C17

Graphs in practical situations

CHAPTER ASSIGNMENT · 202 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Show your working. Draw graphs on graph paper and attach them. Where a book graph is needed, its corner points are given in a table: join them with straight lines, in order.

Practice questions from *Cambridge IGCSE Mathematics Core and Extended* (4th edition), Chapter 17 (Graphs in practical situations), for classroom use. The book's graphs are given here as tables of corner points (read from the book's figures). The Check yourself and Chapter quiz questions are Guru Jazzy's own.

Exercise 17.1 · Conversion graphs

17.1.1 Given that 80 km = 50 miles, draw a conversion graph up to 100 km. Using your graph estimate:

(a) how many miles is 50 km, [1]

(b) how many kilometres is 80 miles, [1]

(c) the speed in miles per hour (mph) equivalent to 100 km/h, [1]

(d) the speed in km/h equivalent to 40 mph. [1]

17.1.2 You can roughly convert temperature in degrees Celsius to degrees Fahrenheit by doubling the degrees Celsius and adding 30. Draw a conversion graph up to 50 °C. Use your graph to estimate the following:

(a) the temperature in °F equivalent to 25 °C, [1]

(b) the temperature in °C equivalent to 100 °F, [1]

(c) the temperature in °F equivalent to 0 °C, [1]

(d) the temperature in °C equivalent to 200 °F. [1]

17.1.3 Given that 0 °C = 32 °F and 50 °C = 122 °F, on the same graph as in question 2, draw a true conversion graph.

(i) Use the true graph to calculate the conversions in question 2. [4]

(ii) Where would you say the rough conversion is most useful? [1]

17.1.4 Long-distance calls from New York to Harare are priced at 85 cents/min off peak and $1.20/min at peak times.

(a) Draw, on the same axes, conversion graphs for the two different rates. [2]

(b) From your graph estimate the cost of an 8 minute call made off peak. [1]

(c) Estimate the cost of the same call made at peak rate. [1]

(d) A call is to be made from a telephone box. If the caller has only $4 to spend, estimate how much more time he can talk for if he rings at off peak instead of at peak times. [2]

17.1.5 A maths exam is marked out of 120. Draw a conversion graph to change the following marks to percentages.

(a) 80	(b) 110	(c) 54	(d) 72

Exercise 17.2 · Speed, distance and time

17.2.1 Find the average speed of an object moving:

(a) 30 m in 5 s	(b) 48 m in 12 s	(c) 78 km in 2 h
(d) 50 km in 2.5 h	(e) 400 km in 2 h 30 min	(f) 110 km in 2 h 12 min

17.2.2 How far will an object travel during:

(a) 10 s at 40 m/s	(b) 7 s at 26 m/s	(c) 3 h at 70 km/h
(d) 4 h 15 min at 60 km/h	(e) 10 min at 60 km/h	(f) 1 h 6 min at 20 m/s?

17.2.3 How long will it take to travel:

(a) 50 m at 10 m/s	(b) 1 km at 20 m/s	(c) 2 km at 30 km/h
(d) 5 km at 70 m/s	(e) 200 cm at 0.4 m/s	(f) 1 km at 15 km/h?

Exercise 17.3 · Travel graphs

17.3.1 Draw a distance–time graph for the first 10 seconds of an object travelling at 6 m/s. [2]

17.3.2 Draw a distance–time graph for the first 10 seconds of an object travelling at 5 m/s. Use your graph to estimate:

(a) the time taken to travel 25 m, [1]

(b) how far the object travels in 3.5 seconds. [1]

17.3.3 Two objects A and B set off from the same point and move in the same straight line. B sets off first, while A sets off 2 seconds later. Using the distance–time graph estimate:

The book's graph (distance in m against time in s), as corner points:

Object	Points (time s, distance m)
A	(2, 0) to (4, 80)
B	(0, 0) to (6, 80)

(a) the speed of each of the objects, [2]

(b) how far apart the objects would be 20 seconds after the start. [2]

17.3.4 Three objects A, B and C move in the same straight line away from a point X. Both A and C change their speed during the journey, while B travels at the same constant speed throughout.

The book's graph (distance from X in m against time in s), as corner points:

Object	Points (time s, distance m)
A	(0, 0) to (1, 6) to (4, 8)
B	(0, 4) to (6, 8)
C	(0, 0) to (6, 1) to (8, 8)

From the distance–time graph estimate:

(a) the speed of object B, [1]

(b) the two speeds of object A, [2]

(c) the average speed of object C, [1]

(d) how far object C is from X 3 seconds from the start, [1]

(e) how far apart objects A and C are 4 seconds from the start. [1]

Exercise 17.4 · Travel graphs of journeys

17.4.1 Two friends, Paul and Helena, arrange to meet for lunch at noon. They live 50 km apart and the restaurant is 30 km from Paul's home. The **travel graph** illustrates their journeys.

