

## A1-2 Relations 2

- understand the terms 'variable', 'independent' and 'dependent' and convert between different forms of a relation

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### Summary

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The quantities in a relation are often called variables. The independent variable is generally the one which is known and the dependent variable is the one which is worked out.

In a table, the independent variable goes in the first row or column; in a graph, it is on the horizontal axis, in a set of ordered pairs, it is the first number in each pair.

When converting a relation between table, graph and set of ordered pairs, the independent variable need to remain the independent variable.

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### Learn

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#### Variables, dependent and independent

Whether presented as a table, a graph or a set of ordered pairs, the relation between number of children and joining cost for the Matrix Club indicates the cost for various numbers of children.

Number of children and joining cost are the two quantities involved in the relation. The quantities involved in a relation are often called 'variable quantities'. They are called 'variable quantities' because they vary from one family to the next. Variable quantities are usually called '**variables**' for short. So, when talking about relations, the word '**variable**' means the same as 'quantity'.



In a relation, it is sometimes useful to call one of the variables the independent variable and the other variable the dependent variable. The idea is that the value of the **dependent variable** depends on or is determined by the value of the **independent variable**. The independent variable is usually the one which is known and

the dependent variable is the one which is worked out.

In the case of the Matrix Club relation, the number of children is the independent variable and the joining cost is the dependent variable. There are no strict rules to decide which is the independent and which is the dependent variable in a relation, but when a family joins the club, the number of children they have is usually used to work out the cost. Most parents don't use the cost of joining the Matrix Club to work out how many children they have. Thus we generally consider that the joining cost depends upon the number of children rather than vice versa.

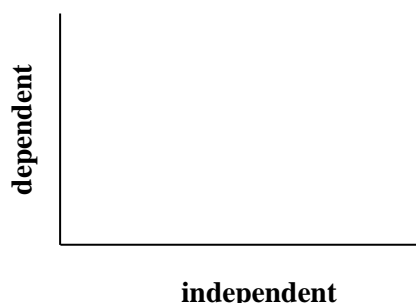
When writing a relation, there are conventions about where the independent and dependent variable values go.

In table representations of relations, the independent variable is always placed in the left column or the top row, the dependent variable in the right column or the bottom row.

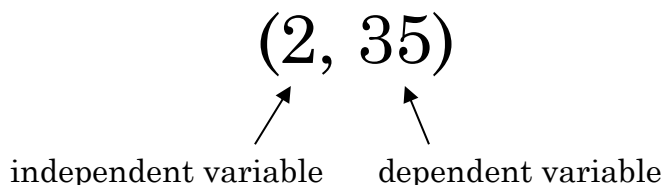
<b>independent</b>	
<b>dependent</b>	

<b>independent</b>	<b>dependent</b>

In a graph, the independent variable is always placed along the bottom on the horizontal axis, the dependent variable up the side on the vertical axis.



When relations are presented as ordered pairs, the first number in the ordered pair is always the value of the independent variable, the second number is always the value of the dependent variable.



## Practice

Q1 Decide which is the independent and which is the dependent variable in each of the following relations:

- (a) (1, 3), (2, 6), (3, 9) where the first number is the number of cups of soup mix and the second number is the number of cups of water that should be added.

(b)

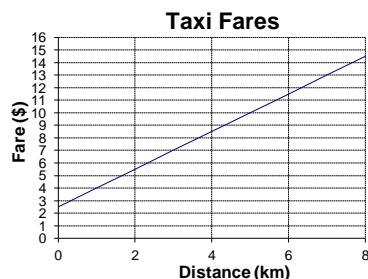
Mass (kg)	Terminal velocity (m/s)
50	60
60	69
70	77
80	84



(c)

Date	4	5	6	7
Maximum temperature	22	26	25	27

- (d) the relation between taxi fare and distance travelled in this graph:



## Converting Relations between Different Forms

We sometimes have a relation expressed in one form and we need to express it in another form: we need to convert it from one form to another.

This is easy to do. We have to be sure that the independent variable in the original form of the relation is also the independent variable in the new form of the relation.

