METTOY

science adventure

ELECTRONIC SET

WARNING.

All the circuits in these kits have been designed to operate from a 9 volt supply. This voltage is provided from six 1.5 Volt batteries, (Ever Ready HP7, or their equivalent). Never attempt to attach these circuits to a Mains Voltage Supply. You will burn both the components and yourself.

CONTENTS

INTRODUCTION

The circuits in this kit are made up on a chassis, consisting of a mounting plate and a front plate.

Mounting cards must be put on the mounting plate to show which components must be used and how the components are connected together.

Having done this you can take the mounting plate and the mounting card, and the front panel and the front card and connect them together to form the chassis. You can then mount the front panel components – pushbutton switches, lamp, potentiometer – where necessary.

The components which are mounted on the front panel of the kit which you are building are indicated with symbols at the top edge of the mounting card.

The next step is to mount the resistors, capacitors and transistors on the mounting card in the positions shown.

Read the instructions for assembling each set thoroughly and see whether there are any special remarks on it, such as the connection of the pick-up, Morse key, etc.

When you have done everything stated in the general instructions and the instructions for assembling the sets, then the job is finished.

THE COMPONENTS, AND HOW TO RECOGNISE THEM

Near the back of this handbook you will find a parts list. In this list you will see a picture of each component, its electrical symbol (as used in circuit diagrams), its symbol as used on the mounting cards, its name and part number. From this parts list you will see which components are which.

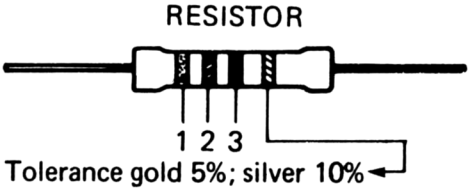
The mounting cards are complete with a description of how and why each circuit works. You must cut along the dotted line to separate the two parts before using the mounting cards.

Transistors

There are two different types of transistor, but each has its type number printed on it. To help you further the BC148 has a yellow spot close to its collector terminal, and the BF194 has no such spot. The base, emitter and collector

terminals of each transistor are marked as "B", "E" and "C" respectively on the underside of its mounting base, and on each mounting card. Transistors are very sensitive and also very expensive components: You must make sure that they are connected exactly as shown on the mounting card in order to avoid damaging them.

Colour Code and Numerical Marking for Resistors and Capacitors



All capacitors (5, 6) and resistors (4) have their values marked on them by one of two methods. Resistors have colours on them which correspond to numbers and by using the Colour Code you can

Colour	1st band (1st digit)	2nd band (2nd digit)	3rd band (multiplication factor)
black	0	0	X 1
brown	1	1	X 10
red	2	2	X 100
orange	3	3	X 1,000
yellow	4	4	X 10,000
green	5	5	X 100,000
blue	6	6	X 1,000,000
violet	7	7	
grey	8	8	
white	9	9	

work out the value of any resistor coded in this way. Capacitors use both numbers (a numerical system of marking) and the Colour Code. Ceramic capacitors are usually marked with the Colour Code and other types of capacitor, such as electrolytic (6) and polyester (5), use the numerical coding.

Any resistor or capacitor value may be worked out from the above table. The first colour gives the first digit of the value, the second colour gives the second digit of the value and the third band gives the multiplication factor. Thus a resistor marked brown, black, brown is 1 and 0, i.e. 10, times 10 = 10 x 10 = 100. The fourth band on a resistor gives the manufacturing tolerance, gold is a tolerance of 5% and silver is a tolerance of 10%.

Resistors which are colour coded have values of OHMS.

The electrical abbreviation for Ohm is the symbol Ω. Larger values may be written as Kil-ohms (kΩ) or Meg-ohms (MΩ).

Then 1MΩ = 1,000 kΩ = 1,000,000Ω
and 1kΩ = 1,000Ω

As an example, take the resistor marked with the bands (from left to right) yellow, violet, red, silver. This has a value of 4,700Ω and a tolerance of 10%. It may also be written 4k7Ω or 4.7kΩ (±10%).

