Pipes and Cisterns

INTRODUCTION

Pipes are connected to a *tank* or *cistern* and are used to fill or empty the tank.

Inlet A pipe connected with a tank or a cistern that fills it is known as *inlet*.

Outlet A pipe connected with a tank or cistern emptying it is known as *outlet*.

Pipes and Cistern problems are similar to those on time and work. The only difference here is the work done is in terms of filling or emptying a cistern and the time taken is the time taken by a pipe or leak (crack) to fill or empty a cistern, respectively.

Generally, the time taken to fill a cistern is taken as positive and the time taken to empty a cistern is taken as negative. The amount of work done, i.e., filling or emptying a cistern is generally taken as unity, unless otherwise specified.

SOME BASIC FORMULAE

1. If an inlet can completely fill the empty tank in X hrs, the part of the tank filled in 1 hr $= \frac{1}{X}$.
2. If an outlet can empty the full tank in Y hrs, the part of the tank emptied in 1 hr $= \frac{1}{Y}$.
3. If both inlet and outlet are open, net part of the tank filled in 1 hr $= \frac{1}{X} - \frac{1}{Y}$.

Illustration 1 A pipe can fill a tank in 5 hrs. Find the part of tank filled in one hour

Solution: The part of the tank filled in 1 hr = 1/5.

Illustration 2 A pipe can fill a tank in 28 minutes. Find the time in which 1/7 part of the tank will be filled

Solution: We have, 1/28 part of the tank is filled in 1 min.

$\therefore$ 1/7 part of the tank is filled in 28/7 minutes

= 4 minutes.

Illustration 3 A pipe can empty a cistern in 40 minutes. Find the time in which 3/4 part of the cistern will be emptied

Solution: We have, 1/40 part of the cistern is emptied in = 1 min.

$\therefore$ 3/4 part of the cistern is emptied in

$$= 40 \times \frac{3}{4} = 30 \text{ minutes}$$

Illustration 4 A pipe can empty a cistern in 12 hrs. Find the part of the cistern emptied in 4 hrs

Solution: We have, part of the cistern emptied in 1 hr = 1/12,

$\therefore$ part of the cistern emptied in 4 hrs $= \frac{1}{12} \times 4 = \frac{1}{3}$

Illustration 5 A tap can fill a cistern is 8 hrs and another can empty it in 16 hrs. If both the taps are opened simultaneously, find the time (in hrs) to fill the cistern

Solution: Here $X = 8$ and $Y = 16$

$\therefore$ Part of the cistern filled in 1 hr

$$= \frac{1}{X} - \frac{1}{Y}$$

$$= \frac{1}{8} - \frac{1}{16} = \frac{1}{16}$$

$\therefore$ Total time taken to fill the cistern = 16 hrs

SOME USEFUL SHORT-CUT METHODS

1. Two pipes A and B can fill (or empty) a cistern in X and Y hrs, respectively, while working alone. If both the pipes are opened together, then the time taken to fill (or empty) the cistern is given by

$$\left(\frac{XY}{X+Y}\right)\text{hrs.}$$

Explanation

Part of the cistern filled (or emptied) by pipe A alone in 1 hr $= \frac{1}{X}$.

Part of the cistern filled (or emptied) by pipe B alone in 1 hr $= \frac{1}{Y}$.

$\therefore$ Part filled (or emptied) by $(A + B)$ in 1 hr

$$= \frac{1}{X}+\frac{1}{Y} = \frac{X+Y}{XY}.$$

Therefore, both the pipes A and B together will fill (or empty) the cistern in $\left(\frac{XY}{X+Y}\right)$ hrs.

Illustration 6 Two pipes A and B can fill a cistern in 20 and 30 minutes, respectively. If both the pipes are opened simultaneously, how long will it take to fill the cistern?

Solution: Here $X = 20$ and $Y = 30$

$\therefore$ Part of the cistern filled by $(A + B)$ in 1 min

$$= \frac{1}{X}+\frac{1}{Y} = \frac{1}{20}+\frac{1}{30} = \frac{5}{60} = \frac{1}{12}$$

$\therefore$ Both the pipes A and B together will fill the cistern in 12 minutes.

2. Three pipes A, B and C can fill a cistern in X, Y and Z hrs, respectively, while working alone. If all the three pipes are opened together, the time taken to fill the cistern is given by

$$\left(\frac{X\times Y\times Z}{XY+YZ+ZX}\right)\text{hrs.}$$

Explanation

Part of the cistern filled by A alone in 1 hr $= \frac{1}{X}$

Part filled by B alone in 1 hr $= \frac{1}{Y}$

Part filled by C alone in 1 hr $= \frac{1}{Z}$

All the three pipes are opened.

$\therefore$ Part filled in 1 hr

$$= \frac{1}{X}+\frac{1}{Y}+\frac{1}{Z} = \frac{XY+YZ+ZX}{XYZ}$$

$\therefore$ Cistern will be filled in $\frac{XYZ}{XY+YZ+ZX}$ hrs

Note:

We can generate more formulae like above by replacing negative sign wherever a pipe starts emptying a cistern instead of the standard positive sign.

Illustration 7 Two pipes A and B can separately fill a cistern is 8 hrs and 12 hrs, respectively, while a third pipe C can empty it in 6 hrs. In what time will the cistern be full, if all the pipes are opened together?

Solution: Here $X = 8$, $Y = 12$ and $Z = -6$

$\therefore$ The cistern will be full in

$$= \left(\frac{8\times12\times-6}{8\times12-12\times6-6\times8}\right)\text{hrs}$$

$$= \left(\frac{576}{24}\right)\text{hrs or, 24 hrs.}$$

3. Two pipes A and B can fill a cistern in X hrs and Y hrs, respectively. There is also an outlet C. If all the three pipes are opened together, the tank is full in Z hrs. The time taken by C to empty the full tank is given by

$$\left(\frac{XYZ}{XZ+YZ-XY}\right)\text{hrs.}$$

Explanation

Part of the tank emptied by C in 1 hr

$$= \left(\frac{1}{X}+\frac{1}{Y}-\frac{1}{Z}\right)$$

$\therefore$ C can empty the full tank in $\left(\frac{XYZ}{XZ+YZ-XY}\right)$ hrs.

Illustration 8 Two taps A and B can fill a cistern in 30 minutes and 60 minutes, respectively. There is third exhaust tap C at the bottom of the tank. If all taps are opened at the

same time, the cistern will be full in 45 minutes. In what time can exhaust tap C empty the cistern when full?

Solution: Here $X = 30$, $Y = 60$ and $Z = 45$

$\therefore$ Exhaust tap C can empty the cistern in

$$= \left(\frac{XYZ}{XZ+YZ-XY}\right) \text{ minutes}$$

$$= \left(\frac{30\times60\times45}{30\times45\times60\times45-30\times60}\right) \text{ minutes}$$

$$= 36 \text{ minutes.}$$

4. A tank takes X hrs to be filled by a pipe. But due to a leak, it is filled in Y hrs. The amount of time in which the leak can empty the full tank

$$= \left(\frac{XY}{Y-X}\right) \text{hrs.}$$

Illustration 9 A pipe can fill a tank in 12 hrs. Due to leakage in the bottom, it is filled in 24 hrs. If the tank is full, how much time will the leak take to empty it?

Solution: Here $X = 12$ and $Y = 24$.

$\therefore$ The time taken by the leak to empty the full tank

$$= \left(\frac{XY}{Y-X}\right) \text{hrs} = \left(\frac{12\times24}{24-12}\right) \text{hrs or 24 hrs:}$$

5. A cistern has a leak which can empty it in X hrs. A pipe which admits Y litres of water per hour into the cistern is turned on and now the cistern is emptied in Z hrs. The capacity of the cistern is

$$\left(\frac{XYZ}{Z-X}\right) \text{litres.}$$

Illustration 10 A leak in the bottom of a tank can empty the full tank in 6 hrs. An inlet pipe fills water at the rate of 4 litres per minute. When the tank is full, the inlet is opened and due to leak, the tank is empty in 8 hrs. Find the capacity of the tank.

Solution: Here $X = 6$, $Y = 4 \times 60 = 240$ and $Z = 8$

$\therefore$ The capacity of the tank is

$$= \left(\frac{XYZ}{Z-X}\right) \text{litres} = \left(\frac{6\times240\times8}{8-6}\right) \text{litres}$$

$$= 5760 \text{ litres.}$$

6. One fill pipe A is k times faster than the other fill pipe B.

(a) If B can fill a cistern in x hrs, then the time in which the cistern will be full, if both the fill pipes are opened together, is $\left(\frac{x}{k+1}\right)$ hrs.

(b) If A can fill a cistern in y hrs, then the time in which the cistern will be full, if both the fill pipes are opened together, is $\left(\frac{k}{k+1}\right) y$ hrs.

Illustration 11 One fill pipe A is 10 times faster than second fill pipe B. If B can fill a cistern in 55 minutes, then find the time when the cistern will be full if both fill pipes are opened together

Solution: Here $k = 10$ and $x = 55$.

$\therefore$ Cistern will be full in

$$= \left(\frac{x}{k+1}\right) \text{ minutes}$$

$$= \left(\frac{55}{10+1}\right) \text{ minutes or 5 minutes.}$$

Illustration 12 One fill pipe A is 4 times faster than second fill pipe B. If A can fill a cistern in 15 minutes, then find the time when the cistern will be full if both fill pipes are opened together

Solution: Here $k = 4$ and $y = 15$

$\therefore$ Cistern will be full in

$$= \left(\frac{k}{k+1}\right) y \text{ minutes} = \left(\frac{4}{4+1}\right) 15 \text{ minutes}$$

$$= 12 \text{ minutes.}$$

7. If one fill pipe A is k times faster and takes x minutes less time than the other fill pipe B, then

(a) the time taken to fill a cistern, if both the pipes are opened together is $\left(\frac{kx}{(k-1)^2}\right)$ minutes.

(b) A will fill the cistern in $\left(\frac{x}{k-1}\right)$ minutes.

(c) B will fill the cistern in $\left(\frac{kx}{k-1}\right)$ minutes.

Illustration 13 One fill pipe A is 5 times faster than second fill pipe B and takes 32 minutes less than the fill pipe B. When will the cistern be full if both fill pipes are opened together?

Solution: Here $k = 5$ and $x = 32$

$\therefore$ Cistern will be full in

$$= \frac{kx}{(k-1)^2} \text{ minutes} = \frac{5\times32}{(5-1)^2} \text{ minutes}$$

$$= 10 \text{ minutes.}$$

Practice Exercises

Difficulty Level-1 (Based on Memory)

1. Three-fourths of a tank is full of water. If 5 litres are added to it, then four-fifths of the tank becomes full. What is the capacity of the tank?

(*a*) 75 litres (*b*) 80 litres
(*c*) 100 litres (*d*) 120 litres

[Based on MAT, 2004]

2. A vessel is fully filled with a special liquid. Four litres of liquid is drawn out of this vessel and is replaced with water. If the ratio of the special liquid to the water becomes 1:2, then what is the capacity of the vessel?

(*a*) 8 litres (*b*) 10 litres
(*c*) 12 litres (*d*) 14 litres

[Based on MAT, 2002]

3. A pipe can fill a cistern in 6 hrs. Due to a leak in its bottom, it is filled in 7 hrs. When the cistern is full, in how much time will it be emptied by the leak?

(*a*) 42 hrs (*b*) 40 hrs
(*c*) 43 hrs (*d*) 45 hrs

[Based on MAT, 2002]

4. 12 buckets of water fill a tank when the capacity of each bucket is 13.5 litres. How many buckets will be needed to fill the same tank, if the capacity of each bucket is 9 litres?

(*a*) 8 (*b*) 16
(*c*) 15 (*d*) 18

5. A leak in the bottom of a tank can empty the full tank in 8 hrs. An inlet pipe fills water at the rate of 6 litres a minute. When the tank is full, the inlet is opened and due to the leak, the tank is empty in 12 hrs. How many litres does the cistern hold?

