UNIT 18 *Speed, Distance and Time* Activities

Activities

ACTIVITY 18.1 *Speed to School*

Collect data in a table as below, for pupils in a class. Use the data to calculate average speeds. (For distances, either use the shortest distance from a pupil's house to school measured from an accurate local map, or use the actual distance walked/cycled/driven.)

Name	*Distance*	*Time*		*Travel Time*	*Speed*
		Departure	*Arrival*		

Extension

1. Compare the average speeds with the mode of transport.
2. Undertake a similar survey of all staff at the school.

ACTIVITY 18.2 *Running Speeds*

The Men's World Records (May 2000) for the 100 m, 200 m, 400 m, 800 m, 1500 m, 3000 m, 5000 m and 10 000 m running races are given in the table below.

Distance (m)	*Name*	*Country*	*Date of Record*	*Time*
100	Maurice Green	USA	16/6/99	9.79 seconds
200	Michael Johnson	USA	1/8/96	19.32 seconds
400	Michael Johnson	USA	26/8/99	43.18 seconds
800	Wilson Kipketer	DEN	24/8/97	1 minutes 41.11 seconds
1500	Hicham El Guerrouj	MAR	14/7/98	3 minutes 26.00 seconds
3000	Daniel Komen	KEN	1/9/96	7 minutes 20.67 seconds
5000	Haile Gebrselassie	ETH	13/6/98	12 minutes 39.36 seconds
10 000	Haile Gebrselassie	ETH	1/6/98	26 minutes 22.75 seconds

1. For each record, calculate the average speed in

   (a) metres per second, (b) kilometres per hour.

2. Plot the data for 400 m to 10 000 m on a graph of time (seconds) against distances (m). What do you notice?

3. Repeat questions 1 and 2 using the Women's World Record data.
   You can find this on the internet at the IAAF (International Amateur Athletics Federation) website at

   http://www.iaaf.org

Extension

A. Use your graph (or the speed data from Question 1) to estimate the times for a world record Marathon (42.195 km) for Men (or Women). Check your value with the current records:

Men	Khalid Khannouchi	MAR	24/10/99	2 hours 5 minutes 42 seconds
Women	Tegla Loroupe	KEN	26/9/99	2 hours 20 minutes 43 seconds

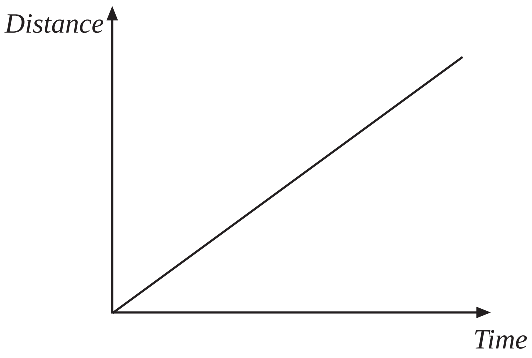
B. The whole class can collect data on the speeds at which pupils sprint. It may be interesting to use a variety of distances. Collect data in a table as shown below and calculate the speed for each pupil.

Name	*Distance*	*Time*	*Speed*

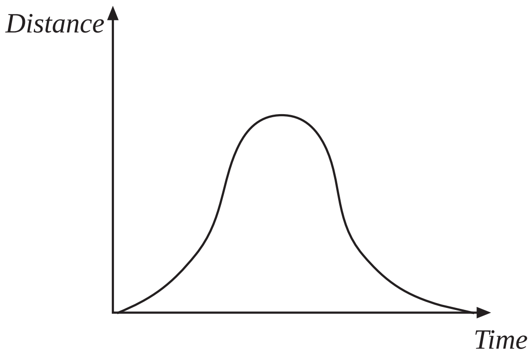
ACTIVITY 18.3 *Interpreting Distance-Time Graphs*

Describe clearly and concisely what is happening in each of the distance-time graphs below. Give a suitable practical context for each situation.

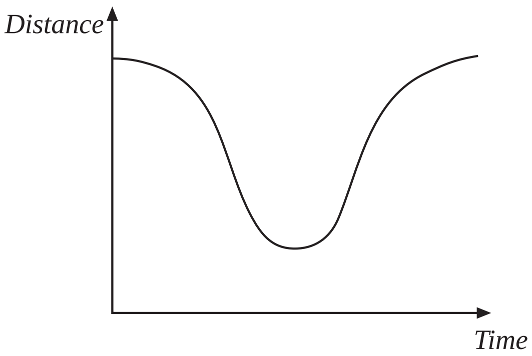
1.



