Time, Speed, and Distance

Basic Concepts

- **Speed:** The distance covered per unit time. Formula: Speed = Distance / Time
- **Distance:** The total length of the path traveled. Formula: Distance = Speed × Time
- **Time:** The duration taken to cover a distance. Formula: Time = Distance / Speed

Important Relationships

1. **If time is constant:** Distance $\propto$ Speed (higher speed, more distance covered).
2. **If speed is constant:** Distance $\propto$ Time (longer time, more distance covered).
3. **If distance is constant:** Speed $\propto$ 1/Time (higher speed, lesser time taken).

Units and Conversions

- **Speed Units:** Kilometers per hour (km/h), Meters per second (m/s), Miles per hour (mph)
- **Conversion Formulas:**
    - 1 km/h = (5/18) m/s
    - 1 m/s = (18/5) km/h = 3.6 km/h
    - 1 mile = 1.60934 km
    - 1 yard = 3 feet
    - 1 mile = 1760 yards = 5280 feet
    - 1 hour = 60 minutes = 3600 seconds
    - 1 mph = (22/15) ft/s

Formulas for Common Problems

1. **Average Speed:**
    - If a journey covers two equal distances at different speeds S_1 and S_2:
        - Average Speed = $\frac{2S_1S_2}{S_1+S_2}$
    - If time taken is equal for two speeds:
        - Average Speed = $\frac{S_1+S_2}{2}$
2. **Relative Speed:**

- **Same direction:** Relative Speed = $S_1 - S_2$
- **Opposite direction:** Relative Speed = $S_1 + S_2$
- **Time taken when moving in opposite directions:** Time = $\frac{L_1+L_2}{S_1+S_2}$
- **Time taken when moving in the same direction:** Time = $\frac{L_1+L_2}{S_1-S_2}$

3. **Train Problems:**

   - **Train passing an electric pole or a person:** Speed = Length of Train / Time
   - **Two trains crossing each other:** $S_1 + S_2 = \frac{L_1+L_2}{t}$
   - **Train crossing a stationary object (platform, tunnel):** Time = $\frac{L_1+L_2}{S}$
   - **Train crossing a moving object (with length):**
     - **Opposite direction:** Time = $\frac{L_1+L_2}{S_1+S_2}$
     - **Same direction:** Time = $\frac{L_1+L_2}{S_1-S_2}$

4. **Boat and Stream:**

   - Speed in still water = (Upstream speed + Downstream speed) / 2
   - Speed of stream = (Downstream speed - Upstream speed) / 2

Concept of Acceleration

- **Acceleration (a):** The rate of change of speed.
  - Formula: $a = \frac{V-U}{t}$
  - **Final Speed Formula:** $V = U + at$
  - **Distance Formula:** $S = Ut + \frac{1}{2}at^2$
  - **Acceleration due to gravity:** $g = 9.8m/s^2$

Additional Key Concepts

- **Race Problems:** If A beats B by X meters in a race of D meters, then A's speed to B's speed is: Ratio = $\frac{D}{D-X}$
- **Chasing Problems:** If A chases B with speeds S_A and S_B, and the initial gap is D, then time to catch up = $\frac{D}{S_A-S_B}$

Examples

Example 1

Problem: A train 120 meters long passes an electric pole in 12 seconds and another train of the same length traveling in the opposite direction in 8 seconds. Find the speed of the second train.

Solution:

- Speed of first train = 120 / 12 = **10 m/s**
- Speed of second train = (120 / 8) - 10 = **5 m/s**

Example 2

Problem: Two trains moving in the same direction at speeds of 70 km/h and 90 km/h. The faster train crosses a man in the slower train in 36 sec. Find the length of the faster train.

Solution:

- Relative speed = 90 - 70 = **20 km/h** = (20 × 5/18) = **50/9 m/s**
- Length of faster train = (50/9) × 36 = **200 meters**

Example 3

Problem: A train covers first half of the distance at 40 km/h and the remaining half at 60 km/h. Find the average speed.

Solution:

- Average speed = 2×40×6040+60\frac{2 \times 40 \times 60}{40 + 60} = **48 km/h**

Example 4

Problem: A car covers 8 km in the first quarter of an hour, 6 km in the second quarter, and 16 km in the third quarter. Find the average speed of the car.