Resistors

47 ohm	yellow violet black
220 ohm	red red brown
1,000 ohm	brown black red
2,200 ohm	red red red
3,300 ohm	orange orange red
4,700 ohm	yellow violet red
10,000 ohm	brown black orange
47,000 ohm	yellow violet orange
220,000 ohm	red red yellow
470,000 ohm	yellow violet yellow

Capacitor Numerical Coding

The capacitors packed with this kit may not at first sight appear to be correct. There are several ways that manufacturers use for marking.

This is because the units can be different. These units are all based on the basic unit of capacitance, the Farad. (The Farad is written F for short). Unfortunately, the Farad is very large, too big for our use in electronics. So instead we use smaller units. These are the Pico-Farad (pF), the nano-Farad (nF), (the unit kpF is the same as nF) and the micro-Farad (μF). They work like this:

1F = 1,000,000μF
= 1,000,000,000nF (or kpF)
= 1,000,000,000,000pF.

You can see that a micro-Farad (μF) is a million times bigger than a pico-Farad (pF) and a Farad is a million times bigger than a micro-Farad (μF).

As an example,
47,000pF can be written as 47kpF, 47nF or 0.047μF and 0.1μF can be written as 100kpF, 100nF or 100,000pF.

Electrolytic capacitors, the ones in metal cans, generally are larger values and are usually written in μF. Particular attention must be paid to mounting these capacitors. The grooved end of the can must point towards the + sign on the mounting cards. Connecting an electrolytic capacitor the wrong way round will result in the whole circuit not working properly and may damage the capacitor and the other components.

Lamp

The lamp is a 6 volt 50 milli-amp type. Only this value may be used with the kit without damaging other components.

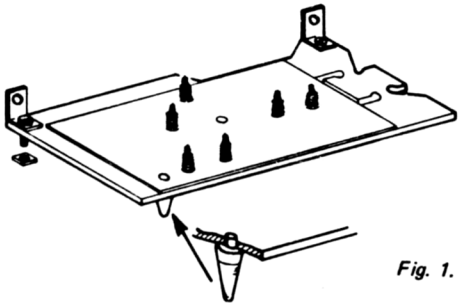


Fig. 1.

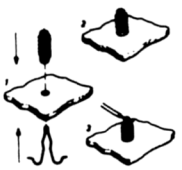


Fig. 2.

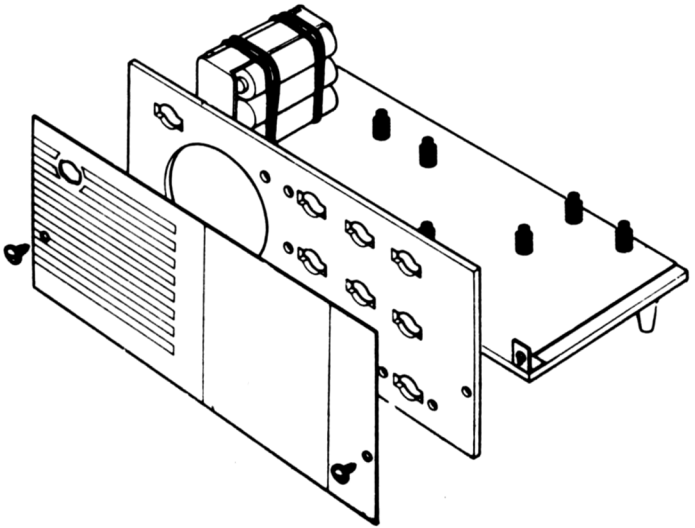


Fig. 3.