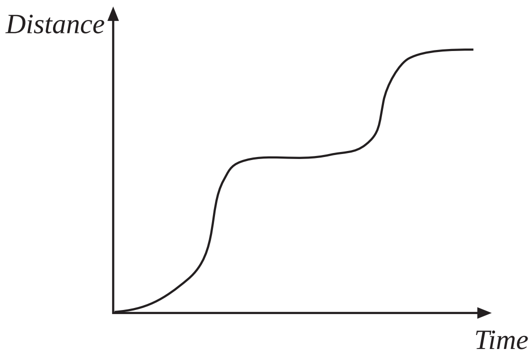
2.



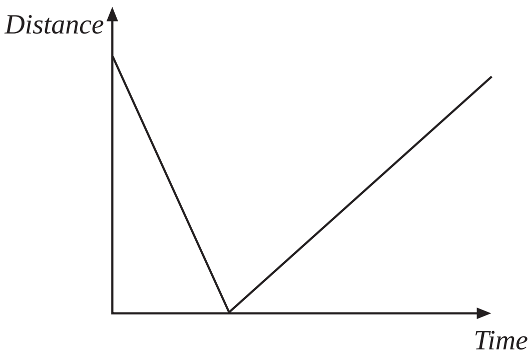
3.



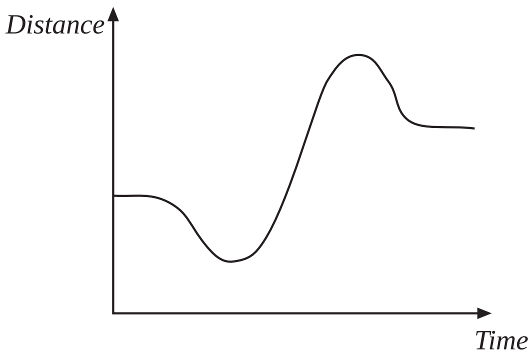
4.



5.



6.



Extension

Draw your own distance-time graph and challenge a friend to describe what is happening and to give it a practical context.

ACTIVITY 18.4 *Premiership Goal Rates*

Manchester United won the Premiership in the 1999/2000 football season, scoring almost 100 goals. This worksheet analyses the goal rate for all teams to see if the data can help managers to improve their strategies.

1. Collect data for goals scored in each match played last season by Premiership teams. (You can find this on the internet at http://www.soccernet.com/)

2. Calculate the average rate of scoring for each team in:

   (a) goals / match,

   (b) goals / hour (assuming each match is 90 minutes long).

3. Does the order of the teams based on points correspond with the order that would be obtained based on scoring rate?

4. Calculate the goals *against* / match for each team for the season.

5. Calculate the goal difference for each club. Does the order of the team based on points correspond with the order based on goal difference?

6. Plot goals *scored* / match against goals *against* / match for all the teams. Identify each team on the graph by 1, 2, ..., 20 , according to their final placings. Are there any significant trends in this data?

Extension

Repeat this procedure with the First Division, or a local league, or your school league, etc.

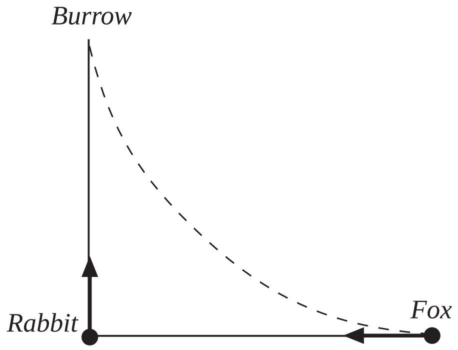
Does this data help you give advice to the manager of a team?

ACTIVITY 18.5 *Pursuit Curves*

Suppose a rabbit, feeding in the middle of a field, sees a fox running directly towards it. The rabbit runs in a straight line towards its burrow.

If the fox always continues to move towards the rabbit, it will trace out a curve as shown.