The book's graph (distance from Paul's home in km against time), as corner points:

Person	Points (time, distance km)
Paul	(11 00, 0) to X (11 40, 30) to (13 00, 30)
Helena	(11 00, 50) to Y (12 00, 30) to (13 00, 30)

(a) What is Paul's average speed between 11 00 and 11 40? [1]

(b) What is Helena's average speed between 11 00 and 12 00? [1]

(c) What does the line XY represent? [1]

17.4.2 A car travels at a speed of 60 km/h for 1 hour. It then stops for 30 minutes and then continues at a constant speed of 80 km/h for a further 1.5 hours. Draw a distance–time graph for this journey. [3]

17.4.3 A girl cycles for 1.5 hours at 10 km/h. She then stops for an hour and then travels for a further 15 km in 1 hour. Draw a distance–time graph of the girl's journey. [3]

17.4.4 Two friends leave their houses at 16 00. The houses are 4 km apart and the friends travel towards each other on the same road. Fyodor walks at 7 km/h and Yin walks at 5 km/h.

(a) On the same axes, draw a distance–time graph of their journeys. [2]

(b) From your graph, estimate the time at which they meet. [1]

(c) Estimate the distance from Fyodor's house to the point where they meet. [1]

17.4.5 A train leaves a station P at 18 00 and travels to station Q 150 km away. It travels at a steady speed of 75 km/h. At 18 10 another train leaves Q for P at a steady speed of 100 km/h.

(a) On the same axes, draw a distance–time graph to show both journeys. [2]

(b) From the graph, estimate the time at which both trains pass each other. [1]

(c) At what distance from station Q do both trains pass each other? [1]

(d) Which train arrives at its destination first? [1]

17.4.6 A train sets off from town P at 09 15 and heads towards town Q 250 km away. Its journey is split into the three stages, a, b and c. At 09 00 a second train leaves town Q heading for town P. Its journey is split into the two stages, d and e.

The book's graph (distance from P in km against time), as corner points:

Stage	From (time, km from P)	To (time, km from P)
a	(09 15, 0)	(10 00, 100)
b	(10 00, 100)	(10 15, 100)
c	(10 15, 100)	(11 00, 250)
d	(09 00, 250)	(10 00, 150)
e	(10 00, 150)	(10 45, 0)

Using the graph calculate the following:

(a) the speed of the first train during stages a, b and c, [3]

(b) the speed of the second train during stages d and e. [2]

Exercise 17.5 · Acceleration and deceleration

17.5.1 (Questions 1 to 6.) Using the graphs below, calculate the acceleration/deceleration in each case. Each book graph is a single straight line on a speed–time graph:

Graph	Start (time, speed)	End (time, speed)	Acceleration or deceleration
1	(0 s, 0 m/s)	(16 s, 6 m/s)	
2	(0 s, 2 m/s)	(15 s, 5 m/s)	
3	(0 s, 0 m/s)	(5 s, 35 m/s)	
4 (time axis in min)	(0 min, 0 m/s)	(⅔ min = 40 s, 70 m/s)	
5	(0 s, 5 m/s)	(20 s, 0 m/s)	
6 (time axis in min)	(0 min, 60 m/s)	(1 min = 60 s, 0 m/s)	

17.5.7 Sketch a graph to show an aeroplane accelerating from rest at a constant rate of 5 m/s^2 for 10 seconds. [2]

17.5.8 A train travelling at 30 m/s starts to decelerate at a constant rate of 3 m/s^2. Sketch a speed–time graph showing the train's motion until it stops. [2]

Exercise 17.6 · Speed–time graphs

17.6.1 The graph shows the speed–time graph of a boy running for 20 seconds.
The book's graph, as corner points (time s, speed m/s): (0, 0) to (4, 6) to (8, 6) to (20, 0).
Calculate:

(a) the acceleration during the first four seconds, [1]

(b) the acceleration during the second period of four seconds, [1]

(c) the deceleration during the final twelve seconds. [1]

17.6.2 The speed–time graph represents a cheetah chasing a gazelle.
The book's graph, as corner points (time s, speed m/s):

