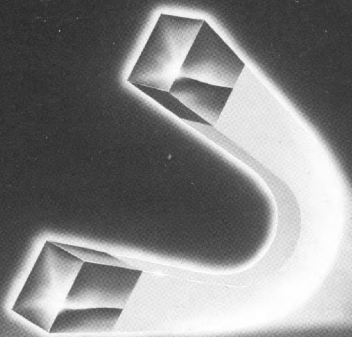


Sinclair[®] & Macmillan ZX Spectrum[®]

Science Horizons

MAGNETS



CASSETTE 48K RAM

SCIENCE HORIZONS

MAGNETS

Acknowledgements

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Educational aims

The main aim of *Magnets* is to give the user an understanding of the polarity of magnets (i.e. that they have North and South poles) and their behaviour (i.e. that like poles repel and unlike poles attract). The program also demonstrates that the power of attraction and repulsion depends on the strength of the magnet.

It is important to realise that the behaviour of real magnets is very complex. In order to make the model simpler *Magnets* is played on a draughtboard, giving the magnets freedom to attract or repel in 2 dimensions only.

In playing the game, the user has to consider the basic principles of magnetic behaviour, and plan a strategy according to the position and the strength of each of the magnets on the board.

Loading the program

Make sure your ZX Spectrum® is connected as explained in the Sinclair ZX Spectrum® manual.

Check that the tape is at the beginning.

Type **LOAD "MAGNETS"** then press **ENTER** or
type **LOAD** then press **ENTER**
Start the tape.

The message **Loading please wait** should appear on the screen.
The program takes about 3 minutes to load.

Running the program

Magnets can be played by 2 people, or by one person against the computer. Each player has 2 types of magnet:

'pawn' magnets which can be moved around the board, and
'supermagnets' which are fixed in position.

To win the game you must *either*:

remove all your opponent's pawn magnets from the board, *or*
conquer all your opponent's supermagnets.

When the program has loaded, 2 large magnets are represented on the screen, in different colours.

For 1 player (playing against the computer)

You are Player 1.

Press **SPACE** to choose your colour, then

press **ENTER** to confirm your choice.

Press **SPACE** until **COMPUTER** appears below the other, then

press **ENTER** to confirm.

For 2 players

Press **SPACE** to select the colour magnet for Player 1, then press **ENTER** to confirm. Press **SPACE** until **PLAYER 2** appears below the other magnet, then press **ENTER** to confirm.

The 'draughtboard' appears, with the magnets in their starting position. Each player begins the game with:

10 'pawn' magnets, with a magnetic charge of 1 unit

a 'supermagnet' on the edge of the board (marked **A**)

further 'supermagnets' (**B, C, D, E**) standing by at the side of the board.

a bank of 25 'pawn' magnets at the side of the board.

North and South

North poles for magnets of both sides are coloured - green for one player, magenta (pink) for the other. South poles for magnets of both sides are white.

To move your pawn magnets

Player 1's first magnet flashes to indicate it is ready for the first move. A player can move *any* of his or her magnets, or introduce an additional pawn magnet from the bank on to the board.

To select the magnet you wish to move press **SPACE**, which takes you through all your pawn magnets and your bank.

When your chosen magnet is flashing:

press **C** to turn the magnet through 90° (a 1/4 turn or right angle) in a clockwise direction

press **V** to turn your magnet through 90° in an anticlockwise direction

press **Y** to move your magnet up, down, forwards, or backwards.

G J
N

Remember you can only move one square at a time. If you do wish to rotate your magnet, you must do so *before* making your move.

Note that a magnet cannot move on top of another one, or move off the board (unless it is pushed by another magnet), or move into the area normally taken up by a supermagnet.

To capture pawn magnets

In order to win at *Magnets* you can use a number of strategies including:

capturing your opponent's pawn magnets, and so building up the strength of your own pawn magnets,

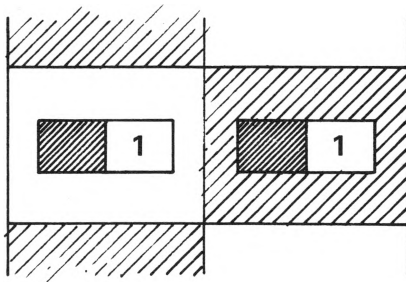
combining some of your own pawn magnets to give you pawn magnets of greater strength.

When you have these stronger pawn magnets, you can then use them to capture more of your opponent's magnets, or push them off

the board, and also to conquer your opponent's supermagnets, as explained further on in this booklet.

Whether you want to capture your opponent's pawn magnets, or build up your own, the technique is the same:

Make sure your magnet has its *opposite* pole facing the one you want to capture (for example, your North facing the other magnet's South).



Rotate your magnet, if necessary, using **C** or **V**, then move it in line with the other magnet. This can be across the board, or up and down the board. You will have to experiment with strengths and distances to see how close you need to be to capture a magnet. When you begin to build up your pawns of strength 1, you need to be in the square next to another magnet in order to capture it.

As you join magnets, you can see their strengths increase. For example, joining 2 pawns of strength 1 gives you a single magnet of strength 2.

