CHAPTER 9

Speed and Acceleration

All our daily activities involve movement and speed. Speed change occurs when there is an activity that causes movement.

Azizulhasni Awang, our national cyclist has an illustrious career with stunning display of speed. He won a gold medal in the Track Cycling World Championship in Hong Kong for Men's keirin event.

WHAT WILL YOU LEARN?

WORD LINK

• Speed	• *Laju*
• Distance	• *Jarak*
• Time	• *Masa*
• Unit	• *Unit*
• Acceleration	• *Pecutan*
• Deceleration	• *Nyahpecutan*
• Average speed	• *Laju purata*
• Uniform speed	• *Laju seragam*
• Non-uniform speed	• *Laju tak seragam*
• Stationary	• *Pegun*

WALKING THROUGH TIME

Galileo Galilei is the first scientist who measured speed as distance per time.

For more information:

http://rimbunanilmu.my/mat_t2e/ms169

WHY STUDY THIS CHAPTER?

- The knowledge in this chapter can be applied in the field of careers such as automotive engineering, astronauts, physics studies, sports and astronomy.

CREATIVE ACTIVITY

Aim: Introducing speed and acceleration.
Materials: Three sets of remote control cars, stopwatch, racing track and whistle.
Steps:
1. Choose three students.
2. Each person is given the same type of remote control car.
3. Each person uses the remote control to move the car on the track provided when the whistle is blown.
4. Record the time and winner for this activity.
5. What is the relationship between time, speed and acceleration in winning the race?

9.1 Speed

9.1.1 Speed as a rate

LEARNING STANDARD

Explain the meaning of speed as a rate involving distance and time.

Take a look at the back of a truck or bus. There is a speed limit symbol for each of the vehicles. What does the symbol mean? What will the consequences be if the driver does not comply with the speed limit stated on the symbol?

COGNITIVE STIMULATION Group

Aim: Explaining the meaning of speed as a rate involving distance and time.
Materials: Stop watch, manila card (50 m sprint results sheet)
Steps:
1. Students form groups of four.
2. Select three students as runners from each group.
3. The students will run 50 m on the track provided.
4. Records the time taken by each student.
5. Complete the table in the manila card.
   Next, calculate the value of distance divided by time taken for each runner.

Name of runner	Distance (m)	Time (s)	$\frac{\text{Distance (m)}}{\text{Time (s)}}$
	50		
	50		
	50		

6. Display your group's result.

Discussion:
(i) List the names of the first, second and third place winners in your group.
(ii) What conclusions can the group make based on the results?

In the activity above, the first student has completed the run in the shortest possible time and the last student recorded the longest time.

The students ran an equal distance, so the student's speed was the ratio of the distance over their running time.

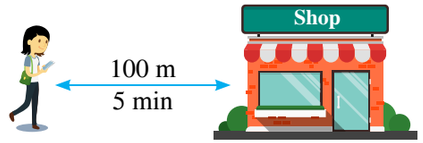
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

TIPS

If I walk 10 km in an hour, then my speed is 10 km/h. If a particle moves 1 metre in one second, then the speed of the particle is 1 m/s.

EXAMPLE 1

Aida walks to a shop over a distance of 100 m in 5 minutes.
Calculate the speed.



Solution:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{100 \text{ m}}{5 \text{ min}}$$

$$= 20 \text{ m/min}$$

Therefore, Aida walks 20 metres every minute.

TIPS

m/min is read as "metre per minute".

EXAMPLE 2

Khairul Hafiz and Badrul Hisham are young state sprinters. During a 100 m event, Khairul Hafiz finished in 10.18 seconds while Badrul Hisham finished in 10.25 seconds. Calculate their speed respectively.

Solution:

$$\text{Speed of Khairul Hafiz} = \frac{\text{Distance}}{\text{Time}} = \frac{100 \text{ m}}{10.18 \text{ s}} = 9.82 \text{ m/s}$$

$$\text{Speed of Badrul Hisyam} = \frac{\text{Distance}}{\text{Time}} = \frac{100 \text{ m}}{10.25 \text{ s}} = 9.76 \text{ m/s}$$

TIPS

D : Distance
S : Speed
M : Time

$$S = \frac{D}{M}$$

$$M = \frac{D}{S}$$

$$D = S \times M$$

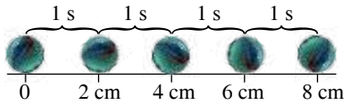
9.1.2 Uniform and non-uniform speed

LEARNING STANDARD

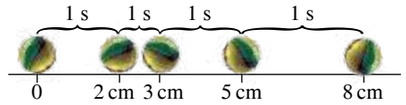
Describe the differences between uniform and non-uniform speed.