Line	Points
Top line	(0, 0) to (4, 30) to (14, 30) to (16, 0)
Lower line	(1, 0) to (5, 20) to (14, 20) to (16, 0)

(a) Does the top graph represent the cheetah or the gazelle? [1]

(b) Calculate the cheetah's acceleration in the initial stages of the chase. [1]

(c) Calculate the gazelle's acceleration in the initial stages of the chase. [1]

(d) Calculate the cheetah's deceleration at the end. [1]

17.6.3 The speed–time graph represents a train travelling from one station to another.

The book's graph (time in minutes, speed in m/s), as corner points:

Stage	a	b	c	d	e	f
From	(0, 0)	(1, 30)	(6, 30)	(8, 0)	(12, 25)	(16, 25)
To	(1, 30)	(6, 30)	(8, 0)	(11, 0), then up to (12, 25)	(16, 25)	(20, 0)

(a) Calculate the acceleration during stage a. [1]

(b) Calculate the deceleration during stage c. [1]

(c) Calculate the deceleration during stage f. [1]

(d) Describe the train's motion during stage b. [1]

(e) Describe the train's motion 10 minutes from the start. [1]

Exercise 17.7 · Area under a speed–time graph

17.7.1 The table below gives the speed of a boat over a 10-second period.

Time (s)	0	2	4	6	8	10
Speed (m/s)	5	6	7	8	9	10

(a) Plot a speed–time graph for the 10-second period. [2]

(b) Calculate the acceleration of the boat. [1]

(c) Calculate the total distance travelled during the 10 seconds. [2]

17.7.2 A cyclist travelling at 6 m/s applies the brakes and decelerates at a constant rate of 2 m/s^2.

(a) Copy and complete the table below. [2]

Time (s)	0	0.5	1	1.5	2	2.5	3
Speed (m/s)	6						0

(b) Plot a speed–time graph for the 3 seconds shown in the table above. [2]

(c) Calculate the distance travelled during the 3 seconds of deceleration. [2]

17.7.3 A car accelerates as shown in the graph.

The book's graph, as corner points (time s, speed m/s): (0, 0) to (40, 60) to (60, 60).

(a) Calculate the rate of acceleration in the first 40 seconds. [1]

(b) Calculate the distance travelled over the 60 seconds shown. [2]

(c) After what time had the motorist travelled half the distance? [2]

17.7.4 The graph represents the cheetah and gazelle chase from question 2 in Exercise 17.6. (Use the corner points given in 17.6.2.)

(a) Calculate the distance run by the cheetah during the chase. [2]

(b) Calculate the distance run by the gazelle during the chase. [2]

17.7.5 The graph represents the train journey from question 3 in Exercise 17.6. Calculate, in km, the distance travelled during the 20 minutes shown. (Use the corner points given in 17.6.3.) [3]

17.7.6 An aircraft accelerates uniformly from rest at a rate of 10 m/s^2 for 12 seconds before it takes off. Calculate the distance it travels along the runway. [2]

17.7.7 The speed–time graph below depicts the motion of two motorbikes A and B over a 15-second period.

The book's graph (time in s, speed in km/h), as corner points:

Motorbike	Points
A	(0, 40) to (15, 60)
B	(0, 0) to (9, 70) to (15, 70)

At the start of the graph, motorbike A overtakes a stationary motorbike B. Assume they then travel in the same direction.

(a) Calculate motorbike A's acceleration over the 15 seconds in m/s^2. [2]

(b) Calculate motorbike B's acceleration over the first 9 seconds in m/s^2. [2]

(c) Calculate the distance travelled by A during the 15 seconds (give your answer to the nearest metre). [2]

(d) Calculate the distance travelled by B during the 15 seconds (give your answer to the nearest metre). [2]

(e) How far apart were the two motorbikes at the end of the 15-second period? [1]

Exercise 17.8 · Non-linear travel graphs

17.8.1 A stone is dropped off a tall cliff. The distance it falls is given by the equation $d = 4.9t^2$, where d is the distance fallen in metres and t is the time in seconds.

(a) Complete the table of results below for the first 10 seconds. [2]

Time (s)	0	2	4	6	8	10
Distance (m)	0		78.4			

(b) Plot the results in a graph. [2]

(c) From your graph calculate the speed the stone was travelling at after 5 seconds. [2]

17.8.2 A car travelling at 20 m/s applies the brakes. The speed of the car is given by the equation $s = 20 - 0.75t^2$, where s is the speed in m/s and t is the time in seconds.