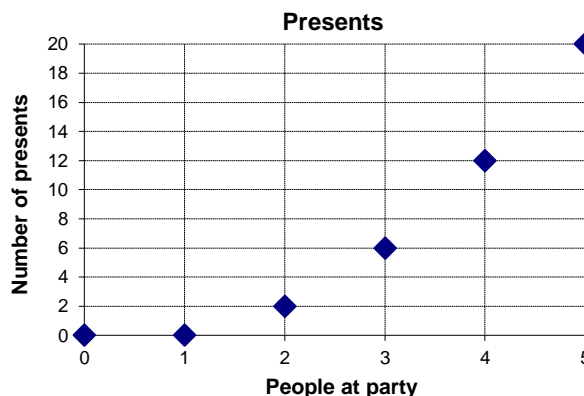
If it is expressed as a table, the pairs of values can be read off and plotted as points on a graph or written as ordered pairs.

If it is expressed as a graph, each point on the graph gives a value pair (the distance across gives the first number and the distance up gives the second number) which can be written as an ordered pair or put into table form.

If the relation is expressed as a set of ordered pairs, each pair can be put into a table or plotted on a graph.

As an example, we will convert this graph to a set of ordered pairs and to a table.

Reading off the positions of the data points, we get the following ordered pairs: (0, 0), (1, 0), (2, 2), (3,6), (4, 12) and (5, 20), where the first number is the number of people and the second number is the number of presents. Make sure you can see how this is done.



As a table, the pairs might look like this:

People	0	1	2	3	4	5
Presents	0	0	2	6	12	20

## Practice

- Q2 The air temperature at 1 p.m. was  $21.5^{\circ}$ . At 2 p.m. it was  $22.7^{\circ}$ . By 3 p.m. it had risen to  $23.1^{\circ}$ . By 4 p.m. it was down to  $21.8^{\circ}$ . By 5 p.m. it was  $19.3^{\circ}$ . Express the relation between time and air temperature as:
- a set of ordered pairs.
  - a table.
  - a graph.
- Q3 The Jones have one dog and spend \$45 per week on dog food. The Blighs have 2 dogs and spend \$30 a week on dog food. The McTavishes have 9 dogs and spend \$114 a week on dog food. The Folkes have 3 dogs and spend \$60 a week on dog food. The Jeffersons have 2 dogs and spend \$12 a week on dog food. Express the relation between number of dogs and weekly cost for dog food for these families as a set of ordered pairs, as a table and as a graph.
- Q4 The relation between number of people staying in a motel room and the charge is given by the relation:  
 (1, 70), (2, 90), (3, 100), (4, 100), (5, 110).  
 Express this relation:
- as a table
  - as a graph

- Q5 Express the following relation between the temperature and pressure of the gas in a container as a set of ordered pairs and as a graph.

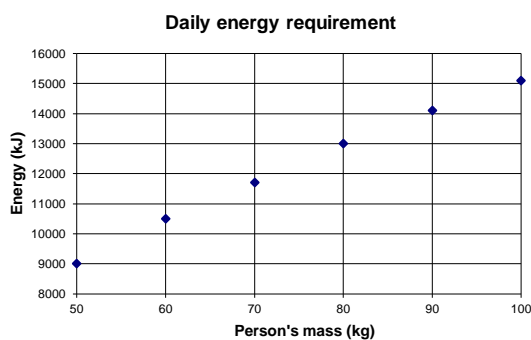
Temp (°C)	10	55	90	148
Pressure (kPa)	102	119	131	153

- Q6 The following relation is between the number of cars for which a garage is designed and the cost of the garage in dollars:

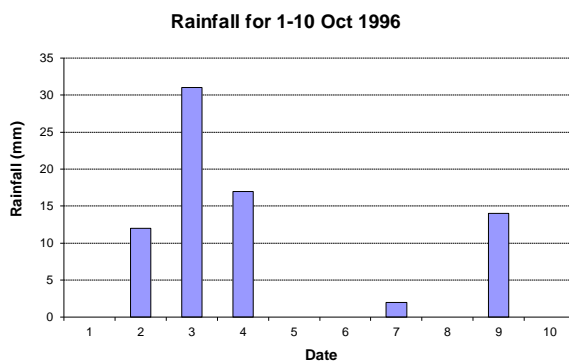
*A single garage costs \$4500, a double garage \$6500 and a 3-car garage \$8800.*

Express this relation as a table.

