16 Pipes and Cisterns

IMPORTANT FACTS AND FORMULAE

I. Inlet: *A pipe connected with a tank or a cistern or a reservoir, that fills it, is known as an* ***inlet****.*
Outlet: *A pipe connected with a tank or a cistern or a reservoir, emptying it, is known as an* ***outlet****.*

II. (*i*) If a pipe can fill a tank in x hours, then part filled in 1 hour $= \frac{1}{x}$.

(*ii*) If a pipe can empty a full tank in y hours, then part emptied in 1 hour $= \frac{1}{y}$.

(*iii*) If a pipe can fill a tank in x hours and another pipe can empty the full tank in y hours (where $y > x$), then on opening both the pipes, the net part filled in 1 hour $= \left(\frac{1}{x} - \frac{1}{y}\right)$.

(*iv*) If a pipe can fill a tank in x hours and another pipe can empty the full tank in y hours (where $x > y$), then on opening both the pipes, the net part emptied in 1 hour $= \left(\frac{1}{y} - \frac{1}{x}\right)$.

ILLUSTRATIVE EXAMPLES

Ex. 1. ***A tank 9 ft by 5 ft by 2ft is fitted with an inlet pipe and an exhaust pipe. The inlet pipe pours in 576 cu. inch of water per minute and the exhaust pipe can empty the full tank in 3 hours. If the tank is full and both pipes are open, how many hours will it take to empty it?***

Sol. Volume of the tank = (9 × 5 × 2) cu. *ft* = 90 cu. ft.
= (90 × 12 × 12 × 12) cu. inch.

Volume of water drained by the exhaust pipe in one minute

$$= \left(\frac{90 \times 12 \times 12 \times 12}{3 \times 60}\right) \text{ cu. inch} = 864 \text{ cu. inch.}$$

Net volume drained in one minute, when both the pipes are opened = (864 – 576) cu. inch = 288 cu. inch.

$\therefore$ Required time $= \left(\frac{90 \times 12 \times 12 \times 12}{288 \times 60}\right)$ hrs = 9 hrs.

Ex. 2. ***Pipe A can fill a tank in 30 hours and pipe B in 45 hours. If both the pipes are opened in an empty tank, how much time will they take to fill it?***

Sol. Part filled by A in 1 hour $= \frac{1}{30}$; Part filled by B in 1 hour $= \frac{1}{45}$.

Part filled by (A + B) in 1 hour $= \left(\frac{1}{30} + \frac{1}{45}\right) = \frac{10}{180} = \frac{1}{18}$.

Hence, pipes A and B together will fill the tank in 18 hours.

Ex. 3. ***A cistern can be filled by pipes A and B in 4 hours and 6 hours respectively. When full, the cistern can be emptied by pipe C in 8 hours. If all the pipes were turned on at the same time, in how much time will the cistern be filled?***

Sol. Net part filled in 1 hour $= \left(\frac{1}{4} + \frac{1}{6} - \frac{1}{8}\right) = \frac{7}{24}$.

$\therefore$ The cistern will be full in $\frac{24}{7}$ hrs, i.e. $3\frac{3}{7}$ hrs.

Ex. 4. ***A pipe can empty a tank in 40 minutes. A second pipe with diameter twice as much as that of the first is also attached with the tank to empty it. How much time will the two pipes together take to empty the tank?*** **(C.P.O., 2005)**

Sol. Let the diameters of the pipes be d and $2d$ and the times taken by them to empty the tank be t and T minutes respectively.

Since the time taken to fill or empty a tank is inversely proportional to the square of the diameter of the pipe, we have:

$$t \propto \frac{1}{d^2} \Rightarrow t = \frac{k}{d^2} \Rightarrow \frac{k}{d^2} = 40.$$

Again, $T \propto \frac{1}{(2d)^2} \Rightarrow T = \frac{k}{4d^2} \Rightarrow T = \frac{1}{4} \times \frac{k}{d^2} = \frac{1}{4} \times 40 = 10.$

Thus, net part emptied in 1 min $= \left(\frac{1}{40} + \frac{1}{10}\right) = \frac{5}{40} = \frac{1}{8}.$

Hence, the two pipes together will empty the tank in 8 minutes.

Ex. 5. ***A tap can fill a tank in 10 minutes and another can empty it in 6 minutes. If the tank is already two-fifths full and both the taps are opened together, will the tank be filled or emptied? How long will it take before the tank is either filled completely or emptied completely, as the case may be?*** **(M.A.T., 2004, 05; S.S.C., 2004)**

Sol. Clearly, the outlet pipe is faster than the inlet pipe and so, the tank will be emptied.

Part to be emptied $= \frac{2}{5}.$

Net part emptied in 1 minute $= \left(\frac{1}{6} - \frac{1}{10}\right) = \frac{2}{30} = \frac{1}{15}.$

$\therefore \quad \frac{1}{15} : \frac{2}{5} :: 1 : x$ or $x = \left(\frac{2}{5} \times 1 \times 15\right) = 6$ min.

So, the tank will be emptied in 6 minutes.

Ex. 6. ***A cistern has two taps which fill it in 12 minutes and 15 minutes respectively. There is also a waste pipe in the cistern. When all the three are opened, the empty cistern is full in 20 minutes. How long will the waste pipe take to empty the full cistern?*** **(M.A.T., 2005)**

Sol. Work done by the waste pipe in 1 minute

$$= \frac{1}{20} - \left(\frac{1}{12} + \frac{1}{15}\right) = -\frac{1}{10}$$ [–ve sign means emptying]

$\therefore$ Waste pipe will empty the full cistern in 10 minutes.

Ex. 7. ***An electric pump can fill a tank in 3 hours. Because of a leak in the tank it took $3\frac{1}{2}$ hours to fill the tank. If the tank is full, how much time will the leak take to empty it?***

Sol. Work done by the leak in 1 hour $= \left[\frac{1}{3} - \frac{1}{\left(\frac{7}{2}\right)}\right] = \left(\frac{1}{3} - \frac{2}{7}\right) = \frac{1}{21}.$

$\therefore$ The leak will empty the tank in 21 hours.

Ex. 8. ***Two pipes can fill a cistern in 14 hours and 16 hours respectively. The pipes are opened simultaneously and it is found that due to leakage in the bottom it took 32 minutes more to fill the cistern. When the cistern is full, in what time will the leak empty it?*** **(I.I.F.T., 2005)**

Sol. Work done by the two pipes in 1 hour $= \left(\frac{1}{14} + \frac{1}{16}\right) = \frac{15}{112}.$

$\therefore$ Time taken by these pipes to fill the tank $= \frac{112}{15}$ hrs = 7 hrs 28 min.

Due to leakage, time taken = 7 hrs 28 min + 32 min = 8 hrs.

$\therefore$ Work done by (two pipes + leak) in 1 hour $= \frac{1}{8}.$

Work done by the leak in 1 hour = $\left(\frac{15}{112}-\frac{1}{8}\right)=\frac{1}{112}$.

Hence, the leak will empty the full cistern in 112 hours.

Ex. 9. ***If two pipes function simultaneously, the reservoir will be filled in 12 hours. The second pipe fills the reservoir 10 hours faster than the first. How many hours does it take the second pipe to fill the reservoir?***

Sol. Let the reservoir be filled by first pipe in x hours.

Then, second pipe will fill it in $(x + 10)$ hours.

$\therefore \quad \frac{1}{x}+\frac{1}{(x+10)}=\frac{1}{12} \Leftrightarrow \frac{x+10+x}{x(x+10)}=\frac{1}{12} \Leftrightarrow x^2-14x-120=0$

$\Leftrightarrow (x-20)(x+6)=0 \Leftrightarrow x=20$ [Neglecting –ve value of x]

So, the second pipe will take $(20 + 10)$ *i.e.* 30 hrs to fill the reservoir.

Ex. 10. ***A tank is fitted with two inlet pipes A and B, and an outlet pipe C. A is twice as efficient as B which in turn is twice as efficient as C. The empty tank gets filled in 16 hours when all the three pipes are opened. How many hours will be taken to fill the empty tank if B is plugged and the other two pipes are opened?***

Sol. Suppose A alone takes x hours to fill the tank. Then, B alone takes $2x$ hours to fill the tank and C alone takes $4x$ hours to empty the tank.

[$\because$ time taken to fill or empty a tank is inversely proportional to the efficiency of the pipe]

$\therefore \quad \frac{1}{x}+\frac{1}{2x}-\frac{1}{4x}=\frac{1}{16} \Leftrightarrow \frac{8+4-2}{8x}=\frac{1}{16} \Leftrightarrow x=\left(\frac{10\times 16}{8}\right)=20.$

Net part filled by A and C in 1 hour = $\left(\frac{1}{x}-\frac{1}{4x}\right)=\frac{3}{4x}=\frac{3}{80}$.