Look at the movement of the marbles in the diagram below. Marble *A* and marble *B* are rolled on the table. The movement of the marbles is described as follows.

Marble *A*

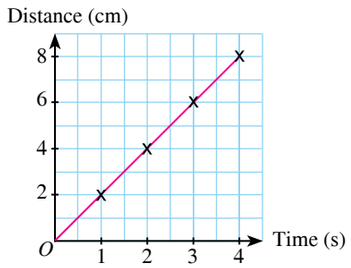


Marble *B*

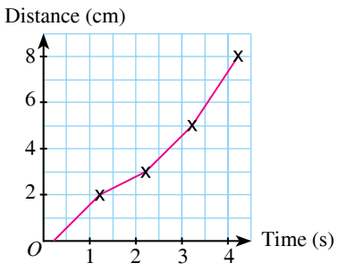


Compare the distance travelled by marbles *A* and *B* within 4 seconds. Which marble has a uniform speed and which marble has a non-uniform speed? Explain.

Distance-Time Graph for Marble *A*



Distance-Time Graph for Marble *B*



Marble *A*

Marble *A* moves at equal distance in equal interval of time. Thus, marble *A* moves at **a uniform speed**.

Therefore, **uniform speed** is the speed that covers equal distance in equal interval of time.

Marble *B*

Marble *B* moves at unequal distance in equal interval of time. Thus, marble *B* moves at **a non-uniform speed**.

Therefore, **non-uniform speed** is the speed that covers unequal distance in equal interval of time.

EXAMPLE 3

Farid drove a trailer for 170 km within the first 2 hours and 190 km within the next 4 hours. Did Farid drive the trailer at a uniform speed? Explain.

Solution:

Speed for the first 2 hours $= \frac{170 \text{ km}}{2 \text{ h}}$

$= 85 \text{ km/h}$

Speed for next 4 hours $= \frac{190 \text{ km}}{4 \text{ h}}$

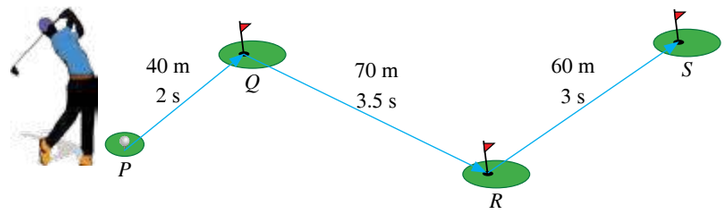
$= 47.5 \text{ km/h}$

Therefore, the speed of the trailer is **non-uniform**.

TIPS

km/h can also be written as $\frac{\text{km}}{\text{h}}$ or kmh^{-1}.

EXAMPLE 4



Encik Mahesh hit the golf ball from pole *P* to pole *S* passing through pole *Q* and pole *R*. Did the golf ball have a uniform speed? Explain.

Solution:

Speed of ball from *P* to *Q* $= \frac{40 \text{ m}}{2 \text{ s}}$

$= 20 \text{ m/s}$

Speed of ball from *Q* to *R* $= \frac{70 \text{ m}}{3.5 \text{ s}}$

$= 20 \text{ m/s}$

Speed of ball from *R* to *S* $= \frac{60 \text{ m}}{3 \text{ s}}$

$= 20 \text{ m/s}$

Therefore, the speed of the golf ball is **uniform**.

THINK SMART

Time (s)	0	1	2	3	4
Distance (m)	0	10	20	30	40

Time (s)	0	1	2	3	4
Distance (m)	0	3	7	16	30

Draw the distance-time graph. From the graph conclude on uniform and non-uniform speed.

9.1.3 Average speed

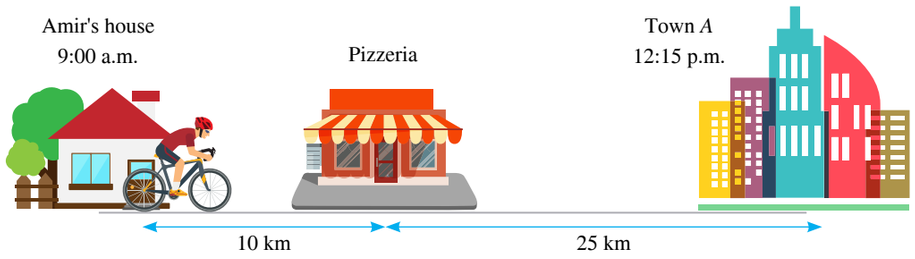
LEARNING STANDARD

Perform calculation involving speed and average speed including unit conversion.

The Electric Train Service (ETS) from Kuala Lumpur to Butterworth moves at a non-uniform speed. In this situation, the average speed is used to give an idea of the speed of the train.