(a) Plot a graph of the car's motion from the moment the brakes are applied until the moment it comes to rest. [2]

(b) Estimate from your graph the time it takes for the car to come to rest. [1]

(c) Calculate the car's deceleration after 2 seconds. [2]

17.8.3 The distance of an object from its starting point is given by the equation $x = t^3 - 2t^2$, where x is the distance in metres from the start and t is the time in seconds.

(a) Plot a distance–time graph for the first 6 seconds of motion. [2]

(b) Using your graph, estimate the speed of the object after 3.5 seconds. [2]

Student assessment 1

SA1.1 Absolute zero (0 K) is equivalent to −273 °C and 0 °C is equivalent to 273 K. Draw a conversion graph which will convert K into °C. Use your graph to estimate:

(a) the temperature in K equivalent to −40 °C, [1]

(b) the temperature in °C equivalent to 100 K. [1]

SA1.2 A Canadian plumber has a call-out charge of 70 Canadian dollars and then charges a rate of $50 per hour.

(a) Draw a conversion graph and estimate the cost of the following: [1]

(i) a job lasting 4½ hours, [1]

(ii) a job lasting 6¾ hours. [1]

(b) If a job cost $245, estimate from your graph how long it took to complete. [1]

SA1.3 A boy lives 3.5 km from his school. He walks home at a constant speed of 9 km/h for the first 10 minutes. He then stops and talks to his friends for 5 minutes. He finally runs the rest of his journey home at a constant speed of 12 km/h.

(a) Illustrate this information on a distance–time graph. [3]

(b) Use your graph to estimate the total time it took the boy to get home that day. [1]

SA1.4 Below are four distance–time graphs A, B, C and D. Two of them are not possible.

The book's four sketches, described in words:

Graph	What the line does
A	Rises, goes flat, falls a little, goes flat, rises, goes flat, then rises again.
B	Two lines meet at one point on the right: one rises from the origin, the other falls to that point from high up on the distance axis at time 0.
C	Rises steadily, jumps straight up (a vertical step), then rises steadily again.
D	A horizontal line above the time axis.

(a) Which two graphs are impossible? [1]

(b) Explain why the two you have chosen are not possible. [2]

Student assessment 2

SA2.1 The graph below is a speed–time graph for a car accelerating from rest.

The book's graph, as corner points (time s, speed m/s): (0, 0) to (15, 30).

(a) Calculate the car's acceleration in m/s^2. [1]

(b) Calculate, in metres, the distance the car travels in 15 seconds. [2]

(c) How long did it take the car to travel half the distance? [2]

SA2.2 The speed–time graph represents a 100 m sprinter during a race.

The book's graph, as corner points (time s, speed m/s): (0, 0) to (3, 12) to (10, 12) to (14, 0).

(a) Calculate the sprinter's acceleration during the first two seconds of the race. [1]

(b) Calculate the sprinter's deceleration at the end of the race. [1]

(c) Calculate the distance the sprinter ran in the first 10 seconds. [2]

(d) Calculate the sprinter's time for the 100 m race. Give your answer to 3 s.f. [2]

SA2.3 A motorcyclist accelerates uniformly from rest to 50 km/h in 8 seconds. He then accelerates to 110 km/h in a further 6 seconds.

(a) Draw a speed–time graph for the first 14 seconds. [2]

(b) Use your graph to find the total distance the motorcyclist travels. Give your answer in metres. [3]

SA2.4 The graph shows the speed of a car over a period of 50 seconds.

The book's graph, as corner points (time s, speed m/s): (0, 15) to (15, 30) to (40, 30) to (50, 0).

(a) Calculate the car's acceleration in the first 15 seconds. [1]

(b) Calculate the distance travelled while the car moved at constant speed. [1]

(c) Calculate the total distance travelled. [2]

SA2.5 The distance of an object from its starting position is given by the equation: $s = t^3 - 10t^2 + 21t + 25$, where s is the distance from the start in metres and t is the time in seconds.

(a) Copy and complete the table of results: [2]

Time (secs)	0	1	2	3	4	5	6
Distance (m)			35			5	

(b) Plot a graph of distance from the start against time for the first 6 seconds of motion. [2]

(c) Estimate from your graph when the object is stationary. [2]

(d) Estimate the velocity of the object when t = 5 seconds. [2]

Student assessment 3

SA3.1 The graph below is a speed–time graph for a car decelerating to rest.
The book's graph, as corner points (time s, speed m/s): (0, 30) to (12, 0).