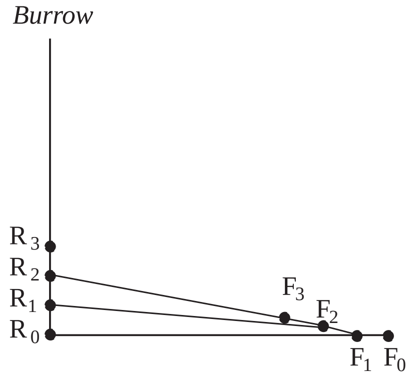
Depending on their speeds, it will either catch the rabbit or the rabbit will reach safety.



Let us look at a particular case in which

Rabbit speed	=	$10\ \text{m s}^{-1}$	Distance of rabbit from burrow	=	100 m
Fox speed	=	$15\ \text{m s}^{-1}$	Distance of fox from rabbit	=	100 m

We can approximate to the curve traced out by the fox by re-plotting every second. In the first second the rabbit moves 10 m and the fox 15 m towards the initial position of the rabbit. In the next second the rabbit moves another 10 m, whilst the fox moves 15 m towards the second rabbit position, and so on.



1. On graph paper, draw an accurate diagram and see if the fox catches the rabbit.

2. Repeat the problem with the fox's speed equal to:

   (a) $16\ \text{m s}^{-1}$ (b) $20\ \text{m s}^{-1}$

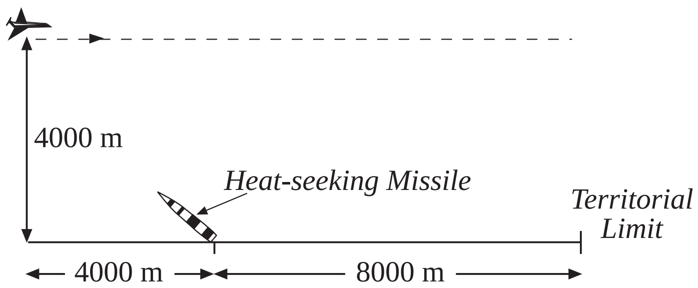
3. Find an approximation for the *critical speed* of the fox, that is, the speed at which the fox will just catch the rabbit.

The same situation arises with heat-seeking missiles. Once they have locked on to their target, they always move directly towards it.

4. A spy plane at a height of 4000 m is travelling at a constant speed of $200\ \text{m s}^{-1}$.

   A heat-seeking missile is fired at the plane when it is 4000 m due west of an airbase.

   If the missile's speed is $220\ \text{m s}^{-1}$, will the missile hit the plane before it reaches the limit of territorial land, 8000 m due east? (Use approximations every 10 seconds.)



Extension

Find the critical speed for the missile in question 4.

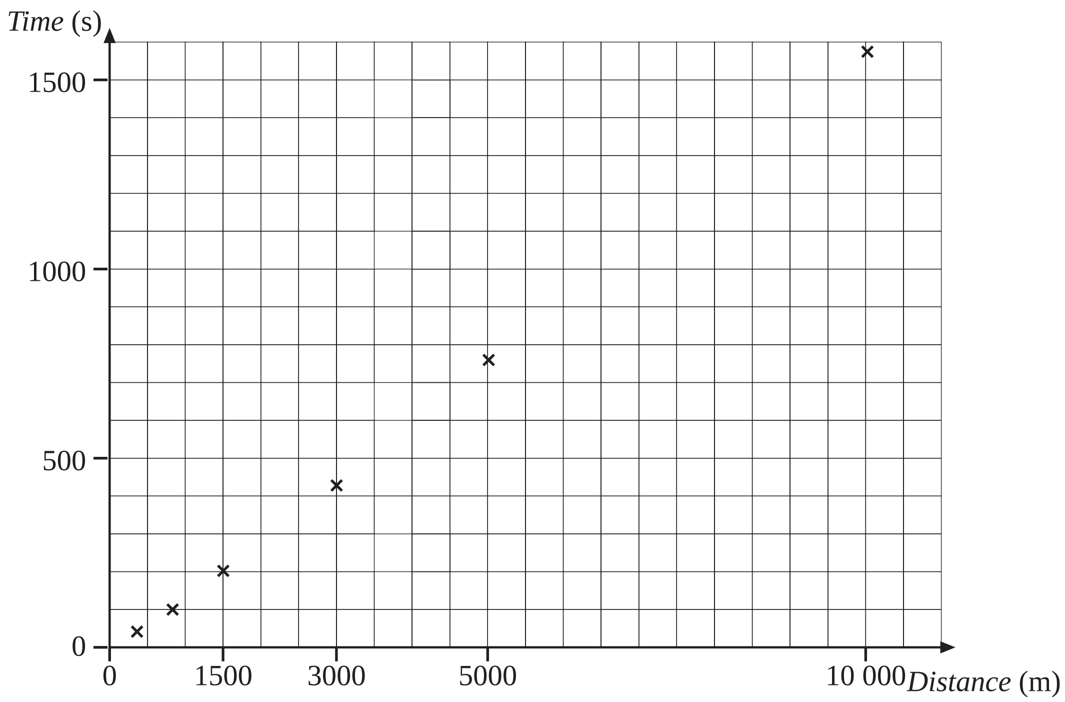
ACTIVITIES 18.1 - 18.5 Sheet 1 *Notes for Solutions*