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

EXAMPLE 5



Amir started cycling from his house to town *A* at 9:00 a.m.. Along the way, he stopped at a pizzeria to rest and eat before he resumed his journey. He arrived in town *A* at 12:15 p.m.. Calculate the average speed of the journey in km/h.

Solution:

Total distance = 10 km + 25 km
= 35 km

Total time taken = 12:15 – 9:00
= 3 h 15 min

$$\text{Average speed} = \frac{35 \text{ km}}{3.25 \text{ h}}$$

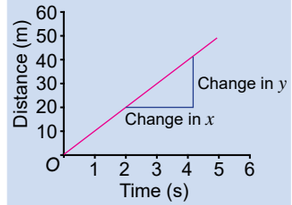
$$= 10.77 \text{ km/h}$$

3 h 15 min
$= 3 \text{ h} + \left(\frac{15}{60}\right) \text{h}$
= 3 h + 0.25 h
= 3.25 h

TIPS

DISTANCE-TIME GRAPH

Gradient of distance-time graph = Speed



$$\text{Gradient} = \frac{\text{Change in } y}{\text{Change in } x}$$

$$= \frac{20 \text{ m}}{2 \text{ s}}$$

Speed = 10 m/s

EXAMPLE 6

A bus departs from Puchong at 0825 and arrives in Perai at 1345. If the total distance travelled is 354 km, calculate the average speed in km/h.

Solution:

Total distance = 354 km

Total time taken = 1345 – 0825
= 5 hours 20 min

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time taken}}$$

$$= \frac{354 \text{ km}}{5.33 \text{ h}}$$

$$= 66.42 \text{ km/h}$$

$5 \text{ h} + \left(\frac{20}{60}\right) \text{h}$
= 5 h + 0.33 h
= 5.33 h

CHAPTER 9

EXAMPLE 7

The speed limit on Jalan Persekutuan is 90 km/h. Convert this speed to
(a) m/s (b) km/min

Solution:

(a) $90 \text{ km/h} = \frac{90 \text{ km}}{1 \text{ h}}$

$$= \frac{90 \times 1\,000 \text{ m}}{1 \times 3\,600 \text{ s}}$$

$$= \frac{90\,000 \text{ m}}{3\,600 \text{ s}}$$

= 25 m/s

(b) $90 \text{ km/h} = \frac{90 \text{ km}}{1 \text{ h}}$

$$= \frac{90 \text{ km}}{1 \times 60 \text{ min}}$$

$$= \frac{90 \text{ km}}{60 \text{ min}}$$

= 1.5 km/min

EXAMPLE 8

Convert 120 m/s to km/min.

Solution:

$$120 \text{ m/s} = \frac{120 \text{ m}}{1 \text{ s}}$$

$$= \frac{120 \div 1\,000 \text{ km}}{1 \div 60 \text{ min}}$$

$$= \frac{0.12 \text{ km}}{0.017 \text{ min}}$$

= 7.06 km/min

FLASHBACK

1 km = 1 000 m
1 m = 100 cm

×1 000 ×100
km m cm
÷1 000 ÷100

1 hour = 60 minutes
1 minute = 60 seconds

×60 ×60
hour minute second
÷60 ÷60

EXAMPLE 9

Karmila has won a gold medal in the women's triathlon event. She began the event with a 10 km run, followed by a 1 500 m swim and ended with a 40 km cycling. She completed the event in 1 hour 56 minutes. Calculate the average speed in km/h for the entire event.

Solution:

$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time taken}}$$

$$= \frac{10 \text{ km} + 1\,500 \text{ m} + 40 \text{ km}}{1 \text{ hour } 56 \text{ min}}$$

$$= \frac{10 \text{ km} + 1.5 \text{ km} + 40 \text{ km}}{1.93 \text{ h}}$$

$$= \frac{51.5 \text{ km}}{1.93 \text{ h}}$$

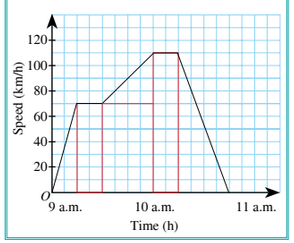
= 26.68 km/h

$\frac{1\,500}{1\,000}$ m
= 1.5 km

1 h + 56 min
$= 1 \text{ h} + \left(\frac{56}{60}\right) \text{h}$
= 1 h + 0.93 h
= 1.93 h

DO YOU KNOW?

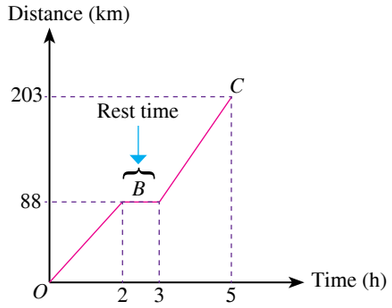
The area under the graph is equal to distance.