(a) Calculate the car's deceleration in m/s^2. [1]

(b) Calculate, in metres, the distance the car travels in 12 seconds. [2]

(c) How long did it take the car to travel half the distance? [2]

SA3.2 The graph below shows the speeds of two cars A and B over a 15-second period.
The book's graph (time in s, speed in km/h), as corner points:

Car	Points
A	(0, 15) to (15, 30)
B	(0, 0) to (10, 35) to (15, 35)

(a) Calculate the acceleration of car A in m/s^2. [2]

(b) Calculate the distance travelled in metres during the 15 seconds by car A. [2]

(c) Calculate the distance travelled in metres during the 15 seconds by car B. [2]

SA3.3 A motor cycle accelerates uniformly from rest to 30 km/h in 3 seconds. It then accelerates to 150 km/h in a further 6 seconds.

(a) Draw a speed–time graph for the first 9 seconds. [2]

(b) Use your graph to find the total distance the motor cycle travels. Give your answer in metres. [3]

SA3.4 Two cars X and Y are travelling in the same direction. The speed–time graph (below) shows their speeds over 12 seconds.

The book's graph, as corner points (time s, speed m/s):

Car	Points
X	(0, 0) to (7, 25) to (12, 25)
Y	(0, 40) to (12, 0)

(a) Calculate the deceleration of Y during the 12 seconds. [1]

(b) Calculate the distance travelled by Y in the 12 seconds. [2]

(c) Calculate the total distance travelled by X in the 12 seconds. [2]

SA3.5 The speed of an object is recorded over a period of 5 seconds. Its speed is given by the equation $v = t^3 - 4t^2 - t + 14$, where v is the speed of the object in m/s and t is the time in seconds.

(a) Plot a speed–time graph for the object's motion in the first 5 seconds. [2]

(b) Explain the acceleration of the object at the graph's lowest point. Justify your answer. [2]

(c) Estimate the acceleration of the object when t = 2 seconds. [2]

Check yourself

1. Explain why the gradient of a distance–time graph gives the speed. [2]

2. A bus travels 36 km in 45 minutes. Find its average speed in km/h. [2]

3. A speed–time graph is a horizontal line at 15 m/s from 0 to 8 s. What is the acceleration, and how far does the object travel? [2]

4. A car slows from 24 m/s to 0 in 6 s. Find its deceleration and the distance it travels while braking. [3]

5 Convert 54 km/h into m/s, showing your method. [2]

6 Explain why a tangent drawn by eye gives only an estimate of the speed at one moment. [2]

Chapter quiz

Q1 A conversion graph uses €1 = 40 baht. About how many baht is €6?

A	B	C	D
46 baht	160 baht	240 baht	400 baht

Q2 A bus travels 180 km in 2 h 15 min. What is its average speed?

A	B	C	D
80 km/h	81.8 km/h	90 km/h	120 km/h

Q3 How far does a runner go in 40 s at 7.5 m/s?

A	B	C	D
5.3 m	47.5 m	280 m	300 m

Q4 On a distance–time graph, what does a horizontal line show?

A	B	C	D
Constant speed	The object is not moving	Acceleration	Returning to the start

Q5 A distance–time line rises 120 m in 8 s. What is the speed?

A	B	C	D
8 m/s	15 m/s	112 m/s	960 m/s

Q6 What does the gradient of a speed–time graph give?

A	B	C	D
Distance travelled	Average speed	Acceleration	Time taken

Q7 A car goes from 0 to 24 m/s in 6 s at a steady rate. What is its acceleration?

A	B	C	D
0.25 m/s²	4 m/s²	18 m/s²	144 m/s²

Q8 A speed–time line goes down from 15 m/s to 0 in 5 s. What is happening?

A	B	C	D
Decelerating at 3 m/s²	Accelerating at 3 m/s²	Stopped for 5 s	Moving back at 3 m/s

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Q9 What does the area under a speed–time graph give?

A	B	C	D
Acceleration	Distance travelled	Average speed	Deceleration

Q10 A bike speeds up from 0 to 10 m/s in 8 s. How far does it go in that time?

A	B	C	D
18 m	40 m	80 m	1.25 m

Q11 A van holds 12 m/s for 20 s, then stops in 6 s. Total distance?

A	B	C	D
240 m	276 m	312 m	72 m

Q12 How do you find the speed at one moment on a curved distance–time graph?

A	B	C	D
Read the distance	Find the area under it	Gradient of a tangent	Divide distance by 2

End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/o-level-mathematics/chapter-17-graphs-in-practical-situations/