Pipes and Cisterns

Solution

1. **Answer: (B)**
Let, total work = 60 units (LCM of 15, 20 & 12)
Efficiency of A = 60/15 = 4 units/minute
B's efficiency = 60/20 = 3 units/minute
C's efficiency = 60/12 = (-5) units/minute
∴ tank filled in 1 min = 2 units
Total time = $\frac{60}{2} = 30\ minutes$

2. **Answer: (B)**
The correct answer is Option 4 i.e. 15 hours
From the question, we can say that Pipe P is an outlet pipe while pipe Q is inlet pipe.
Suppose pipe P will empty the complete tank in x hours;
1/5 – 1/x = 1/6
1/x = 1/5 – 1/6
x = 30
Hence, pipe P will take 15 hours to vacate the tank if it is half filled.

3. **Answer: (E)**
Let the total capacity of the cistern be 60 units (LCM)
So, the efficiency of pipe A = 4 units/hr
The efficiency of pipe B = 5 units/hr
Let efficiency of pipe C = x units/hr
So, according to question,
60/(4 + 5 – x) = 60/9 + 20/60
60/(9 – x) = 20/3 + 1/3 = 21/3 = 7
63 – 7x = 60
$x = \frac{3}{7}\ \frac{units}{hr}$
Required time = $\frac{60}{3} \times 7 = 140hr$

4. **Answer: (A)**
Part filled by A,B and C together in 3 hour = 3/11
Remaining 8/11 part is filled by A and C together 16 hours
Now, work done by A,B and C in 8 hours is equal to the work done by A and C
Let their efficiency are A,B,C
8(A + 2 + C) = 16 (A + C)
B = A + C
Efficiency of B is equal to the efficiency of A and C
Then B alone can fill the tank in 22 hour.

5. **Answer: (B)**
X can do a piece of work in 10 minutes.
Y can do a piece of work in 30 minutes.
Z can do a piece of work in 15 minutes.
Minute's work of all the three pipes together = 1/10 + 1/30 + 1/15 = 6/30 = 1/5 part
To fill the whole cistern, time taken = 1/(1/5)
= 5 minutes

6. **Answer: (B)**
The correct answer is Option 2 i.e. 20 hours
Two pipes A and B can fill a tank in 60 hours and 40 hours respect and pipe C can empty the tank in 15 hours.
Suppose the capacity of tank = LCM of 60, 40 and 15 = 120 units
Efficiency = Work/Time
Hence,
Efficiency of A = 120/60 = 2
Efficiency of B = 120/40 = 3
Efficiency of C = 120/15 = 8
Pipes A and B are opened for 12 hours.
So,
Tank filled in 12 hours
= 12 × (2 + 3) = 60 units
Remaining tank = 120 – 60 = 60 units
Pipe C is also opened.
So, Time in which tank will be empty
= 60/(2 + 3 – 8) = – 60/3 = – 20
20 hours is the answer.

7. **Answer: (B)**
1 hour work of all three pipes
$= \frac{1}{5} + \frac{1}{9} - \frac{1}{15} = \frac{11}{45}\ units$
Time taken by all three pipes to fill the tank
$= \frac{45}{11} hours = 4\frac{1}{11} hours$

8. **Answer: (D)**

ATQ –
2(A + B) = 6C
A + B = 3C
Also given, A + B + C = $\frac{1}{9}$
4C = $\frac{1}{9}$
C = 36 hours

9. Answer: (A)
Let P fills 2x litres a day.
Then Q fills 3x liters a day
R fills $\frac{4}{3} \times 3x = 4x\ liters\ a\ day$
And S fills $\frac{3}{2} \times 4x = 6x$ liters a day
Let total capacity of tank be 9x liters
Time taken by P and R to fill the tank together = $\frac{9x}{2x+4x} = \frac{3}{2} days$
Time taken by S and Q to fill the tank together = $\frac{9x}{3x+6x} = 1x days$
Required ratio = 3 : 2

10. Answer: (C)
A = 45 hr
A : B = 100 : 150
= 2 : 3
Total capacity of tank = 45 × 2 = 90 liter
C = $\frac{90}{3} - 7.5$
= 22.5 hr
C efficiency = $\frac{90}{22.5}$
$= 4\frac{l}{hr}$
According to question ⇒ $\frac{5X}{4(X+9)} = \frac{1}{2}$
⇒ 10X – 4X = 36
X = 6 hr

11. Answer: (A)
When both the pipes are open, portion of the tank filled in 1 minute = 1/20 + 1/30 = 1/12
Hence, it takes 12 minutes to fill the tank.
Therefore, half tank will be filled in 6 minutes
Time taken to fill the remaining half of the tank with outlet pipe = 24 – 6 = 18 minutes
Let the portion of the tank leaked in one minute be 1/a
Now, the second half of the tank gets filled in 18 minutes.
So, 18(1/20 + 1/30 – 1/a) = ½
1/12 – 1/a = 1/36
Or 1/a = 1/18
Hence the leakage pipe can empty the tank in 18 minutes. It pumps out 50 litres of water per minute.
Therefore the capacity of the tank is 900 litres.