CHAPTER 9

EXAMPLE 10

Siti joined a school trip to Kuala Lumpur. The school bus departed from school (O) at 7:00 a.m.. On their way, they stopped at Ulu Bernam rest area B for a short break. They continued their journey to Kuala Lumpur (C). The graph shows the movement of the bus from the school to Kuala Lumpur. Calculate the average speed of the trip in km/h.



Solution:

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

$$= \frac{203 \text{ km}}{5 \text{ h}}$$

$$= 40.6 \text{ km/h}$$

9.1.4 Solving problems

LEARNING STANDARD

Solve problems involving speed.

EXAMPLE 11

Khairul Idham Pawi has made the country proud in the World Motorcycle Championship (MotoGP) when he won the Moto3 category at the German Grand Prix. He took 47 minutes 8 seconds to finish the race on the 40.38 km track. Calculate

(a) Khairul's motorcycle speed in km/h.

(b) the difference in time between Khairul's speed and second place winner's speed if the latter speed was 0.85 km/min.

Solution:

Understanding the problem

- Race distance = 40.38 km.
- Race time taken = 47 minutes 8 seconds.
- Calculate the speed of Khairul's motorcycle and difference in time with the second place winner.

Planning the strategy

- Time = $\frac{\text{Distance}}{\text{Speed}}$
- Time difference = Second place winner – Winner's time

Implementing the strategy

(a) Khairul's motorcycle speed = $\frac{\text{Distance}}{\text{Time}} = \frac{40.38 \text{ km}}{47 + \left(\frac{8}{60}\right) \text{ min}}$ ← Change unit: seconds to minute.

$$= \frac{40.38 \text{ km}}{47.13 \text{ min}}$$

$$= \frac{40.38 \text{ km}}{\left(\frac{47.13}{60}\right) \text{hour}}$$ ← Change unit: minutes to hour.

$$= \frac{40.38 \text{ km}}{0.79 \text{ hour}}$$

$$= 51.11 \text{ km/h}$$

(b) The second place winner's motorcycle time = $\frac{\text{Distance}}{\text{Speed}}$

$$= \frac{40.38 \text{ km}}{0.85 \text{ km/min}}$$

$= 47.5$ mins ← 0.5 x 60 = 30 seconds to change from minute to second.

$= 47$ mins 30 s

Time difference between Khairul and the second place winner = 47 mins 30 s – 47 mins 8 s

= 22 s

Conclusion

(a) The speed of Khairul's motorcycle is 51.11 km/h.

(b) The time difference between the second place winner and Khairul is 22 seconds.

EXAMPLE 12

Mr Tan took 3 hours 7 minutes to drive from Kuala Lumpur to Skudai at an average speed of 103 km/h. However he took $\frac{3}{4}$ of an hour longer on his return trip from Skudai to Kuala Lumpur. Calculate the average speed of Mr Tan's return journey in km/h.

Solution:

Understanding the problem

- Average speed = 103 km/h.
- Duration of the trip = 3 hours 7 minutes.
- Return period = $\frac{3}{4}$ of an hour more than the trip to Skudai.
- Calculate the average speed of Mr Tan's return journey.

Planning the strategy

- Distance = Speed × Time
- Average speed = $\frac{\text{Total distance}}{\text{Total time}}$

Implementing the strategy

Distance from Kuala Lumpur to Skudai

$= 103 \text{ km/h} \times \left(3 + \frac{7}{60}\right) \text{h}$

Change unit from minute to hour

$= 103 \text{ km/h} \times 3.12 \text{ h}$

$= 321.36 \text{ km}$

Average speed of Mr Tan's return journey

$= \frac{321.36 \text{ km}}{3 \text{ h} + \left(\frac{7 + 45}{60}\right) \text{h}}$ ← $\frac{3}{4}$ h = 45 minutes

Change unit from minute to hour

$= \frac{321.36 \text{ km}}{3 \text{ h} + 0.87 \text{ h}}$

$= \frac{321.36 \text{ km}}{3.87 \text{ h}}$

$= 83.04 \text{ km/h}$

Conclusion

The average speed of Mr Tan's return journey is 83.04 km/h.

