.W.K.

Specific speed of torque

$$= \frac{N\sqrt{p}}{H^{5/4}}$$

$$N_s = \frac{500\sqrt{10,000}}{(81)^{5/4}}$$

$$N_s = 205.76$$

It is in the range of 60 – 300

So we will use francis turbine

24. (b)

25. (c)

- Centrifugal pumps convert mechanical energy into hydraulic energy by means of centrifugal force.
- The flow of water leaving the impeller is free vortex.
- The impeller of a centrifugal pump may have volute casing. Vortex casing and volute casing with guide blades.

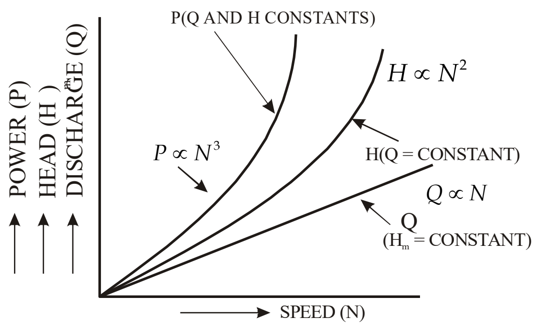
26. (b)

Important points for Impulse turbine:-

- The width of the bucket for a Pelton wheel is generally five times the diameter of jet.
- The depth of the bucket for a Pelton wheel is generally 1.2 times the diameter of jet.
- The number of buckets on the periphery of a Pelton wheel is given by $\left(\frac{D}{2d} + 15\right)$, where D is the pitch diameter of the wheel and d is the diameter of the jet.
- The ratio of D/d is called jet ratio.
- The maximum number of jets, generally, employed on Pelton wheel are six.

27. (c)

For centrifugal pump



when impeller diameter (d) is constant

Discharge(Q) $\propto$ N

Head(H) $\propto N^2$

Power(P) $\propto N^3$

When speed (N) is constant

Discharge(Q) $\propto d^3$

Head(H) $\propto d^2$

Power(P) $\propto d^5$

28. (d)

In reaction turbines the formation, growth and collapse of vapour filled cavities or bubbles in a flowing liquid due to local fall in fluid pressure is called cavitation.

Hence in case of reaction turbine (francis or kaplan) cavitation can take place.

29. (c)

Cavitation :-

The formation, growth and collapse of vapour filled cavities or bubbles in a flowing liquid due to local fall in fluid pressure is called cavitation.

The cavitation hydraulic machine affects in the following ways :

- It cause noise and vibration of various parts.
- It makes surface rough.
- It reduces the discharge of a turbine.
- It causes sudden drop in power output and efficiency.

The cavitation in reaction turbines can be avoided to a great extent by using the following methods:

- By installing the turbine below the tail race level
- By using stainless steel runner of the turbine
- By providing highly polished blades to the runner
- By running the turbine runner to the designed speed

30. (a)

The characteristic curves of centrifugal pumps plot the course of the following parameters against flow rate (Q.)

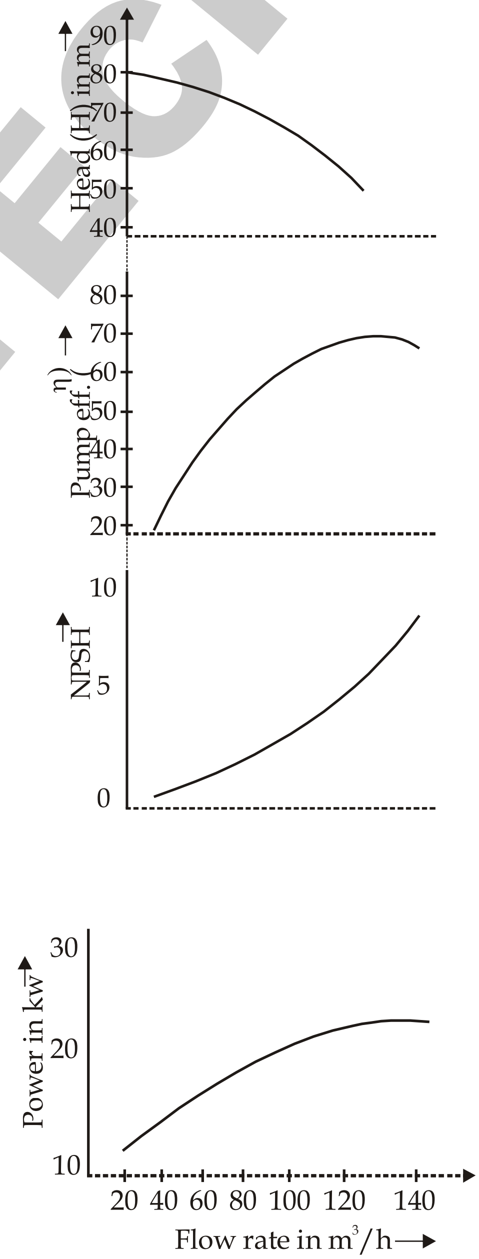
(i) Head (H)

(ii) Power input (P)

(iii) Pump efficiency (η)

(iv) NPSH

The characteristic curve's shape is primarily determined by the pump type (i.e. Impeller, pump casing or specific speed secondary influence such as cavitation.