- Q7 Express the relation below as a set or ordered pairs and as a table.



- Q8 Express the following relation as a set of ordered pairs and as a table.



- Q9 Express the following relation between the mass of an unflawed, clear, brilliant-cut diamond and its value as a set of ordered pairs and as a graph.

Mass (carats)	0.25	0.5	0.75	1	1.5	2
Value (\$)	220	760	1500	2850	5200	9300

Q10 The newspaper clipping below describes the relation between the day of the week and the number of people visiting a travelling stunt show.

## STUNT SHOW A SMASH HIT

Last week's visit by the travelling stunt show brought an enthusiastic response from the people of Dawson.

57 people visited the show on the first day. On the second day, the number was up 12 to 69. On the third day, the number was up a further 21 on the second day's total.

72 came through the gate on day 4 of the show and 90 on day 5. 212 made day 6 the best day, closely followed by 187 on day 7.

Bob Mushroom, the tour organiser, said he was happy with the turn out and hopes to make Dawson a regular stop on future tours.



- Decide which is the best choice of independent and dependent variables.
- Write the relation in table form.
- Present the relation as a graph. (Use a simple scatter graph like the one used for the Matrix Club.)
- Represent the relation in a different graphical form which might be more interesting or eye-catching in a newspaper article.

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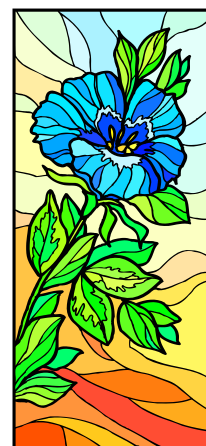
### Solve

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Q51 Dorbert is going to arrange 60 identical square tiles to make a rectangle. As a set of ordered pairs, write the relation between the number of squares across and the number of squares down. Make the number across the independent variable.

Q52 The Arsonville Petunia Growers Society has 8 members. They meet every week, but not all members come to every meeting. When they meet, every member gives a petunia to every other member present. Write the relation between number of members present and number of petunias given as a table. Choose the most likely quantity for the independent variable.



**Revision Set 1**

Q61 This is the relation between diameter and area for circles. It is given as a set of statements.

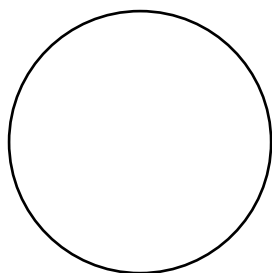
A circle of diameter 6 cm has an area of about  $28 \text{ cm}^2$

A circle of diameter 7 cm has an area of about  $37 \text{ cm}^2$

A circle of diameter 8 cm has an area of about  $50 \text{ cm}^2$

A circle of diameter 9 cm has an area of about  $64 \text{ cm}^2$

A circle of diameter 10 cm has an area of about  $79 \text{ cm}^2$



- (a) What is the independent variable?
- (b) What is the dependent variable?
- (c) Re-write the relation as a set of ordered pairs

Q62 This is the relation between heart rate and age for young children. It is given as a set of ordered pairs.

The first number is the age in years, the second number is the heart rate in beats per minute:  $(0, 125), (1, 108), (2, 102), (3, 94), (4, 94), (5, 89), (6, 90)$