MOUNTING INSTRUCTIONS

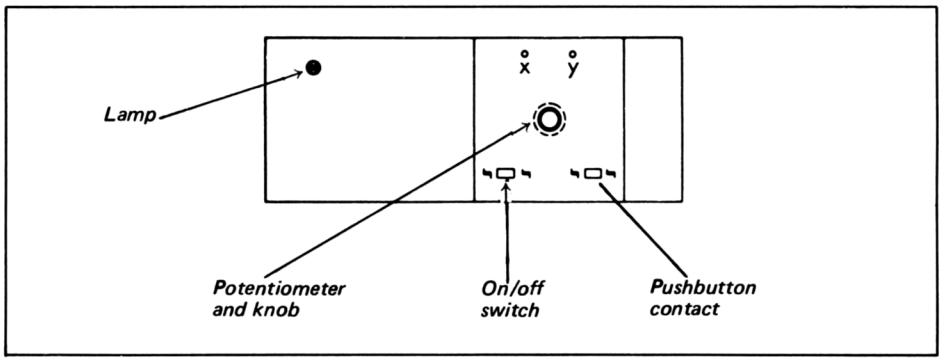
The Chassis

Take the mounting plate (49) and the mounting card (64) for the circuit which you wish to build. Hold the mounting plate with the largest cut-out portion facing away from you and the shiny side uppermost (Fig.1). Take the mounting card and push out all the cut-out holes; these holes are then the connecting points of the circuit. Place the mounting card on the plate so that you can read the numbers on the card.

Line-up the holes on the plate and the card and then push hairpin springs (20) through the plate and card from underneath (Fig.2).

Do not push springs through the circled holes. Next place the mounting plate flat on a table and push the large coil springs (21) over the hairpin springs. Fix two brackets (46) to the mounting plate with two screws (44) and two nuts (33). Finally screw the front card (63) and the front panel (48) to the mounting plate with two screws (45) as shown by Fig.3 and push the legs (47) into the mounting plate.

You can now mount the front panel components which are needed as explained on the next few pages. The positions of these components are shown below:



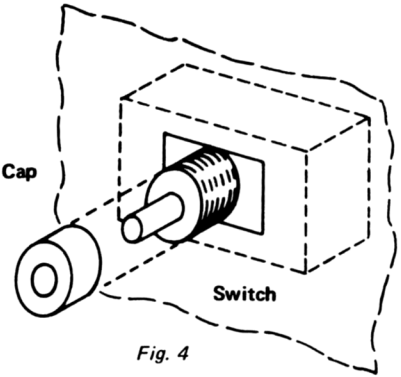


Fig. 4

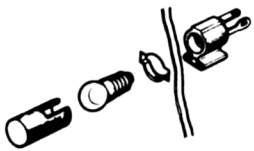


Fig. 5

Fig. 6

Push on/Push off Switch Fig.4.

The push on/push off switch (29) is the switch with the black body. To mount this simply unscrew the cap and, keeping the grub screws facing downwards, push the switch through the front panel from the back and screw the cap back in place. To connect this switch into the circuit when required, unscrew the grub screws one or two turns and push in the bared end of wire. Re-tighten the grub screws.

Pushbutton Contact Switch Fig.4.

The pushbutton contact switch (30) has a brown body. It is mounted in exactly the same way as the previous switch.

This component is not a switch as such, but operates as a bell-push. That is, contact is made between the terminals only when the button is depressed. On release contact is again broken.

Indicator Lamp Fig.5.

Hold the lampholder (26) behind the

hole and screw the bulb (14) into it through the hole.

Make sure the lamp is screwed right into the holder, or its connections will not be properly made.

Slide the red window (27) over the bulb with the tabs over the lampholder.

Potentiometer Fig.7.

Push two hairpin springs through the front panel from the outside and put large coil springs over them. Take the potentiometer (40) and put the extension shaft (42) on to it. Put the potentiometer mounting holes over the two springs and fix it with two pieces of wire as shown in the figure.

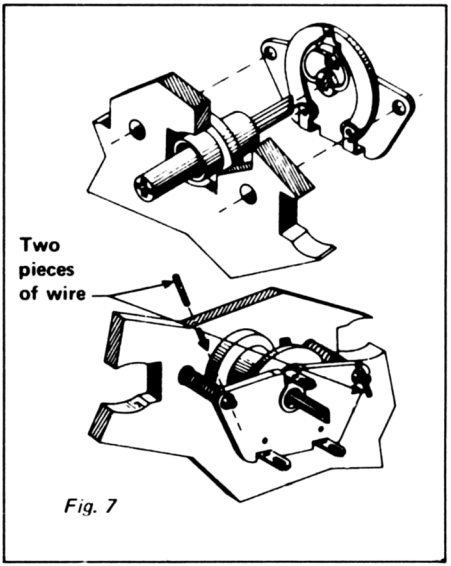


Fig. 7

Knob Fig.6.