SELF PRACTICE 9.1

1. Match the correct time for the given distance and speed.

Speed = 44.1 km/h Distance = 150 km	Speed = 120 km/h Distance = 90 km	Speed = 125 m/s Distance = 500 m
4 seconds	3 hour 24 minutes	45 minutes

2. Based on the following diagram, calculate the distance travelled for each given situation.

(a)

Speed = 80 km/h, Time = $1\frac{1}{2}$ hours

(b)

Speed = 343 km/min, Time= 4.5 minutes

(c)

Speed = 3 m/min, Time = 5.5 minutes

(d)

Speed = 250 km/h, Time = 2 hours 40 minutes

3. Malaysia's Paralympic athlete, Mohamad Ridzuan Mohamad Puzi clocked the fastest time of 12.07 seconds in the 100 metre event at the 2016 Paralympic Games in Rio de Janeiro, Brazil. Calculate the speed in the m/s.

4. The distance from Tanjung Malim to Muar is 272 km. A bus departs from Tanjung Malim at 0830. The average speed of the bus is 80 km/h. At what time will the bus arrive in Muar? State your answer in the 24-hour system.

5. Convert the following speed unit to the specified unit.
(a) 50 km/h to m/min. (b) 0.8 m/s to km/h. (c) 110 km/h to km/min.

6. Umar drove his taxi from Ipoh to Kuala Lumpur via the highway. He stopped at Tapah to pick up some goods before proceeding to Kuala Lumpur. He drove from Ipoh to Tapah at an average speed of 100 km/h over a distance of 60 km. If the average speed of his taxi from Ipoh to Kuala Lumpur is 110 km/h over a distance of 220 km, calculate the average speed of Umar's taxi from Tapah to Kuala Lumpur.

7. A leopard can reach a speed of 25.9 m/s, especially when chasing its prey. State the speed in km/h.

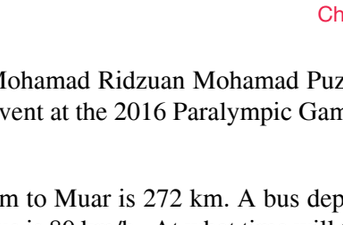
9.2 Acceleration

9.2.1 Acceleration and deceleration

LEARNING STANDARD

Explain the meaning of acceleration and deceleration as a rate involving speed and time.

Sprinters begin a race at the starting line. Once the race begins, their speed will increase as they sprint towards the finishing line. The increase in speed results in acceleration.



After they have passed the finishing line, they will slow down. The decrease in speed results in deceleration.

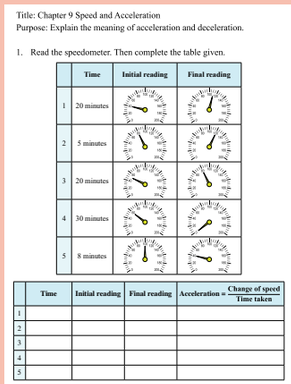
COGNITIVE STIMULATION Individual

Aim: Explaining the meaning of acceleration and deceleration

Material: Worksheets

Steps:

1. Open the file MS179.
2. Complete the table.
3. State whether it is an acceleration or a deceleration.



Title: Chapter 9 Speed and Acceleration
Purpose: Explain the meaning of acceleration and deceleration.

1. Read the speedometer. Then complete the table given.

	Time	Initial reading	Final reading
1	20 minutes		
2	5 minutes		
3	20 minutes		
4	30 minutes		
5	8 minutes		

	Time	Initial reading	Final reading	Acceleration = $\frac{\text{Change of speed}}{\text{Time taken}}$
1				
2				
3				
4				
5				

DO YOU KNOW?

The speed of a vehicle is usually expressed in rotation per minute (rpm).

QR CODE

Scan the QR Code or file http://rimbunanilmu.my/mat_t2e/ms179 to get the worksheet.

The change of speed can be calculated by finding the difference between the final speed and the initial speed of a linear moving object. From the activity, the increase in speed results in acceleration and the decrease in speed results in deceleration. Therefore, acceleration and deceleration is a rate involving speed and time.

EXAMPLE 13

A racing car accelerates from a stationary state and reaches a speed of 120 km/h in 6 seconds. Calculate the acceleration.

Solution:

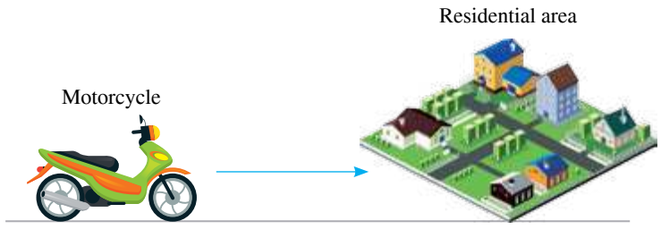
$$\text{Change of speed} = 120 \text{ km/h} - 0 \text{ km/h}$$
$$= 120 \text{ km/h}$$
$$\frac{120 \text{ km}}{1 \text{ h}} = \frac{120 \text{ km}}{60 \times 60 \text{ s}}$$ ← 60 x 1 min
$$= 0.033 \text{ km/s}$$
$$\text{Acceleration} = \frac{0.033 \text{ km/s}}{6 \text{ s}}$$ ← $\frac{120 \text{ km}}{1 \text{ hour}} = \frac{120 \text{ km}}{3\,600 \text{ s}}$
$$= 0.0056 \text{ km/s per second or km/s}^2$$

ATTENTION

The stationary state is the fixed state of an object.