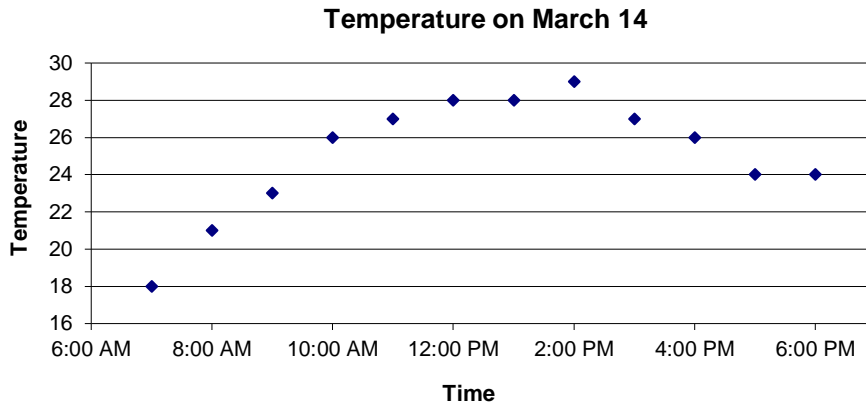
- (a) What is the independent variable?
- (b) What is the dependent variable?
- (c) Re-write the relation as a graph.

Q63 The relation below shows, as a table, average life expectancy for females of various ages in 17<sup>th</sup> Century England.

Age	0	20	40	60	80
Life expectancy	36	49	64	70	85

- (a) What is the independent variable?
- (b) What is the dependent variable?
- (c) Re-write the relation as a set of ordered pairs.

Q64 The relation between temperature and time for March 14 is shown below.



- (a) What is the independent variable?
- (b) What is the dependent variable?
- (c) Re-write the relation as a table.

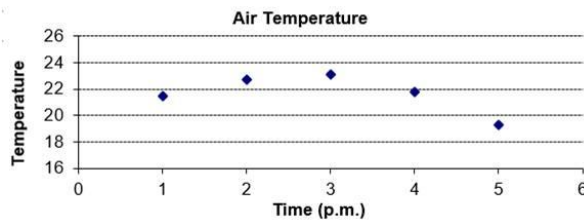
## Answers

- Q1 (a) independent: no. of cups of soup mix, dependent: number of cups of water  
 (b) independent: mass, dependent: terminal velocity  
 (c) independent: date, dependent: maximum temperature  
 (d) independent: distance, dependent: fare
- Q2 (a) (1, 21.5), (2, 22.7), (3, 23.1), (4, 21.8), (5, 19.3)  
 where the first number is time (p.m.) and the second number is the temperature

(b)

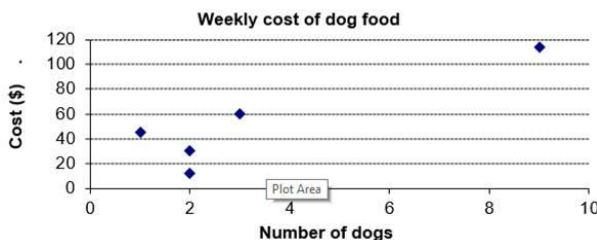
Time (p.m.)	1	2	3	4	5
Temperature	21.5	22.7	23.1	21.8	19.3

(c)



- Q3 (1, 45), (2, 30), (9, 14), (3, 60), (2, 12) where the first number is the number of dogs and the second number is weekly cost of dog food

Time (p.m.)	1	2	9	3	2
Temperature	45	30	114	60	12

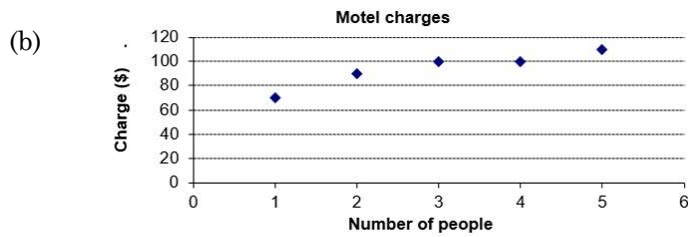




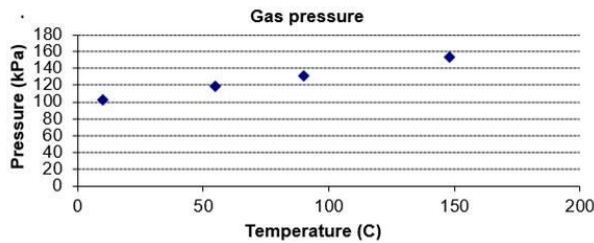
Q4

(a)