Put a grubscrew (32) into a square nut (33) for only a few turns. Put this assembly into the rectangular hole of the knob. Slide the knob on to the shaft and secure it with a small screwdriver.

Battery Holder Fig.8.

The battery holder (15) is made to hold six 1.5 Volt batteries which are Ever-Ready HP7 or their equivalent. These batteries then provide the voltage supply for all the experiments in this kit. You must never attempt to plug these circuits into the mains supply.

To load the batteries into the holder simply take each battery with the base against the spring in the holder and push it into place. Attach the assembly on to

the mounting plate by using two rubber bands as shown in Fig.8.

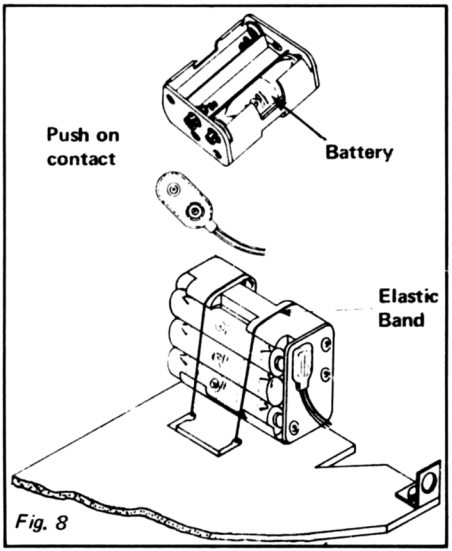


Fig. 8

Outside Connections on the Front Panel (X & Y)

A hairpin spring is put into the hole from behind.

A bared wire end is also put through the hole and a large coil spring is then pushed over the spring from the front side. Push the large coil spring firmly so that the wire is squeezed tightly between the spring and the panel and cannot be pulled out.

MAKING THE CONNECTIONS

You are now ready to build your first complete model. Start with circuit 1 (the simplest) and work towards the more difficult models as you gain experience.

Mount the components in the positions shown on the mounting card. Each component is mounted by holding down the large coil spring and pushing the wire of the component into the exposed loop of the hairpin spring and releasing the coil spring as in Fig.9.


Fig. 9

Make sure that component leads do not touch each other, except when they are connected together. A useful tip when bending leads:– do not put a sharp bend in close to the component body. This way the lead will not become brittle and break next time you use it.

The transistors should be fixed as shown in Fig. 10.

Slide the slotted base plate over the three hairpin springs. See that these springs are put in the right position. Push the plate down and push connecting wires through the springs.

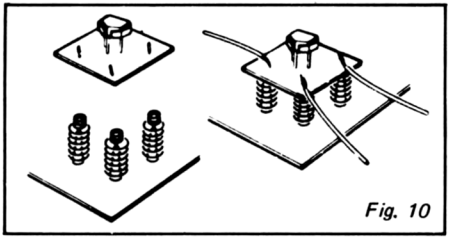


Fig. 10

Mount all the components shown and then all the black lines on the card will be covered by the wire from the components. You will still be able to see red lines on the card and these red lines show you where to connect lengths of red insulated wire (17).

The broken red lines show where a connecting lead goes through a circled hole and is connected to a component underneath the mounting board.

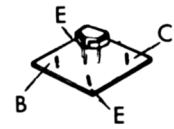
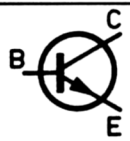
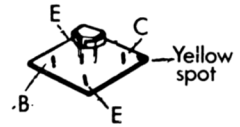
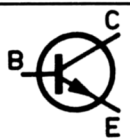
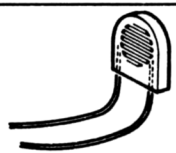
Take the red wire and cut it into the lengths which you require. It is always better to cut the wire slightly longer than necessary. Bare both ends of the wire and connect them to the springs as you did with the components.

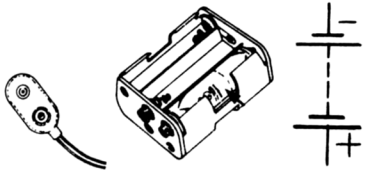
To connect the leads to the lamp and potentiometer the small coil springs (22) must be used. Fit a small coil spring over the component tag. Press this spring down and push the bared end of the wire through the hole in the tag. Then release the spring so that the wire is held firmly in place. Having made the connections, make sure that the springs are not touching one another or metal parts other than the tag or wire.