Hence, A and C will fill the tank in $\frac{80}{3}$ hrs. *i.e.* $26\frac{2}{3}$ hrs. or 26 hrs 40 mins.

Ex. 11. ***Two pipes A and B can fill a tank in 12 minutes and 15 minutes respectively while a third pipe C can empty the full tank in 20 minutes. All the three pipes are opened in the beginning. However, pipe C is closed 6 minutes before the tank is filled. In what time will the tank be full?***

Sol. Let the tank be full in x minutes.

Then, pipes A and B worked for x minutes, while pipe C worked for $(x – 6)$ minutes.

$\therefore \quad \frac{x}{12}+\frac{x}{15}-\frac{(x-6)}{20}=1 \Leftrightarrow \frac{5x+4x-3(x-6)}{60}=1 \Leftrightarrow 6x+18=60 \Leftrightarrow 6x=42 \Leftrightarrow x=7.$

Hence, the tank will be full in 7 minutes.

Ex. 12. ***Pipes A and B can completely fill a water tank in 4 hours and 5 hours respectively. A pipe C can empty a tank filled completely with water in 3 hours. Initially, the tank is empty and all pipes are closed. Pipe A is opened first at time t = 0 and pipe C is opened at the instant when the tank is exactly half filled with water. Pipe B is opened after pipe C and at the instant when the tank is exactly one-fourth filled with water. Find the total time taken to fill the tank completely counting from t = 0.***

Sol. The whole process involves 3 steps:

Step 1: *Pipe A alone fills half the tank.*

Let time taken be t_1. Then, t_1 = 2 hrs.

Step 2: *Pipe A and C together empty* $\left(\frac{1}{2}-\frac{1}{4}\right)=\frac{1}{4}$ *of the tank.*

Let time taken be t_2.

Work alone by A and C in 1 hour = $\left(\frac{1}{4}-\frac{1}{3}\right)=-\frac{1}{12}$. [– ve sign means emptying]

$\therefore \quad \frac{1}{12}:\frac{1}{4}::1: t_2$ or $t_2=\frac{1}{4}\times 12=3$ hrs.

Step 3: *Pipes A, B and C together fill* $\left(1-\frac{1}{4}\right)=\frac{3}{4}$ *of the tank.*

Let time taken be t_3.

Work done by A, B and C in 1 hour = $\left(\frac{1}{4}+\frac{1}{5}-\frac{1}{3}\right)=\frac{7}{60}$.

$\therefore \quad \frac{7}{60}:\frac{3}{4}::1: t_3$ or $t_3 = \frac{3}{4}\times\frac{60}{7} = \frac{45}{7} = 6\frac{3}{7}$ hrs.

Hence, total time taken = $(t_1 + t_2 + t_3) = \left(2+3+6\frac{3}{7}\right)$ hrs. = $11\frac{3}{7}$ hrs.

Ex. 13. ***A cistern has three pipes A, B and C. A and B can fill it in 3 hours and 4 hours respectively while C can empty the completely filled cistern in 1 hour. If the pipes are opened in order at 3, 4 and 5 p.m. respectively, at what time will the cistern be empty?*** (S.S.C., 2007)

Sol. Let the cistern be emptied t hours after 3 p.m.

Then, work done by pipe A in t hours + work done by pipe B in $(t - 1)$ hours + work done by pipe C in $(t - 2)$ hours = 0

$\Rightarrow \frac{t}{3}+\frac{(t-1)}{4}-\frac{(t-2)}{1} = 0 \Rightarrow 4t + 3(t - 1) - 12(t - 2) = 0$

$\Rightarrow -5t + 21 = 0 \Rightarrow 5t = 21 \Rightarrow t = 4\frac{1}{5}$ hrs = 4 hrs 12 min.

So, the cistern will be emptied 4 hrs 12 min after 3 p.m. i.e. 7 : 12 p.m.

Ex. 14. ***Three pipes A, B and C are attached to a tank. 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 open successively for 1 minute each, how soon will the tank be filled?*** (Campus Recruitment, 2006)

Sol. (A + B + C)'s 3 minutes' work when opened alternately = $\left(\frac{1}{20}+\frac{1}{30}-\frac{1}{15}\right) = \frac{1}{60}$.

Part filled in (3 × 55) i.e. 165 min = $\frac{55}{60} = \frac{11}{12}$. Remaining part = $\left(1-\frac{11}{12}\right) = \frac{1}{12}$.

Now it is A's turn.

Part filled by A in 1 min = $\frac{1}{20}$. Remaining part = $\left(\frac{1}{12}-\frac{1}{20}\right) = \frac{1}{30}$, which is filled by B in the next minute.

So, total time taken = (165 + 2) min = 167 min = 2 hrs 47 min.

Ex. 15. ***Two pipes A and B can fill a tank in 24 minutes and 32 minutes respectively. If both the pipes are opened simultaneously, after how much time B should be closed so that the tank is full in 18 minutes?*** (S.S.C., 2006)

Sol. Let B be closed after x minutes. Then,

Part filled by (A + B) in x min + part filled by A in $(18 - x)$ min = 1

$\therefore \quad x\left(\frac{1}{24}+\frac{1}{32}\right)+(18-x)\times\frac{1}{24} = 1 \Leftrightarrow \frac{7x}{96}+\frac{18-x}{24} = 1 \Leftrightarrow 7x + 4(18 - x) = 96 \Leftrightarrow x = 8.$

Hence, B must be closed after 8 minutes.

Ex. 16. ***A keg is fitted with 3 taps – A, B and C. All the three taps, if opened together, can drain the full keg in $1\frac{1}{2}$ minutes. Taps B and C together take 2 minutes to drain the keg while taps A and C together take $2\frac{4}{13}$ minutes to drain it. How long will taps A and B together take to drain the keg?***

Sol. Let taps A, B and C individually take, x, y and z minutes respectively to drain the keg.

Then, $\frac{1}{x}+\frac{1}{y}+\frac{1}{z} = \frac{2}{3}; \ \frac{1}{y}+\frac{1}{z} = \frac{1}{2}; \ \frac{1}{x}+\frac{1}{z} = \frac{13}{30}$.

(A + B)'s 1 minute's work = $\frac{1}{x}+\frac{1}{y} = 2\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)-\left(\frac{1}{y}+\frac{1}{z}\right)-\left(\frac{1}{x}+\frac{1}{z}\right)$

$= 2\times\frac{2}{3}-\frac{1}{2}-\frac{13}{30} = \frac{4}{3}-\frac{1}{2}-\frac{13}{30} = \frac{12}{30} = \frac{2}{5}$.

Hence, A and B together can drain the keg in $\frac{5}{2}$ i.e., $2\frac{1}{2}$ minutes.

EXERCISE
(OBJECTIVE TYPE QUESTIONS)

Directions: *Mark (√) against the correct answer:*

1. In 1 minute, $\frac{3}{7}$ of a bucket is filled. The rest of the bucket can be filled in **(R.R.B., 2006)**

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

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

2. The petrol tank of an automobile can hold g litres. If a litres was removed when the tank was full, what part of the full tank was removed? **(Campus Recruitment, 2008)**

(*a*) $g - a$ (*b*) $\frac{g}{a}$

(*c*) $\frac{a}{g}$ (*d*) $\frac{(g-a)}{a}$

(*e*) $\frac{(g-a)}{g}$

3. Water is continuously supplied from a reservoir to a locality at the steady rate of 10,000 litres per hour. When delivery exceeds demand the excess water is stored in a tank. If the demand for 8 consecutive three-hour periods is 10000, 10000, 45000, 25000, 40000, 15000, 60000 and 35000 litres respectively, what will be the minimum capacity required of the water tank (in thousand litres) to meet the demand and avoid any wastage? **(Campus Recruitment, 2004)**

(*a*) 10 (*b*) 30

(*c*) 40 (*d*) 50

4. Two pipes A and B can fill a tank in 20 and 30 minutes respectively. If both the pipes are used together, how long will it take to fill the tank? **(M.A.T., 2003; C.P.O., 2003)**

(*a*) 12 minutes (*b*) 15 minutes

(*c*) 25 minutes (*d*) 50 minutes

5. A pipe can fill a tank in x hours and another pipe can empty it in y ($y > x$) hours. If both the pipes are open, in how many hours will the tank be filled? **(S.S.C., 2007)**

(*a*) $(x - y)$ hours (*b*) $(y - x)$ hours

(*c*) $\frac{xy}{x-y}$ hours (*d*) $\frac{xy}{y-x}$ hours

6. A tap can completely fill a water tank in 8 hours. The water tank has a hole in it through which the water leaks out. The leakage will cause the full water tank to get empty in 12 hours. How much time will it take for the tap to fill the tank completely with the hole? **(R.B.I., 2004)**

(*a*) 16 hours (*b*) 18 hours

(*c*) 24 hours (*d*) None of these

7. A tap can fill a tank in 48 minutes whereas another tap can empty it in 2 hours. If both the taps are opened at 11 : 40 A.M, then the tank will be filled at **(JMET, 2004)**

(*a*) 12 : 40 P.M. (*b*) 1 : 00 P.M

(*d*) 1 : 20 P.M (*d*) 1 : 30 P.M.