(*a*) 7580 (*b*) 7960
(*c*) 8290 (*d*) 8640

[Based on MAT, 2005]

6. Pipes *A* and *B* running together can fill a cistern in 6 minutes. If *B* takes 5 minutes more than *A* to fill the cistern, then the time in which *A* and *B* will fill the cistern separately will be respectively:

(*a*) 15 minutes, 20 minutes(*b*) 15 minutes, 10 minutes
(*c*) 10 minutes, 15 minutes(*d*) 25 minutes, 20 minutes

[Based on MAT, 2001]

7. A tap can fill a tank in 48 minutes, whereas another tap can empty it in 2 hrs. If both the taps are opened at 11:40 a.m., then the tank will be filled at:

(*a*) 12:40 p.m. (*b*) 1:30 p.m.
(*c*) 1:00 p.m. (*d*) 1:20 p.m.

[Based on IIT Joint Man. Ent. Test, 2004]

8. A tin of oil was four-fifths full. When six bottles of oil were taken out and four bottles of oil were poured into it, it was three-fourths full. How many bottles of oil can it contain?

(*a*) 20 (*b*) 10
(*c*) 30 (*d*) 40

[Based on MAT (Feb), 2008]

9. A certain tank can be filled by pipes *A* and *B* separately in 4 and 5 minutes respectively, whereas pipe *C* can empty in 3 minutes. How long will it take to fill or empty the four-fifths of the full tank, if all the three pipes start together?

(*a*) $2\frac{5}{7}$ minutes to fill (*c*) $6\frac{2}{7}$ minutes to fill
(*c*) $6\frac{6}{7}$ minutes to fill (*d*) $1\frac{5}{7}$ minutes to fill

[Based on MAT (Feb), 2011]

10. When the waste pipe is closed, two taps can separately fill a cistern in 10 and 12 minutes respectively. When the waste pipe is opened they together fill it in 15 minutes. How long does it take the waste pipe to empty the cistern, when the taps are closed?

(*a*) 7 minutes 10 seconds (*c*) 8 minutes 34 seconds
(*c*) 12 minutes (*d*) 10 minutes

[Based on MAT (Feb), 2011]

11. A tank is connected with four pipes *A*, *B*, *C* and *D* of which two are filling the tank and other two are emptying it. The time taken by *A*, *B*, *C* and *D* to finish their jobs are 10 hrs, 15 hrs, 20 hrs and 30 hrs, respectively. All four pipes are opened. When the tank was empty, it took 12 hrs to fill it completely. Which two are the outlet pipes?

(*a*) *A* and *B* (*b*) *C* and *D*
(*c*) *A* and *C* (*d*) *B* and *D*

12. Two pipes can fill a tank in 8 hrs and 12 hrs, respectively whereas an escape pipe can empty it in 6 hrs. If the three pipes are opened at 1 pm, 2 pm and 3 pm respectively, at what time will the tank be filled?

(*a*) 8 am (*c*) 7 am
(*c*) 5 am (*d*) 7.30 am

[Based on MAT (Feb), 2011]

13. Two pipes *P* and *Q* can fill a cistern in 3 and 6 minutes, respectively, while an empty pipe *R* can empty the cistern in 4 min. All the three pipes are opened together and after 2 minutes pipe *R* is closed. Find when the tank will be full:

(*a*) 3 minutes (*c*) 6 minutes
(*c*) 5 minutes (*d*) 8 minutes

[Based on MAT (Dec), 2010]

14. There is a leak in the bottom of a cistern. Before the leak, it could be filled in $4\frac{1}{2}$ hrs. It now takes $\frac{1}{2}$ hrs longer. If the cistern is full, in how much time would the leakage empty the full cistern?

(*a*) 23 hrs (*c*) 35 hrs

(*c*) 52 hrs (*d*) 45 hrs

[Based on MAT (Dec), 2010, 2009]

15. Two filling pipes *A* and *B* can fill a tank in 30 hrs and 20 hrs respectively. Pipe *B* alone is kept open for half the time and both pipes are kept open for the remaining time. In how many hrs, will the tank be completely full?

(*a*) 25 hrs (*c*) 40 hrs

(*c*) 15 hrs (*d*) 28 hrs

[Based on MAT (Dec), 2010]

16. Two pipes *A* and *B* can fill a tank in 20 and 30 hrs, respectively. Both the pipes are opened to fill the tank but when the tank is one-third full, a leak develops in the tank through which one-fourth water supplied by both pipes goes out. What is the total time taken to fill the tank?

(*a*) $14\frac{2}{3}$ hrs (*c*) 15 hrs

(*c*) $12\frac{1}{2}$ hrs (*d*) $9\frac{1}{2}$ hrs

[Based on MAT (Dec), 2010]

17. A tank is filled by three pipes with uniform flow. The first two pipes operating simultaneously fill the tank in the same time during which the tank is filled by the third pipe alone. The second pipe fills the tank 5 hrs faster than the first pipe and 4 hrs slower than the third pipe. The time required by the first pipe is:

(*a*) 6 hrs (*c*) 10 hrs

(*c*) 15 hrs (*d*) 30 hrs

[Based on MAT (Sept), 2010]

18. A booster pump can be used for filling as well as for emptying a tank. The capacity of the tank is 2400 m^3. The emptying capacity of the tank is 10 m^3 per minute higher than its filling capacity and the pump needs 8 minutes lesser to empty the tank than it needs to fill it. What is the filling capacity of the pump?

(*a*) 50 m^3/minute (*c*) 60 m^3/minute

(*c*) 72 m^3/minute (*d*) 36 m^3/minute

[Based on MAT (Sept, Dec), 2010]

19. Two pipes can fill a tank in 10 hrs and 15 hrs, respectively. However, leakage at the bottom of the tank delays the filling of the tank by 3 hrs when both the pipes are open simultaneously. How much time would the leak take to empty the full cistern?

(*a*) 22 hrs (*b*) 18 hrs

(*c*) 12 hrs (*d*) 21 hrs

[Based on MAT (May), 2010]

20. Two pipes can fill a cistern in 15 minutes and 18 minutes respectively. Both the pipes are operating together but 3 minutes before the cistern is full, one of the pipes is closed. The cistern will be filled now in:

(*a*) $9\frac{1}{7}$ minutes (*c*) $3\frac{3}{11}$ minutes

(*c*) $7\frac{3}{11}$ minutes (*d*) None of these

[Based on MAT (May), 2010]

21. Two taps *A* and *B* can fill a cistern in 12 minutes and 15 minutes respectively. They are opened together but after a few minutes, *A* is turned off and the rest of the cistern is filled by *B* in 5 minutes. After how many minutes was *A* turned off?

(*a*) 4 minutes (*c*) 7 minutes

(*c*) 6 minutes (*d*) None of these

[Based on MAT (May), 2010]

22. Three pipes *A*, *B* and *C* can fill a tank in 20 minutes, 10 minutes and 30 minutes, respectively. When the tank is empty, all the three pipes are opened. *A*, *B* and *C* discharge chemical solutions *x*, *y* and *z* respectively. The proportion of solution *y* in the liquid in the tank after 3 minutes is:

(*a*) 6/11 (*c*) 7/11

(*c*) 8/11 (*d*) 5/11

[Based on MAT (Feb), 2010]

23. Three taps *A*, *B* and *C* can fill a tank in 12, 15 and 20 hrs, respectively. If *A* is open all the time and *B* and *C* are open for one hour each alternatively, the tank will be filled in:

(*a*) 6 hrs (*c*) 7 hrs

(*c*) 5 hrs (*d*) None of these

[Based on MAT (Feb), 2010]

24. In what time would a cistern be filled by three pipes whose diameters are 2 cm, 3 cm and 4 cm running together, when the largest alone can fill it is 58 minutes? The amount of water flowing in each pipe is proportional to the square of its diameter:

(*a*) 36 minutes (*c*) 32 minutes

(*c*) 23 minutes (*d*) 28 minutes

[Based on MAT (Dec), 2009]

25. A cistern has 3 pipes *A*, *B* and *C*. *A* and *B* running alone can fill it up in 2 hrs and 3 hrs respectively, while *C* is a waste pipe. If all the 3 pipes be opened at once, 7.24 of the cistern will be filled up in 30 minutes. In what time can *C* empty the full cistern?

(*a*) 5 hrs (*c*) 4 hrs

(*c*) 3 hrs (*d*) 6 hrs

[Based on MAT (Dec), 2009]

26. One fill pipe *A* is 3 times faster than second fill pipe *B* and takes 32 minutes less than the fill pipe *B*. When will the cistern be full if both pipes are opened together?

(*a*) 12 minutes (*c*) 24 minutes

(*c*) 30 minutes (*d*) Data inadequate

[Based on MAT (Sept), 2009]

27. A cistern can be filled by two pipes filling separately in 12 and 16 minutes, respectively. Both pipes are opened together for a certain time but being clogged, only seven-eighths of full quantity water flows through the former and only five-sixths through the latter pipe. The obstructions, however, being suddenly removed, the cistern is filled in 3 minutes from that moment. How long was it before the full flow began?

(*a*) 4.5 minutes (*c*) 2.5 minutes
(*c*) 3.5 minutes (*d*) 5.5 minutes

[Based on MAT (May), 2009]

28. A cistern has a leak which would empty it in 8 hrs. A tap is turned on which admits 6 litres a minute into the cistern and it is now emptied in 12 hrs. The cistern can hold:

(*a*) 7860 litres (*c*) 6840 litres
(*c*) 8640 litres (*d*) None of these

[Based on MAT (Feb), 2009]

29. A bath tube can be filled by a cold water pipe in 20 minutes and by a hot water pipe in 30 minutes. A person leaves the bathroom after turning on both pipes simultaneously and returns at the moment when the bath tub should be full. Finding however, that the waste pipe has been open, he now closes it. In 3 minutes more the bath tub is full. In what time would the waste pipe empty it?

(*a*) 38 minutes (*c*) 45 minutes
(*c*) 43 minutes (*d*) 48 minutes

[Based on MAT (Dec, May), 2008]

30. Six pipes are fitted to a water tank. Some of these are inlet pipes and the others outlet pipes. Each inlet pipe can fill the tank in 9 hrs and each outlet pipe can empty the tank in 6 hrs. On opening all the pipes, an empty tank is filled in 9 hrs. The number of inlet pipes is:

(*a*) 2 (*b*) 4
(*c*) 3 (*d*) 5

[Based on MAT (Sept), 2008]

31. A leak in the bottom of a cistern can empty the tank in 12 hrs. An inlet pipe fills water at the rate of 5 litres a minute. When the tank is full, the inlet is opened and due to the leak, the tank is emptied in 15 hrs. How many litres does the cistern hold?

(*a*) 8260 (*b*) 12000
(*c*) 15000 (*d*) 18000

32. Two taps can fill a tank in 20 minutes and 30 minutes, respectively. There is an outlet tap at exactly half level of that rectangular tank which can pump out 100 litres of water per minute. If the outlet tap is open, then it takes 24 minutes to fill an empty tank. What is the volume of the tank?

(*a*) 1800 litres (*c*) 1500 litres
(*c*) 1200 litres (*d*) 2400 litres

[Based on MAT (May), 2007]

33. A cistern can be filled by two pipes filling separately in 12 and 16 minutes, respectively. Both pipes are opened together for a certain time but being clogged, only seven-eighths of the full quantity of water flows through the former and only 5/6 through the latter pipe. The obstructions, however, being suddenly removed, the cistern is filled in 3 minutes from that moment. How long was it before the full flow began?

(*a*) 2.5 minutes (*c*) 4.5 minutes
(*c*) 3.5 minutes (*d*) 5.5 minutes

[Based on MAT (May), 2006]

34. There are two indentical vessels X and Y. Y is filled with water to the brim and X is empty. There are two pails A and B, such that B can hold half as much water as A. One operation is said to be executed when water is transferred from Y to X using A once and water is transferred to Y from X using B once. If A can hold half a litre of water and it takes 40 operations to equate the water level in X and Y, what is the total volume of water in the system?

(*a*) 10 litres (*b*) 20 litres
(*c*) 40 litres (*d*) $20\frac{3}{4}$ litres

[Based on MAT (Sept), 2009]

35. Pipe A can fill a tank in 3 hrs and 45 minutes. 2 hrs after the pipe started filling the empty tank the motor stopped working. What per cent of the tank was left empty?