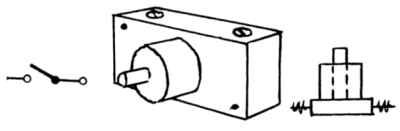
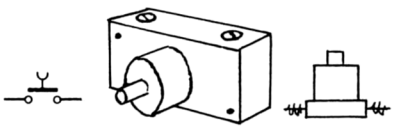
Finally load the batteries into the holder (15) and clip on the push-on contact. The red wire is the positive one (+) [Fig.8].

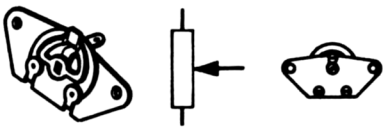
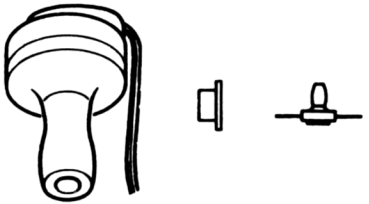
This experiment should now work and you can carry out the other experiments in due course since you now know how to mount every component. But before you switch on it is best if you read the section headed Final Check, on the last pages of the handbook. If you follow the suggestions in that section we are sure you will get a lot of enjoyment from all your experiments.

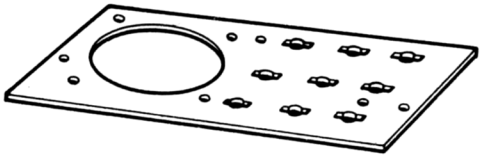
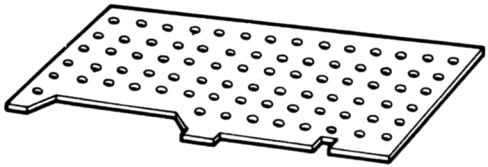
LIST OF COMPONENTS

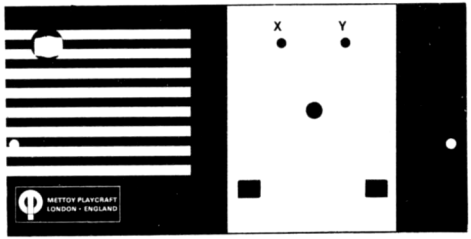
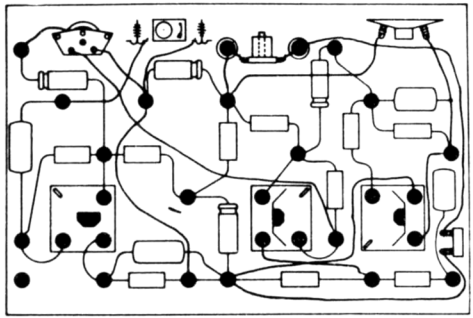
Component and Symbol	Reference Number	Description	Quantity per Kit
 	1	**Transistor (T) BF194**	1
 	2	**Transistor (T) BC148**	1
 	4	**Resistor (R)** 1 x 47 Ohm, 1 x 220 Ohm, 1 x 1,000 Ohm, 1 x 2,200 Ohm, 1 x 3,300 Ohm, 1 x 4,700 Ohm, 1 x 10,000 Ohm, 1 x 47,000 Ohm, 1 x 220,000 Ohm, 1 x 470,000 Ohm	10
 	5	**Polyester capacitor (C)** 2 x 0.1 uF, 1 x 47,000 pF	3
 	6	**Electrolytic capacitor (C)** 1 x 125 uF, 1 x 10 uF	2
 	10	**Light dependent Resistor (LDR)**	1

Component and Symbol	Reference Number	Description	Quantity per Kit
	14	Lamp 6 V, 50 mA	1
	15	Battery holder for 6 penlite cells and push-on contact (Every Ready HP7 batteries on their equivalent)	1
	17	Insulated wire	4 m
	20	Hairpin spring	23
	21	Large coil spring	23
	22	Small coil spring	10