8. A tank with capacity T litres is empty. If water flows into the tank from pipe X at the rate of x litres per minute and water is pumped out by Y at the rate of y litres per minute and $x > y$, then in how many minutes will the tank be filled? **(M.B.A., 2002)**

(*a*) $(x - y)$ 60 T (*b*) $(T - x)y$

(*c*) $\frac{T}{(x-y)}$ (*d*) $\frac{T}{(y-x)}$

9. Pipes A and B can fill a tank in 20 hours and 30 hours respectively and pipe C can empty the full tank in 40 hours. If all the pipes are opened together, how much time will be needed to make the tank full? **(D.E.T. Exam, 2004)**

(*a*) $10\frac{3}{7}$ hours (*b*) $12\frac{4}{5}$ hours

(*c*) $17\frac{1}{7}$ hours (*d*) $19\frac{1}{4}$ hours

10. A pipe can fill a tank in 3 hours. There are two outlet pipes from the tank which can empty it in 7 and 10 hours respectively. If all the three pipes are opened simultaneously, then the tank will be filled in **(M.B.A., 2002)**

(*a*) 8 hours (*b*) 9 hours

(*c*) 10 hours (*d*) 11 hours

11. In what time would a cistern be filled by three pipes whose diameters are 1 cm, $1\frac{1}{3}$ cm and 2 cm running together, when the largest alone will fill it in 61 minutes, the amount of water flowing in by each pipe, being proportional to the square of its diameter? **(Railways, 2006)**

(*a*) 25 minutes (*b*) 30 minutes

(*c*) 36 minutes (*d*) 40 minutes

12. A tap can fill a tank in 6 hours. After half the tank is filled, three more similar taps are opened. What is the total time taken to fill the tank completely?

(*a*) 3 hrs 15 min (*b*) 3 hrs 45 min

(*c*) 4 hrs (*d*) 4 hrs 15 min

13. A cistern has two pipes. One can fill it with water in 8 hours and other can empty it in 5 hours. In how many hours will the cistern be emptied if both the pipes are opened together when $\frac{3}{4}$ of the cistern is already full of water?

(*a*) $3\frac{1}{3}$ hours (*b*) 6 hours

(*c*) 10 hours (*d*) $13\frac{1}{3}$ hours

14. A vessel has three pipes connected to it, two to supply liquid and one to draw liquid. The first alone can fill the vessel in $4\frac{1}{2}$ hours, the second in 3 hours and the third can empty it in $1\frac{1}{2}$ hours. If all the pipes are opened simultaneously when the vessel is half full, how soon will it be emptied? **(M.B.A., 2007)**

(*a*) $4\frac{1}{2}$ hours (*b*) $5\frac{1}{2}$ hours

(*c*) $6\frac{1}{2}$ hours (*d*) None of these

15. Two pipes A and B can separately fill a cistern in 60 minutes and 75 minutes respectively. There is a third pipe in the bottom of the cistern to empty it. If all the three pipes are simultaneously opened then the cistern is full in 50 minutes. In how much time, the third pipe alone can empty the cistern?

(*a*) 90 min (*b*) 100 min

(*c*) 110 min (*d*) 120 min

16. Eight pipes are fitted to a water tank. Some of these are water pipes to fill the tank and the remaining are waste pipes used to empty the tank. Each water pipe can fill the tank in 12 hours and each waste pipe can empty it in 36 hours. On opening all the pipes an empty tank is filled in 3 hours. The number of waste pipes is

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 5

17. A pump can fill a tank with water in 2 hours. Because of a leak, it took $2\frac{1}{3}$ hours to fill the tank. The leak can drain all the water of the tank in **(C.P.O., 2006; S.S.C., 2002)**

(*a*) $4\frac{1}{3}$ hours (*b*) 7 hours

(*c*) 8 hours (*d*) 14 hours

18. Two taps A and B can fill a tank in 5 hours and 20 hours respectively. If both the taps are open then due to a leakage, it took 30 minutes more to fill the tank. If the tank is full, how long will it take for the leakage alone to empty the tank?

(*a*) $4\frac{1}{2}$ hrs (*b*) 9 hrs

(*c*) 18 hrs (*d*) 36 hrs

19. Three pipes A, B and C can fill a tank from empty to full in 30 minutes, 20 minutes and 10 minutes respectively. When the tank is empty, all the three pipes are opened. A, B and C discharge chemical solutions P, Q and R respectively. What is the proportion of solution R in the liquid in the tank after 3 minutes? **(D.M.R.C., 2003)**

(*a*) $\frac{5}{11}$ (*b*) $\frac{6}{11}$

(*c*) $\frac{7}{11}$ (*d*) $\frac{8}{11}$

20. Two pipes A and B together can fill a cistern in 4 hours. Had they been opened separately, then B would have taken 6 hours more than A to fill the cistern. How much time will be taken by A alone to fill the cistern?

(*a*) 1 hr (*b*) 2 hrs

(*c*) 6 hrs (*d*) 8 hrs

21. One pipe can fill a tank three times as fast as another pipe. If together the two pipes can fill the tank in 36 minutes, then the slower pipe alone will be able to fill the tank in **(C.B.I., 2003)**

(*a*) 81 min (*b*) 108 min

(*c*) 144 min (*d*) 192 min

22. A tank is filled in 5 hours by three pipes A, B and C. The pipe C is twice as fast as B and B is twice as fast as A. How much time will pipe A alone take to fill the tank?

(*a*) 20 hrs (*b*) 25 hrs

(*c*) 35 hrs (*d*) Cannot be determined

(*e*) None of these

23. A swimming pool is filled by three pipes with uniform flow. The first two pipes operating simultaneously fill the pool in the same time during which the pool is filled by the third pipe alone. The second pipe fills the pool 5 hours faster than the first pipe and 4 hours slower than the third pipe. The time required by the first pipe is **(M.B.A., 2002; M.A.T., 2006)**

(*a*) 6 hrs (*b*) 10 hrs

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

24. 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*) 15

(*c*) 16 (*d*) 18

25. Bucket P has thrice the capacity as bucket Q. It takes 60 turns for bucket P to fill the empty drum. How many turns will it take for both the buckets P and Q, having each turn together to fill the empty drum?
(*a*) 30 (*b*) 40
(*c*) 45 (*d*) 90

26. Two pipes A and B can fill a tank in 12 minutes and 15 minutes respectively. If both the pipes are opened simultaneously and pipe A is closed after 3 minutes, then how much more time will it take to fill the tank by pipe B? **(C.D.S., 2002; Bank P.O., 2006)**
(*a*) 7 min 15 sec (*b*) 7 min 45 sec
(*c*) 8 min 5 sec (*d*) 8 min 15 sec

27. Two pipes A and B can fill a tank in 15 minutes and 20 minutes respectively. Both the pipes are opened together but after 4 minutes, pipe A is turned off. What is the total time required to fill the tank?
(*a*) 10 min 20 sec (*b*) 11 min 45 sec
(*c*) 12 min 30 sec (*d*) 14 min 40 sec

28. Two pipes A and B can fill a tank in 15 hours and 20 hours respectively while a third pipe C can empty the full tank in 25 hours. All the three pipes are opened in the beginning. After 10 hours, C is closed. In how much time will the tank be full?
(*a*) 12 hrs (*b*) 13 hrs
(*c*) 16 hrs (*d*) 18 hrs

29. A large tanker can be filled by two pipes A and B in 60 minutes and 40 minutes respectively. How many minutes will it take to fill the tanker from empty state if B is used for half the time and A and B fill it together for the other half? **(D.M.R.C., 2003)**
(*a*) 15 min (*b*) 20 min
(*c*) 27.5 min (*d*) 30 min

30. Two pipes A and B can fill a cistern in 12 minutes and 15 minutes respectively while a third pipe C can empty the full cistern in 6 minutes. A and B are kept open for 5 minutes in the beginning and then C is also opened. In what time is the cistern emptied? **(M.A.T., 2005)**
(*a*) 30 min (*b*) 33 min
(*c*) $37\frac{1}{2}$ min (*d*) 45 min

31. Two pipes A and B can fill a tank in 20 and 30 hours 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-third water supplied by both the pipes goes out. The total time taken to fill the tank is **(M.A.T., 2006)**
(*a*) 12 hours (*b*) 14 hours
(*c*) 16 hours (*d*) 18 hours

32. Four pipes can fill a reservoir in 15, 20, 30 and 60 hours respectively. The first pipe was opened at 8 a.m, second at 9 a.m., third at 10 a.m. and fourth at 11 a.m. When will the reservoir be full?
(*a*) 1 p.m. (*b*) 2 p.m.
(*c*) 2.30 p.m. (*d*) 3 p.m.