(*a*) 58% (*b*) $46\frac{2}{3}\%$
(*c*) $33\frac{1}{3}\%$ (*d*) $53\frac{1}{3}\%$

36. Pipes A and B can fill a tank in 5 and 6 hrs, respectively. Pipe C can empty it in 12 hrs. The tank is half full. All the three pipes are in operation simultaneously. After how much time the tank will be full?

(*a*) $3\frac{9}{17}$ hrs (*b*) 11 hrs
(*c*) $2\frac{8}{11}$ hrs (*d*) $1\frac{13}{17}$ hrs

[Based on MAT, 1999]

37. A cistern has two taps (which fill it in 12 minutes and 15 minutes, respectively) and an exhaust tap. When all the three taps are opened together, it takes 20 minutes. to fill an empty cistern. How long will the exhaust tap take to empty it?

(*a*) 20 minutes (*b*) 16 minutes
(*c*) 12 minutes (*d*) 10 minutes

[Base d on MAT, 1999]

38. A cistern is normally filled in 8 hrs, but takes two hrs longer to fill because of a leak in its bottom. If the cistern is full, the leak will empty it in:

(*a*) 16 hrs (*b*) 25 hrs
(*c*) 40 hrs (*d*) 20 hrs

[Based on MAT, 2000]

39. Two taps can fill a tank in 12 minutes and 18 minutes, respectively. Both the taps are kept open for 2 minutes and

then the tap that fills the tank in 12 minutes is turned off. In how many more minutes will the tank be filled?

(*a*) 9 (*b*) 10

(*c*) 12 (*d*) 13

40. Pipe *A* and Pipe *B* can completely fill a cistern in 8 and 12 hrs, respectively. The two pipes are simultaneously opened but due to a leak at the bottom of the cistem it takes 6 hrs extra to fill the cistern. Find the time in which the leak can empty the full cistern.

(*a*) 10 hrs (*b*) $\frac{120}{13}$ hrs

(*c*) $\frac{123}{15}$ hrs (*d*) none of these

41. A vessel has three pipes connected with it, two to supply liquid and one of draw liquid. The first alone can fill the vessel in $4\frac{1}{2}$ hrs, the second in 3 hrs and the third can empty it in $1\frac{1}{2}$ hrs. If all the pipes are opened simultaneously when the vessel is half full, how soon will it be emptied?

(*a*) $5\frac{1}{2}$hrs (*b*) $3\frac{1}{8}$hrs

(*c*) $4\frac{1}{3}$hrs (*d*) None of these

[Based on NMAT, 2006]

42. One filling pipe *A* is 6 times faster than second filling pipe *B*. If *B* can fill a cistern in 28 minutes, then find the time when the cistern will be full if both the pipes are opened together.

(*a*) 6 minutes (*b*) 8 minutes

(*c*) 4 minutes (*d*) 7 minutes

43. *A*, *B*, *C* are pipes attached to a cistern. *A* and *B* can fill it in 20 and 30 minutes respectively, while *C* can empty it in 15 minutes. If *A*, *B* and *C* are kept in operation successively for one minute each, how soon will the cistern be filled?

(*a*) 167 minutes (*b*) 160 minutes

(*c*) 166 minutes (*d*) 164 minutes

44. A pump can be operated both for filling a tank and for emptying it. The capacity of tank is 2400 m^3. The emptying capacity of the pump is 10 m^3 per minute higher than its filling capacity. Consequently, the pump needs 8 minutes less to empty the tank than to fill it. Find the filling capacity of the pump.

(*a*) 45 m^3/minute (*b*) 30 m^3/minute

(*c*) 50 m^3/minute (*d*) 55 m^3/minute

[Based on MAT, 2011]

45. Two pipes *A* and *B* can fill a cistern in 12 minutes and 15 minutes respectively, while a third pipe *C* can empty it in 6 minutes. Both *A* and *B* pipes are opened together for 5 minutes and then the third pipe *C* is opened. In what time will the cistern be empted?

(*a*) 39 minutes (*b*) 47 minutes

(*c*) 45 minutes (*d*) 25 minutes

[Based on MAT, 2011]

46. To fill a certain tank, pipes *A*, *B* and *C* take 20 minutes, 15 minutes and 12 minutes, respectively. If the three pipes are opened in every alternate minute, how long will it take to fill the tank?

(*a*) 5 minutes (*b*) 10 minutes

(*c*) 12 minutes (*d*) 15 minutes

[Based on MAT, 2011]

47. A bath can be filled by the cold water and hot water pipes in 10 minutes and 15 minutes, respectively. A person leaves the bathroom after turning on both pipes simultaneously and returns at the moment when the bath should be full. Finding, however, that the waste pipe has been open, he then closes it. In exactly four minutes more the bath is fill. In how much time would the waste pipe empty the full bath, if it alone opened?

(*a*) 9 minutes (*b*) 10 minutes

(*c*) 12 minutes (*d*) None of these

[Based on MAT, 2012]

48. *A*, *B* and *C* are three pipes attached to a cistern. *A* and *B* can fill it in 20 minutes and 30 minutes respectively, while *C* can empty in 15 minutes. If *A*, *B* and *C* be kept open successively for 1 minute each, how soon will the cistern be filled?

(*a*) 180 minutes (*b*) 60 minutes

(*c*) 157 minutes (*d*) 155 minutes

[Based on MAT, 2012]

49. Two taps can separately fill a cistern in 10 minutes and 15 minutes, respectively. If these two pipes and a waste pipe are kept open simultaneously, the cistern gets filled in 18 minutes. the waste pipe can empty the full cistern in:

(a) 7 minutes (b) 13 minutes

(c) 23 minutes (d) 9 minutes

[Based on MAT, 2012]

50. A tank is fitted with 8 pipes, some of them that fill the tank and other pipes are meant to empty the tank. Each pipe that fills the tank can fill it in 8 h, while each of those that empty the tank can empty it in 6 h. All the pipes are kept open. When tank is full, it will take exactly 6 hrs for the tank to empty. How many pipes are filing the tank?

(*a*) 5 (*b*) 7

(*c*) 8 (*d*) 4

[Based on MAT (Feb), 2012]

51. A leak in the bottom of a tank can empty the full tank in 6 h. An inlet pipe fills water at the rate of 4 L per minute. When the tank is full, the inlet is opened and due to the leak the tank is emptied in 8 h. The capacity of the tank is:

(*a*) 9600 L (*b*) 5760 L

(*c*) 2880 L (*d*) None of these

[Based on MAT (Feb), 2012]

52. Two pipes A and B can fill a cistern in 12 minutes and 15 minutes, respectively, while a third pipe C can empty it in 6 minutes. Both A and B pipes are opened together for 5 minutes in the beginning and then the third pipe C is also opened. In what time will the cistern be emptied?

(a) 30 minutes (b) 33 minutes

(c) 37.5 minutes (d) 45 minutes

[Based on MAT (Feb), 2012]

53. A tank is fitted with 8 pipes, some of them that fill the tank and other pipes are meant to empty the tank. Each pipe that fills the tank can fill it in 8 h, while each of those that empty the tank can empty it in 6 h. All the pipes are kept open. When tank is full, it will take exactly 6 hrs for the tank to empty. How many pipes are filing the tank?

(a) 5 (b) 7

(c) 8 (d) 4

[Based on MAT (Feb), 2012]

54. A leak in the bottom of a tank can empty the full tank in 6h. An inlet pipe fills water at the rate of 4 L per minute. When the tank is full, the inlet is opened and due to the leak the tank is emptied in 8 h. The capacity of the tank is:

(a) 9600 L (b) 5760 L

(c) 2880 L (d) None of these

[Based on MAT (Feb), 2012]

55. Two pipes A and B can fill a cistern in 12 minutes and 15 minutes, respectively, while a third pipe C can empty it in 6 minutes. Both A and B pipes are opened together for 5 minutes in the beginning and then the third pipe C is also opened. In what time will the cistern be emptied?

(a) 30 minutes (b) 33 minutes

(c) 37.5 minutes (d) 45 minutes

[Based on MAT (Feb), 2012]

56. Pipe A can fill an empty tank in 30 h, while pipe B can fill it in 45 h. Pipe A and B are opened and closed alternatively, i.e., first pipe A is opened, then B, again A and then B and so on for 1 hr each time without any time gaps. In how many hours will the tank be filled when it was empty, initially?

(a) 36 hrs (b) 54 hrs

(c) 48 hrs (d) 60 hrs

[Based on MAT, 2013]

57. Two pipes A and B can fill a tank in 30 minutes and 40 minutes respectively. If both the pipes are opened simultaneously, after how much time should B be closed so that the tank gets filled in 20 minutes?

(a) 12 minutes (b) $13\frac{1}{3}$ minutes

(c) $11\frac{1}{3}$ minutes (d) $15\frac{1}{2}$ minutes

[Based on MAT, 2013]

58. One inlet pipe A is 3 times faster than second inlet pipe B and take 20 minutes less than inlet pipe B. When will the cistern be full if both pipes are opened together?

(a) 16 minutes (b) 15/2 minutes

(c) 15 minutes (d) None of these

59. There are three pipes, A, B and C, opening into a tank. Each pipe can be used to fill or empty the tank at the same respective rate. The ratio of the rates of the three pipes at, which they either fill or empty the tank 2:3:4. Pipes A and B, working together, take 3 hrs to fill the tank when both are used as inlet pipes. In the first, second and third hours of operation, the pipes, A, B and C, respectively are used as emptying pipes, while the other two pipes are used as filling pipes. What is the fraction of the tank to be filled at the end of the three hours?

(a) $\frac{1}{5}$ (b) $\frac{3}{5}$

(c) $\frac{2}{5}$ (d) $\frac{4}{5}$

[Based on MAT, 2013]

60. A booster pump can be used for filling as-well-as for emptying a tank. The capacity of the tank is 2400 m^3. The emptying capacity of the tank is 10 m^3 per minute higher than its filling capacity and the pump needs 8 minutes lesser to empty the tank than it need to fill it. What is the filling capacity of the pump?

(a) 60 m^3/minu (b) 50 m^3/minu

(c) 72 m^3/minu (d) None of these

[Based on MAT, 2013]

61. A cistern, open at the top, is to be lined with sheet lead which weights 27 kg/m^3. The cistern is 4.5 m long and 3 m wide and holds 50 m^3. The weight of lead required is:

(a) 1764.60 kg (b) 1864.62 kg

(c) 1660.62 kg (d) 1860.62 kg

[Based on MAT, 2013]

62. Six pipes are fitted to a water tank. Some of these are inlet pipes and the others outlet pipes. Each inlet pipe can fill the tank in 9 hrs and each outlet pipe can empty the tank in 6 hrs. On opening all the pipes, an empty tank is filled in 9 hrs. The number of inlet pipes is:

(a) 4 (b) 3

(c) 2 (d) 5

[Based on MAT, 2013]

63. The fuel indicator in a car shows $\frac{1}{5}$th of the fuel tank as full. When 22 more liters of fuel are poured into the tank, the indicator rests at three-fourth of the full mark. What is the capacity of the fuel tank?

(a) 40 litres (b) 30 litres

(c) 25 litres (d) 35 litres

[Based on MAT, 2013]

64. A tank of capacity 25 L has an inlet and an outlet tap. If both are opened simultaneously, the tank is filed in 5 minutes. But if the outlet flow rate is doubled and taps opened the tank never gets filled up. Which of the following can be outlet flow rate?

(*a*) 3 L/min (*b*) 4 L/min

(*c*) 5 L/min (*d*) None of these

[Based on MAT, 2014]

65. A tank of 4800 m^3 capacity is full of water. The discharging capacity of the pump is 10 m^3/minute higher than its filling capacity. As a result the pump needs 16 minutes less to discharge the fuel then to fill up the tank. Find the filling capacity of the pump.