31. (b)

The characteristic curves of centrifugal pumps plot the course of the following parameters against flow rate (Q.)

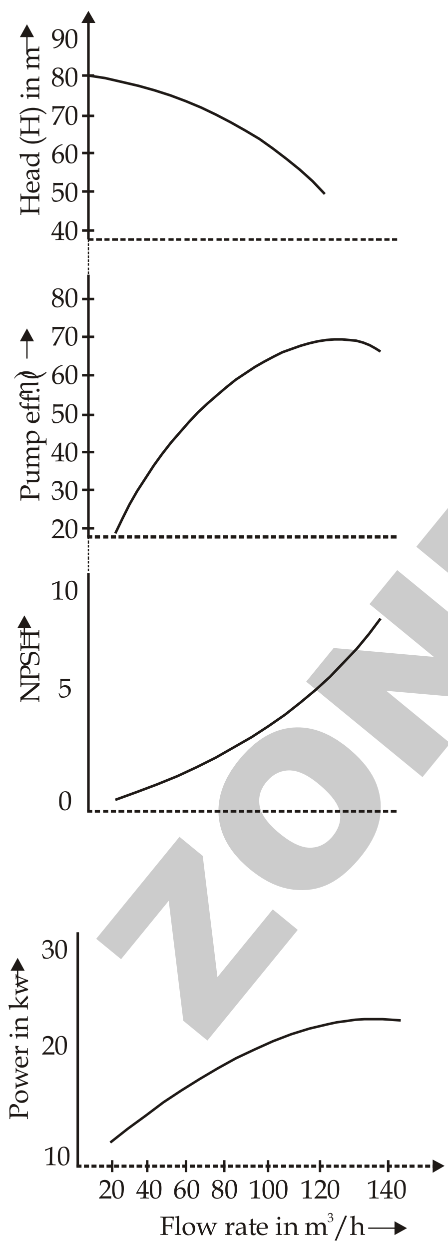
(i) Head (H)

(ii) Power input (P)

(iii) Pump efficiency (η)

(iv) NPSH

The characteristic curve's shape is primarily determined by the pump type (i.e. Impeller, pump casing or specific speed secondary influence such as cavitation.



32. (c)

The characteristic curves of centrifugal pumps plot the course of the following parameters against flow rate (Q.)

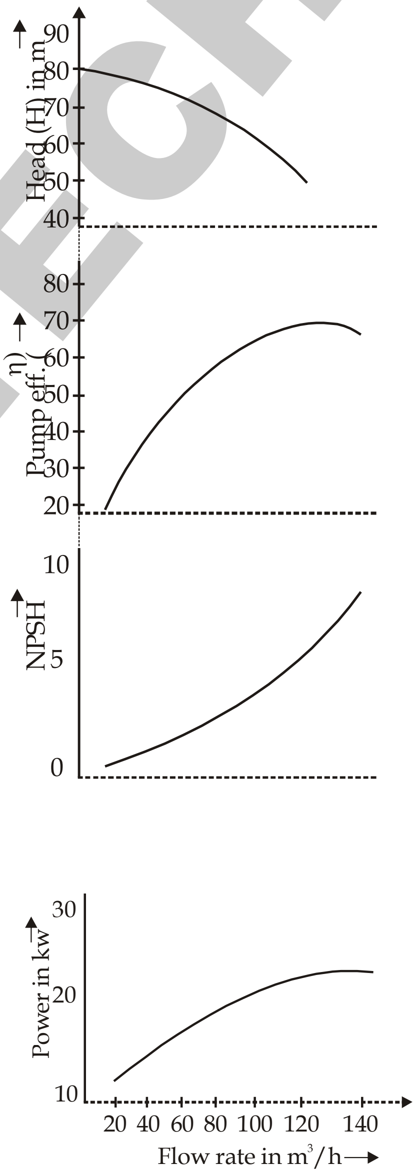
(i) Head (H)

(ii) Power input (P)

(iii) Pump efficiency (η)

(iv) NPSH

The characteristic curve's shape is primarily determined by the pump type (i.e. Impeller, pump casing or specific speed secondary influence such as cavitation.



33. (a)

34. (d)

35. (d)

36. (d)

37. (a)

38. (c)

39. (b)

40. (b)

The specific speed of centrifugal pump is given by the formula

$$N_S = \frac{\sqrt{Q}N}{H^{3/4}}$$

Here, Q is the discharge, h is the manometric head of the pump.

Plugging the values in the above equation

$$700 = \frac{700\text{sqrt}\left(3840 / 60\right)}{h^{3/4}}$$

$$h = 16 \text{ m}$$

Now the number of impellers required to supply the total head of 80 m is calculated as

$$H = n*h$$

$$80 = n*16$$

$$n = 5$$

Therefore total 5 impellers are required.