Component and Symbol	Reference Number	Description	Quantity per Kit
	25	Knob	1
	26	Lamp holder	1
	27	Window for lamp	1
	28	Rubber Band	5
	29	Push on/push off switch (Black)	1
	30	Push button contact switch (Brown)	1
	32	Grub screw (3 mm)	1

Component and Symbol	Reference Number	Description	Quantity per Kit
	33	Square nut (3 mm)	3
	40	Potentiometer (R) 10,000 Ohms	1
	41	Earphone	1
	42	Extension shaft for potentiometer	1

Component and Symbol	Reference Number	Description	Quantity per Kit
	44	Screw (3 x 8) mm)	2
	45	Screw for mounting chassis	2
	46	Bracket for mounting chassis	2
	47	Leg	2
	48	Frontpanel	1
	49	Mounting plate	1

Component and Symbol	Reference Number	Description	Quantity per kit
	63	Front Card	1
	64	Mounting Cards	12

FINAL CHECK

When you have done everything stated in the general instructions and the instructions for assembling the sets, then the job is finished. First of all, check that you have not overlooked something. That is, ensure that:

- the components are in the correct place.
- the wires are not touching one another, where they should not be.
- all electrolytic capacitors are fitted properly with the positive end as marked.
- you have not connected any transistor the wrong way round.

When you have checked all this, including the assembly instructions, then you can switch on. If you have made no mistakes then your set will work well. If it doesn't, read the section on 'Checking for faults'.

CHECKING FOR FAULTS

If a set does not work properly switch it off immediately and start with the following points:

Check the wiring. Compare it with the wiring diagram on the mounting board. Make certain that you have not forgotten any connection or any component. Look and see if the wires make proper contact in the wire terminals and that they do not touch one another where they should not.

Check that you have not confused the positive and negative poles of the battery and that the batteries are in the correct position.

Check whether the transistors have been connected the right way (collector, base, emitter.)

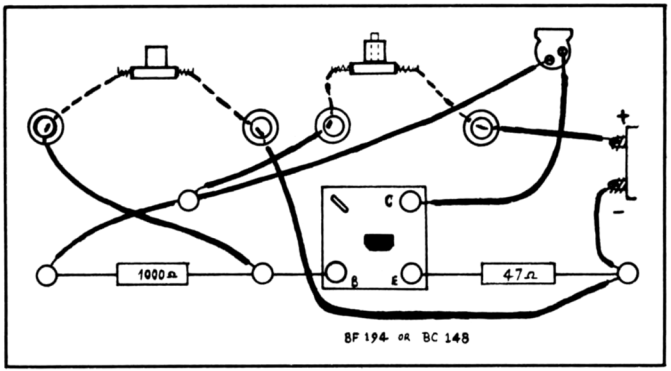
Check whether the electrolytic capacitors are connected in the right direction, that is, with the groove (+) as printed on the wiring diagram.

Look at the colour code information given to make sure that you have used the correct resistors.

If necessary take a new battery to see whether the lamp is damaged. The circuits only work with the lamp provided (6 volt at 0.05 Amp). Any other voltage or current rating lamp will not function properly.

Check that your batteries are not flat.

You can test your transistors if you suspect them to be faulty using the circuit below. The table tells you whether they are working or not. There are two tests to be made, one with the push-button depressed, and one with the pushbutton in its normal position.



Test	Result 1	Result 2	Result 3	Result 3
1) Push button in normal position	Lamp lights	Lamp lights	Lamp does not light	Lamp does not light
2) Push button depressed	Lamp does not light	Lamp lights	Lamp does not light	Lamp lights
Conclusion:	Working	Faulty	Faulty	Faulty

REPLACEMENT PARTS

All of the components in your SCIENCE ADVENTURE ELECTRONIC SET are available at the prices quoted in our current Spares Price List

If replacement parts are required please forward the attached order form, accompanied by the necessary Postal Order * to

METTOY PLAYCRAFT LTD.
SCIENCE ADVENTURE SPARES DEPT.,
14 HARLESTONE ROAD,
NORTHAMPTON
NN5 7AF.
ENGLAND.

*** Note: Where the value of the order is 15p. or less, please add 10p. postage and packing.**
Orders over 15p. postage and packing free.

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