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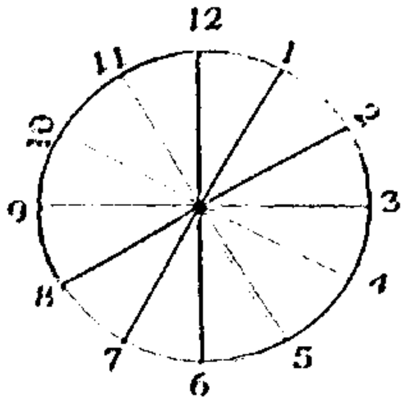
17 CLOCK

We all are familiar with the clocks. Let us understand it in relation to second, minute and hour hand.



In a clock if any hand completes one revolution, then it completes 360°, and in one revolution the second hand, minute hand, hour hand covers 60 seconds, 60 minutes, 12 hours respectively.

For second hand: - 60 seconds → 360°

$\boxed{1 \text{ sec} \rightarrow 6^\circ}$

5 sec 30°

For minute hand: - 60 minutes → 360°

$\boxed{1 \text{ minute} \rightarrow 6^\circ}$

5 minutes 30°

Also for

Hour hand :- 12 hours → 360°

$\boxed{1 \text{ hour} \rightarrow 30^\circ}$

Now we will study the relation between the hands of a clock.

When second hand has moved by 5 seconds then how much will the minute hand move?

In 1 min., the minute hand moves by 6°

Hence in 5 seconds i.e. in $\frac{5}{60}$ min it moves by

$$\frac{5}{60} \times 6^\circ = 0.5^\circ$$

In 5 second = 0.5° is moved by minute hand

For every 1 sec., minute hand will move by 0.1°

Important

$\boxed{1 \text{ sec} = 0.1^\circ \text{ of minute hand}}$

In 60 minutes, the minute hand gains 55 minutes on the hour hand.

The dial of a clock is a circle whose circumference is divided into 12 parts, called **hour spaces.** Each **hour space** is further divided into 5 parts, called **minute spaces.** This way, the whole circumference is divided into 12 × 5 = 60 minute spaces.

The time taken by the hour hand (smaller hand) to cover a distance of an hour space is equal to the time taken by the minute hand (longer hand) to cover a distance of the whole circumference. Thus, we may conclude that **in 60 minutes, the minute hand gains 55 minutes on the hour hand.**

"In an hour, the hour-hand moves a distance of 5 minute spaces whereas the minute-hand moves a distance of 60 minute spaces. Thus the minute-hand remains 60 - 5 = 55 minute spaces ahead of the hour-hand."

The above conclusion is very much useful in solving the problems related with Clock. Therefore do remember it.

Besides it you need to know some other important facts also

Both hands	**Required Angle**	**Number of times it happens in 12 hours**
to be coincident	0°	11
to be at right angle	90°	22
to be in opposite direction	180°	11
to be in straight line	0° or 180°	22

- The clock is divided into 60 equal minute divisions.
- 1 minute division = $\frac{360^\circ}{60}$ = 6° apart.

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rated by five minute divisions (= 5 × 6°) = 30° apart.

- In one minute, the minute hand moves one minute division or 6°.
- In one minute, the hour hand moves $\frac{1}{2}^{\circ}$.
- In one minute the minute hand gains $5\frac{1}{2}^{\circ}$ more than hour hand.
- When the hands are together, they are 0° apart.
- In every hour, both the hands coincide once but during 11 O'clock to 1 O'clock it happens only once at 12 O'clock.
- When the two hands are at right angle, they are 15 minute spaces apart. This happens twice in every hour but during 8 O'clock to 10 O'clock it happens three times only.
- When the hands are in opposite directions, they are 30 minute spaces apart. This happens once in every hour but from 5 O'clock to 7 O'clock it happens only once.
- The hands are in the same straight line when they are coincident or opposite to each other.
- The hour hand moves around the whole circumference of clock once in 12 hours. So the minute hand is twelve times faster than hour hand.

1. What angle is covered by hour hand in 1 second?

Sol. In 12 hours the hour hand covers 360°

In 1 hour (60 min.) the hour hand covers

$$\frac{360^0}{12} = 30^0$$

In 1 hour i.e. (60 × 60 sec.) the hour hand covers 30°

In 1 second the hour hand covers

$\boxed{1 \text{ Sec.} = \frac{1}{120}^{\circ} \text{ is covered by hour hand}}$

2. What angle is covered by minute hand in 1 second?

Sol. In 1 hour i.e. (60 min.) angle covered by min. hand = 360°

In 1 min. angle covered by min. hand

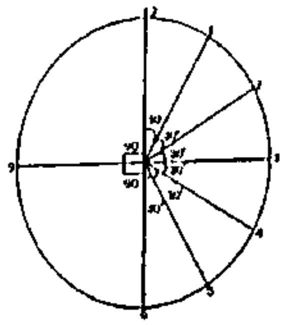
$$\frac{360^0}{60} = 6^0$$

i.e. in 60 sec. angle covered by min. hand 6°

In 1 sec. $\frac{6^0}{60} = \frac{1^0}{10} = 0.1^0$

$\boxed{1 \text{ Sec.} = 0.1^{\circ} \text{ is covered by min. hand}}$

For better understanding of the angles see the diagram given below



Clock

Ex. 1. At what time between 3 and 4 O'clock are the hands of a clock together?

Sol. At 3 O'clock, the hour hand is at 3 and the minute hand is at 12. i.e., they are 15 min. spaces apart. To be together, the minute hand must gain 15 min. over the hour hand.