Speed = 0

EXAMPLE 14



A motorcycle moves from a stationary state and accelerates uniformly to reach a speed of 20 m/s in 5 seconds. What is the speed of the motorcycle?

Solution:

$$\text{Acceleration} = \frac{(20 - 0)\text{m/s}}{5\text{s}}$$
$$= \frac{20 \text{ m/s}}{5\text{s}}$$
$$= 4 \text{ m/s}^2$$

TIPS

Uniform acceleration means the speed increases at a similar rate.

Time (s)	Speed (m/s)
0	0
1	4
2	8
3	12
4	16
5	20

DO YOU KNOW ?

If an object moves at a uniform speed, the acceleration is zero.

After the motorcyclist applies the brake, the motorcycle moves slower at a uniform rate until it stops within 4 seconds. What is the speed of the motorcycle?

Solution:

$$\text{Acceleration} = \frac{(0 - 20)\text{m/s}}{4\text{s}}$$
$$= \frac{-20 \text{ m/s}}{4\text{s}}$$
$$= -5 \text{ m/s}^2$$

Thus, deceleration is 5 m/s^2.

ATTENTION

For deceleration, the negative sign does not need to be written
Example:
Acceleration = –5 m/s^2
or
Deceleration = 5 m/s^2

DO YOU KNOW ?

When any object falls from a high point due to gravitational pull, the acceleration is 9.81 ms^{-2}.

Units commonly used to measure acceleration

Speed unit	Time unit	Acceleration unit
km/h	hour	km/h^2 or kmh^{-2} or km/h per hour
m/s	second	m/s^2 or ms^{-2} or m/s per second

9.2.2 Unit conversion

LEARNING STANDARD

Perform calculations involving acceleration including unit conversion.

EXAMPLE 15

Convert 420 m/min per min to km/min per minute.

Solution:

$$\frac{420 \text{ m/min}}{\text{min}} = \frac{420 \text{ m}}{\text{min}} \div \text{min}$$
$$= \frac{420 \times 1 \text{ m}}{\text{min}} \div \text{min}$$
$$= \left(\frac{420 \times \frac{1}{1\,000} \text{ km}}{\text{min}}\right) \div \text{min}$$
$$= \frac{\frac{420}{1\,000} \text{km}}{\text{min}} \div \text{min}$$
$$= \frac{0.42 \text{ km}}{\text{min}} \times \frac{1}{\text{min}}$$
$$= 0.42 \text{ km/min}^2$$

EXAMPLE 16

Rani cycles for $\frac{3}{4}$ of an hour from her home to the Cultural Festival held in the city with a speed change of 18 km/h. Traveling to the Cultural Festival takes 40% less time compared to the time for the return trip at the same speed change. Calculate the difference in acceleration between the trips to and from the Cultural Festival.

Solution:

$$\text{Acceleration when going} = \frac{18 \text{ km/hour}}{\frac{3}{4} \text{ hour}}$$
$$= 24 \text{ km/hour}^2$$

TIPS

Unit km/hour^2 can be written as kmh^{-2} or km/h^2.

$$\text{Time reduced} = \left(\frac{40}{100}\right) \times \frac{3}{4} \text{ hour}$$
$$= 0.3 \text{ hour}$$

$\frac{3}{4}$ hour

$$\text{Time taken for return trip} = 0.75 \text{ hour} - 0.3 \text{ hour}$$
$$= 0.45 \text{ hour}$$

$$\text{Acceleration during return trip} = \frac{18 \text{ km/hour}}{0.45 \text{ hour}}$$
$$= 40 \text{ km/hour}^2$$

$$\text{Difference in acceleration} = 40 \text{ km/hour}^2 - 24 \text{ km/hour}^2$$
$$= 16 \text{ km/hour}^2$$

EXAMPLE 17

Samy drove at a speed of 70 km/h. He increased his speed to 100 km/h in 30 minutes. Calculate the acceleration in

(a) km/h per hour (b) km/h per second

Solution:

(a) Change of speed = 100 km/h – 70 km/h
= 30 km/h

$$\text{Acceleration} = \frac{30 \text{ km/h}}{30 \text{ min}}$$
$$= \frac{30 \text{ km/h}}{\left(\frac{1}{2}\right) \text{h}}$$

30 minutes = $\frac{1}{2}$ hour

$$= 60 \text{ km/h per hour}$$

(b) Time = 30 minutes ← 30 x 1 min
= 30 × 60 s
= 1 800 seconds

$$\text{Acceleration} = \frac{30 \text{ km/h}}{1\,800 \text{ s}}$$
$$= 0.0167 \text{ km/h per second}$$

9.2.3 Solving problems

LEARNING STANDARD

Solve problems involving acceleration.