(*a*) 50 m^3/minu (*b*) 25 m^3/minu

(*c*) 55 m^3/minu (*d*) None of these

[Based on MAT, 2014]

66. A cistern contains 50 Litres of water 5 Litres of water is taken out of it and replaced with wine. The process is repeated again. Find the proportion' of wine and water in the resulting mixture.

(*a*) 1:4 (*b*) 41:50

(*c*) 19:81 (*d*) 81:19

[Based on MAT, 2014]

67. A pump can be operated both for filling a tank and for emptying it. The capacity of tank is 2400 m^3. The emptying capacity of the pump is 10 m^3 per minute higher than its filling capacity. Consequently, the pump needs 8 minutes less to empty the tank than to fill it. Find the filling capacity of the pump.

(*a*) 45 m^3/min (*b*) 30 m^3/min

(*c*) 50 m^3/min (*d*) 55 m^3/min

[Based on SNAP, 2013]

68. A ship, 40 Km from the shore, spring a leak which admits $3\frac{3}{4}$ tonnes of water in 12 minutes 60 tonnes would suffice to sink her, but the ship's pumps can throw out 12 tonnes of water in one hour. Find the average rate of sailing, so that it may reach the shore just as it begins to sink.

(*a*) $1\frac{1}{2}$ Km/h (*b*) $2\frac{1}{2}$ Km/h

(*c*) $3\frac{1}{2}$ Km/h (*d*) $4\frac{1}{2}$ Km/h

[Based on SNAP, 2013]

69. A leak was found in a ship when it was 77 Km from the shore. It was found that the leak admits 2.25 tonnes of water in 5.5 minutes. 92 tonnes will suffice to sink the ship. But the pumps can throw out the water @ 12 tonnes an hour. Find the average rate of sailing at which the ship may reach the shore as it begins to sink.

(*a*) 9.75 Km/h (*b*) 13 Km/h

(*c*) 14.5 Km/h (*d*) 10.5 Km/h

[Based on SNAP 2012]

Difficulty Level-2 (Based on Memory)

1. Two pipes *A* and *B* can fill a tank in 6 hrs and 9 hrs respectively when working alone. A third pipe *C* can empty the same tank in 8 hrs. The pipes are operated such that *A* and *C* are open for the first couple of hrs, then again *B* and *C* for the next 2 hrs, again *A* and *C* for the next 2 hrs, and so on. Operating in such a manner, if 68 litres of water is filled in 30 hrs, then find the volume of the tank.

(*a*) 144 litres (*b*) 108 litres

(*c*) 72 litres (*d*) 216 litres

2. A tank is filled with water through five pipes. The first pipe can fill it in 40 minutes. The second, the third and the fourth together can fill it in 10 minutes; the second, the third and the fifth fill it in 20 minutes; the fourth and the fifth together in 30 minutes. In what time will the tank be filled if all the five pipes work simultaneously?

(*a*) $8\frac{2}{5}$ minutes (*b*) $7\frac{3}{4}$ minutes

(*c*) $8\frac{4}{7}$ minutes (*d*) $8\frac{1}{7}$ minutes

3. Two taps can fill a tank in 20 minutes and 30 minutes respectively. There is an outlet tap at exactly half level of that rectangular tank which can pump out 50 litres of water per minute. If the outlet tap is open, then it takes 24 minutes to fill an empty tank. What is the volume of the tank?

(*a*) 1200 litres (*b*) 1500 litres

(*c*) 1800 litres (*d*) 2400 litres

[Based on IIT Joint Man. Ent. Test, 2004]

4. A cistern can be filled by pipes *A* and *B* in 4 hrs and 6 hrs respectively. When full, the tank can be emptied by pipe *C* in 8 hrs. If all the taps were turned on at the same time, then the cistern will be full in:

(*a*) 3 hrs 18 minutes (*b*) 3 hrs 26 minutes

(*c*) 3 hrs 42 minutes (*d*) 3 hrs 48 minutes

[Based on FMS (Delhi), 2003]

5. Two pipes *A* and *B* can fill a cistern in 12 minutes and 15 minutes respectively but a third pipe *C* can empty the full tank in 6 minutes. *A* and *B* are kept open for 5 minutes

in the beginning and then C is also opened. In what time will the cistern be emptied?

(a) 30 minutes. (b) 33 minutes.

(c) 37.5 minutes. (d) 45 minutes.

[Based on FMS (Delhi), 2002]

6. A steady stream flows into a cistern partly full which has a number of equal holes at the bottom. If 12 holes are opened, the cistern is emptied in 4 hrs and if 10 holes are opened the cistern is emptied in 8 hrs. How many holes should be opened so as to empty the cistern in 2 hrs?

(a) 14 (b) 16

(c) 15 (d) 12

7. Two pipes A and B fill a swimming pool at constant rates of 10 gallons per minute and 15 gallons per minute, respectively. The pool can be filled in 60 hrs, 40 hrs or 24 hrs depending on, whether pipe A alone, pipe B alone, or both pipes are used. If the pool is filled by using pipe B alone for half the time and using both pipes for half the time, how many hrs does it take to fill the pool?

(a) 15 hrs (b) 30 hrs

(c) 38.7 hrs (d) 42 hrs

8. A tank can be filled by a tap in 20 minutes and by another tap in 60 minutes. Both the taps are kept open for 10 minutes and then the first tap is shut of. After this, the tank will be completely filled in:

(a) 10 minutes (b) 12 minutes

(c) 15 minutes (d) 20 minutes

[Based on FMS (MS), 2006]

9. Two pipes can fill a cistern in 14 hrs and 16 hrs respectively, the pipes are opened simultaneously and it is found that due to leakage in the bottom, 32 minutes extra are taken for the cistern to be filled up. If the cistern is full, in what time would the leak empty it?

(a) 96 hrs (b) 102 hrs

(c) 106 hrs (d) 112 hrs

[Based on IIFT, 2005]

10. Pavan builds an overhead tank in his house, which has three taps attached to it. While the first tap can fill the tank in 12 hrs, the second one takes one and a half times more than the first one to fill it completely. A third tap is attached to the tank which empties it in 36 hrs. Now, one day, in order to fill the tank. Pavan opens the first tap and after two hrs opens the second tap as well. However, at the end of the sixth hour, he realizes that the third tap has been kept open right from the beginning and promptly closes it. What will be the total time required to fill the tank?

(a) 8 hrs 48 minutes (b) 9 hrs 12 minutes

(c) 9 hrs 36 minutes (d) 8 hrs 30 minutes

[Based on IIFT, 2006]

11. A cylindrical overhead tank is filled by two pumps–P_1 and P_2. P_1 can fill the tank in 8 hrs while P_2 can fill the tank in 12 h. There is a pipe P_3 which can empty the tank in 8 hrs. Both the pumps are opened simultaneously. The supervisor of the tank, before going out on a work, sets a timer to open P_3 when the tank is half filled so that tank is exactly filled up by the time he is back. Due to technical fault P_3 opens when the tank is one third filled. If the supervisor comes back as per the plan what per cent of the tank is still empty?

(a) 25% tank (b) 12% tank

(c) 10% tank (d) None of these

[Based on ITFT, 2009]

12. Three pipes A, B and C are connected to a tank. These pipes can fill the tank separately in 5 hrs, 10 hrs and 15 hrs, respectively. When all the three pipes were opened simultaneously, it was observed that pipes A and B were supplying water at three-fourths of their normal rates for the 1st hrs after which they supplied water at the normal rate. Pipe C supplied water at two-thirds of its normal rate for first 2 hrs, after which it supplied at its normal rate. In how much time, tank would be filled?

(a) 1.05 hrs (b) 2.05 hrs

(c) 3.05 hrs (d) None of these

[Based on IIFT, 2010]

13. A bath can be filled by the cold water pipe in 10 minutes and by hot water pipe in 15 minutes (independently each). A person leaves the bathroom after turning on both pipes simultaneously and returns at the moment when the bath should be full. Finding, however, that the waste pipe has been opened he now closes it. In 4 minutes more, bath is full. In what time would be the waste pipe empty it?

(a) 6 minutes (b) 9 minutes

(c) 3 minutes (d) 15 minutes

[Based on ATMA, 2008]

14. Pipe A can fill an empty tank in 30 hrs while B can fill it in 45 hrs. Pipes A and B are opened and closed alternatively i.e., first pipe A is opened, then B, again A and then B and so on for 1 hr each time without any time lapse. In how many hrs the tank will be filled when it was empty, initially?

(a) 36 (b) 54

(c) 48 (d) 60

15. An inlet pipe can fill a tank in 5 hrs and an outlet pipe can empty the same tank in 36 hrs, working individually. How many additional number of outlet pipes of the same capacity are required to be opened, so that the tank never over flows?

(a) 3 (b) 6

(c) 8 (d) 7

16. Three pipes A, B and C are attached to a cistern. A can fill it in 10 minutes B in 15 minutes, C is a waste pipe for emptying it. After opening both the pipes A and

B, a man leaves the cistern and returns when the cistern should have been just full. Finding, however, that the waste pipe had been left open, he closes it and the cistern now gets filled in 2 minutes. In how much time the pipe *C*, if opened alone, empty the full cistern.

(*a*) 12 minutes

(*b*) 16 minutes

(*c*) 18 minutes

(*d*) 15 minutes

17. A pump can be used to either fill or drain a tank. The capacity of the tank is 3600 m^3. The draining capacity of the pump is 10 m^3/minute higher than its filling capacity. What is the draining capacity of the pump if it takes 12 minutes more to fill the tank than to drain it?

(*a*) 50 m^3/minute (*b*) 60 m^3/minute

(*c*) 45 m^3/minute (*d*) 90 m^3/minute

[Based on CAT, 2013]

18. A tank connected with 15 pipes. Some of them are inlet pipes, and the rest work as outlets pipes. Each of the inlet pipe can fill the tank in 8 h individually, while each of those that drain the tank, i.e., output pipe, can drain it in 6 h individually. If all the pipes are kept open when the tank is full, it will take exactly 6 h for the tank to empty. How many of these are inlet pipes?

(*a*) 2 (*b*) 8

(*c*) 5 (*d*) 6

[Based on CAT, 2013]

Answer Keys

Difficulty Level-1

1. (*c*)	**2.** (*c*)	**3.** (*a*)	**4.** (*d*)	**5.** (*d*)	**6.** (*c*)	**7.** (*c*)	**8.** (*d*)	**9.** (*c*)	**10.** (*b*)	**11.** (*b*)	**12.** (*c*)	**13.** (*a*)
14. (*d*)	**15.** (*c*)	**16.** (*a*)	**17.** (*c*)	**18.** (*a*)	**19.** (*b*)	**20.** (*d*)	**21.** (*d*)	**22.** (*a*)	**23.** (*b*)	**24.** (*b*)	**25.** (*b*)	**26.** (*a*)
27. (*a*)	**28.** (*c*)	**29.** (*d*)	**30.** (*b*)	**31.** (*d*)	**32.** (*a*)	**33.** (*b*)	**34.** (*b*)	**35.** (*b*)	**36.** (*d*)	**37.** (*d*)	**38.** (*c*)	**39.** (*d*)
40. (*d*)	**41.** (*d*)	**42.** (*c*)	**43.** (*a*)	**44.** (*c*)	**45.** (*c*)	**46.** (*d*)	**47.** (*d*)	**48.** (*a*)	**49.** (*d*)	**50.** (*d*)	**51.** (*b*)	**52.** (*d*)
53. (*d*)	**54.** (*b*)	**55.** (*d*)	**56.** (*a*)	**57.** (*b*)	**58.** (*b*)	**59.** (*c*)	**60.** (*b*)	**61.** (*b*)	**62.** (*a*)	**63.** (*a*)	**64.** (*c*)	**65.** (*a*)
66. (*c*)	**67.** (*c*)	**68.** (*d*)	**69.** (*d*)									

Difficulty Level-2

1. (*a*)	**2.** (*c*)	**3.** (*a*)	**4.** (*b*)	**5.** (*d*)	**6.** (*b*)	**7.** (*b*)	**8.** (*d*)	**9.** (*d*)	**10.** (*b*)	**11.** (*c*)	**12.** (*c*)	**13.** (*d*)
14. (*a*)	**15.** (*d*)	**16.** (*c*)	**17.** (*b*)	**18.** (*b*)								

Explanatory Answers

Difficulty Level-1

1. (*c*) Let, the capacity of the tank be x litres.

$$\therefore \quad \frac{3}{4}x + 5 = \frac{4}{5}$$

$$\Rightarrow \quad x = 100.$$

2. (*c*) Suppose the volume of the vessel be x litres.