33. Two pipes can fill a tank with water in 15 and 12 hours respectively and a third pipe can empty it in 4 hours. If the pipes be opened in order at 8, 9 and 11 a.m. respectively, the tank will be emptied at **(S.S.C., 2005)**
(*a*) 11 : 40 a.m. (*b*) 12 : 40 p.m.
(*c*) 1 : 40 p.m. (*d*) 2 : 40 p.m.

34. Tap A fills a tank in 4 hours whereas tap B empties the full tank in 24 hours. A and B are opened alternately for 1 hour each. Every 2 hours the level of water is found to increase by 0.5 m. The depth of the tank is
(*a*) 2.4 m (*b*) 4.8 m
(*c*) 6.4 m (*d*) 24 m

35. Two pipes A and B can fill a tank in 6 hours and 4 hours respectively. If they are opened on alternate hours and if pipe A is opened first, in how many hours, the tank shall be full? **(Campus Recruitment, 2003)**
(*a*) 4 (*b*) $4\frac{1}{2}$
(*c*) 5 (*d*) $5\frac{1}{2}$

36. Three taps A, B and C can fill a tank in 12, 15 and 20 hours respectively. If A is open all the time and B and C are open for one hour each alternately, the tank will be full in
(*a*) 6 hrs (*b*) $6\frac{2}{3}$ hrs
(*c*) 7 hrs (*d*) $7\frac{1}{2}$

37. Pipe A can fill a tank in 10 hours. Pipe B can fill the same tank in 15 hours. Pipe C can empty the full tank in 20 hours. Pipes A, B and C are opened alternatively for one hour each. If A is opened first, then how many hours will they take to fill the empty tank? **(M.B.A., 2004)**
(*a*) 24 hrs (*b*) $24\frac{2}{3}$ hrs
(*c*) 25 hrs (*d*) 26 hrs

38. 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 if the filling capacity of the pump?
(*a*) 50 m^3/min (*b*) 60 m^3/min
(*c*) 72 m^3/min (*d*) None of these

39. A leak in the bottom of a tank can empty the full tank in 8 hours. 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 hours. How many litres does the tank hold? **(M.A.T., 2005)**

(*a*) 7580 (*b*) 7960

(*c*) 8290 (*d*) 8640

40. Two pipes can fill a tank in 20 and 24 minutes respectively and a waste pipe can empty 3 gallons per minute. All the three pipes working together can fill the tank in 15 minutes. The capacity of the tank is :

(*a*) 60 gallons (*b*) 100 gallons

(*c*) 120 gallons (*d*) 180 gallons

41. Two pipes A and B can fill a cistern in $37\frac{1}{2}$ minutes and 45 minutes respectively. Both the pipes are opened. The cistern will be filled in just half an hour, if the pipe B is turned off after **(S.S.C., 2004)**

(*a*) 5 min (*b*) 9 min

(*c*) 10 min (*d*) 15 min

42. A cistern can be filled by two pipes filling separately in 12 and 16 minutes separately. Both the pipes are opened together for a certain time but being clogged, only $\frac{7}{8}$ of the full quantity of water flows through the former and only $\frac{5}{6}$ 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? **(M.A.T., 2006)**

(*a*) $2\frac{1}{2}$ min (*b*) $3\frac{1}{2}$ min

(*c*) $4\frac{1}{2}$ min (*d*) $5\frac{1}{2}$ min

43. Three pipes can fill a reservoir in 10, 15 and 20 hours respectively. If the three taps are opened one after another in the given order, with a certain fixed time gap between them, the reservoir fills in 5 hours. The time gap is

(*a*) 15 min (*b*) 30 min

(*c*) 45 min (*d*) 1 hr

44. Three pipes A, B and C can fill a tank in 6 hours. After working at it together for 2 hours, C is closed and A and B can fill the remaining part in 7 hours. The number of hours taken by C alone to fill the tank is **(L.I.C.A.A.O., 2003)**

(*a*) 10 (*b*) 12

(*c*) 14 (*d*) 16

45. A bath can be filled by the cold water pipe in 10 minutes and by the hot water pipe in 15 minutes. A person leaves the bathroom after turning on both the pipes. He returns just when the bath should have been full. Finding however, the waste pipe was open, he closes it. In 4 minutes more, the bath is full. In what time will the waste water pipe empty it?

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

(*c*) 9 minutes (*d*) None of these

46. A large fresh water reservoir is fitted with two types of feeder pipes – hot water pipes and cold water pipes. Six cold water pipes alone can fill the reservoir in 12 hours. 3 cold water pipes and 9 hot water pipes together can fill the reservoir in 8 hours. How long will 5 hot water pipes alone take to fill the reservoir?

(*a*) 18 hrs 36 min (*b*) 20 hrs 45 min

(*c*) 21 hrs 36 min (*d*) None of these

47. A town is supplied with water from a big overhead tank which is fed with a constant volume of water regularly. When the tank is full, if 32000 gallons are used daily, the supply fails in 50 days. However, if 37000 gallons are used daily, the supply lasts for 40 days only. How much water can be used daily without the supply ever failing?

(*a*) 12000 gallons (*b*) 15000 gallons

(*c*) 18000 gallons (*d*) 20000 gallons

48. Water flows through a cylindrical pipe of internal diameter 7 cm at the rate of 5 m/s. The time, in minutes, the pipe would take to fill an empty rectangular tank 4m × 3m × 2.31m is **[CDS, 2016]**

(*a*) 28 (*b*) 24

(*c*) 20 (*d*) 12

49. An outlet pipe can empty a cistern in 3 hours. In what time will the empty $\frac{2}{3}$ part of the cistern?

[DMRC—Customer Relationship Assistant (CRA) Exam, 2016]

(*a*) 3 hours (*b*) 5 hours

(*c*) 2 hours (*d*) 4 hours

50. Two pipes A and B can fill a tank in 24h and 30 h respectively. If both the pipes are opened simultaneously in the empty tank, how much time will be taken by them to fill it?

[UPSSC—Lower Subordinate (Pre.) Exam, 2016]

(*a*) 13h 20 min (*b*) 12h 10min

(*c*) 14h (*d*) 10h 5min

51. A tank is 7 metre long and 4 metre wide. At what speed should water run through a pipe 5 cm broad and 4 cm deep so that in 6 hours and 18 minutes water level in the tank rise by 4.5 metre?

[DMRC—Train Operator (Station Controller) Exam, 2016]

(*a*) 10 km/hr. (*b*) 12 km/hr.

(*c*) 8 km/hr. (*d*) None of these

52. Two pieces A and B can fill a tank in 18 hrs and 6 hrs respectively. If both the pipes are opened simultaneously, how much time will be taken to fill the tank?

[Indian Railway Gr. 'D' Exam, 2014]

(*a*) $4\frac{1}{2}$ hrs (*b*) 7 hrs

(*c*) 6 hrs (*d*) 10 hrs

53. Two pipes can fill a tank in 12 hours and 16 hours respectively. A third pipe can empty the tank in 30 hours. If all the three pipes are opened and function simultaneously, they in how much time the tank will be full? (in hours)

[United India Insurance (UIICL) Assistant (Online) Exam, 2015]

(*a*) $10\frac{4}{9}$ (*b*) $9\frac{1}{2}$

(*c*) $8\frac{8}{9}$ (*d*) $7\frac{2}{9}$

54. A tank has two outlets A and B, which together take 6h to empty a full tank when they are opened simultaneously. The tank was initially half-full and both the outlets were opened. After an hour, an inlet pipe 'X' was also opened. If the inlet alone can fill an empty tank in 4h, how much time will it now take to fill the tank completely? (in hours)

[CET—Maharashtra (MBA) Exam, 2016]

(*a*) 8 (*b*) 7

(*c*) $8\frac{1}{2}$ (*d*) 9

ANSWERS

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

SOLUTIONS

1. Time taken to fill the whole bucket = $\frac{7}{3}$ min.

$\therefore$ Required time = $\left(\frac{7}{3}-1\right)$ minutes = $\frac{4}{3}$ minutes.