EXAMPLE 18

Lisnah accelerates her car 4 km/h per second while overtaking a car. If she has been driving at 100 km/h, calculate her speeds after 5 seconds.

Solution:

Understanding the problem
- Acceleration = 4 km/h per second
- Began driving at 100 km/h
- Time = 5 seconds
- Calculate her speeds after 5 seconds

Planning the strategy

Acceleration is the result of increase in speed.

Implementing the strategy

$$\frac{4 \text{ km/h}}{\text{s}} = \frac{\text{Speed after 5 seconds} - 100 \text{ km/h}}{5 \text{ s}}$$

$$\frac{4 \text{ km/h}}{\text{s}} \times 5 \text{ s} = \text{Speed after 5 seconds}$$

20 km/h = Speed after 5 seconds – 100 km/h

$$\text{Speed after 5 seconds} = 20 \text{ km/h} + 100 \text{ km/h}$$
$$= 120 \text{ km/h}$$

Conclusion

Speed after 5 seconds is 120 km/h.

EXAMPLE 19

A motorcycle that moves at a speed of 40 km/h decreases its speed by 20% of it beginning speed within 40 seconds. Calculate the acceleration.

Solution:

Understanding the problem
- Began riding at 40 km/h
- Time = 40 seconds
- Calculate the acceleration

Planning a strategy

Acceleration is the result of increase in speed.

Implementing the strategy

Speed reduction: 100% – 20% = 80%

$$\text{End speed} = \frac{80}{100} \times 40 \text{ km/h}$$
$$= 32 \text{ km/h}$$

$$\text{Acceleration} = \frac{(32 - 40) \text{ km/h}}{40 \text{ s}}$$
$$= -0.2 \text{ km/h per second}$$

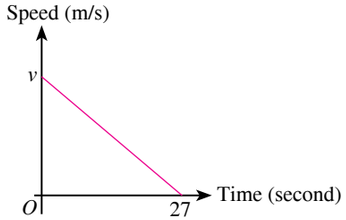
Deceleration = 0.2 km/h per second

Conclusion

The motorcycle acceleration is – 0.2 km/h per second.

EXAMPLE 20

The diagram shows a speed-time graph for the movement of a toy lorry in 27 seconds. The deceleration of the toy lorry is 0.741 m/s^2.



(a) Calculate the speed, v, in m/second.

(b) Calculate the distance covered by the toy lorry after 2.2 seconds.

Solution:

Understanding the problem
- Acceleration = -0.741 m/s^2
- Duration = 27 seconds
- Calculate the speed, v.
- Calculate distance after 2.2 seconds

Planning the strategy

Distance = Speed × Time
Speed = Deceleration × Time

Implementing the strategy

(a) $-0.741 \text{ m/s}^2 = \dfrac{0 - v}{27 \text{ s}}$

$-0.741 \text{ m/s}^2 \times 27 \text{ s} = 0 - v$

$v = 20 \text{ m/s}$

(b) Distance = Speed × Time
= 20 m/s × 2.2s
= 44 m

Conclusion

(a) Speed of toy lorry movement is 20 m/s.
(b) Distance covered by the toy lorry is 44 m.

SELF PRACTICE 9.2

1. State whether each of the following statements is True or False.

Situation	Acceleration	True/False
(a) The speed of a ball rolling on the floor is reduced from 12 cm/s to 2 cm/s in 4 seconds.	–2.5 cms^{-2}	
(b) A trailer accelerates from 90.5 km/h to 123 km/h in $\frac{3}{4}$ hours.	40 kmh^{-2}	
(c) A coconut fell from a tree at a speed of 7 m/s in 0.71 s.	9.86 ms^2	
(d) Puan Mages reduced the speed of her car from 80 km/h to 60 km/h in 0.5 hours	54 km/h^2	

2. Calculate the acceleration for the following situations.
   (a) A car accelerates from 60 km/h to 110 km/h in 30 minutes.
   (b) The speed of a boat decreases from 70 km/h to 40 km/h in 5 minutes.

3. Vinod cycled to his aunt's house at a speed of 8 m/s. Within 4 seconds, he increased his speed to 10 m/s. Calculate the acceleration in ms^{-2}.