We know 55 min. are gained in 60 min.

∴ 15 min. will be gained in

$$\left[\frac{60}{55} \times 15\right] \text{min.} = 16\frac{1}{4} \text{min.}$$

So, the hands will coincide at $16\frac{4}{11}$ min. past 3.

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Ex. 2. At what time between 4 and 5 O'clock will the hand of clock be at right angle?

Sol. At 4 O' clock, the minute hand will be 20 min. spaces behind the hour hand.

Now, when the two hands are at right angle, they are 15 min. spaces apart.

So, there are two possible cases:

Case (I): When the min. hand is 15 min. spaces behind the hour hand.

To be in this position, the min. hand will have to gain (20 - 15) = 5 min. spaces.

We know,

55 min. spaces are gained in 60 min.

$\therefore$ 5 min. spaces are gained in

$$\left[\frac{60}{55}\times 5\right] \text{ min.} = 5\frac{5}{11} \text{ min. past 4.}$$

Case (II): When the min. hand is 15 min. spaces ahead of the hour hand.

To be in this position, the min. hand will have to gain (20 + 15) = 35 min. spaces.

Now, 55 min. spaces are gained in 60 min.

$\therefore$ 35 min. spaces will be gained in $\left[\frac{60}{55}\times 35\right]$

min. $= 38\frac{2}{11}$ min.

So, they are at right angle at $38\frac{2}{11}$ min. past 4.

Ex.3. Find at what time between 8 and 9 O' clock will the hands of a clock be in the same straight line but not together.

Sol. At 8 O'clock, the hour hand is at 8 and the min. hand is at 12 i.e., the two hands are 20 min. spaces apart.

To be in the same straight line but not together they will be 30 min. spaces apart.

So, the min. hand will have to gain (30 - 20) = 10 min. spaces over the hour hand.

Now, 55 min. are gained in 60 min.

10 min. will be gained in $\left[\frac{60}{55}\times 10\right]$ min.

$$= 10\frac{10}{11} \text{ min.}$$

The hands will be in straight line at $10\frac{10}{11}$ min. past 8.

Ex. 4. At what time between 5 and 6 are the hands of a clock will be 3 minutes apart?

Sol. At 5 O' clock, both the hands are 25 minute spaces apart.

Case I: Minute hand is 25 minute spaces apart. In this case, the minute hand has to gain (25 - 3) i.e. 22 minute spaces.

Now, 55 min. are gained in 60 min.

22 min. are gained in

$$\left[\frac{60}{55}\times 22\right] \text{ min.} = 24 \text{ min.}$$

$\therefore$ The hand will be 3 minutes spaces apart at 24 min. past 5.

Case II: Minute hand is 3 minute spaces ahead of the hour hand.

In this case, the minute hand has to gain (25 + 3) i.e., 28 minute spaces.

Now , 55 min. are gained in 60 min.

28 min. are gained in

$$\left[\frac{60}{55}\times 28\right] = 30\frac{6}{11} \text{ min.}$$

The hands will be 3 minutes spaces apart at $30\frac{6}{11}$ min. past 5.

Ex.5. The minute hand of a clock overtakes the hour hand at intervals of 65 minutes of correct time. How much does the clock gain or lose in a day?

Sol. In a correct clock, the minute hand gains 55 minute spaces over the hour hand in 60 minutes. To be together again, the minute hand must gain 60 minutes over the hour hand.

Now, 55 min. are gained in 60 min.

60 min. are gained in $\left[\frac{60}{50}\times 60\right]$ min.

$$= 65\frac{5}{11} \text{ min.}$$

But, they are together after 65 minutes.

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$\therefore$ Gain in 65 minutes $\left[65\frac{5}{11}-65\right]=\frac{5}{11}$ min.

Gain in 24 hrs. $=\left[\frac{5}{11}\times\frac{60\times24}{65}\right]$ min.

$=10\frac{10}{143}$ min.

Ex. 6. A watch which gains uniformly, is 5 min. slow at 8 O'clock in the morning on Sunday, and is 5 minutes 48 seconds fast at 8 pm on following Sunday. When was it correct?

Sol. Time from 8 am on Sunday to 8 pm on following Sunday = 7 days 12 hours = 180 hours.

Thus, the watch gains $\left[5+5\frac{4}{5}\right]$ min.

or $\frac{54}{5}$ min. in 180 hours

Now, $\frac{54}{5}$ min. are gained in 180 hours.

5 min. are gained in $\left[\frac{180\times5\times5}{54}\right]$ hours.

$=83\frac{1}{3}$ hrs

= 83 hrs. 20 min. after 8 am on Sunday

Thus, the watch is correct after 3 days 11 hrs. 20 min. after 8 am on Sunday i.e., it will be correct at 20 min. past 7 pm on Wednesday.

Ex. 7. A clock is set right at 8 am. The clock gains 10 minutes in 24 hours. What will be the true time when the clock indicates 1 pm on the following day?

Sol. Time from 8 am on a day to 1 pm on the following day is 29 hrs.

Now, 24 hrs. 10 min. of this clock = 24 hrs. of the correct clock

Or,

(24 hrs. + 10 min. $=24+\frac{10}{60}=\frac{145}{6}$ hrs.)

= 24 hrs. of the correct clock.

Here $\frac{145}{6}$ hrs. of this clock = 24 hrs. of the correct clock.