Notes and solutions given only where appropriate.

18.2 1.

Distance	*Speed* m/s	km/h
100	10.21	36.76
200	10.35	37.27
400	9.26	33.35
800	7.91	28.48
1500	7.28	26.21
3000	6.81	24.51
5000	6.58	23.70
10 000	6.32	22.75

2.



Data close to straight line.

Extension

A. Estimate of 1 hour 51 minutes using the 10 000 m speed - but this will obviously give an underestimate. (In fact the average speed for the current world record marathon is 5.59 m/s.)

B. The Activity could be planned with the PE department; it does not necessarily require the fastest runners as the real interest is the differences in average speeds over different distances.

ACTIVITY 18.1 - 18.5 Sheet 2 *Notes for Solutions*

18.3 1. Constant speed throughout, starting from the origin.

2. Increasing speed for a while, then reducing to zero speed; turning round and returning in the same way to the start position.

3. Starting away from the origin, increasing speed for a while, but then reducing to zero speed (still same distance from the origin), turning back and returning to the starting point.

4. Starting from the origin, increasing speed but then decreasing to zero speed; remaining stationary for a time, but then repeating the procedure.

5. Starting away from the origin and going at a constant speed until the origin is reached; then returning to the start point at a constant, but slower, speed.

6. Not moving for a while, then moving towards the origin but slowing down and returning, past the start point, at constant speed before gradually reversing again, but then stopping before the start point is reached.

18.4 1 - 5 *Football Premiership: 1999/2000 Season*

Position	Team	Goals Scored For	Against	per Match*	per Hour**	Scoring Rate Position	Goals Against per Match*	Goal Difference	Goal Difference Position
1	Man Utd	97	45	2.55	1.70	1	1.18	52	1
2	Arsenal	73	43	1.92	1.28	2	1.13	30	2
3	Leeds	58	43	1.53	1.02	5	1.13	15	5
4	Liverpool	51	30	1.34	0.89	11	0.79	21	3
5	Chelsea	53	34	1.39	0.93	9	0.89	19	4
6	Aston Villa	46	35	1.21	0.81	13	0.92	11	6
7	Sunderland	57	56	1.50	1.00	6	1.47	1	10
8	Leicester	55	55	1.45	0.96	8	1.45	0	11
9	West Ham	52	53	1.37	0.91	10	1.39	–1	12
10	Tottenham	57	49	1.50	1.00	6	1.29	8	9
11	Newcastle	63	54	1.66	1.11	3	1.42	9	8
12	Middlesbrough	46	52	1.21	0.81	13	1.37	–6	13
13	Everton	59	49	1.55	1.04	4	1.29	10	7
14	Coventry	47	54	1.24	0.82	12	1.42	–7	14
15	Southampton	45	62	1.18	0.79	16	1.63	–17	16
16	Derby	44	57	1.16	0.77	17	1.50	–13	15
17	Bradford	38	68	1.00	0.67	18	1.79	–30	18
18	Wimbledon	46	74	1.21	0.81	13	1.95	–28	17
19	Sheffield Wed	38	70	1.00	0.67	18	1.84	–32	19
20	Watford	35	72	0.92	0.61	20	1.89	–37	20