2. Required part = $\frac{\text{Quantity removed}}{\text{Total capacity}} = \frac{a}{g}$.

3. We have the following table:

Period	Supply	Demand	Excess Qty. in tank
0–3 hrs	30000	10000	20000
3–6 hrs	30000	10000	40000
6–9 hrs	30000	45000	25000
9–12 hrs	30000	25000	30000
12–15 hrs	30000	40000	20000
15–18 hrs	30000	15000	35000
18–21 hrs	30000	60000	5000
21–24 hrs	30000	35000	0

The excess quantity in tank at any time does not exceed 40000 litres, which is the required minimum capacity to avoid wastage.

4. Part filled by A in 1 min = $\frac{1}{20}$; Part filled by B in 1 min = $\frac{1}{30}$.

Part filled by (A + B) in 1 min = $\left(\frac{1}{20}+\frac{1}{30}\right) = \frac{1}{12}$.

$\therefore$ Both the pipes can fill the tank in 12 minutes.

5. Net part filled in 1 hour = $\left(\frac{1}{x}-\frac{1}{y}\right) = \left(\frac{y-x}{xy}\right)$.

$\therefore$ The tank will be filled in $\left(\frac{xy}{y-x}\right)$ hours.

6. Net part filled in 1 hour = $\left(\frac{1}{8}-\frac{1}{12}\right) = \frac{1}{24}$.

$\therefore$ The tank will be filled in 24 hours.

7. Net part filled in 1 hour = $\left(\frac{1}{48}-\frac{1}{120}\right) = \frac{3}{240} = \frac{1}{80}$.

$\therefore$ The tank will be filled 80 mins i.e. 1 hour 20 min. after 11 : 40 A.M. i.e. at 1 P.M.

8. Net volume filled in 1 minute = $(x - y)$ litres. $\therefore$ Time taken to fill the tank = $\frac{T}{(x-y)}$ minutes.

9. Net part filled in 1 hour = $\left(\frac{1}{20}+\frac{1}{30}-\frac{1}{40}\right) = \frac{7}{120}$.

$\therefore$ The tank will be full in $\frac{120}{7}$ i.e. $17\frac{1}{7}$ hours.

10. Net part filled in 1 hour = $\frac{1}{3}-\left(\frac{1}{7}+\frac{1}{10}\right) = \frac{1}{3}-\frac{17}{70} = \frac{19}{210}$.

$\therefore$ The tank will be filled in $\frac{210}{19}$ hrs i.e. $11\frac{1}{19}$ hrs $\cong$ 11 hrs.

11. Let t_1, t_2 and t_3 be the times taken by pipes with diameters 1 cm, $\frac{4}{3}$ cm and 2 cm respectively.

Since time taken to fill the tank is inversely proportional to the amount of water flowing through it, we have

$$t_3 \propto \frac{1}{r^2} \text{ or } t_3 = \frac{k}{r^2} \Rightarrow 61 = \frac{k}{4} \Rightarrow k = 244.$$

Thus, $t_1 = \frac{k}{(1)^2} = 244$; $t_2 = \frac{k}{\left(\frac{4}{3}\right)^2} = \frac{9}{16}\times 244 = \frac{549}{4}$.

$$\text{Net part filled in 1 min} = \frac{1}{244}+\frac{1}{61}+\frac{4}{549}$$
$$= \frac{1}{61}\left(\frac{1}{4}+1+\frac{4}{9}\right) = \frac{1}{61}\left(\frac{9+36+16}{36}\right)$$
$$= \frac{1}{61}\times\frac{61}{36} = \frac{1}{36}.$$

Hence, all the three pipes together would fill the tank in 36 minutes.

12. Time taken by one tap to fill half the tank = 3 hrs.

Part filled by the four taps in one hour $= \left(4\times\frac{1}{6}\right) = \frac{2}{3}$.

Remaining part $= \frac{1}{2}$.

$\therefore \quad \frac{2}{3}:\frac{1}{2}::1:x$ or $x = \left(\frac{1}{2}\times 1\times\frac{3}{2}\right) = \frac{3}{4}$ hrs i.e. 45 min.

So, total time taken = 3 hrs 45 min.

13. Net part emptied in one hour $= \left(\frac{1}{5}-\frac{1}{8}\right) = \frac{3}{40}$.

$\therefore \quad \frac{3}{40}:\frac{3}{4}::1:x$ or $x = \left(\frac{3}{4}\times 1\times\frac{40}{3}\right) = 10$ hrs.

So, the cistern will be emptied in 10 hrs.

14. Net part emptied in 1 hour $= \frac{2}{3}-\left(\frac{2}{9}+\frac{1}{3}\right) = \left(\frac{2}{3}-\frac{5}{9}\right)$

$$= \frac{1}{9}.$$

$\therefore \quad \frac{1}{9}:\frac{1}{2}::1:x$ or $x = \left(\frac{1}{2}\times 9\right) = 4\frac{1}{2}$ hours.

So, the tank will be emptied in $4\frac{1}{2}$ hours.

15. Work done by the third pipe in 1 min.

$$= \frac{1}{50}-\left(\frac{1}{60}+\frac{1}{75}\right) = \left(\frac{1}{50}-\frac{3}{100}\right) = -\frac{1}{100}.$$

[– ve sign means emptying]

$\therefore$ The third pipe alone can empty the cistern in 100 min.

16. Let there be x water pipes and $(8 - x)$ waste pipes.

Now, part filled by each water pipe $= \frac{1}{12}$; part emptied by each waste pipe $= \frac{1}{36}$.

$\therefore \quad \frac{x}{12}-\frac{(8-x)}{36} = \frac{1}{3} \Leftrightarrow 3x-(8-x) = 12 \Leftrightarrow 4x = 20$

$\Leftrightarrow x = 5.$

So, number of waste pipes = (8 – 5) = 3.

17. Work done by the leak in 1 hour $= \left(\frac{1}{2}-\frac{3}{7}\right) = \frac{1}{14}$.

$\therefore$ Leak will empty the tank in 14 hours.

18. Part filled by (A + B) in 1 hour $= \left(\frac{1}{5}+\frac{1}{20}\right) = \frac{1}{4}$.

So, A and B together can fill the tank in 4 hours.

Work done by the leak in 1 hour $= \left(\frac{1}{4}-\frac{2}{9}\right) = \frac{1}{36}$.

$\therefore$ Leak will empty the tank in 36 hours.

19. Part filled by (A + B + C) in 3 minutes

$$= 3\left(\frac{1}{30}+\frac{1}{20}+\frac{1}{10}\right) = \left(3\times\frac{11}{60}\right) = \frac{11}{20}.$$

Part filled by C in 3 minutes $= \frac{3}{10}$.

$\therefore$ Required ratio $= \left(\frac{3}{10}\times\frac{20}{11}\right) = \frac{6}{11}$.

20. Let the cistern be filled by pipe A alone in x hour.

Then, pipe B will fill it in $(x + 6)$ hours.

$$\therefore \quad \frac{1}{x}+\frac{1}{(x+6)} = \frac{1}{4} \Leftrightarrow \frac{x+6+x}{x(x+6)} = \frac{1}{4}$$
$$\Leftrightarrow x^2 - 2x - 24 = 0$$
$$\Leftrightarrow (x-6)(x+4) = 0 \Leftrightarrow x = 6.$$

[Neglecting – ve value of x]

So, A alone will fill the cistern in 6 hrs.

21. Let the slower pipe alone fill the tank in x minutes.

Then, faster pipe alone will fill it in $\frac{x}{3}$ minutes.

$$\therefore \quad \frac{1}{x}+\frac{3}{x} = \frac{1}{36} \Leftrightarrow \frac{4}{x} = \frac{1}{36} \Leftrightarrow x = 144.$$

So, slower pipe alone will fill the tank in 144 min.

22. Suppose pipe A alone takes x hours to fill the tank.

Then, pipes B and C will take $\frac{x}{2}$ and $\frac{x}{4}$ hours respectively to fill the tank.

$$\therefore \quad \frac{1}{x}+\frac{2}{x}+\frac{4}{x} = \frac{1}{5} \Leftrightarrow \frac{7}{x} = \frac{1}{5} \Leftrightarrow x = 35.$$

So, pipe A alone takes 35 hours to fill the tank.

23. Suppose first pipe alone takes x hours to fill the tank. Then, second and third pipes will take $(x - 5)$ and $(x - 9)$ hours respectively to fill the tank.

$$\therefore \quad \frac{1}{x}+\frac{1}{(x-5)} = \frac{1}{(x-9)} \Leftrightarrow \frac{x-5+x}{x(x-5)} = \frac{1}{(x-9)}$$
$$\Leftrightarrow (2x-5)(x-9) = x(x-5)$$
$$\Leftrightarrow x^2 - 18x + 45 = 0$$
$$\Leftrightarrow (x-15)(x-3) = 0$$
$$\Leftrightarrow x = 15. \text{ [neglecting } x = 3]$$

So, first pipe alone takes 15 hrs to fill the tank.