Remember you can only capture, or be captured by, another magnet when you are in line with it. Sometimes it is useful to rotate your own magnet as a defence to avoid being in line with a magnet belonging to your opponent, or block its access to your supermagnet.

To use the pawn bank

To bring a magnet from your pawn bank on to the screen:

press **SPACE** until the bank is flashing

use **C** or **V** to orientate the bank if desired (as described for the pawn magnets)

press **ENTER** to confirm that you wish to bring out a magnet from the bank in this way

a cross appears at the top corner of the board

press **SPACE** to move the cross down the column, and then back up to the top

when a cross is in the position you would like, press **ENTER** to release a pawn magnet there

the number of pawns in the bank will automatically decrease as a magnet is released

Supermagnets

Each player starts the game with a supermagnet on the board (**A**) and 4 more standing by (**B, C, D, E**).

Remember that supermagnets are different to pawn magnets and that they have special properties. They are fixed in position at the edge of the board. In order to win the game you must try to push your opponent's supermagnets off the board.

When you have 'conquered' one supermagnet (**A** for example), then it will be replaced by the next in line (**B**), and so on.

Their strengths are as follows:

A	B	C	D	E
2	3	5	9	13

To conquer a supermagnet you must push it off the board by repelling it using a pawn magnet with greater strength. For example, to push

supermagnet **C** (strength 5) off the board, you must use a pawn magnet of strength 6. When you have built up a magnet of great enough strength, move the magnet so that it is in line with the supermagnet, with *like* poles facing each other.

Beware! If you approach any supermagnet (even your own) with *opposite* poles facing each other then your magnet will be attracted by the supermagnet and will be swept off the board and out of the game! (**Note** that unlike the pawn magnets, the supermagnets do not increase in strength when they conquer a magnet. Supermagnets' strengths remain constant throughout the game.)

When you have pushed your opponent's supermagnet from the board, it will be replaced by the next supermagnet standing by. You have won that supermagnet, and it now joins your own 'army' of supermagnets. If this supermagnet is eventually won by your opponent, it moves out of the game altogether (i.e. it cannot be won more than twice).

To win the game

To win, you must either:
conquer all your opponent's supermagnets, or
remove all your opponent's pawn magnets from the board (not including those still in the pawn bank).

To play again

When the game has finished, or at any time during a game, press **CAPS SHIFT** and **A** together to start again.
Press **SYMBOL SHIFT** and **A** together to remove the program from memory and load a new one.

If at any time you wish to have a print-out of the screen, make sure your ZX Printer® is connected as explained in the manual, then press **CAPS SHIFT** and **Z** together.

More about magnets

The *Magnets* program is an ideal way to become familiar with the

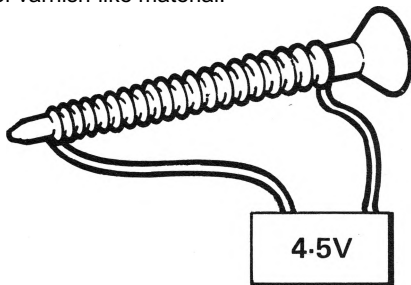
principles of polarity. However, it is interesting to look at how unpredictable real magnets can be when two or more are interacting.

Strong magnets are expensive to buy, but many things found in the home contain magnets. Find out if there are any old radios, loudspeakers, or electric motors from which you could extract a magnet (get permission first!). Ask for help - this requires an adult with the right knowledge and equipment. If you buy a good magnet, store it carefully. Magnets are usually supplied with a 'keep' for safe storage (in the case of a horseshoe magnet this is a metal covering for the 2 ends). Try not to drop or heat a magnet, or its magnetic properties may be weakened or destroyed.

If you have the right materials it is very easy to make a simple **electromagnet**. You need a big nail and some coated copper wire (often found in old radios and electric motors - again, ask permission or advice from the owner!) and a 4.5 volt battery.

SAFETY NOTE: Never use a car battery or mains electricity for experiments.

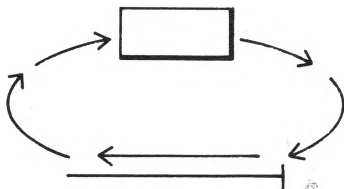
Leaving an end free, twist your wire 20 or 30 times around the nail as shown in the diagram. Scrape the coating from the ends of the wire and connect them to the 2 terminals of the battery. You now have a fairly powerful electromagnet. Note that ordinary plastic-covered wire does not work well - you should use fine copper wire coated with a thin layer of varnish-like material.



You may like to find out how to build a simple electric motor. Electric motors need magnetic fields in order to work.

If you have a strong magnet, you can make weaker magnets using various metal objects. You will need to experiment - not all metals can be magnetised.

For example, try using a pin or a needle. Stroke the pin or needle with your magnet, going in the same direction each time and lifting the magnet clear after each stroke as shown in the diagram.



Once you have magnetised a pin you can make a simple compass. You need a slice of cork from an old stopper (cut by an adult) and a saucer of water. Carefully push the pin through the surface of the cork, then float the cork on the surface of the water. The pin should point North, as shown in the diagram.