$\therefore$ 1 hr = $\frac{24\times6}{145}$

So, 29 hrs. of the clock = $\left[\frac{24\times6}{145}\times29\right]$ hrs. of correct clock = 28 hrs. 48 min. of the correct clock

So, the correct time is 8 am + 28 hrs. 48 min.

= 12 : 48 pm. **Ans.**

Ex. 8. A clock is set right at 5 am. The clock loses 16 minutes in 24 hours. What will be the true time when the clock indicates 10 pm on the 4th day?

Sol. Time from 5 am on a day to 10 pm on 4th day is 89 hours.

Now, 23 hrs. 44 min. $\left[\frac{356}{15}\text{hrs}\right]$ of this clock are the same as 24 hours of the correct clock.

i.e. $\frac{356}{15}$ hrs of this clock = 24 hrs. of correct clock.

89 hrs. of this clock = $\left[\frac{24\times15}{356}\times89\right]$ hrs. of correct clock.

= 90 hrs. of correct clock.

So, the correct time is 11 pm **Ans.**

Ex. 9. What smaller angle will the hour hand and minute hand make at 5 : 15 am?

Sol. Speed of hour hand = 30° per hour

$=\frac{30^0}{60}$ per minute

$=\left[\frac{1}{2}\right]^0$ per minute

$\therefore$ The angle of hour hand from 12 at 5 :15

$=5\times30^\circ+15\times1/2^\circ=150^\circ+7.5^\circ=157.5^\circ$

The angle of minute hand from 12 at 15 minutes = 3 × 30° = 90°

Angle between hour hand and minute hand will be = 157.5° – 90° = 67.5° **Ans.**

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Ex. 10. What will be the smaller angle between hour hand and minute hand at 8 : 30 pm?

Sol. Angle between hands

$= 30° \times 8 - 30 \times 6° + 30 \times \frac{1}{2}°$

$= 240° - 180° + 15° = 240° - 165°$

$= 75°$ **Ans.**

UNIQUE RULE:

To find the angle between the hour hand and the minute hand

I. Multiply 30° to the given hour digit and 11/2° to the minute and subtracts the smaller result to the bigger one.

Ex. What will be the angle between hour hand and minute hand at 8 : 30 pm?

$= 8 \times 30° = 240,\ = 165°$

$= 240° - 165° = 75°$ Ans.

II. If the result of this substraction is more than 180° than we should substract the result from 360°.

Ex. Find the angle between hour hand and minute hand when the time is 1 : 52 (am/pm).

Sol. $01 \times 30° = 30,$

$52 \times 11/2° = 286°$

According to the rule, $286° - 30° = 256°$

(But, the finding result is more than 180° so, we should substract it from 360°)

thus, $360° - 256° = 104°$ **Ans.**

Excercise:

1. At what time between 3 and 4 O'clock are the hands of a clock together?

(1) $16\frac{5}{11}$ min. past 3

(2) [illegible]$\frac{7}{11}$ min. past 3

(3) $16\frac{[illegible]}{11}$ min. past 3

(4) None of these

2. At what time between 5 and 6 are the hands of a clock coinciding each other?

(1) 22 minutes past 5

(2) 30 minutes past 5

(3) $22\frac{8}{11}$ minutes past 5

(4) $27\frac{3}{11}$ minutes past 5

3. At what time between 9 and 10 will the hands of a clock be together?

(1) 45 minutes past 9

(2) 50 minutes past 9

(3) $49\frac{1}{11}$ minutes past 9

(4) $48\frac{2}{11}$ minutes past 9

4. At what times are the hands of a clock together between 2 and 3?

(1) $10\frac{9}{[illegible]}$ min. past 2

(2) $10\frac{10}{11}$ min. past 2

(3) $10\frac{8}{11}$ min. past 2

(4) None of these

5. At what time between 5 and 5:30 O'clock will the hands of a clock be at right angle?

(1) $10\frac{10}{11}$ min. past 5

(2) $10\frac{9}{10}$ min. past 5

(3) $11\frac{10}{11}$ min. past 5

(4) None of these

6. At what times are the hands of a clock at right angles between 7 am and 8 am?

(1) $54\frac{6}{11}$ min. past 7, $21\frac{9}{11}$ min. past 7

(2) $52\frac{5}{11}$ min. past 7, $21\frac{8}{11}$ min. past 7

(3) $56\frac{6}{11}$ min. past 7, $21\frac{8}{11}$ min. past 7

(4) None of these

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7. At what time between 5:30 and 6 will the hands of a clock be at right angles?