24. Capacity of the tank = (12 × 13.5) litres = 162 litres.

Capacity of each bucket = 9 litres.

Number of buckets needed $= \left(\frac{162}{9}\right) = 18.$

25. Let capacity of bucket P be x litres. Then, capacity of bucket $Q = \left(\frac{x}{3}\right)$ litres.

Capacity of the drum = 60 x litres.

$\therefore$ Required number of turns $= \dfrac{60x}{\left(x+\frac{x}{3}\right)} = \left(60x \times \frac{3}{4x}\right) = 45.$

26. Part filled in 3 min $= 3\left(\frac{1}{12}+\frac{1}{15}\right) = \left(3\times\frac{9}{60}\right) = \frac{9}{20}.$

Remaining part $= \left(1-\frac{9}{20}\right) = \frac{11}{20}.$

Part filled by B in 1 min $= \frac{1}{15}.$

$\frac{1}{15}:\frac{11}{20}::1:x$ or $x = \left(\frac{11}{20}\times 1\times 15\right) = 8\frac{1}{4}$ min

= 8 min 15 sec.

$\therefore$ Remaining part is filled by B in 8 min 15 sec.

27. Part filled in 4 minutes $= 4\left(\frac{1}{15}+\frac{1}{20}\right) = \frac{7}{15}.$

Remaining part $= \left(1-\frac{7}{15}\right) = \frac{8}{15}.$

Part filled by B in 1 minute $= \frac{1}{20}.$ $\frac{1}{20}:\frac{8}{15}::1:x$

or $x = \left(\frac{8}{15}\times 1\times 20\right) = 10\frac{2}{3}$ min = 10 min 40 sec.

$\therefore$ The tank will be full in (4 min + 10 min 40 sec) = 14 min 40 sec.

28. Part filled in 10 hours $= 10\left(\frac{1}{15}+\frac{1}{20}-\frac{1}{25}\right) = \frac{23}{30}.$

Remaining part $= \left(1-\frac{23}{30}\right) = \frac{7}{30}.$

(A + B)'s 1 hour's work $= \left(\frac{1}{15}+\frac{1}{20}\right) = \frac{7}{60}.$ $\frac{7}{60}:\frac{7}{30}::1:x$

or $x = \left(\frac{7}{30}\times 1\times\frac{60}{7}\right) = 2$ hours.

$\therefore$ The tank will be full in (10 + 2) hrs = 12 hrs.

29. Part filled by (A + B) in 1 minute $= \left(\frac{1}{60}+\frac{1}{40}\right) = \frac{1}{24}.$

Suppose the tank is filled in x minutes.

Then, $\frac{x}{2}\left(\frac{1}{24}+\frac{1}{40}\right) = 1 \Leftrightarrow \frac{x}{2}\times\frac{1}{15} = 1 \Leftrightarrow x = 30.$

30. Part filled in 5 min $= 5\left(\frac{1}{12}+\frac{1}{15}\right) = \left(5\times\frac{9}{60}\right) = \frac{3}{4}.$

Part emptied in 1 min when all the pipes are opened

$$= \frac{1}{6}-\left(\frac{1}{12}+\frac{1}{15}\right) = \left(\frac{1}{6}-\frac{3}{20}\right) = \frac{1}{60}.$$

Now, $\frac{1}{60}$ part is emptied in 1 min.

$\therefore$ $\frac{3}{4}$ part will be emptied in $\left(60\times\frac{3}{4}\right) =$ 45 min.

31. Part filled by (A + B) in 1 hour $= \left(\frac{1}{20}+\frac{1}{30}\right) = \frac{1}{12}.$

So, A and B together can fill the tank in 12 hrs. $\frac{1}{3}$ part is filled by (A + B) in $\left(\frac{1}{3}\times 12\right) = 4$ hrs.

Since the leak empties one - third water, so time taken to fill the tank = Time taken by (A + B) to fill the whole tank + Time taken by (A + B) to fill one - third tank = (12 + 4) hrs = 16 hrs.

32. Let the time be t hours after 8 a.m.

Then, the first pipe worked for t hours; second pipe for $(t-1)$ hours; third for $(t-2)$ hours and fourth for $(t-3)$ hours.

$\therefore$ $\frac{t}{15}+\frac{(t-1)}{20}+\frac{(t-2)}{30}+\frac{(t-3)}{60} = 1 \Leftrightarrow 4t + 3(t-1) + 2(t-2)$ $+ (t-3) = 60 \Leftrightarrow 10t = 70 \Leftrightarrow t = 7.$

So, the reservoir will be full 7 hours after 8 a.m. i.e. at 3 p.m.

33. Let the tank be emptied t hours after 8 a.m. Then,

Work done by first pipe in t hours + work done by second pipe in $(t-1)$ hours + work done by third pipe in $(t-3)$ hours = 0

$\Rightarrow \frac{t}{15}+\frac{(t-1)}{12}-\frac{(t-3)}{4} = 0$

$\Rightarrow 4t + 5(t-1) - 15(t-3) = 0$

$\Rightarrow -6t + 40 = 0 \Rightarrow 6t = 40 \Rightarrow t = 6\frac{2}{3}$ hrs = 6 hrs 40 min.

So, the tank will be emptied 6 hrs 40 min after 8 a.m. i.e., at 2 : 40 p.m.

34. Part filled in 2 hours $= \left(\frac{1}{4}-\frac{1}{24}\right) = \frac{5}{24}.$

Let the depth of the tank be h metres.

Then, $\frac{5}{24}\ h = 0.5 \Rightarrow h = \left(\frac{0.5\times 24}{5}\right) = 2.4$ m.

35. (A + B)'s 2 hours' work when opened alternately

$$= \left(\frac{1}{6}+\frac{1}{4}\right) = \frac{5}{12}.$$

Part filled in 4 hrs $= \frac{10}{12} = \frac{5}{6}.$

Remaining part $= \left(1-\frac{5}{6}\right) = \frac{1}{6}.$

Now it is A's turn and $\frac{1}{6}$ part is filled by A in 1 hour.

$\therefore$ Total time taken to fill the tank = (4 + 1) hrs = 5 hrs.

36. (A + B)'s 1 hour's work $= \left(\frac{1}{12}+\frac{1}{15}\right) = \frac{9}{60} = \frac{3}{20}.$

(A + C)'s 1 hour's work $= \left(\frac{1}{12}+\frac{1}{20}\right) = \frac{8}{60} = \frac{2}{15}.$

Part filled in 2 hrs $= \left(\frac{3}{20}+\frac{2}{15}\right) = \frac{17}{60}$; Part filled in 6 hrs

$= \left(3 \times \frac{17}{60}\right) = \frac{17}{20}$.

Remaining part $= \left(1 - \frac{17}{20}\right) = \frac{3}{20}$.

Now, it is the turn of A and B and $\frac{3}{20}$ part is filled by A and B in 1 hour.

$\therefore$ Total time taken to fill the tank = (6 + 1) hrs = 7 hrs.

37. (A + B + C)'s 3 hours' work when opened alternately

$= \left(\frac{1}{10} + \frac{1}{15} - \frac{1}{20}\right) = \frac{7}{60}$.

Part filled in (3 × 8) i.e. 24 hrs $= \left(\frac{7}{60} \times 8\right) = \frac{14}{15}$.

Remaining part $= \left(1 - \frac{14}{15}\right) = \frac{1}{15}$.

Now it is A's turn. $\frac{1}{10}$ part is filled by A in 1 hr.

$\frac{1}{15}$ part will be filled by A in $\left(10 \times \frac{1}{15}\right)$hrs $= \frac{2}{3}$hr.

So, total time taken $= 24\frac{2}{3}$ hrs.

38. Let the filling capacity of the pump be x m^3/min.

Then, emptying capacity of the pump = $(x + 10)$ m^3/min.

So, $\frac{2400}{x} - \frac{2400}{(x+10)} = 8 \Leftrightarrow x^2 + 10x - 3000 = 0 \Leftrightarrow (x - 50$

$(x + 60) = 0 \Leftrightarrow x = 50$.

[neglecting – ve value of x]

Hence, filling capacity of the pump = 50 m^3/min.

39. Work done by the inlet in 1 hour $= \left(\frac{1}{8} - \frac{1}{12}\right) = \frac{1}{24}$.

Work done by the inlet in 1 min $= \left(\frac{1}{24} \times \frac{1}{60}\right) = \frac{1}{1440}$.

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

Volume of whole tank = (1440 × 6) litres = 8640 litres.

40. Work done by the waste pipe in 1 minute

$= \frac{1}{15} - \left(\frac{1}{20} + \frac{1}{24}\right) = \left(\frac{1}{15} - \frac{11}{120}\right) = -\frac{1}{40}$.