12. Answer: (A)
Let the total capacity of the tank be = 60a liter
So the flow rate of pipe A = (60a/4) = 15a liter/h
Flow rate of pipe B = (60a/5) = 12a liter/h and flow rate of pipe C = (60a/3) = 20a liter/h
Time taken by pipe A to half – fill the tank = (30a/15a) = 2 hours
Now when both the pipe A and C are opened then net outgoing flow of the water = 20a – 15a = 5a liter
So the time taken to empty the tank to one fourth of its capacity = (15a/5a)
= 3 hours
When pipe B is also opened, total flow rate = 15a + 12a – 20a = 7a liter
Now time taken to fill the tank completely = (45a/7a) = 45/7
So the time tank will be filled in 5 + (45/7) = 80/7 hours

13. Answer: (A)
Let us assume some time l.c.m (10, 15)min = 30 min
Now in 30 min time cold water pipe will fill the bathtub = 30/10 = 3 times
whereas hot water pipe will fill it
= 30/15 = 2 times.
So in 30 min time bathtub will be filled
= 3 + 2 = 5 times.
So emptied bathtub will be fully filled in
= 30/5 = 6 min
time if waste pipe is closed.

Initially waste pipe is opened and after 6 mins the waste pipe is closed, it takes 4 more minutes to fill the bathtub fully.
So waste pipe has emptied 4/6 = 2/3part of bathtub in 6 mins.
Rest 1/3 part of tank can be emptied by the waste pipe in 6/2 = 3 mins.
So waste pipe would empty the tank in
= 6 + 3 = 9 mins

14. Answer: (D)

Let X,Y,Z,W be the inlet pipes
1/X + 1/Y + 1/Z = 1/12
1/Y + 1/Z + 1/W = 1/15
1/X + 1/W = 1/20
Adding the 3 equations,
2 (1/X + 1/Y + 1/Z + 1/W) = 1/12 + 1/15 + 1/20 = 12/60 = 1/5
1/X + 1/Y + 1/Z + 1/W = 1/10
1/Y + 1/Z = 1/10 – (1/X + 1/W)
= 1/10 – 1/20 = 1/20
So second and third pipes can fill the tank in 20 minutes.

15. Answer: (A):

Let the number of valves allotted to fill the tank = 'y'.
The number of valves allotted for draining purpose = (15 – y)
A valve used for filling, fills the purifier in = 15 hour
So, in 1 hour it can fill = $1/15^{th}$ part
Similarly, a valve used for draining, drains the purifier in = 30 hour
So, in 1 hour it can drain = 1/30th part
Given, it took 2 hours to fill with all valves open.
So, according to question,
(2 × y)/15 – (2 × (15 – y))/30 = 1
On solving, we get y = 10
Therefore, number of valves allotted to fill the purifier = 10
The number of valves allotted to drain the purifier = 5
Percentage of valves allotted for draining purpose = 5/15 × 100 = 33.33%

16. Answer: (C)

Net water inflow in the tank during the 1^{st} min = 5 + 3 – 0.5 = 7.5 liter
Net inflow during the 2^{nd} min
= 8 – 1 = 7 liter
Net inflow during the 3rd min
= 8 – 1.5 = 6.5 liter and so on.
We can see that the net water inflow during every minute forms an A.P where
1^{st} term = 7.5 and common difference = – 0.5
Since, the net inflow is decreasing, we have to consider the last instance where the inflow is positive.
During the 15th minute, inflow
= 8 – 7.5 = 0.5 liter
During the 16th minute, inflow
= 8 – 8 = 0 liter
After this, outflow rate will be higher than inflow rate and the tank will start draining.
So we have to find the sum of the A.P series where 1st term (a) = 7.5 and common difference (d) = – 0.5 and the last(15th term) = 0.5
So required sum = n/2[a + l] = 15/2[7.5 + 0.5] = 60 liter
So the maximum amount of water which can be filled in the tank is 60 liter.

17. Answer: (C)

Let's suppose time taken by A to fill the tank is x min and by (B) is y min.
Therefore, 1/x + 1/y = 3/20 – – (1)
Now according to the 2nd condition it takes x – 1 min for A to fill the tank and it takes y + 2 min for B to fill the tank.
Therefore, 1/(x – 1) + 1/(y + 2) = 1/7 – – (2)
From equation (1) x = 20y/(3y – 20)
And from equation (2) x – 1 = 7(y + 2)/(y – 5)
By equating these two values of x we will get y = 12 min and x = 15 min

18. Answer: (B)

Total capacity of cistern = (3 + 4 + 5) × 45
= 540 unit (Cistern can be filled in 45 min by all the 3 taps together).
Time taken to fill initial 8/15th of the cistern

= 45 × (8/15) = 24 min
Since all the taps are initially opened for 24 min. So, total cost to fill 8/15th of the cistern = 24 × (2 + 3 + 4) = 216
Remaining part = 540 × (7/15) = 252 unit
If tap A is closed, then total cost to fill remaining part = (3 + 4) × [252/(4 + 5)] = 196
If tap B is closed, then total cost to fill remaining part = (2 + 4) × [252/(3 + 5)] = 189
If tap C is closed, then total cost to fill remaining part = (2 + 3) × [252/(3 + 4)] = 180
Hence, when pipe C is closed the cost is minimum.
Now the required ratio = 216: 180
= 6:5

19. Answer: (B)
Outlet flow of each pipe = 187.5% of 8
= 15 L/min
Total amount of water flow(outlet) in 1 min when all the pipes are opened
= (2 × 15) – (3 × 8) = 6 L
In 45 min amount of water outflows
= 45 × 6 = 270 L
New inlet flow rate = 150% of 8 = 12 L/min
New outlet flow rate = 90% of 15 = 13.5 L/min
Now in 1 min amount of water filled when all the pipes are opened = (3 × 12) – (2 × 13.5)
= 9 L
Time taken to fill 270 L of water = T
= 270/9 = 30 min