(1) $43\frac{5}{11}$ minutes past 5

(2) $43\frac{7}{11}$ minutes past 5

(3) 40 minutes past 5

(4) 45 minutes past 5

8. At which of the following times between 10 and 11 O'clock will the hand of clock be at right angle?

(1) $38\frac{2}{11}$ min. past 10

(2) $6\frac{5}{11}$ min. past 10

(3) $38\frac{3}{11}$ min. past 10

(4) $8\frac{2}{11}$ min. past 10

9. Find at what time between 8 and 9 O'clock will the hands of a clock be in the same straight line but not together.

(1) $10\frac{10}{11}$ min. past 8

(2) $10\frac{9}{11}$ min. past 8

(3) $11\frac{10}{11}$ min. past 8

(4) None of these

10. Find at what time between 2 and 3 O'clock will the hands of a clock be in the same straight line but not together.

(1) [illegible] min. past 2

(2) $43\frac{7}{11}$ min. past 2

(3) $43\frac{3}{11}$ min. past 2

(4) None of these

11. Find at what time between 9 and 10 O'clock will the hands of a clock be in the same straight line but not together.

(1) $16\frac{4}{11}$ min. past 9

(2) $16\frac{5}{11}$ min. past 9

(3) $16\frac{3}{11}$ min. past 9

(4) None of these

12. At which of the following times between 5 and 6 are the hands of a clock 3 minutes apart?

(1) 24 min. past 5

(2) 26 min. past 5

(3) $30\frac{5}{11}$ min. past 5

(4) 22 min. past 5

13. At which of the following times between 4 and 5 are the hands of a clock 3 minutes apart?

(1) $18\frac{6}{11}$ min. past 4

(2) $26\frac{5}{11}$ min. past 4

(3) $25\frac{5}{11}$ min. past 4

(4) $25\frac{3}{11}$ min. past 4

14. At what time between 3 and 4 is the minute-hand 7 minutes ahead of the hour-hand?

(1) $8\frac{8}{11}$ min. past 3

(2) 24 min. past 3

(3) 25 min. past 3

(4) 22 min. past 3

15. At what time between 3 and 4 is the minute-hand 4 minutes behind the hour-hand?

(1) 12 minutes past 3

(2) 11 minutes past 3

(3) 19 minutes past 3

(4) None of these

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16. The minute hand of a clock overtakes the hour hand at intervals of 63 minutes of correct time. How much a day does the clock gain or lose?

(1) $56\frac{8}{77}$ min. gain

(2) $56\frac{8}{77}$ min. lose

(3) $57\frac{8}{77}$ min. gain

(4) $57\frac{8}{77}$ min. lose

17. How much does a watch gain or lose per day, if its hands coincide every 64 minutes of correct time?

(1) $32\frac{8}{11}$ min. gain

(2) $31\frac{8}{11}$ min. gain

(3) $32\frac{3}{11}$ min. gain

(4) $32\frac{8}{11}$ min. lose

18. At which of the following times between 3 and 4 O'clock when the angle between the hands of a watch is one-third of a right angle.

(1) $10\frac{10}{11}$ min. past 3

(2) $10\frac{9}{11}$ min. past 3

(3) $11\frac{9}{11}$ min. past 3

(4) $21\frac{9}{11}$ min. past 3

19. Find the smaller angle between the two hands of a clock of 15 minutes past 4 O'clock.

(1) 38.5° (2) 36.5°

(3) 37.5° (4) None of these

20. Find the smaller angle between the two hands of a clock at 4.30 pm.

(1) 45° (2) 30°

(3) 60° (4) None of these

21. At what angle (smaller) are the two hands of a clock inclined at 20 minutes past 5?

(1) 30° (2) 45° (3) 50° (4) 40°

22. At what angle (smaller) are the two hands of a clock inclined at 32 minutes past 9?

(1) 94° (2) 95° (3) 93° (4) 92°

23. At what angle (smaller) are the two hands of a clock inclined at 17 minutes past 9?

(1) $167\frac{1}{2}°$ (2) $172\frac{1}{2}°$ (3) $166\frac{1}{2}°$ (4) $176\frac{1}{2}°$

24. At what angle are the two hands of a clock inclined at 38 minutes past 7?

(1) 01° (2) 02° (3) 03° (4) $1\frac{1}{2}°$

25. At what angle (larger) are the two hands of a clock inclined at 48 minutes past 12?

(1) 264° (2) 263° (3) 265° (4) 266°

26. At what angle are the two hands of a clock inclined at 4 minutes to 12?

(1) 22° (2) 20° (3) 21° (4) 23°

27. How many times do the hands of a clock point opposite to each other in 12 hours?

(1) 6 times (2) 10 times

(3) 11 times (4) 12 times

28. How many times are the hands of a clock at right angles in a day?

(1) 24 times (2) 48 times

(3) 22 times (4) 44 times

29. How many times in a day are the hands of a clock straight?

(1) 48 times (2) 24 times

(3) 44 times (4) 22 times

30. A watch which gains uniformly, is 5 min. slow at 8 O'clock in the morning on Sunday, and is 5 min. 48 sec. fast at 8 pm on following Sunday. When was it correct?

(1) 20 min. past 7 pm on Tuesday

(2) 20 min. past 7 pm on Wednesday

(3) 10 min. past 7 pm on Tuesday

(4) 10 min. past 7 pm on Wednesday

31. A clock is set right at 8 am. The clock gains 10 minutes in 24 hours. What will be the true time when the clock indicates 1 pm on the following day?

(1) 28 hrs. (2) 28 hrs. 48 min.

(3) 28 hrs. 42 min.

(4) None of these

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32. A clock is set right at 4 am. The clock loses 20 min. in 24 hours. What will be the true time when the clock indicates 3 am on 4th day?

(1) 4 am (2) 5 am (3) 3 am (4) 4 pm

33. A watch, which gains uniformly is 2 min. slow at noon on Monday, and is 4 min. 48 seconds fast at 2 pm on the following Monday. When was it correct?