[– ve sign means emptying]

$\therefore$ Volume of $\frac{1}{40}$ part = 3 gallons.

Volume of whole tank = (3 × 40) gallons = 120 gallons.

41. Let B be turned off after x minutes. Then,

Part filled by (A + B) in x min + Part filled by A in $(30 - x)$ min = 1

$\therefore \quad x\left(\frac{2}{75} + \frac{1}{45}\right) + (30 - x).\frac{2}{75} = 1$

$\Leftrightarrow \frac{11x}{225} + \frac{(60 - 2x)}{75} = 1$

$\Leftrightarrow 11x + 180 - 6x = 225$.

$\Leftrightarrow 5x = 45 \Leftrightarrow x = 9$.

42. Suppose the full flow began after x minutes.

Then, part filled by both pipes with obstruction in x min + part filled by both pipes with full flow in 3 min = 1

$\Rightarrow x\left(\frac{7}{8} \times \frac{1}{12} + \frac{5}{6} \times \frac{1}{16}\right) + 3\left(\frac{1}{12} + \frac{1}{16}\right) = 1$

$\Rightarrow x\left(\frac{7}{96} + \frac{5}{96}\right) + 3 \times \frac{7}{48} = 1 \Rightarrow \frac{x}{8} = \frac{9}{16}$

$\Rightarrow x = \frac{9}{2} = 4\frac{1}{2}$.

43. Let the fixed time gap be x hrs. Then, Part filled by first pipe in 5 hrs + part filled by second pipe in $(5 - x)$ hrs + part filled by third pipe in $(5 - 2x)$ hrs = 1

$\Rightarrow \frac{5}{10} + \frac{(5 - x)}{15} + \frac{(5 - 2x)}{20} = 1$

$\Rightarrow 30 + 4(5 - x) + 3(5 - 2x) = 60 \Rightarrow 10x = 5 \Rightarrow x = \frac{1}{2}$.

Hence, the fixed time gap is $\frac{1}{2}$ hr i.e. 30 min.

44. Part filled in 2 hours $= \frac{2}{6} = \frac{1}{3}$,

Remaining part $= \left(1 - \frac{1}{3}\right) = \frac{2}{3}$.

(A + B)'s 7 hours' work $= \frac{2}{3}$; (A + B)'s 1 hour's work

$= \frac{2}{21}$.

$\therefore$ C's 1 hour's work = [(A + B + C)'s 1 hour's work – (A + B)'s 1 hour's work] $= \left(\frac{1}{6} - \frac{2}{21}\right) = \frac{1}{14}$.

Hence, C alone can fill the tank in 14 hours.

45. Part filled by two inlet pipes in 1 min $= \frac{1}{10} + \frac{1}{15} = \frac{1}{6}$.

Part filled by two inlet pipes in 4 min $= \left(4 \times \frac{1}{6}\right) = \frac{2}{3}$.

Time after which the waste pipe is closed = Time taken by two inlets to fill the bath = 6 min.

Part filled by (2 inlets + 1 waste pipe) in 6 min

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

Part filled by (2 inlets + 1 waste pipe) in 1 min

$= \left(\frac{1}{3} \times \frac{1}{6}\right) = \frac{1}{18}$.

$\therefore$ Work done by waste pipe in 1 min $= \left(\frac{1}{18} - \frac{1}{6}\right) = -\frac{1}{9}$.

[– ve sign means emptying]

Hence, the waste pipe can empty the cistern in 9 minutes.

46. Let one cold water pipe and one hot water pipe individually take x and y hours respectively to fill the reservoir.

Then, $\frac{6}{x} = \frac{1}{12}$ or $x = 72$.

Also, $\frac{3}{x}+\frac{9}{y}=\frac{1}{8} \Rightarrow \frac{3}{72}+\frac{9}{y}=\frac{1}{8}$

$\Rightarrow \frac{9}{y}=\frac{1}{8}-\frac{1}{24}=\frac{1}{12} \Rightarrow y=108.$

Work done by 5 hot water pipes in 1 hr $= \frac{5}{y} = \frac{5}{108}$.

So, 5 hot water pipes alone will take $\frac{108}{5}$ hrs, i.e. $21\frac{3}{5}$ hrs or 21 hrs 36 min to fill the reservoir.

47. Let the volume of the overhead tank be x litres and the constant volume being fed per day to the tank be y litres. Then, $x + 50y = 32000 \times 50 \Rightarrow x + 50y = 1600000$ ...(i)

$x + 40y = 37000 \times 40 \Rightarrow x + 40y = 1480000$ ...(*ii*)

Subtracting (*ii*) from (*i*), we get $10y = 120000$ or $y = 12000$.

Clearly, the supply won't ever fail if the regular demand is equal to the regular supply, which is 12000 gallons.

48. Volume of water in a rectangular tank
$= 400 \times 300 \times 231$ cc

Volume of cylinder $= \pi r^2 h = \pi \times \left(\frac{7}{2}\right)^2 \times 500$

Required time

$= \frac{400\times300\times231}{\pi\times\left(\frac{7}{2}\right)^2\times500}$

$= \frac{400\times300\times231\times4\times7}{22\times49\times500}$

= 1440 seconds = 24 minutes

49. The outlet pipe empties the one complete cistern in 3 hours.

$\therefore$ Time taken to empty $\frac{2}{3}$ Part of the cistern

$= \frac{2}{3}\times3=2$ hours.

50. A's 1 hour work $= \frac{1}{24}$

B's 1 hour work $= \frac{1}{30}$

LCM of 24 and 30 = 120

1 hour work of together A and B's

$= \frac{1}{24}+\frac{1}{30}=\frac{5+4}{120}=\frac{9}{120}=\frac{3}{40}$

$\therefore$ Total time to fill the tank $= \frac{40}{3}$

$= 13\frac{1}{3}$ hour = 13 hours 20 minutes

51. Rate of flow of water = x cm/minute

$\therefore$ Volume of water that flowed in the tank in 1 minutes
$= 5 \times 4 \times x = 20x$ cu.cm.

$\therefore$ Volume of water that flowed in the tank in 6 hours 18 minutes.

i.e. $(6 \times 60 + 18) = 378$ minutes
$= 2 \times 378$ cu.cm.

According to the question, $20x \times 378 = 700 \times 400 \times 450$

$\Rightarrow x = \left(\frac{700\times400\times450}{20\times378}\right)$ cm/minutes

$= \left(\frac{700\times400\times450\times60}{100000\times20\times378}\right)$ km/hour.

= 10 km/hour.

52. Part of tank filled by A in 1 hour $= \frac{1}{18}$ part

Part of tank filled by B in 1 hour $= \frac{1}{6}$ part

Part of tank filled by pipes A and B in 1 hour $= \frac{1}{18}+\frac{1}{6}$

$= \frac{1+3}{18}=\frac{4}{18}=\frac{2}{9}$

$\therefore$ Required time taken by pipe A and B $= \frac{9}{2}$ hours

$= 4\frac{1}{2}$ hours

53. First pipe fill the tank in 1 hour $= \frac{1}{12}$ part of tank

Second pipe fill the tank in 1 hour $= \frac{1}{16}$ part of tank

Third pipe empty the tank in 1 hour $= \frac{1}{30}$ part of tank.

When all three pipes are opened simultaneously, part of the tank filled in 1 hour

$= \frac{1}{12}+\frac{1}{16}-\frac{1}{30}$

LCM of 12, 16 and 30 = 240

$= \frac{20+15-8}{240}=\frac{27}{240}$

$\therefore$ Required time taken by all the three pipes $= \frac{240}{27}$

$= \frac{80}{9}=8\frac{8}{9}$ Hours

54. Part of the tank filled by inlet in 1h. $= \frac{1}{4}$

Part of the tank emptied by outlets A and B together in $1h = \frac{1}{6}$

Let the time taken to fill the tank completely = ah

$\therefore \left(\frac{a-1}{4}\right)-\frac{a}{6}=\frac{1}{2}$

$\Rightarrow \frac{6a-6-4a}{24}=\frac{1}{2}$

$\Rightarrow 2a-6=12$

$\Rightarrow 2a=18$

$\Rightarrow a=9h$

EXERCISE

(DATA SUFFICIENCY TYPE QUESTIONS)

Directions *(Questions 1–4): Each of the questions given below consists of a statement and/or a question and two statements numbered I and II given below it. You have to decide whether the data provided in the statement(s) is/are sufficient to answer the given question. Read both the statements and:*

Give answer (a) if the data in Statement I alone are sufficient to answer the question, while the data in Statement II alone are not sufficient to answer the question;

Give answer (b) if the data in Statement II alone are sufficient to answer the question, while the data in Statement I alone are not sufficient to answer the question;

Give answer (c) if the data either in Statement I or in Statement II alone are sufficient to answer the question;

Give answer (d) if the data even in both Statements I and II together are not sufficient to answer the question;

Give answer (e) if the data in both Statements I and II together are necessary to answer the question.