Number of people	1		2	3	4	5
Charge (\$)	70		90	100	100	110



Q5 (10, 102), (55, 119), (90, 131), (148, 153) where the first number is the temperature (°C) and the second number is the pressure (kPa)



Q6

Size of garage	1-car	2-car	3-car
Cost (\$)	4500	6500	8800

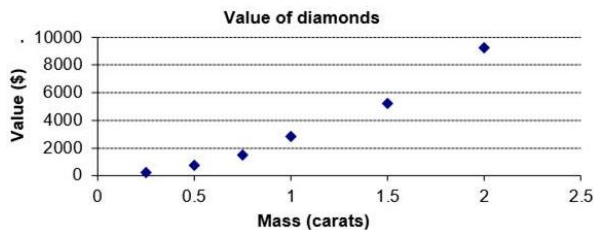
Q7 (50, 9 000), (60, 10 500), (70, 11 800), (80, 13 000), (90, 14 100), (100, 15 100), where the first number is the mass in kg and the second is the daily energy requirement in kJ

Mass (kg)	50	60	70	80	90	100
Energy requirement (kJ)	9 000	10 500	11 800	13 000	14 100	15 100

Q8 (1, 0), (2, 12), (3, 31), (4, 17), (5, 0), (6, 0), (7, 2), (8, 0), (9, 14), (10, 0), where the first number is the date and the second is the rainfall in millimetres.

Date in Oct 1996	1	2	3	4	5	6	7	8	9	10
Rainfall (mm)	0	12	31	17	0	0	2	0	14	0

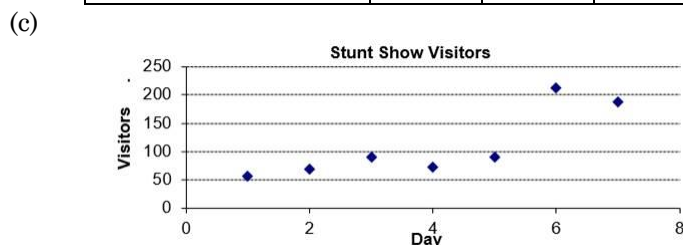
Q9 (0.25, 220), (0.5, 760), (0.75, 1 500), (1, 2 850), (1.5, 5 200), (2, 9 300) where the first number is the mass in carats and the second is the value in dollars



Q10 (a) Independent – day of the week. Dependent – number of visitors

(b)

Day	1	2	3	4	5	6	7
Number of visitors	57	69	90	72	90	212	187



(d) Various possible

Q51 (1, 60), (2, 30), (3, 20), (4, 15), (5, 12), (6, 10), (10, 6), (12, 5), (15, 4), (20, 3), (30, 2), (60, 1), where the first number is the number of ties across and the second number is the number of tiles down.

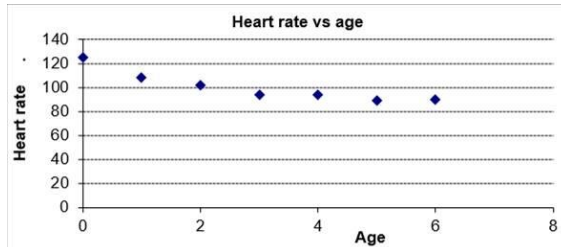
Q52

Members	0	1	2	3	4	5	6	7	8
Hand shakes	0	0	1	3	6	10	15	21	28

Q61 (a) diameter (b) area

(c) (6, 28), (7, 37), (8, 50), (9, 64), (10, 79), where the first number is the diameter in cm and the second number is the area in  $\text{cm}^2$

Q62 (a) age (b) heart rate (c)



Q63 (a) age (b) life expectancy

(c) (0, 36), (20, 49), (40, 64), (60, 70), (80, 85) where the first number is the age and the second is the life expectancy.

Q64 (a) time (b) temperature

(c)	Time	7am	8	9	10	11	12	1	2	3	4	5	6pm
	Temperature	18	21	23	26	27	28	28	29	27	26	24	24