(1) 2 pm on Tuesday
(2) 2 pm on Wednesday
(3) 3 pm on Thursday
(4) 1 pm on Friday

34. A watch which gains 5 seconds in 3 minutes was set right at 7 am. In the afternoon of the same day when the watch indicated quarter past 4 O'clock, the true time is-

(1) $59\frac{7}{12}$ minutes past 3
(2) 4 pm
(3) $58\frac{7}{11}$ minutes past 3
(4) $2\frac{3}{11}$ minutes past 4

35. How many times do the hands of a clock coincide in a day?

(1) 24 (2) 20 (3) 21 (4) 22

36. At what time between 4 and 5 will the hands of a watch be equidistant from the figure 5.

(1) $27\frac{9}{11}$ min. past 4
(2) $27\frac{8}{13}$ min. past 4
(3) $27\frac{9}{13}$ min. past 4
(4) None of these

37. If the hands of a clock coincide every 65 minutes of correct time. How much does the clock gain or lose in 24 hours?

(1) $11\frac{10}{143}$ min. gain
(2) $10\frac{10}{143}$ min. lose
(3) $10\frac{9}{143}$ min. gain
(4) None of these

Directions (38 - 42): The questions given below are based on a vertical mirror and a clock. The clock has dots on its dial and not numbers written on it. Read the questions carefully and find out the real/reflected time.

38. If the real time is 12 : 30, then what is the time shown by the reflection?

(1) 12 : 30 (2) 11 : 30
(3) 6 : 30 (4) 1 : 30

39. If the time by any clock is 6 O'clock, what is the reflected time?

(1) 12 : 30 (2) 6 : 00
(3) 6 : 30 (4) 12 : 00

40. If the time shown by the reflection is 1 : 40, then what is the real time?

(1) 11 : 40 (2) 5 : 45
(3) 10 : 20 (4) 11 : 20

41. If the time shown by the reflection is 12 : 25, then what is the real time?

(1) 12 : 25 (2) 12 : 35
(3) 11 : 35 (4) 10 : 35

42. If on the dial of a clock, we substitute the numbers with the reversed order of alphabets K to V so that 'V' substitutes '5' and 'U' substitutes' '6' and the process is continued, then which alphabet will come in place of 11?

(1) Q (2) O (3) M (4) P

Answer with explanations:

1. 3; At 3 O'clock, the hour hand is at 3 and the minute hand is at 12. It means that they are 15 min. spaces apart. To be together, the minute hand must gain 15 minutes over the hour hand. Now, we know that 55 min. are gained in 60 min.

$\therefore$ 15 min. are gained in

$$\frac{60}{55}\times 15 = \frac{180}{11} = 16\frac{4}{11} \text{ min.}$$

Therefore, the hands will be together at $16\frac{4}{11}$ min. past 3.

2. 4; At 5 O'clock, the hour hand is at 5 and the minute hand is at 12. It means that they are 25 min. spaces apart. To be coincide, the minute hand must gain 25 minutes over the hour hand. Now, we know that 55 min. are gained in 60 min.

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∴ 25 min. are gained in

$\frac{60}{55} \times 25 = \frac{300}{11} = 27\frac{3}{11}$ min.

Therefore, the hands will be together at

$27\frac{3}{11}$ min. past 5.

3. 3; At 9 O'clock, the hour hand is at 9 and the minute hand is at 12. It means that they are 45 min. spaces apart. To be together, the minute hand must gain 45 minutes over the hour hand. Now, we know that 55 min. are gained in 60 min.

∴ 45 min. are gained in

$\frac{60}{55} \times 45 = \frac{540}{11} = 49\frac{1}{11}$ min.

Therefore, the hands will be together at

$49\frac{1}{11}$ min. past 9.

4. 2; At 2 O'clock, the hour hand is at 2 and the minute hand is at 12. It means that they are 10 min. spaces apart. To be together, the minute hand must gain 10 minutes over the hour hand. Now, we know that 55 min. are gained in 60 min.

∴ 10 min. are gained in

$\frac{60}{55} \times 10 = \frac{120}{11} = 10\frac{10}{11}$ min.

Therefore, the hands will be together at

$10\frac{10}{11}$ min. past 2.

5. 1; At 5 O'clock, there are 25 min. spaces between hour and minute hands.To be at right angle, they should be 15 min. spaces apart. To be in this position, the min. hand should have to gain 25 – 15 = 10 min. spaces.

Now, we know that 55 min. spaces are gained in 60 min.

∴ 10 min. spaces are gained in

$\frac{60}{55} \times 10 = \frac{120}{11} = 10\frac{10}{11}$ min.

∴ they are at right angle at $10\frac{10}{11}$ min. past 5.

6. 1; At 7 O'clock, there are 35 min. spaces between hour and minute hands.To be at right angle, they should be 15 min. spaces apart. So, there are two cases:

Case I:

When the minute hand is 15 min. spaces behind the hour hand.

To be in this position, the min. hand should have to gain 35 – 15 = 20 min. spaces.

Now, we know that 55 min. spaces are gained in 60 min.

∴ 20 min. spaces are gained in

$\frac{60}{55} \times 20 = \frac{240}{11} = 21\frac{9}{11}$ min.

∴ they are at right angle at $21\frac{9}{11}$ min. past 7.

Cae II:

When the minute hand is 15 min. spaces ahead of the hour hand.

To be in this position, the min. hand should have to gain 35 + 15 = 50 min. spaces.

Now, we know that 55 min. spaces are gained in 60 min.

∴ 50 min. spaces will be gained in

$\frac{60}{55} \times 50 = \frac{600}{11} = 54\frac{6}{11}$ min.

∴ they are at right angle at $54\frac{6}{11}$ min. past 7.

7. 2; At 5 O'clock, there are 25 min. spaces between hour and minute hands.To be at right angle, they should be 15 min. spaces apart. So, there are two cases:

Case I:

When the minute hand is 15 min. spaces behind the hour hand.