Therefore, the quantity of special liquid in the vessel $= x$ litres.

After 1st operation

Quantity of special liquid $= x - 4$

Water $= 4$

After 2nd operation

Quantity of special liquid

$$= (x-4) - \frac{6}{x}(x-4) \text{ i.e., } x + \frac{24}{x} - 10$$

$$\text{Water} = 4 - \frac{6}{x} \times 4 + 6 = 10 - \frac{24}{x}$$

$$\therefore \quad \frac{x + \frac{24}{x} - 10}{10 - \frac{24}{x}} = \frac{1}{2}$$

$$\Rightarrow \quad 2x + \frac{48}{x} - 20 = 10 - \frac{24}{x}$$

$$\Rightarrow \quad 2x + \frac{72}{x} - 30 = 0$$

$$\Rightarrow \quad 2x^2 - 30x + 72 = 0$$

$$\Rightarrow \quad x^2 - 15x + 36 = 0$$

$$\Rightarrow \quad x = 12.$$

3. (*a*) In one hour, $\frac{1}{6}$ of the cistern can be filled.

In one hour, only $\frac{1}{7}$ of the cistern can be filled due to leak in its bottom.

$\therefore$ In one hour, $\frac{1}{6} - \frac{1}{7} = \frac{1}{42}$ of the cistern is empty.

$\therefore$ The whose cistern will be emptied in 42 hrs.

4. (*d*) Capacity of the tank = $12 \times 13.5 = 162$ litres

Number of buckets required, if the capacity of the bucket is 9 litres = $\frac{162}{9} = 18$.

5. (*d*) Work done by inlet in 1 hr = $\frac{1}{8} - \frac{1}{12} = \frac{1}{24}$

Work done by inlet in 1 minute = $\frac{1}{24} \times \frac{1}{60} = \frac{1}{1440}$

$\because$ Volume of $\frac{1}{1440}$ part = 6 litres

$\therefore$ Volume of whole = $1440 \times 6 = 8640$ litres.

6. (*c*) Suppose pipe A fills the cistern in x minutes.

Therefore pipe B will fill the cistern in $(x + 5)$ minutes.

$\therefore$ In one minute, pipes A and B together can fill $\left[\frac{1}{x} + \frac{1}{x+5}\right]$ of the cistern.

$$\Rightarrow \quad \frac{1}{x} + \frac{1}{x+5} = \frac{1}{6}$$

$$\Rightarrow \quad x = 10$$

$\therefore$ Pipe A and B can fill the cistern in 10 minutes and 15 minutes respectively.

7. (*c*) In one minute, $\frac{1}{48} - \frac{1}{120} = \frac{1}{80}$ of tank can be filled.

$\therefore$ The whole tank can be filled in 80 minutes.

8. (*d*) Let, the tin oil contain x number of bottles.

$$\frac{4}{5}x - 6 + 4 = \frac{3}{4}x$$

$$\Rightarrow \quad \frac{1}{20}x = 2$$

$$\therefore \quad x = 40 \text{ bottles.}$$

9. (*c*) Net part filled in 1 minutes= $\frac{1}{4} + \frac{1}{5} - \frac{1}{3}$

$$= \frac{15 + 12 - 20}{60} = \frac{7}{60}$$

$\because$ $\frac{7}{60}$ part is filled = 1 minutes

$$\Rightarrow \quad 1 \text{ part is filled} = \frac{60}{7} \text{ min}$$

$$\Rightarrow \quad \frac{4}{5} \text{ th part is filled} = \frac{60}{7} \times \frac{4}{5} = \frac{48}{7}$$

$$= 6\frac{6}{7} \text{ minutes to fill.}$$

10. (*b*) Work done by the waste pipe in 1 minutes

$$= \frac{1}{15} - \left(\frac{1}{10} + \frac{1}{12}\right)$$

$$= \frac{8 - (12 + 10)}{120} = -\frac{14}{120}$$

$\therefore$ Waste pipe will empty the full cistern

$$= \frac{120}{14} = \frac{60}{7}$$

= 8 minutes 34 seconds.

11. (*b*) Efficiency of $A = 10\%$

Efficiency of $B = 6.66\%$

Efficiency of $C = 5\%$

Efficiency of $D = 3.33\%$

Efficiency of $A + B + C + D = 8.33$

(time = 12 hous)

Now, go through options and consider A and B as inlet pipes and C and D as outlet pipes, then

$$(10 + 6.66) - (5 + 3.33) = 8.33$$

Which is required, hence, it is certain that C and D are outlet pipes.

12. (*c*) Upto 3 pm both pipe fill the tank

$$= \frac{2}{8} + \frac{1}{12} = \frac{1}{4} + \frac{1}{12} = \frac{4}{12} = \frac{1}{3} \text{ part}$$

$\therefore$ Remaining part = $1 - \frac{1}{3} = \frac{2}{3}$

$$\therefore \quad \left(\frac{1}{8} + \frac{1}{12} - \frac{1}{6}\right)x = \frac{2}{3}$$

$$\Rightarrow \quad \frac{(6 + 4 - 8)x}{48} = \frac{2}{3}$$

$$\Rightarrow \quad \frac{2x}{48} = \frac{3}{2}$$

$$\Rightarrow \quad x = 16 \text{ hrs}$$

Hence, the cistern can be filled at 1 p.m + 16 hrs = 5 a.m.

13. (*a*) Part of the tank filled in 2 minutes $= \left(\frac{2}{3}+\frac{2}{6}-\frac{2}{4}\right) = \frac{1}{2}$

P and Q can fill $\frac{1}{2}$ part of tank in

$$\frac{1}{2}\times\left(\frac{3\times 6}{3+6}\right) = 1 \text{ minutes}$$

So, tank will be full in 3 minutes.

14. (*d*) Let, leakage can empty the full cistern in x hrs.

Then, $\dfrac{\frac{9}{2}\times x}{x-\frac{9}{2}} = 5$

$$\Rightarrow \quad \frac{9}{2}x = 5x - \frac{45}{2}$$

$$\Rightarrow \quad \frac{1}{2}x = \frac{45}{2}$$

$$\Rightarrow \quad x = 45 \text{ hrs.}$$

15. (*c*) Let, the tank be completely full in x hrs.

Pipe A is open for $\frac{x}{2}$ hrs and pipe B is open for x hrs.

$$\therefore \quad \frac{x}{2}\times\frac{1}{30}+x\times\frac{1}{20} = 1$$

$$\Rightarrow \quad \frac{x+3x}{60} = 1$$

$$\Rightarrow \quad x = 15 \text{ hrs}$$

16. (*a*) Together both pipes can fill the tank in $\left(\frac{20\times 30}{20+30}\right)$ hrs $= 12$ hrs

One-third tank can be filled in 4 hrs.

Now, there is a leak which can empty the tank in (12×4) hrs $= 48$ hrs

So, two-thirds tank can be filled in

$$\frac{2}{3}\times\left(\frac{12\times 48}{48-12}\right) \text{ hrs} = 10\frac{2}{3} \text{ hrs}$$

So, total time to fill the tank

$$= 4+10\frac{2}{3}$$

$$= 14\frac{2}{3} \text{ hrs.}$$

17. (*c*) Let, first pipe can fill the tank in x h.

Second pipe can fill the tank in $(x-5)$ hrs.

Third pipe can fill the tank in $(x-9)$ hrs.

According to the question,

$$\frac{x\times(x-5)}{x+x-5} = x-9$$

$$\Rightarrow \quad x^2-5x = 2x^2-23x+45$$

$$\Rightarrow \quad x^2-18x+45 = 0$$

$$\Rightarrow \quad (x-15)(x-3) = 0$$

$$\Rightarrow \quad x = 15 \text{ hrs as } x = 3 \text{ hrs is not possible.}$$

18. (*a*) Let, the filled capacity of the tank be x m^3/minute.

Then, emptied capacity of the tank

$$= (x+10) \text{ m}^3\text{/minute}$$

$$\therefore \quad \frac{2400}{x}-\frac{2400}{x+10} = 8$$

$$\Rightarrow \quad 2400\left[\frac{10}{x(x+10)}\right] = 8$$

$$\Rightarrow \quad x(x+10) = 3000$$

$$\therefore \quad x = 50 \text{ m}^3\text{/minute.}$$

19. (*b*) Two pipes can fill the tank in $\left(\frac{10\times 15}{10+15}\right)$ hrs $= 6$ hrs

Due to leakage, the tank is filled in 9 hrs.

Let full tank can be empty in x hrs.

So, $\quad 9 = \dfrac{6\times x}{x-6}$

$$\Rightarrow \quad 9x-54 = 6x$$

$$\Rightarrow \quad x = 18 \text{ hrs.}$$

20. (*d*) Let, the cistern will be filled in x minutes.

Case I First pipe was closed

$$\frac{x-3}{15}+\frac{x}{18} = 1$$

$$\Rightarrow \quad \frac{6x-18+5x}{90} = 1$$

$$\Rightarrow \quad 11x-18 = 90$$

$$\Rightarrow \quad x = 9\frac{9}{11} \text{ mins}$$

Case II Second pipe was closed.

$$\frac{x}{15}+\frac{x-3}{18} = 1$$

$$\frac{6x+5x-15}{90} = 1$$

$$11x-150 = 90$$

$$x = 9\frac{6}{11} \text{ minutes}$$

Note: It is not given that which pipe was closed.

So, you have to calculate both the cases.

21. (*d*) Let, A was turned off after x minutes.

Then, $\frac{x}{12}+\frac{x+5}{15}=1$

$\Rightarrow \frac{5x+4x+120}{60}=1$

$\Rightarrow \quad 9x+20=60$

$\Rightarrow \quad x=4\frac{4}{9}$ minutes

22. (*a*) Filling done by all 3 pipes in 3 minutes

$$=\frac{3}{20}+\frac{3}{10}+\frac{3}{30}=\frac{11}{20}$$

Filling done by 2nd pipe in 3 minutes $=\frac{3}{10}$

So, required ratio $=\frac{3/10}{11/20}=\frac{6}{11}$

23. (*b*) Filling done by pipe A and B in 1 hr

$$=\frac{1}{12}+\frac{1}{15}=\frac{3}{20}$$

Filling done by pipe A and C in 1 hr

$$=\frac{1}{12}+\frac{1}{20}=\frac{2}{15}$$

Filling done in first 2 hrs $=\frac{3}{20}+\frac{2}{15}=\frac{17}{60}$

Filling done in 6 hrs $=\frac{17}{60}\times 3=\frac{51}{60}$

Remaining filling $=1-\frac{51}{60}=\frac{3}{20}$

Now in 7th hour, filling done by pipes A and B, so time

$$=\frac{\frac{3}{20}}{\frac{3}{20}}=1 \text{ hr}$$

So, total time = 7 hrs.

24. (*b*) Pipe whose diameter is 4 cm fills the cistern in 58 minutes. Let, the capacity of cistern be x l.

Then, flow rate of 4 cm diameter pipe $=\frac{x}{58}$ l/minute

$\therefore \quad \frac{x}{58} \propto (4)^2$

$\Rightarrow \quad \frac{x}{58}=K\times 16 \Rightarrow K=\frac{x}{928}$

Flow rate of 3 cm diameter pipe $=\frac{x}{928}\times(3)^2$ l/minute

$\therefore$ Time required by 3 cm diameter pipe to fill the cistern $=\frac{x}{9x}\times 928=103\frac{1}{9}$ minutes

Flow rate of 2 cm diameter pipe $=\frac{x}{928}\times(2)^2$ l/minute

$\therefore$ Time required by 2 cm diameter pipe to fill the cistern $=\frac{x}{4x}\times 928=232$ minutes

$\therefore$ Time required by all the three pipes working together $=\frac{58\times 103\frac{1}{9}\times 232}{58\times 103\frac{1}{9}+58\times 232+103\frac{1}{9}\times 232}$

$$=\frac{58\times 928\times 232}{58\times 928+58\times 232\times 9+928\times 232}$$

= 32 minutes.