Solution:

- Total distance = 8 + 6 + 16 = **30 km**
- Total time = **0.75 hours**

- Average speed = 30 / 0.75 = **40 km/h**
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Question for Practice

1. In a 200 m race A beats B by 20 m. B beats C by 10 m in a 250 m race. By how many meters will A beat C in a 1 km race?
   (a) 146 m (b) 164 m (c) 136 m (d) 144 m

2. A boat with speed 20 m/s in still water take 1/3 hr and ½ hr in order to cover same distance downstream and upstream respectively. Then the speed of the current is:
   (a) 6 m/s (b) 8 m/s (c) 3 m/s (d) 4 m/s

3. Vijay goes Delhi to Bhopal at a uniform speed of 40 km/hr and comes back at a uniform speed of 60 km/hr. Then his average speed over the entire journey in km/hr.
   (a) 50 (b) 52.5 (c) 48 (d) 51.5

4. Ravi and Gautama are heading towards each other. If they meet at 45m from Ravi's starting point. After meeting they reach at the other's starting point in 16 hrs and 25 hrs respectively, then the initial separation between Ravi and Gautama was:
   (a) 81 m (b) 100 m (c) 90 m (d) 110 m

5. A, B, C are running on a circular track of 100 m circumference with speeds 10 m/s, 20 m/s 25 m/s respectively. if they started from common starting point at the same time then when they will again meet earliest at the starting point after how much time.
   (a) 100 secs (b) 25 secs (c) 20 secs (d) 200 secs

6. Two trains, separated by 480 kms, are approaching each other with speed 70 kmph and 50 kmph respectively. A bird with speed 100 km/hr started from the front of first train goes to front of second train and comes back to front of first and continues to and fro so on till the trains collide. What is the total distance travelled by the bird?
   (a) 500 kms (b) 400 kms (c) 480 kms (d) 600 kms

7. Two trains are approaching each other from opposite sides and crosses each other in 14 seconds. What is the speed of second train if speed of first train is 7 km/hr and the length of the trains is 126 m and 240 m respectively?
   (a) 67.14 kmph (b) 87.11 kmph (c) 77.14 kmph (d) 97. 11 kmph

8. A bus has to go a distance of 80 km in 10 hrs if it covers first half of journey in 3/5 of time, what should be its speed to cover the remaining distance in the assigned time
   (a) 20 km/hr (b) 10 km/hr (c) 5 km/hr (d) 8 km/hr

9. A train's average speed including stoppages in 45 km/hr while excluding stoppages it is 54 km/hr. what is the stoppage time per hour?
   (a) 12 min (b) 9 min (c) 15 min (d) 10 min

10. Dalbir and Asim are approaching from opposite ends of a linear race track of 100 m. After passing each other they reach end points of the track and return back. Now they meet at 35 m from where Dalbir started after 45 seconds. Find the speed of Asim.
    (a) 3 m/s (b) 3.5 m/s (c) 4.5 m/s (d) 5 m/s

11. A boy covers a certain distance between his house and school on a cycle. Having an average speed of 15 kmph, he is late by 10 min. however with an average speed of 20 kmph. He reaches the school 5 min. earlier. Find the distance between his house and school.
    (a) 15 km (b) 20 km (c) 25 km (d) 30 km

12. Two trains are moving in the same direction at the speeds of 70 kmph and 90 kmph respectively. The faster train crosses a man sitting in the slower train in 36 sec. find the length of the faster train.
(a) 200 m (b) 225 m (c) 250 m (d) Can't be determined

13. If A and B run at 6 km/hr and 12 km/hr on a circular track 6 km long when will they meet for the first time if they are running in opposite direction
(a) 20 min (b) 28 min (c) 29 min (d) 10 min

14. A and B run around a circular track of length 600 m at the respective speeds of 15 m/sec and 20 m/sec starting from the same point and at the same time travelling in the same direction. When will they meet each other at the starting point for the first time?
(a) 2 min (b) 4 min (c) 6 min (d) 7 min

15. A car travels a distance 840 km at a uniform speed if the speed of the car is 10 km/hr more it takes 2 hours less to cover the same distance then the original speed of the car was
(a) 80 km/hr (b) 70 km/hr (c) 60 km/hr (d) 40 km/hr

16. A tourist covers half of this journey by train at 60 km/hr, half of the remainder by bus at 30 km/hr and the rest by cycle at 10 km/hr. the average speed of the tourist in km/hr during his entire journey is
(a) 36 (b) 30 (c) 24 (d) 18

17. A cars travels 8 km in the first quarter of an hour, 6 km in the second quarter and 16 km in the third quarter. The average speed of the car in km per hour the entire journey is
(a) 30 (b) 36 (c) 40 (d) 24

18. We are driving along a highway at a constant speed of 55 miles per hour (mph). You observe a car one half mile behind you. The car is moving fast and zooms past you exactly one minute later. How fast is this car traveling (mph) if its speed is constant?
(a) 80 km/hr (b) 70 km/hr (c) 72 km/hr (d) 85 km/hr