* divide goals scored by 38 (no. of matches played) ** divide goals scored by 57 (no. of hours played)

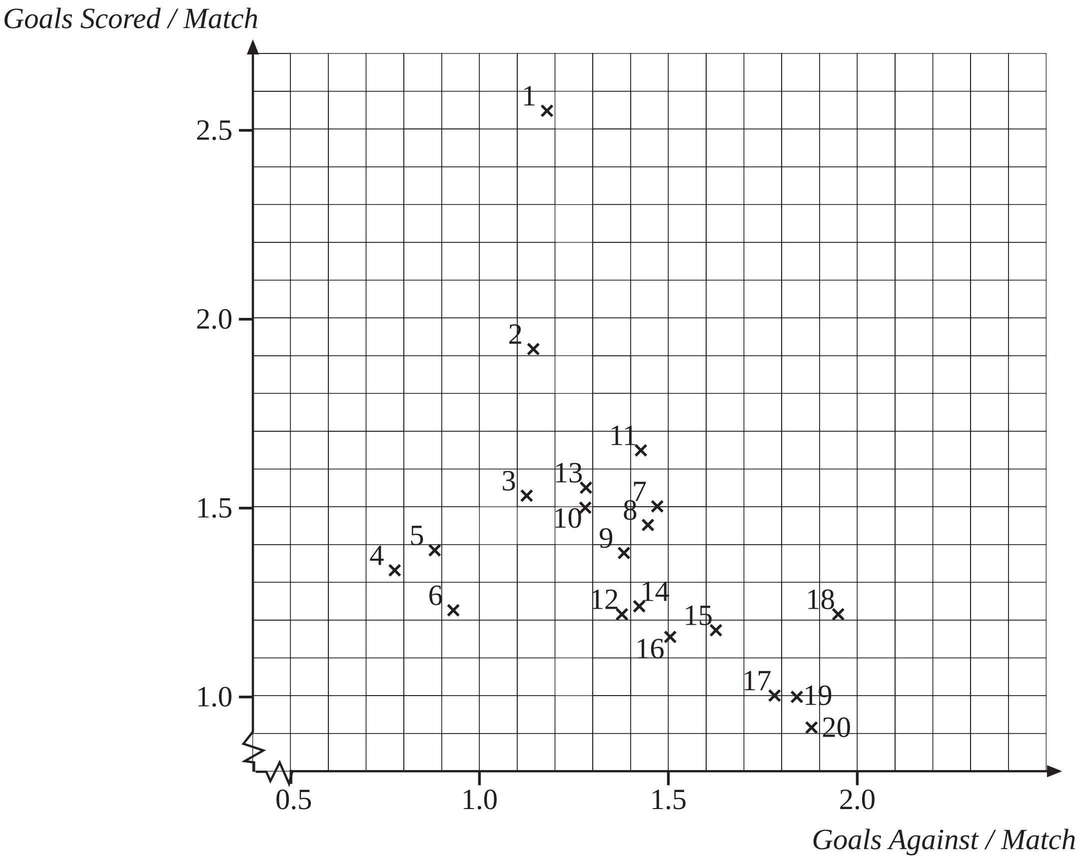
ACTIVITY 18.1 - 18.5 Sheet 3 *Notes for Solutions*

18.3 3. Yes, there is a difference but not for the top two teams; Newcastle, though, would move up from 11th to 3rd if scoring rate per match were used to calculate the positions.

At the bottom end, Wimbledon would have escaped relegation if this method were used.

5. Quite good correspondence; top 2 teams stay the same, but again, Wimbledon would avoid the drop.

6.