25. (*b*) A's work in 1 hr $=\frac{1}{2}$

B's work in 1 hr $=\frac{1}{3}$

C's work in 1 hr $=\frac{1}{x}$

Work done by all 3 pipes in 30 minutes $=\frac{7}{24}$ full

Work done by all 3 pipes in 1 hrs $=\frac{7}{24}\times\frac{60}{30}=\frac{7}{12}$ full

so, $\frac{1}{2}+\frac{1}{3}+\frac{1}{x}=\frac{7}{12}$

$\Rightarrow \quad \frac{5}{6}+\frac{1}{x}=\frac{7}{12}$

$\Rightarrow \quad \frac{1}{x}=-\frac{1}{4}$

$\Rightarrow \quad x=-4$ hrs

Hence, C can empty in 4 hrs.

26. (*a*) Let, pipe A takes x minutes to fill the cistern.

Then, pipe B takes $3x$ minutes to fill the cistern.

$\therefore \quad 3x-x=32$

$\Rightarrow x=16$ minutes and $3x=48$ minutes

So, both pipes can fill the cistern in $\left(\frac{48\times 16}{48+16}\right)$ minutes = 12 minutes.

27. (*a*) Part of the cistern filled in 3 minutes

$$=\frac{3}{12}+\frac{3}{16}=\frac{21}{48}=\frac{7}{16}$$

Let, remaining $\frac{9}{16}$ part was filled in x minutes.

Then, $\frac{x}{12}\times\frac{7}{8}+\frac{x}{16}\times\frac{5}{6}=\frac{9}{16}$

$\Rightarrow \quad x\left(\frac{7+5}{96}\right)=\frac{9}{16}$

$\Rightarrow \quad x=\frac{9}{16}\times\frac{96}{12}=4.5$ minutes.

28. (*c*) Let the tap can fill the cistern in x hrs.

$$\therefore \quad \frac{x \times 8}{x-8} = 12$$

$$\Rightarrow \quad 8x = 12x - 96$$

$$\Rightarrow \quad x = 24 \text{ hrs}$$

$\therefore$ Capacity of cistern

$$= 24 \times 60 \times 6 = 8640 \text{ litres}$$

29. (*d*) The usual time required to fill the tank when both the pipes are opened $= \left(\frac{1}{20} + \frac{1}{30}\right) = \frac{1}{12}$, i.e., 12 minutes.

It means work done by all the three pipes for 12 minutes + work done by both the pipes for 3 minutes = 1. Let, the waste pipe takes x minutes to empty the tank. Then,

$$12\left[\frac{1}{20} + \frac{1}{30} - \frac{1}{x}\right] + 3\left[\frac{1}{20} + \frac{1}{30}\right] = 1$$

$$\Rightarrow \quad 12\left[\frac{1}{12} - \frac{1}{x}\right] + 3\left[\frac{1}{12}\right] = 1$$

$$\Rightarrow \quad 12\left[\frac{x-12}{12x}\right] = \frac{3}{4}$$

$$\Rightarrow \quad 16x - 192 = 12x$$

$$\Rightarrow \quad 4(x-12) = 3x$$

$$\Rightarrow \quad x = 48 \text{ minutes.}$$

30. (*b*) Let, the number of inlet pipes be x, then number of outlet pipes will be $(6-x)$.

Then, $\frac{x}{9} - \frac{(6-x)}{6} = -$

$$\Rightarrow \quad \frac{2x - 18 + 3x}{18} = \frac{1}{9}$$

$$\Rightarrow \quad 5x = 20$$

$$\therefore \quad x = 4$$

Hence, number of inlet pipes is 4.

31. (*d*) Part of tank filled in one hour $\frac{1}{12} - \frac{1}{15} = \frac{1}{60}$

So, the inlet can fill the tank in 60 hrs.

$\therefore$ Capacity of the tank $= 60 \times 60 \times 5 = 18000$.

32. (*a*) The two filler taps can fill the tank in

$$\left[\frac{20 \times 30}{(30+20)}\right] = 12 \text{ minutes}$$

The above information implies that half of the tank will be filled in 6 minutes.

Hence, it took (24 – 6 = 18) minutes to fill the remaining half of the tank when the outlet pump was open. Thus, the total time required to empty half of the cistern

$$0 = \frac{18 \times 6}{18-6} = \frac{18 \times 6}{12} = 9 \text{ minutes}$$

Thus, the capacity of the tank

$$= 100 \times 9 \times 2$$

$$= 1800 \text{ litres}$$

33. (*b*) Both the pipes A and B can fill $\frac{1}{12} + \frac{1}{16} = \frac{7}{48}$ of the cistern in one minute, when there is no obstruction with obstruction, both the pipes can fill $\frac{1}{12} \times \frac{7}{8} + \frac{1}{16} \times \frac{5}{6} = \frac{7}{96} + \frac{5}{96} = \frac{1}{8}$ of the cistern in one minute

Let, the obstruction were remained after x minutes.

$\therefore$ With obstruction, $\frac{x}{8}$ of the cistern could be filled in x minutes and so the remaining $1 - \frac{x}{8} = \frac{8-x}{8}$ of the cistern was filled without obstruction is 3 minutes, i.e., in 1 minute $\frac{8-x}{24}$ of the cistern was filled with obstruction

$$\Rightarrow \quad \frac{8-x}{24} = \frac{7}{48}$$

$$\Rightarrow \quad 16 - 2x = 7$$

$$\Rightarrow \quad x = 4.5 \text{ minutes.}$$

34. (*b*) In one operation, $\frac{1}{4}$ litre water is transferred from Y to X.

In 40 operations, total quantity of water transferred

$$= \frac{1}{4} \times 40$$

$$= 10 \text{ litre}$$

$\therefore$ Total volume of water in the system

$$= 10 \times 2 = 20 \text{ litres.}$$

35. (*b*) The tank is filled in 3 hrs and 45 minutes = 225 minutes.

$\therefore$ In 120 minutes, the pipe fills $\frac{120}{225} = \frac{8}{15}$

Required percentage $= \frac{7}{15} \times 100 = 46\frac{2}{3}\%$

36. (*d*) In one hour,

$$\frac{1}{5} + \frac{1}{6} - \frac{1}{12} = \frac{12 + 10 - 5}{60}$$

$$= \frac{17}{60} \text{ of the tank is filled}$$

Therefore, $\frac{1}{2}$ of the tank is filled in

$$\frac{60}{17} \times \frac{1}{2} = \frac{30}{17} \text{ hrs} = 1\frac{13}{17} \text{ hrs.}$$

37. (*d*) Let, Tap A can fill the cistern in 12 minutes.

Let, Tap B can fill the cistern in 15 minutes.

Let, Tap C can empty the cistern in x minutes.

$$\therefore \quad \frac{1}{12} + \frac{1}{15} - \frac{1}{x} = \frac{1}{20}$$

$$\Rightarrow \quad x = 10.$$

38. (*c*) Cistern's 1 hr filling capacity $= \frac{1}{8}$

Cistern's 1 hr filling capacity due to leak $= \frac{1}{10}$

$\therefore$ Cistern's 1 hr emptying capacity due to leak

$$= \frac{1}{8} - \frac{1}{10} = \frac{1}{40}$$

Hence, when the cistern is full, it will get empty in 40 hrs.

39. (*d*) In 2 minutes, the taps fills $2\left(\frac{1}{12} + \frac{1}{18}\right)$ or $\frac{5}{18}$ of the tank.

Therefore, $\frac{13}{18}$ of the tank is to be filled by the second tap at the rate of $\frac{1}{18}$ of the tank per minute. This will take another 13 minutes.

40. (*d*) Time taken to fill the cistern when pipe and pipe *B* are opened simultaneously $= \frac{(8 \times 12)}{(8+12)} = 4.8$ hrs

Time taken due to the leek to fill the cistem

$$= 4.8 + 6 = 10.8 \text{hrs}$$

Time taken by the leak alone to empty the cistern

$$= \frac{(10.8 \times 4.8)}{(10.8 - 4.8)} = 8.64 \text{ hrs.}$$

41. (*d*) 1st pipe can fill in $\frac{9}{2}$ hrs

2nd pipe can fill in 3 hrs

And 3rd pipe can empty in $\frac{3}{2}$ hrs

The vessel in emptied is

$$\frac{2}{9} + \frac{1}{3} - \frac{2}{3} = -\frac{1}{9}$$

$\therefore$ Then, vessel full emptied in 9 hrs

$\therefore$ Then, vessel half emptied in $\frac{9}{2}$ hrs is $4\frac{1}{2}$ hrs.

42. (*c*) In one minute, *B* will fill $\frac{1}{28}$ cistern.

Hence, *A* will fill $\frac{6}{28}$ cistern. Work done by both the pipes in 1 minute $= \left(\frac{1}{28} + \frac{6}{28}\right) = \frac{1}{4}$ cistern. Hence, they will fill 1 cistern in 4 minutes.

43. (*a*) Work done in 3 minutes $= \left(\frac{1}{20} + \frac{1}{30} - \frac{1}{15}\right) = \frac{1}{60}$.

$\therefore$ Work done in $3 \times 55 = 165$ minutes $= \frac{55}{60}$

Remaining tank $= \left(1 - \frac{55}{60}\right) = \frac{5}{60} = \frac{1}{12}$

Now, its *A*'s turn. $\frac{1}{20}$ part of the tank is filled by *A* in 1 minutes, Since there is still $\left(\frac{1}{12} - \frac{1}{20}\right) = \frac{1}{30}$ tank to be filled, which will be filled by *B* in 1 minutes.

Therefore, required time $= (165 + 2) = 167$ minutesutes.

44. *(c)* Let, filling capacity $= x$ m^3/min

And emptying capacity $= (x + 10)$ m^3/min

Then, according to the question,

$$\frac{2400}{x} - \frac{2400}{x+10} = 8$$

$$\Rightarrow \quad 2400\left[\frac{1}{x} - \frac{1}{x+10}\right] = 8$$

$$\Rightarrow \quad 2400\left[\frac{1+10-x}{x(x+10)}\right] = 8$$

$$\Rightarrow \quad x(x+10) = \frac{2400 \times 10}{8}$$

$$\Rightarrow \quad x^2 + 10x - 3000 = 0$$

$$\Rightarrow \quad x^2 + 60x - 50x - 3000 = 0$$

$$\Rightarrow \quad (x - 50)(x + 60) = 0$$

$$\Rightarrow \quad x = 50 \text{m}^3/\text{min}.$$

45. *(c)* Part filled by $(A + B)$ in 1 minute $= \frac{1}{12} + \frac{1}{15}$

Part filled by $(A + B)$ in 5 minutes $= 5\left(\frac{1}{12} + \frac{1}{15}\right)$

$$= \frac{9 \times 5}{60} = \frac{3}{4}$$

Part emptied by $(A + B + C)$ in 1 minutes

$$= \frac{1}{6} - \frac{1}{12} - \frac{1}{15} = \frac{1}{60}$$

Thus, time taken to empty the full tank = 60 minutes

Hence, time taken to empty the $\frac{1}{3}$ tank

$$= 60 \times \frac{3}{4} = 45 \text{min}$$

46. *(d)* Part of tank filled in 3 minutes $= \frac{1}{20} + \frac{1}{15} + \frac{1}{12} + = \frac{1}{5}$

Thus, tank will be filled in $3 \times 5 = 15$ minutes.