19. Two cars start at the same time from the same location and go in the same direction.The speed of the first car is 50 km/h and the speed of the second car is 60 km/h. The number of hours it takes for the distance between the two cars to be 20 km is _____.
(a) 1 (b) 2 (c) 3 (d) 6

20. Two trains started at 7 AM from the same point. The first train travelled north at a speed of 80 km/h and the second train travelled south at a speed of 100 km/h. The time at which they were 540 km apart is _____AM.
(a) 9 (b) 10 (c) 11 (d) 11.30

21. Mohan beats Satish by 20 m in a 200 m race. To do a favour to Satish, in a second similar race Mohan started from 20 m behind the start line, though Satish started from start point. Then
(a) They reached simultaneously (b) Satish beats Mohan by 20 m
(c) Mohan beats Satish by 2 m (d) Satish beats Mohan by 2 m

22. An automobile travels from city A to city B and returns to city A by the same route. The speed of the vehicle during the onward & return journeys were constant at 60 km/hr and 90 km/hr respectively. What is the average speed in km /hr for the entire journey?
(a) 72 (b) 73 (c) 74 (d)75

23. It takes 10 s and 15 s , respectively, for two trains travelling at different constant speeds to completely pass a telegraph post.The length of the first train is 120m and that of the second train is 150 m. The magnitude of the difference in the speeds of the two trains (in m/s) is –
(a) 2 (b)10 (c)12 (d) 22

24. A train that is 280 meters long, travelling at a uniform speed, crosses a platform in 60 seconds and passes a man standing on the platform in 20 seconds. What is the length of the platform in 20 seconds? What is the length of the platform in meters?
(a) 280 (b) 420 (c) 700 (d) 560

25. From the time the front of a trains enters a platform, it takes 25 sec for the back of the train to leave the platform, while train travelling at a constant speed of 54 km/hr. At the same speed, it takes 14 sec to pass a man running at 9 km/hr in the same direction as the train. What is the length of the train and that of the platform in meters respectively?
(a)210 & 140 (b)162.5 & 187.5 (c)245 & 130 (d)175 & 200

26. A tiger is 50 leaps of its own behind a deer. The tiger takes 5 leaps per minute to the deer's 4. If the tiger and the deer cover 8 meter and 5 meter per leap respectively. After how much distance (in meters) will the tiger have to run before it catches the deer?
(a) 600 (b) 800 (c) 640 (d) 720

DIRECTIONS (27-30): Read the data given below –
Two trains start from the opposite stations A and B which are 100 m apart, at the same time. A bird flies from the faster train towards the slower one starting at the same time. The velocities of the two trains and the bird are in G.P. the bird being the fastest. The bird reaches the second train in 10 sec and then immediately flies back towards the front of faster train. It continues to do so till the two trains meet after 50/3 sec.

27. What is the velocity of the slower train?
(a) 1m/s (b) 2m/s (c) 3 m/s (d) 4 m/s

28. After how many seconds from where the bird first started flying does the bird again reach the faster train?
(a) 20/3 sec (b) 10 sec (c) 40/3 sec (d) 50/3 sec

29. What is the velocity of the bird?
(a)6 m/s (b)7 m/s (c) 8m/s (d) 9 m/s

30. What will be the total distance travelled by the bird till the two trains meet?
(a)200/3 m (b)100m (c)400/3 m (d)500/3 m

31. When travelling with 60km/hr, Ravi reached office 2 hrs before the scheduled time & while travelling with 40 km/hr he reached office late 2 hrs after the scheduled time. At what speed he should travel so that he reaches office at scheduled time?
(a) 50 Km/hr (b) 45 km/hr (c) 55 km/hr (d) 48 km/hr

32. The speed of a car is 45 km/h. The distance traveled by car in 240 minutes is same as the distance traveled by train in 25 minutes. What is the speed of the trainin km/h?
(a) 420 km/hr (b) 330 km/hr (c) 120 km/hr (d) 432 km/hr

33. A passenger train runs at the rate of 80 kmph. It starts from the station, 6 hours after a goods train leaves the station. The passenger train overtakes the goods trainafter 4 hours. The speed of goods train is

(a) 32 km/hr (b) 45 km/hr (c)50 km/hr (d) 64 km/hr

34. Three cars leave A for B in equal time intervals. They reach B simultaneously and then leave for Point C which is 240 km away from B. The first car arrives at Can hour after the second car. The third car, having reached C, immediately turns back and heads towards B. The first and the third car meet a point that is 80 km away from C. What is the difference between the speed of the first and the third car?