1. How long will it take to empty the tank if both the inlet pipe A and the outlet pipe B are opened simultaneously?

I. A can fill the tank in 16 minutes.

II. B can empty the full tank in 8 minutes.

2. Two taps A and B, when opened together, can fill a tank in 6 hours. How long will it take for the pipe A alone to fill the tank?

I. B alone takes 5 hours more than A to fill the tank.

II. The ratio of the time taken by A to that taken by B to fill the tank is 2 : 3.

3. A tank is fitted with two inlet pipes A and B. Both the pipes are kept open for 10 minutes so that the tank is two-thirds full and then pipe A is closed. How much time will pipe B take to fill the remaining part of the tank?

I. Pipe A is thrice as fast as pipe B.

II. Pipe B alone can fill the tank in 60 minutes.

4. How much time will the leak take to empty the full cistern?

I. The cistern is normally filled in 9 hours.

II. It takes one hour more than the usual time to fill the cistern because of a leak in the bottom.

Directions *(Questions 5-6): Each of the questions below consists of a question followed by three statements. You have to study the question and the statements and decide which of the statement(s) is/are necessary to answer the question:*

5. A tank is fitted with two taps A and B. In how much time will the tank be full if both the taps are opened together? **(SNAP, 2005)**

I. A is 50% more efficient than B.

II. A alone takes 16 hours to fill the tank.

III. B alone takes 24 hours to fill the tank.

(*a*) II and III only (*b*) All I, II and III

(*c*) I and II only (*d*) I and III only

(*e*) Any two of the three

6. If both the pipes are opened, how many hours will be taken to fill the tank?

I. The capacity of the tank is 400 litres.

II. The pipe A fills the tank in 4 hours.

III. The pipe B fills the tank in 6 hours.

(*a*) Only I and II (*b*) Only II and III

(*c*) All I, II and III (*d*) Any two of the three

(*e*) Even with all the three statements, answer cannot be given.

Directions: *The question given below is followed by three statements. You have to decide whether any information given in the statement(s) is not required.*

7. A water tank has been filled with two filler taps P and Q and a drain pipe R. Taps P and Q fill at the rate of 5 litres per minute and 9 litres per minute respectively. What is the capacity of the tank? **(M.A.T., 2006)**

I. Tap R drains out at the rate of 6 litres per minute.

II. If all the three taps are opened simultaneously, then the tank is filled in $4\frac{1}{2}$ hours.

III. Tap R drains the filled tank in 15 hours.

(*a*) II and either I or III (*b*) Either I or II

(*c*) II and III together (*d*) Any one of them

ANSWERS

1. (*e*) **2.** (*c*) **3.** (*c*) **4.** (*e*) **5.** (*e*) **6.** (*b*) **7.** (*b*)

SOLUTIONS

1. I. A's 1 minute's filling work = $\frac{1}{16}$.

II. B's 1 minute's emptying work = $\frac{1}{8}$.

(A + B)'s 1 minute's emptying work = $\left(\frac{1}{8}-\frac{1}{16}\right) = \frac{1}{16}$.

$\therefore$ Tank will be emptied in 16 minutes. Thus, both I and II are necessary to answer the question.

Hence, correct answer is (*e*).

2. (A + B)'s 1 hour filling work = $\frac{1}{6}$.

I. Suppose A takes x hours to fill the tank. Then, B takes $(x + 5)$ hours to fill the tank.

$\therefore$ (A's 1 hour work) + (B's 1 hour work) = (A + B)'s 1 hour work

$$\Leftrightarrow \frac{1}{x}+\frac{1}{(x+5)}=\frac{1}{6} \Leftrightarrow \frac{(x+5)+x}{x(x+5)}=\frac{1}{6}$$

$\Leftrightarrow x^2 + 5x = 12x + 30 \Leftrightarrow x^2 - 7x - 30 = 0$

$\Leftrightarrow x^2 - 10x + 3x - 30 = 0$

$\Leftrightarrow x(x - 10) + 3(x - 10) = 0$

$\Leftrightarrow (x - 10)(x + 3) = 0 \Leftrightarrow x = 10.$

So, A alone takes 10 hours to fill the tank.

II. Suppose A takes $2x$ hours and B takes $3x$ hours to fill the tank. Then, $\frac{1}{2x}+\frac{1}{3x} = \frac{1}{6}$

$$\Leftrightarrow \left(\frac{1}{2}+\frac{1}{3}\right).\frac{1}{x} = \frac{1}{6} \Leftrightarrow \frac{5}{6x} = \frac{1}{6} \Leftrightarrow x = 5.$$

So, A alone takes $(2 \times 5) = 10$ hours to fill the tank.

Thus, each one of I and II alone gives the answer. Hence, correct answer is (*c*).

3. I. Let B's 1 min. work = $\frac{1}{x}$. Then, A's 1 min. work = $\frac{3}{x}$.

(A + B)'s 1 min. work = $\left(\frac{1}{x}+\frac{3}{x}\right) = \frac{4}{x}$. (A + B)'s 10 min. work = $\left(\frac{4}{x}\times 10\right) = \frac{40}{x}$.

$\therefore \quad \frac{40}{x} = \frac{2}{3} \Leftrightarrow x = 60.$

$\therefore$ B's 1 min. work = $\frac{1}{60}$.

$\frac{1}{60}$ part is filled by B in 1 min. $\frac{1}{3}$ part is filled by B in $\left(60\times\frac{1}{3}\right)$ min. = 20 min.

II. B's 1 min. work = $\frac{1}{60}$.

$\frac{1}{60}$ part is filled by B in 1 min. $\frac{1}{3}$ part is filled by B in $\left(60\times\frac{1}{3}\right)$ min. = 20 min.

Hence, correct answer is (c).

4. I. Time taken to fill the cistern without leak = 9 hours.

Part of cistern filled without leak in 1 hour = $\frac{1}{9}$.

II. Time taken to fill the cistern in presence of leak = 10 hours.

Net filling in 1 hour = $\frac{1}{10}$. Work done by leak in 1 hour = $\left(\frac{1}{9}-\frac{1}{10}\right) = \frac{1}{90}$.

$\therefore$ Leak will empty the full cistern in 90 hours.

Clearly, both I and II are necessary to answer the question.

$\therefore$ Correct answer is (*e*).

5. II. A's 1 hour work = $\frac{1}{16}$.

Suppose B fills the tank in x hours. Then, B's 1 hour work = $\frac{1}{x}$.

I. Work done by A in 1 hour = 150% of $\frac{1}{x}$

$$= \left(\frac{1}{x}\times\frac{150}{100}\right) = \frac{3}{2x}.$$

$\therefore \quad \frac{3}{2x} = \frac{1}{16} \Leftrightarrow x = 24.$

So, B can fill the tank in 24 hours.

(A + B)'s 1 hour work = $\left(\frac{1}{16}+\frac{1}{24}\right) = \frac{5}{48}$.

$\therefore$ (A + B) can fill the tank in $\frac{48}{5}$ hrs. Thus, I & II give the answer.

III. Work done by B in 1 hour = $\frac{1}{24}$.

From II & III, we get the same answer.

From III & I, we get : A's 1 hour work = 150% of $\frac{1}{24}$

$= \left(\frac{1}{24}\times\frac{150}{100}\right) = \frac{1}{16}$.

Thus, from III & I, we get the same answer.

$\therefore$ Correct answer is (*e*).

6. II. Part of the tank filled by A in 1 hour = $\frac{1}{4}$.

III. Part of the tank filled by B in 1 hour = $\frac{1}{6}$.

(A + B)'s 1 hour's work = $\left(\frac{1}{4}+\frac{1}{6}\right) = \frac{5}{12}$.

$\therefore$ When both A and B are opened together, they will fill the tank in $\frac{12}{5}$ hrs = 2 hrs 24 min.

So, II and III are needed. $\therefore$ Correct answer is (*b*).

7. I and III.

Capacity of the tank = (6 × 60 × 15) litres = 5400 litres.

$\therefore$ II is not required.

II and III.

Work done by P and Q in 1 hour

$$= \left(\frac{2}{9} - \frac{1}{15}\right) = \frac{(10-3)}{45} = \frac{7}{45}.$$

$\therefore$ P and Q together can fill it in $\frac{45}{7}$ hrs.

Volume flown through P and Q in 1 hr = {(6 + 8) × 60} litres. = 840 litres.

Capacity of the tank = $\left(840 \times \frac{45}{7}\right)$ litres = 5400 litres.

$\therefore$ I is not required.

Thus, either I or II is not required. Hence, correct answer is (*b*).