47. *(d)* Time taken by cold water and hot water pipes to fill the both

$$= \frac{10 \times 15}{10 + 15} = \frac{10 \times 15}{25} = 6 \text{ minutes}$$

Thus, when the waste pipe is also open, then time taken to fill the bath = 6 + 4 = 10 minutes

Now, let waste pipe can empty the full bath in x minutes Then,

$$\frac{1}{10} + \frac{1}{15} - \frac{1}{x} = \frac{1}{10}$$

$$\Rightarrow \quad \frac{1}{x} = \frac{1}{15} \quad \Rightarrow \quad x = 15 \text{ minutes}$$

48. *(a)* Part of cistern filled in 3 minutes $= \frac{1}{20} + \frac{1}{30} - \frac{1}{15} = \frac{1}{60}$

Thus, time taken to fill the cistern = 3 × 60 = 180 minutes

49. *(d)* Let, waste pipe can empty the full cistern in x minutes. Then,

$$\frac{1}{10} + \frac{1}{15} - \frac{1}{x} = \frac{1}{18}$$

$$\Rightarrow \quad \frac{1}{x} = \frac{1}{10} + \frac{1}{15} - \frac{1}{18} = \frac{9+6-5}{90} = \frac{1}{9}$$

$$\Rightarrow \quad x = 9 \text{ minutes}$$

50. *(d)* Let, the number of pipes that fill and empty the tank be x and $8 - x$ respectively. Then,

$$\frac{8-x}{6} - \frac{x}{8} = \frac{1}{6}$$

$$\Rightarrow \quad \frac{4(8-x)-3x}{24} = \frac{1}{6}$$

$$\Rightarrow \quad 32 - 7x = 4$$

$$\Rightarrow \quad 7x = 28 \quad \Rightarrow \quad x = 4$$

51. *(b)* Let, the inlet pipe can fill the tank in x hrs. Then,

$$\frac{1}{6} - \frac{1}{x} = \frac{1}{8}$$

$$\Rightarrow \quad \frac{1}{x} = \frac{1}{6} - \frac{1}{8} = \frac{1}{24}$$

Therefore, inlet pipe will take 24 hrs to fill the tank.

Now,

In 1 minute inlet pipe fill = 4 litres

∴ In 24 h, inlet pipe will fill = 4 × 60 × 24

= 5760 litres

Which is the capacity to tank.

52. *(d)* Part of cistern that is filled by A and B in 5 minutes

$$= 5\left(\frac{1}{12} + \frac{1}{15}\right) = \frac{3}{4}$$

Now, the time taken to empty the cistern, when all the pipes are opened

$$= \frac{1}{\frac{1}{6} - \frac{1}{12} + \frac{1}{15}} = \frac{1}{\frac{10-5-4}{60}} = 60 \text{ minutes}$$

∴ Time taken to empty $\frac{3}{4}$ part of the cistern

$= \frac{3}{4} \times 60 = 45$ minutes

53. *(d)* Let, the number of pipes that fill and empty the tank be x and $8 - x$ respectively. Then,

$$\frac{8-x}{6} - \frac{x}{8} = \frac{1}{6}$$

$$\Rightarrow \quad \frac{4(8-x)-3x}{24} = \frac{1}{6}$$

$$\Rightarrow \quad 32 - 7x = 4$$

$$\Rightarrow \quad 7x = 28 \quad \Rightarrow \quad x = 4$$

54. *(b)* Let, the inlet pipe can fill the tank in x hrs. Then,

$$\frac{1}{6} - \frac{1}{x} = \frac{1}{8}$$

$$\Rightarrow \quad \frac{1}{x} = \frac{1}{6} - \frac{1}{8} = \frac{1}{24}$$

Therefore, inlet pipe will take 24 hrs to fill the tank.

Now,

In 1 minute inlet pipe fill = 4 litres

∴ In 24 hrs, inlet pipe will fill = 4 × 60 × 24

= 5760 litres

Which is the capacity to tank.

55. *(d)* Part of cistern that is filled by A and B in 5 minutes

$$= 5\left(\frac{1}{12} + \frac{1}{15}\right) = \frac{3}{4}$$

Now, the time taken to empty the cistern, when all the pipes are opened

$$= \frac{1}{\frac{1}{6} - \frac{1}{12} + \frac{1}{15}} = \frac{1}{\frac{10-5-4}{60}} = 60 \text{ minutes}$$

∴ Time taken to empty $\frac{3}{4}$ part of the cistern

$= \frac{3}{4} \times 60 = 45$ min.

56. *(a)* Part of tank filled by pipe A in 1 hr = 1/30

Part of tank filled by pipe B in 1 hr = 1/45

Then, part of tank filled in 2 hrs when one pipe is opened at a time

$$= \frac{1}{30} + \frac{1}{45} = \frac{3+2}{90}$$

$$= \frac{5}{90} = \frac{1}{18}$$

Now, let the tank takes x hrs to be filled. Then,

$$\frac{1}{18} \times x = 1 \quad \Rightarrow x = 18 \text{ hrs}$$

Also, $\frac{1}{18}$ part is filled in 2 hrs

∴ Tank is filled in $2 \times \text{h} = 2 \times 18 = 36$ hrs

57. *(b)* Let, the pipe B be closed x minutes before it gets completely filled.

Now, pipe A is open for 20 minutes.

Similarly, pipe B is closed after $(20 - x)$ minutes

Then, we are given,

$$\frac{1}{30} \times 20 + \frac{1}{40}(20 - x) = 1$$

$$\Rightarrow \quad \frac{2}{3} + \frac{20-x}{40} = 1$$

$$\Rightarrow \quad \frac{80+60-3x}{120} = 1$$

$$\Rightarrow \quad 140 - 3x = 120$$

$\Rightarrow \quad 140 - 120 = 3x$

$\Rightarrow \quad 3x = 20 \quad \Rightarrow \quad x = \frac{20}{3}$

$\therefore$ Pipe B is closed after $(20 - x)$ minutes

$= 20 - \frac{20}{3} = \frac{60 - 20}{3} \quad \frac{40}{3} = 13\frac{1}{3}$ minutes

58. *(b)* Let, the time taken by pipe A = x minutes

$\therefore$ Time taken by pipe B = $3x$ minutes

Now, by given condition,

$3x - x = 20 \quad \Rightarrow \quad 2x = 20 \quad \Rightarrow \quad x = \frac{20}{2} = 10$ minutes

$\therefore$ Time taken by pipe A to fill the tank = 10 minutes

Time taken by pipe B to fill the tank

$= 3x = 3 \times 10$

$= 30$ minutes

Now, time taken, when both are opened at the same time, to fill the tank

$\frac{1}{10} + \frac{1}{30} = \frac{3+1}{30} = \frac{4}{30} = \frac{2}{15} = \frac{15}{2}$ minutes.

59. *(c)* Let, the common ratio be x.

Since, pipe A takes $2x$ hrs to fill or empty the tank.

Pipe B takes $3x$ hrs to fill or to empty the tank.

Pipe C takes $4x$ hrs to fill or to empty the tank.

Now, Pipe A and B can fill the tank in 3 hrs

$\therefore \quad \frac{1}{2x} + \frac{1}{3x} = \frac{1}{3}$

$\Rightarrow \frac{3+2}{6x} = \frac{1}{3} \quad \Rightarrow x = \frac{5 \times 3}{6} = \frac{5}{2}$

So, pipe A, B and C simultaneously take 5 hrs, 7.5 hrs and 10 hrs to fill or to empty the tank.

The fraction of the tank to be filled after three hours

$= \left(\frac{1}{5} + \frac{1}{7.5} - \frac{1}{10}\right) + \left(\frac{1}{7.5} + \frac{1}{10} - \frac{1}{5}\right) + \left(\frac{1}{10} + \frac{1}{5} - \frac{1}{7.5}\right)$

$= \left(\frac{6+4-3}{30}\right) + \left(\frac{4+3-6}{30}\right) + \left(\frac{3+6-4}{30}\right)$

$= \frac{7}{30} + \frac{1}{30} + \frac{5}{30} = \frac{13}{30} = \frac{2}{5}$

Hence, after 3 hrs tank is $\frac{2}{5}$ filled.

60. *(b)* Let, the filling capacity of pump be x m^3/min,

Let, the emptying capacity of pump will be $(x + 10)$ m^3/min.

We are given

$\frac{2400}{x} - \frac{2400}{x+10} = 8$

$\Rightarrow \quad 2400\left[\frac{10}{x(x+10)}\right] = 8$

$\Rightarrow \quad x^2 + 10x - 3000 = 0$

$\Rightarrow \quad (x + 60)(x - 50) = 0$

But $x = -60$ (not possible)

$\therefore \quad x = 50$

Hence, the filling capacity of pump is 50 m^3/minute

61. *(b)* We have, length of cistern = 4.5 m

Breadth of cistern = 3 m

Volume/capacity of cistern = 50 m^3

$\therefore$ Height of cistern

$= \frac{50}{4.5 \times 3} = \frac{100}{27}$ m

Area to be lined with sheet lead

$= 4.5 \times 3 + 2 \times \frac{100}{27}(4.5 + 3)$

$= 13.5 + 2 \times \frac{100}{27} \times 7.5$

$= 13.5 + \frac{1500}{27}$

$= \frac{1864.5}{27}$ m^3

$\therefore$ Weight of lead required

$= \frac{1864.5}{27} \times 27 = 1864.5$ kg

≈ 1864.62 kg

62. *(a)* Let, the number of inlet pipes be x.

$\therefore$ Number of outlet pipes = $6 - x$

It is given that, $\frac{x}{9} - \frac{(6-x)}{6} = \frac{1}{9}$

$\Rightarrow \quad \frac{2x - 3x \times 6 + 3x}{18} = \frac{1}{9}$

$\Rightarrow \quad 5x - 18 = 2$

$\therefore \quad x = 4$

63. (*a*) Let, the capacity of tank be x litres.

$\therefore \quad \frac{1}{5}x + 22 = \frac{3}{4}x$

$\Rightarrow \quad \frac{3}{4}x - \frac{1}{5}x = 22$

$\Rightarrow \quad \frac{11x}{20} = 22$

$\therefore \quad x = 40$ litres.

64. *(c)* Capacity of tank = 25 litres

and time taken to fill the tank by both pipes = 5 minutes

$\therefore$ Outlet flow rate $= \dfrac{\text{Capacity}}{\text{Times taken}}$

$= \dfrac{25}{5} = 5$ L/min

65. *(a)* Let, he filling capacity be x m^3/min.

So, the discharging capacity = $(x + 10)$ m^3/min

Time taken to fill the tank $= \dfrac{4800}{x}$ minutes and time taken to discharge the fuel from tank $= \dfrac{4800}{x+10}$ minutes

We are given

$$\frac{4800}{x} - \frac{4800}{x+10} = 16$$

$$\Rightarrow \frac{4800x + 48000 - 4800x}{x(x+0)} = 16$$

$$\Rightarrow 48000 = 16(x^2 + 10x)$$

$$\Rightarrow 3000 = x^2 + 10x$$

$$\Rightarrow x^2 + 10x - 3000 = 0$$

$$\Rightarrow x^2 + 60x - 50x - 3000 = 0$$

$$\Rightarrow x(x+60) - 50(x+60) = 0$$

$$\Rightarrow (x-50)(x+60) = 0$$

$$\Rightarrow x = 50, -60$$

$\therefore$ $x = 50$, because x cannot be negative.

$\therefore$ Filling capacity of pump = 50 m^3/min.

66. *(c)* After 5 litres water taken out, remaining water = 50 – 5 = 45 litres

Since the water is replaced with wine.

$\therefore$ Quantity of wine = 5 litres

Now, in the next step same process is done and 10% of water and 10% of wine is taken out from the mixture.

Therefore, in the mixture, remaining water = 45 – 4.5 = 40.5 litres and remaining wine = 5 – 0.5 = 4.5 litres

Now, 5 litres of wine is added.

So, total quantity of wine in final mixture

= 4.5 + 5 = 9.5 litres

And remaining water in final mixture = 40.5 litres

$\therefore$ Required ratio = 9.5:40.5 = 95:405 = 19:81.

67. *(c)* Capacity of tank = 2400 m^3

Let, the empting capacity of pump = x m^3/minutes

Then, filling capacity of pump = $(x-10)$ m^3/min

We are given:

$$\frac{2400}{x-10} - \frac{2400}{x} = 8$$

$$\Rightarrow 2400x - 2400(x-10) = 8(x)(x-10)$$

$$\Rightarrow 2400x - 2400x + 24000 = 8x^2 - 80x$$

$$\Rightarrow 8x^2 - 80x - 24000 = 0$$

$$\Rightarrow x^2 - 10x - 3000 = 0$$

$$\Rightarrow (x-60)(x+50) = 0$$

$\Rightarrow x = 60$ as $x \neq -50$

$\therefore$ Filling capacity of pump = 60 − 10 = 50 m^3/min.