(a)80 kmph (b)20 kmph (c)60 kmph (d)40 kmph

35. A train can travel 20% faster than a car. Both start from point A at the same timeand reach point B 80 kms away from A at the same time. On the way, however, thetrain lost about 32 minutes while stopping at the stations. The speed of the car is:

(a)30 kmph (b)40 kmph (c)25 kmph (d)50 kmph

36. By walking at a speed of 24 m/s instead of 60 m/s, a person takes 45 moreminutes to travel a certain distance x. What is the value of x in km?

(a) 108 (b) 120 (c) 30 (d) 90

37. The speed of a car is 56 km/hr. The distance travelled by the car in 270 minutesis same as the distance travelled by a train in 63 minutes. What is the speed of thetrain in km/hr?

(a) 300 (b)360 (c)240 (d)180

38. If a person walks at 15 km/hr instead of 12 km/hr, he would have walked 30 kmmore. The actual distance travelled by him is:

(a) 180 km (b) 150 km (c) 120 km (d) 90 km

39. Two trains A and B start simultaneously from stations X and Y towards each other respectively. After meeting at a point between X and Y,train A reaches station Y in 9 hours and train B reaches station X in 4 hours from the time they have met each other. If the speed of trainA is 36 km/hr, what is the speed of trainB?

(a)24 km/hr (b)54 km/hr (c) 81 km/hr (d)16 km/hr

40. There are three runners Tom, Dick and Harry with their respective speeds of 10kmph, 20kmph and 30kmph they are initially at P and they have to run between the two points P and Q which are 10 km apart from each other. They start their race at 6 am and end at 6 pm on the same day. If they run between P and Q withoutany break, then how many times they will be together either at P or Q during the given time period?

(a) 5 (b) 7 (c) 4 (d) 12

41. Rishab starts for a weeding venue at 6pm and drives at a speed of 60km/hr.Ramesh starts for the same venue at 6.30 pm,and drives at a speed of 75km/hr.When will both reach the venue, provided they reach at the same time.

(a)8.00pm (b)9.30pm (c)9pm (d)8.30pm

42. Riya and Priya set on a journey. Riya moves eastward at a speed of 20kmph and Priya moves westward at a speed of 30 kmph.How far will be priya from Riyaafter 30 minutes

(a) 25km (b)10kms (c)50kms (d)30kms

43. A car averages 55 mph for the first 4 hours of a trip and averages 70 mph for each additional hour. The average speed for the entire trip was 60 mph. How manyhours long is the trip?
(a) 6 (b) 8 (c) 11 (d) 12

44. A train 120 meters long passes an electric pole in 12 seconds and another train of same length traveling in opposite direction in 8 seconds. The speed of the second train is
(a) 60 Km (b) 66 Km (c) 72 Km (d) NOT

45. Two trains, 200 and 160 meters long take a minute to cross each other while traveling in the same direction and take only 10 seconds when they cross in opposite directions. What are the speeds at which the trains are traveling?
(a) 21 m/s; 15 m/s (b) 30 m/s; 24 m/s
(c) 18 m/s; 27 m/s (d) 15 m/s; 24 m/s

46. At 10 a.m. two trains started traveling toward each other from stations 287 miles apart. They passed each other at 1:30 p.m. the same day. If the average speed of the faster train exceeded the average speed of the slower train by 6 miles per hour, which of the following represents the speed of the faster train, in miles per hour?
(a) 38 (b) 40 (c) 44 (d) 50

47. Two trains are 2 kms apart. Speed of one train is 20m/s and the other train is running at 30 m/s. Lengths of the trains are 200 and 300m. In how much time dothe trains cross each other?
(a)15 (b) 40 (c) 10 (d) NOT

48. A train 120 meter long passes an electric pole in 12 seconds and another train of same length traveling in opposite direction in 8 seconds. The speed of the second train is
(a) 20 kmph (b) 15 kmph (c)72 kmph (d) 25 kmph

49. A train runs first half of the distance at 40 km/hr and the remaining half at 60km/hr. What is the average speed for the entire journey?
(a) 20 kmph (b) 40 kmph (c) 48 kmph (d)50 kmph

50. A train approaches a tunnel AB. Inside the tunnel a cat located at a point that is 1/3 of the distance AB measured from the entrance A. When the train whistles the cat runs. If the cat moves to the entrance of the tunnel A, the train catches the cat exactly at the entrance. If the cat moves towards the exit B, the train catches the cat exactly at the exit. What is the ratio of speed of the train to that of the cat?
(a) 3:1 (b) 3:2 (c) 1:3 (d) NOT

ANSWERS

Time Speed and Distance

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