Reject the case I, because this incidence will happen before 5 : 30.

Cae II:

When the minute hand is 15 min. spaces ahead of the hour hand.

To be in this position, the min. hand should have to gain 25 + 15 = 40 min. spaces.

Now, we know that 55 min. spaces are gained in 60 min.

∴ 40 min. spaces will be gained in

$\frac{60}{55} \times 40 = \frac{480}{11} = 43\frac{7}{11}$ min.

∴ they are at right angle at $43\frac{7}{11}$ min. past 5.

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8. 1. At 10 O'clock, there are 50 min. spaces between hour and minute hands. To be at right angle they should be 15 min spaces apart. So, there are two cases

Case I:

When the minute hand is 15 min. spaces behind the hour hand.

To be in this position, the min. hand should have to gain 50 − 15 = 35 min spaces

Now, we know that 55 min. spaces are gained in 60 min

∴ 35 min. spaces are gained in

$\frac{60}{55} \times 35 = \frac{420}{11} = 38\frac{2}{11}$ min

∴ they are at right angle at $38\frac{2}{11}$ min past 10

Cae II:

When the minute hand is 15 min. spaces ahead of the hour hand

To be in this position, the min. hand should have to gain 15 − 10 = 5 min spaces

Now, we know that 55 min. spaces are gained in 60 min

∴ 5 min. spaces will be gained in

$\frac{60}{55} \times 5 = \frac{60}{11} = 5\frac{5}{11}$ min

∴ they are at right angle at $5\frac{5}{11}$ min past 10

9. 1. To be in same straight line (but not together) the angle between the hour and minute hands must be 180°, ie, 30 min spaces apart

At 8 O'clock they are 40 min. spaces apart

Therefore, to be in opposite directions the minute hand will have to gain 40 − 30 = 10 min. spaces

Now, 10 min. spaces will be gained in

$\frac{60}{55} \times 10 = \frac{120}{11} = 10\frac{10}{11}$ min

∴ the hand will in opposite directions at $10\frac{10}{11}$ min past 8

10. 2. To be in same straight line (but not together) the angle between the hour and minute hands must be 180°, ie, 30 min spaces apart

At 2 O'clock they are 10 min. spaces apart

Therefore, to be in opposite directions the minute hand will have to gain 30 + 10 = 40 min spaces

Now, 40 min. spaces will be gained in

$\frac{60}{55} \times 40 = \frac{480}{11} = 43\frac{7}{11}$ min

∴ the hand will in opposite directions at $43\frac{7}{11}$ min past 2

11. 1. To be in same straight line (but not together) the angle between the hour and minute hands must be 180°, i.e. 30 min spaces apart

At 9 O'clock they are 15 min. spaces apart

Therefore, to be in opposite directions the minute hand will have to gain 30 − 15 = 15 min. spaces

Now, 15 min. spaces will be gained in

$\frac{60}{55} \times 15 = \frac{180}{11} = 16\frac{4}{11}$ min

Hence the hand will in opposite directions at $16\frac{4}{11}$ min past 9

12. 1. At 5 O'clock the two hands are 25 min spaces apart

Case I:

When the minute hand is 3 minute spaces behind the hour hand.

In this case, the minute hand will have to gain (25 − 3), ie, 22 minute spaces.

Now, we know that 22 min. spaces will be gained in

$\frac{60}{55} \times 22 = 24$ min

Hence they will be 3 min. apart at 24 min past 5

Case II:

When the minute hand is 3 min. spaces ahead of the hour hand.

In this case, the minute hand will have to gain (25 + 3), ie, 28 minute spaces.

Now, we know that 28 minute spaces will be gained in

$\frac{60}{55} \times 28 = \frac{336}{11} = 30\frac{6}{11}$ min.

Hence, the hands will be 3 min. apart at

$30\frac{6}{11}$ min. past 5.

13. 1; At 4 O'clock, the two hands are 20 min. spaces apart.

Case I:

When the minute hand is 3 minute spaces behind the hour hand.

In this case, the minute hand will have to gain (20 -3), ie, 17 minute spaces. Now, we know that 17 min. spaces will be gained in

$\frac{60}{55}\times 17 = \frac{204}{11} = 18\frac{6}{11}$ min.

Hence, they will be 3 min. apart at $18\frac{6}{11}$ min. past 4.

Case II:

When the minute hand is 3 min. spaces ahead of the hour hand.

In this case, the min-hand will have to gain (20 + 3), ie, 23 minute spaces.

Now, we know that 23 minute spaces will be gained in

$\frac{60}{55}\times 23 = \frac{276}{11} = 25\frac{1}{11}$ min.

Hence the hands will be 3 min. apart at

$25\frac{1}{11}$ min. past 4.

14. 2; At 3 O'clock, the two hands are 15 min. spaces apart.

When the minute hand is 7 min. spaces ahead of the hour hand. In this case, the min-hand will have to gain (15 + 7), i.e, 22 minute spaces.

Now, we know that 22 minute spaces will be gained in $\frac{60}{55}\times 22 = 24$ min.

Hence, the minute hand will be 7 min. spaces ahead of the hour hand at 24 min. past 3.

15. 1; At 3 O'clock, the two hands are 15 min. spaces apart.

When the minute hand is 4 minute spaces behind the hour hand. In this case, the minute hand will have to gain (15 - 4), i.e. 11 minute spaces. Now, we know that 11 min. spaces will be gained in $\frac{60}{55}\times 11 = 12$ min.

Hence, they will be 4 min. apart at 12 min. past 3.