68. *(d)* Ship will get $3.75 \times 5 - 12 = 6.75$ tonnes of water in 1 hr.

Time to admit 60 tonnes of water $= \dfrac{60}{6.75}$ hrs

$\therefore$ Required speed $= \dfrac{40 \times 6.75}{60} = 4\dfrac{1}{2}$ Km/h

69. *(d)* Capacity of water throwing pump

$= \dfrac{12}{60} \times 5.5 = 1.1$ tonnes per 5.5 minutes

Capacity of the leak to admit water = 2.25 tonnes per 5.5 minutes.

In 5.5 minutes, net water accumulated by the leak

= (2.25 − 1.1) = 1.15 tonnes

Thus, to admit 92 tonnes of water, it will take

$\dfrac{5.5}{1.15} \times 92 = 440$ min $= \dfrac{440}{60}$ hrs

Speed required for the ship to sail through safely

$= \dfrac{77 \times 60}{440} = 10.5$ Km/h

Difficulty Level-2

1. (*a*) In the first 2 hrs,

A and C can fill $2\times\left(\frac{1}{6}-\frac{1}{8}\right)V=\frac{V}{12}$

In 2 hrs, B and C can fill $2\times\left(\frac{1}{9}-\frac{1}{8}\right)V=\frac{-V}{36}$

In 30 hrs, A and C will operate for 16 hrs and B and C for 14 hrs.

$$\Rightarrow \quad \frac{16}{2}\times\frac{V}{12}+\frac{14}{2}\times\left(\frac{-V}{36}\right)=68$$

$\Rightarrow \quad V=144$ litres.

2. (*c*) Suppose that in one minute each pipe separately can fill x, y, z, u, v parts of the tank. Then,

$$40x=1$$
$$10y+10z+10u=1$$
and $$20y+20z+20v=1$$
$$30u+30v=1$$

$$\Rightarrow \quad y+z+u=\frac{1}{10}, y+z+v=\frac{1}{20}$$

and $$u+v=\frac{1}{30}$$

$$\Rightarrow \quad 2(u+v+z+y)=\frac{11}{60}$$

and $$2x=\frac{1}{20}$$

$$\therefore\ 2(x+y+z+u+v)=\frac{1}{20}+\frac{11}{60}=\frac{14}{60}=\frac{7}{30}$$

$$\therefore\ x+y+z+u+v=\frac{7}{60}$$

$\therefore$ All together they take $\frac{60}{7}$ or $8\frac{4}{7}$ minutes to fill the tank.

3. (*a*) In one minute, $\frac{1}{20}+\frac{1}{30}=\frac{1}{12}$ of the tank can be filled.

The whole tank can be filled in 12 minutes.
Total time to fill the tank = 24 minutes

$\therefore$ Outlet tap is taking 12 minutes to empty half tank at the speed of 50 litre/minute

$\therefore$ Volume of half tank $= 50\times 12 = 600$ litres

$\therefore$ Volume of full tank = 1200 litres.

4. (*b*) In one hour, $\frac{1}{4}+\frac{1}{6}-\frac{1}{8}=\frac{6+4-3}{24}=\frac{7}{24}$ of the cistern can be filled.

$\therefore$ Whole cistern could be filled in $\frac{24}{7}$ hrs, i.e., 3 hrs and 26 minutes appox.

5. (d) In one minute, pipes A, B and C can fill $\frac{1}{12}+\frac{1}{15}-\frac{1}{6}$ $=-\frac{1}{60}$ of the cistern, i.e., if all the three pipes are opened simultaneously, then the cistern can be emptied in 60 minutes.

In one minute, pipes A and B can fill $\frac{1}{12}+\frac{1}{15}=\frac{3}{20}$ of the cistern.

In five minutes, $\frac{15}{20}=\frac{3}{4}$ of the cistern will be filled.

$\therefore$ $\frac{3}{4}$ of the cistern can be emptied in

$\frac{3}{4}\times 60 = 45$ minutes.

6. (*b*) Let, the steady stream can fill the cistern in x hrs.

So, in one hour, stream can fill $\frac{1}{x}$ th of the cistern

Let, one (equal) hole can empty the cistern in y hrs.

So, in one hour, one hole can empty $\frac{1}{y}$ th of the cistern.

Therefore, in one hour 12 holes can empty $\frac{12}{y}$ th of the cistern

Hence, portion emptied in one hour $=\frac{1}{x}-\frac{12}{y}$

Portion emptied in 4 hrs $=4\left(\frac{1}{x}-\frac{12}{y}\right)$ (1)

Portion emptied by 10 holes in 8 hrs

$$=8\left(\frac{1}{x}-\frac{10}{y}\right) \quad (2)$$

Equating equations (1) and (2) we get, $\frac{x}{y}=\frac{1}{8}$

Portion emitted by n holes in 2 hrs $=2\left(\frac{1}{x}-\frac{n}{y}\right)$.

Now equating this equation with either equation (1) or (2), we get $n = 16$.

7. (*b*) Let, the time taken be $t \Rightarrow \frac{(1/2)t}{40}+\frac{(1/2)t}{24}=1$

$$\Rightarrow \quad \frac{t}{80}+\frac{t}{48}=1$$

$$\Rightarrow \quad t=\frac{80\times 48}{128}=30 \text{ hrs.}$$

8. (*d*) Part filled in 10 minutes.

$$\frac{10}{20}+\frac{10}{60}=\frac{2}{3}$$

Remain = 1/3 filled by second time $= 1/3\times 60 = 20$ minutes.

9. (*d*) The time taken by two pipes of fill the tank

$$= \frac{1}{\frac{1}{14}+\frac{1}{16}} = \frac{112}{8+7} = \frac{112}{15}$$

$= 7$ hrs 28 minutes

Now, total time taken = 7 hrs 28 minutes + 32 minutes = 8 hrs.

Let, leakage can empty the tank in x hour.

$$\therefore \quad \frac{1}{14}+\frac{1}{16}-\frac{1}{x}=\frac{1}{8}$$

$$\Rightarrow \qquad x = 112 \text{ hrs.}$$

10. (*b*) After 6 hrs remaining part was filled by 2 pipes.

$$\therefore \quad \frac{6}{12}+\frac{4}{18}-\frac{6}{36}=\frac{20}{36}=\frac{5}{9}$$

$$\therefore \text{ Remaining part} = \frac{4}{9}$$

$A + B$ can fill the tank in $\frac{36}{3+2} = \frac{36}{5}$ hrs

$$\therefore \quad \frac{4}{9} \text{ part filled in}$$

$$\frac{36}{5}\times\frac{4}{9} = \frac{16}{5} = 3\frac{1}{5}$$

$$\therefore \text{ Total time} = 6 + 3\frac{1}{5} \text{ hrs}$$

$= 9$ hrs 12 minutes.

11. (*c*) P_1 and P_2 can fill the tanks $\frac{24}{5}$ hrs

[$\because$ in 1 hrs these fill $\left(\frac{1}{8}+\frac{1}{12}\right)$ part of tank]

$$\therefore \text{ It takes } \frac{12}{5} \text{ hrs in filling half the tank}$$

Far remaining half of the tanks P_3 will open and this will take 6 hrs

$$\therefore \text{ Supervisor has gone out for } \left(\frac{12}{5}+6\right) \text{ hrs}$$

Now, l/3rd tank will fill in $\frac{8}{5}$ hrs

$$\therefore \text{ In remaining } \frac{42}{5} \text{ hrs only } \frac{33}{60} \text{th part of tank will fill}$$

$$\therefore \text{ empties part of tank} = 1-\left(\frac{1}{3}+\frac{33}{60}\right)=\frac{6}{60}$$

which is 10% of tank.

12. (*c*) The part of the tank filled by A and B in first two hrs

$$= \frac{3}{4}\left(\frac{1}{5}+\frac{1}{10}\right)+\left(\frac{1}{5}+\frac{1}{10}\right)$$

The part of tank filled by C in first two hrs

$$= 2\left(\frac{2}{3}\right)\left(\frac{1}{15}\right)$$

Remaining part of the tank to be filled $= \frac{139}{360}$

In 1 h, all the three pipes together will fill $= \frac{11}{30}$

Hence, the time taken to fill the remaining tank

$$= \left(\frac{139}{360}\right)\left(\frac{30}{11}\right) = 1.0530 \text{ hrs.}$$

Thus, the total time taken to fill the tank = 3.05 hrs.

13. (*d*) Waste pipe alone empties the bath in

$$\frac{xy}{x+y}\left[1+\frac{xy}{(x+y)t}\right] \text{ minutes} \qquad (1)$$

Here $x = 10$ minutes, $y = 15$ minutes and $t = 4$ minutes

Putting these values in Eq. (1), we get

$$\frac{10\times15}{10+15}\left[1+\frac{10\times15}{(10+15)\times4}\right]$$

$$\frac{10\times15}{25}\left[1+\frac{10\times15}{25\times4}\right] = 15 \text{ minutes.}$$

14. (*a*) In one hour pipe A can fill $= \frac{1}{30}$ part of the tank.

Therefore, in 36 hrs the tank will be completely filled.

Alternatively: Efficiency of pipe $A = 3.33\%$

Efficiency of pipe $B = 2.22\%$

and Combined efficiency = 5.55%

Therefore in 2 hrs pipe A and B fill 5.55%

Thus to fill 100% tank, these pipe will take 36 hrs.

15. (*d*) Since, an inlet pipe is 7.2 times more efficient than an outlet pipe, therefore, in order to ensure that the tank never overflows, we will need total 8 outlet pipes.

Thus, we need only **7** more (8 – 1 = 7) outlet pipes.

16. (*c*) Let, the pipe C alone empties the cistern in x minutes. A and B together can fill the cistern in $\frac{10\times15}{10+15}=6$ minutes. Since, waste pipe was left open for 6 minutes, then in 6 minutes, $\frac{6}{x}$ part of the cistern will be emptied by waste pipe C. Now $\frac{6}{x}$ part of the cistern would be filled by A and B together in 2 minutes. Therefore cistern will be filled in $\frac{x}{3}$ minutes.

$$\therefore \qquad \frac{x}{3} = 6 \Rightarrow x = 18 \text{ minutes.}$$

17. *(b)* Let, x m^3/minute be the filling capacity of the pump. Therefore, the draining capacity of the pump will be $(x+10)$ m^3/minute.

The time taken to fill the tank is $\frac{3600}{x}$

The time taken to drain the tank is $\frac{3600}{x+10}$.

We know that it takes extra 12 min to fill the tank than to drain it.

Therefore,

$3600x + 36000 - 3600x = 12(x^2 + 10x)$

$\Rightarrow \quad 36000 = 12(x^2 + 10x)$

$\Rightarrow \quad 3000 = x^2 + 10x$

$\Rightarrow \quad x^2 + 10x - 3000 = 0$

$\Rightarrow \quad (x+60)(x-50) = 0$

$\Rightarrow \quad x = -60$ or $x = 50$

So, we will accept the positive value of x (= 50).

Therefore, draining capacity of the pump is

$50 + 10 = 60$ m^3/minute.

18. *(b)* Suppose there are n inlet pipes and $(15 - n)$ outlet pipes.

Therefore, $(15-n)\frac{1}{6} - n \times \frac{1}{8} = \frac{1}{6}$

$\Rightarrow \quad \frac{15-n}{6} - \frac{n}{8} = \frac{1}{6}$

$\Rightarrow \quad \frac{60-4n-3n}{24} = \frac{1}{6}$

$\Rightarrow \quad -7n + 60 = \frac{24}{6}$

$\Rightarrow \quad -7n = -60 + 4$

$\Rightarrow \quad -7n = -56$

$\therefore \quad n = 8$

$\therefore$ Number of inlet pipes = 8.