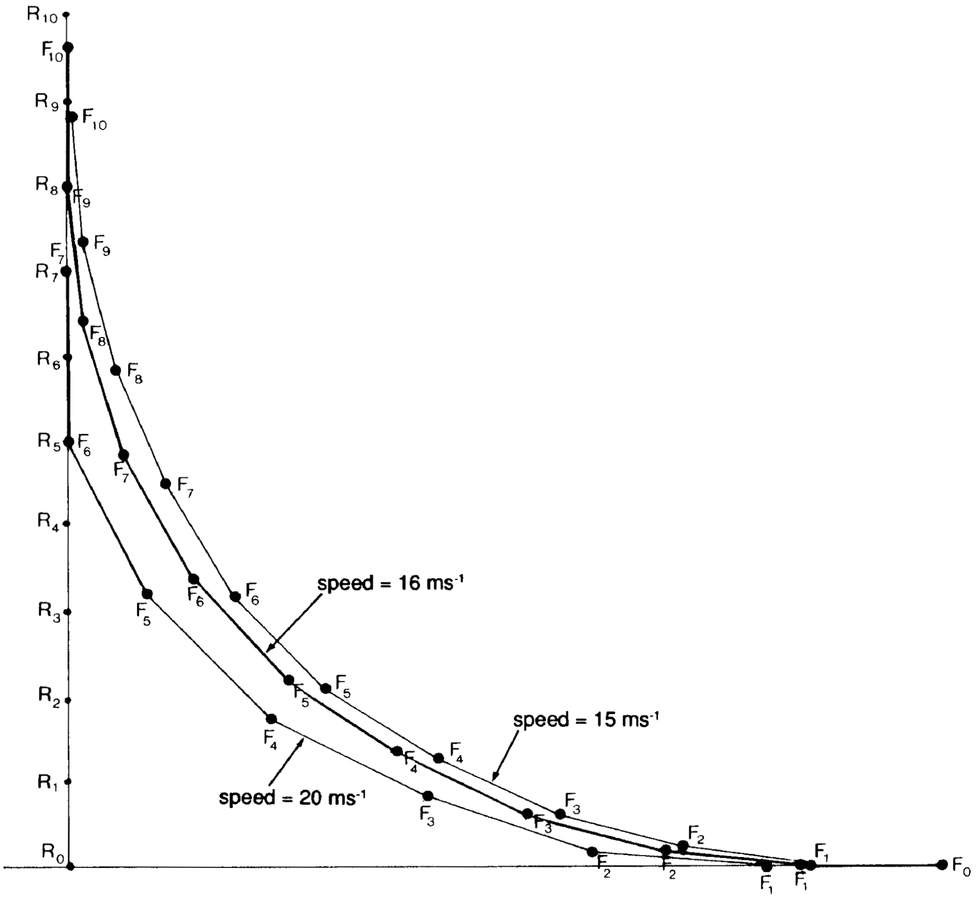


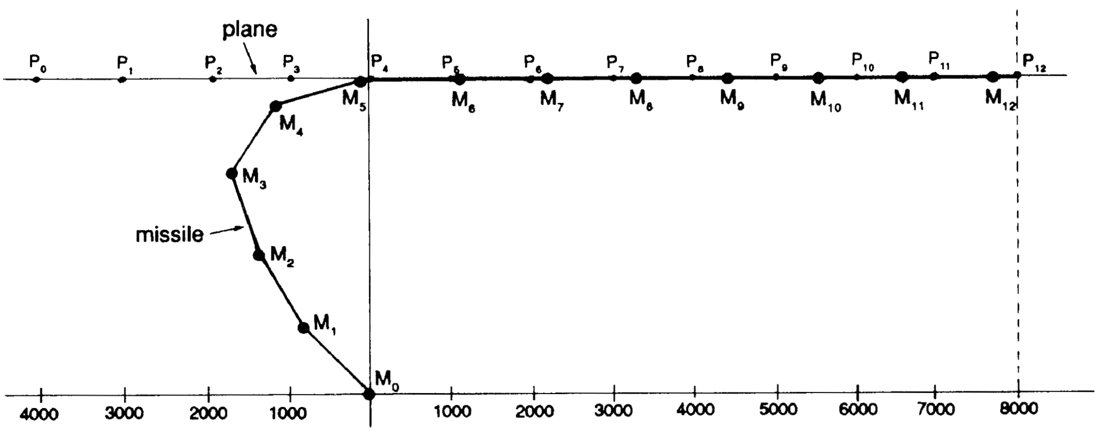
Some negative correlation particularly for the top and bottom teams.

ACTIVITY 18.1 - 18.5 Sheet 4 *Notes for Solutions*

18.5 It is important here to draw the graphs accurately and to be careful in labelling the positions at each time interval. Sketches for the two problems are shown below.

The critical speed for the fox is about 16.5 ms^{-1}.





Extension Critical speed for the missile is about 230 ms^{-1} .