16. 1; In a correct clock, the minute hand gains 55 min. spaces over the hour-hand in 60 minutes. To be together again, the minute-hand must gain 60 min. over the hour hand.

We know that 60 min. are gained in

$\frac{60}{55}\times 60 = 65\frac{5}{11}$ min.

But they are together after 63 minutes.

Hence, gain in 63 minutes

$= 65\frac{5}{11} - 63 = 2\frac{5}{11} = \frac{27}{11}$ min.

Therefore gain in 24 hrs.

$= \frac{27\times 60\times 24}{11\times 63} = 56\frac{8}{77}$ min.

17. 1; In a correct clock, the minute hand gains 55 min. spaces over the hour-hand in 60 minutes. To be together again, the minute-hand must gain 60 min. over the hour hand.

We know that 60 min. are gained in

$\frac{60}{55}\times 60 = 65\frac{5}{11}$ min.

But they are together after 64 minutes.

Hence gain in 64 minutes

$= 65\frac{5}{11} - 64 = 1\frac{5}{11} = \frac{16}{11}$ min.

Therefore gain in 24 hrs.

$= \frac{16\times 60\times 24}{11\times 64} = 32\frac{8}{11}$ min.

18. 1; At 3 O'clock the two hands of the clock are 15 minute spaces apart. Here we have to look for the time when the angle between the two hands are 30°. Note that 30° means 5 minute spaces apart. There will be two such cases.

Case I :

When the minute hand is 5 minute spaces behind the hour hand.

In this case, the minute hand will have to gain (15 -5), i.e. 10 minute spaces. Now, we know that 10 min. spaces will be gained in

$\therefore$ 10 min. are gained in

$\frac{60}{55}\times 10 = \frac{120}{11} = 10\frac{10}{11}$ min.

Therefore, the hands will be together at

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$10\frac{10}{11}$ min. past 3.

Hence they will be 5 min. spaces apart at

$10\frac{10}{11}$ min. past 3.

Case II:

When the minute hand is 5 min. spaces ahead of the hour hand.

In this case, the minute hand will have to gain (15 + 5), i.e. 20 minute spaces. Now, we know that 20 minute spaces will be gained in

$\therefore$ 20 min. spaces are gained in

$\frac{60}{55}\times 20=\frac{240}{11} = 21\frac{9}{11}$ min.

Hence, they will be 5 min. spaces apart at $21\frac{9}{11}$ min. past 3.

19\. 3; At 4 O'clock the two hands of the clock are 20 minute spaces apart.We know that 5 minute spaces is equal to 30°. Therefore 20 minute spaces implies 120°. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°.Therefore after 15 minutes minute hand rotates 90° whereas hour hand rotates 7.5°. Hence the required angle is (120 - 90 + 7.5) = 37.5°

20\. 1; At 4 O'clock the two hands of the clock are 20 minute spaces apart. We know that 5 minute spaces is equal to 30°. Therefore 20 minute spaces implies 120°. Also, we know that in 1 minute, minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 30 minutes, minute hand rotates 180° whereas hour hand rotates 15°.

Hence, the required angle is
(180 - 120 - 15) = 45°.

21\. 4; At 5 O'clock the two hands of the clock are 25 minute spaces apart. We know that 5 minute spaces is equal to 30°. Therefore 25 minute spaces implies 150°. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 20 minutes minute hand rotates 120° whereas hour hand rotates 10°. Hence the required angle is
(150 - 120 + 10) = 40°.

22\. 1; At 9 O'clock the two hands of the clock are 45 minute spaces apart.We know that 5 minute spaces is equal to 30°. Therefore 45 minute spaces implies 270°. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 32 minutes minute hand rotates (32 × 6) = 192° whereas hour hand rotates 16°. Hence the required angle is
(270° - 192° + 16°) = 94°.

23\. 4; At 9 O'clock the two hands of the clock are 45 minute spaces apart. We know that 5 minute spaces is equal to 30°. Therefore 45 minute spaces implies 270°. Also, we know that in 1 minute, minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 17 minutes minute hand rotates (17 × 6) = 102° whereas hour hand rotates 8.5°. Hence the required angle is (270 - 102 + 8.5) = 176.5°.

24\. 1; At 7 O'clock the two hands of the clock are 35 minute spaces apart. We know that 5 minute spaces is equal to 30°. Therefore 35 minute spaces implies 210°. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 38 minutes minute hand rotates (38 × 6) = 228° whereas hour hand rotates 19°. Hence the required angle is
(210 - 228 + 19) = 1°.

25\. 1; At 12 O'clock the two hands of the clock are 0 minute spaces apart. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 48 minutes minute hand rotates (48 × 6) = 288° whereas hour hand rotates 24°. Hence the required angle is (288 - 24) = 264°.

26\. 1; At 11 O'clock the two hands of the clock are 5 minute spaces apart. We know that 5 minute spaces is equal to 30°. Also, we know that in 1 minute minute hand rotates by 6° whereas hour hand rotates by 0.5°. Therefore after 56 minutes minute hand rotates (56 × 6) = 336° whereas hour hand rotates 28°. Hence, the required angle is (30 + 336 - 28) = 338°. But there is no such choices. Now look for the angle (360 - 338) = 22°.

27\. 3; The hands of a clock point opposite to each other 11 times in every 12 hours (because between 5 and 7, at 6 O'clock only they point opposite to each other).

28. 4; In 12 hours, they are at right angles 22 times (because two positions of 3 O'clock and 9 O'clock are common). Therefore, in a day they are at right angles for 44 times.