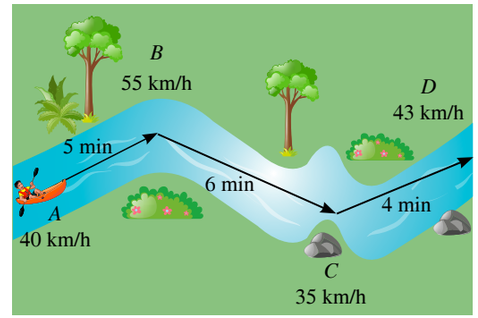
4. Based on an experiment, the speed of an object decreases from 145 cm/s to 75 cm/s in 8 seconds. Calculate the deceleration.

GENERATING EXCELLENCE

1. Categorise the object in the box whether it has uniform or non-uniform speed.

lift	hour	waves	fan	wind	mini bus

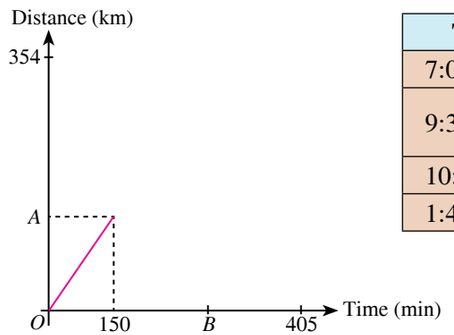
2. Wafi participated in a kayaking competition at Sungai Lembing. He started the competition from station A and proceeded to B, C and D.



Based on the given information, calculate the kayak acceleration from
(a) station A to station B.
(b) station B to station C.
(c) station C to station D.

3. Every morning Shu Mei cycles to school from her home via the post office. The distance from her home to the post office is 4 km, while the distance from the post office to the school is 5 km. Given the average speed of the bicycle is 18 km/h, calculate
   (a) the time for the entire trip for Shu Mei to reach school in minutes.
   (b) the time Shu Mei reaches her school if she starts riding her bicycle at 6:40 a.m.

4. Syahmi drove 354 km from Kuala Lumpur to his hometown in Terengganu. The table below shows his travel notes.



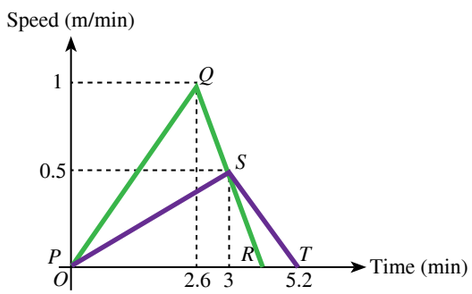
Time	October 21, 2017 / Saturday
7:00 a.m.	Started the trip.
9:30 a.m.	Stopped at Temerloh Rest and Service Area for breakfast after driving 185 km.
10:05 a.m.	Continued journey to Terengganu.
1:45 p.m.	Arrived at the village.

(a) State the value of A and B.

(b) Complete the graph for Syahmi's whole journey.

(c) Calculate the average speed, in km/h, for the whole trip.

5. The diagram below shows the speed-time graph for the movement of two marbles from the opposite directions. The PQR graph represents the movement of the green marbles and the PST graphs represent the movement of the purple marbles. Both marbles are on the same path.



(a) Calculate the acceleration of the green marbles within the first 2.6 minutes.

(b) When will the purple marble stop moving?

(c) What is the maximum speed of the green marbles?

(d) Calculate the time in which the two marbles collide.

6. The distance between Tanjung Malim and Sungai Petani is x km. A car was driven from Tanjung Malim to Sungai Petani at an average speed of 90 km/h. The return journey when the car was driven at an average speed of 105 km/h took 30 minutes. Calculate the value of x.

CHAPTER SUMMARY

Speed and Acceleration

Speed

$$\textbf{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\textbf{Average Speed} = \frac{\text{Total distance}}{\text{Total time taken}}$$

Acceleration

Acceleration is the rate of change of speed with time, in a linear motion.

SELF REFLECTION

At the end of the chapter, I will be able to:

1. Explain the meaning of speed as a rate involving distance and time.	
2. Describe the differences between uniform and non-uniform speed.	
3. Perform calculation involving speed and average speed including unit conversion.	
4. Solve problems involving speed.	
5. Explain the meaning of acceleration and deceleration as a rate involving speed and time.	
6. Perform calculations involving acceleration including unit conversions.	
7. Solve problems involving acceleration.	

MINI PROJECT

Heading the speed limit is one of the regulations when travelling on the road. Maximum speed limit is determined according to certain areas. Compliance to the speed limit is very important to ensure the safety of road users.

You are required to make a report of the speed limit in the following areas.

(a) School

(b) Hospital / clinic

(c) Highway

(d) Hilly areas

Attach images of speed limit signage taken at relevant areas to support your report.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____