29. 3; The hands coincide or are in opposite direction (22 + 22) ie 44 times in a day.

30. 2; Time between the given interval = 180 hrs.
The watch gains
$= 5+5\frac{4}{5}=\frac{54}{5}$ min. in 180 hrs.
$\therefore$ 5 min. is gained in $\frac{180\times5}{54}\times5$ = 83 hrs. 20 min. = 3 days 11 hrs 20 min.
$\therefore$ it was correct at 20 min. past 7 pm on wednesday.

31. 2; Time from 8 am on a day to 1 pm on the following day is 29 hrs.
Now, 24 hrs. 10 min. of this clock are the same as 24 hours of the correct clock.
i.e. $\frac{145}{6}$ hrs. of this clock = 24 hrs of correct clock.
29 hrs. of this clock = $\left(\frac{24\times6}{145}\times29\right)$ hrs. of correct clock = 28 hrs. 48 min. of correct clock.
So, the correct time is 28 hrs. 48 min. after 8 am or 48 min. past 12.

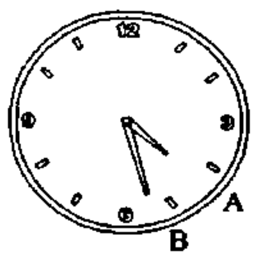
32. 1; Time from 4 am to 3 am on 3rd day
= 24 × 3 − 1 = 71 hrs.
Now, 23 hrs. 40 min. of this clock = 24 hrs. of correct clock.
or, $23\frac{2}{3}=\frac{71}{3}$ hrs of this clock
= 24 hrs. of correct clock.
$\therefore$ 71 hrs. of this clock
$=\frac{24\times3\times71}{71}=72$ hrs. of correct clock.
Therefore, the correct time
= 3 am + (72 − 71) = 4 am

33. 2; Time from Monday noon to 2 pm on following Monday = 7 days 2 hours = 170 hours
The watch gains $\left(2+4\frac{4}{5}\right)$
or, $\frac{34}{5}$ min. in 170 hours
$\therefore$ it will gain 2 min. in $\left(\frac{170\times5}{34}\times2\right)$ hrs.
= 50 hrs. = 2 days 2 hrs.
So, the watch is correct 2 days 2 hours after Monday noon ie at 2 pm on Wednesday.

34. 2; Time from 7 am to quarter past 4 = 9 hours 15 min. = 555 min.
Now, $\frac{37}{12}$ min. of this watch = 3 min. of the correct watch.
555 min. of this watch = $\left(\frac{3\times12}{37}\times555\right)$ min.
$=\left(\frac{3\times12}{37}\times\frac{555}{60}\right)$ hrs. = 9 hrs. of the correct watch.
Correct time is 9 hours after 7 am i.e. 4 pm.

35. 4; The hands of a clock coincide 11 times in every 12 hours (because between 11 and 1, they coincide only once, at 12 O'clock). So, the hands coincide 22 times in a day.

36. 3; The hands will be equidistant from the figure 5,
(i) when they are coincident between 4 and 5, and
(ii) when they are in the position shown in the diagram.



For the 1st case the time would be
$21\frac{9}{11}$ min. past 4.
In the second case suppose that the hour-hand is at A, and the minute-hand at B, so that A5 = 5B. Since the space

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between 4 and 5 is equal to the space between 5 and 6,

$\therefore$ 4A = 6B

Hence, 12B + 4A = 12B + 6B = 30 min.

That is, the two hands, between them have moved through a space of 30 minutes since 4 O'clock. But the minute hand moves 12 times as fast as the hour hand.

Hence, $12B = 30 \times \frac{12}{13} = 27\frac{9}{13}$ min.

$\therefore$ the required time is $27\frac{9}{13}$ min. past 4.

37.2; The minute-hand gains 60 minutes over the hour-hand in $\frac{60 \times 60}{55}$ or $65\frac{5}{11}$ minutes. Therefore, the hands of a correct clock coincide every $65\frac{5}{11}$ minutes.

But the hands of the clock mentioned in the question coincide every 65 minutes.

Hence in 65 minutes, the clock gains $\frac{5}{11}$ min.

$\therefore$ in 60 × 24 min. or 24 hours it gains

$\frac{5}{11} \times \frac{1}{65} \times 60 \times 24 = 10\frac{10}{143}$ min.

38 - 41:

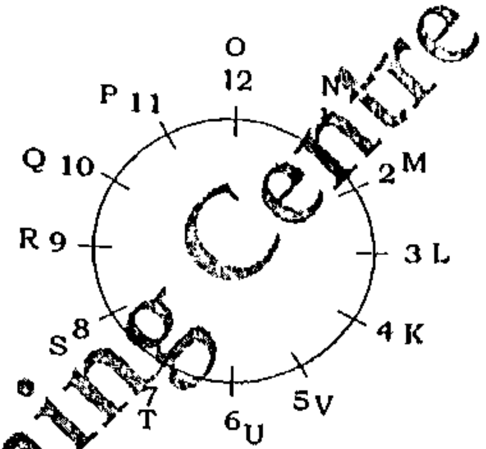
38. 2; Reflection time : 12 - 0.30 = 11 : 30

39. 2; Reflection time : 12 - 6 = 6 O'clock

40. 3; Reflection time : 12 - 1 : 40 = 10 : 20

41. 3; Reflection time : 12 - 0 : 25 = 11 : 35

42. 4;



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