Curriculum projects

Order code	Manufacturer code	Description
13-0104	n/a	NATIONAL CURRICULUM TIMER PROJECT TRAY

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Timer Project

Timer Project

When designers are given a problem to solve, they often break the problem up into a number of smaller activities. This is to make sure that they do not forget any important information that might affect the design.

Situation - The situation will give us a general description of the background to the problem.

There are a number of situations around the home that would benefit from the use of an accurate timer.

Design Brief - The design brief is a summary statement that clearly states the aim of the design project and in a few words states the kind of thing that is needed. For example, "Design a toy" is not very helpful to a designer. "Design a toy for a baby" gives the designer a clearer focus without applying restrictions.

Task 1

Write a design brief for your Timer project

The Design Process

Design Brief → **Investigation** → **Specification** → **Initial Ideas** → **Development** → **Making** → **Evaluation**

Investigation - Before designing we must find out as much as we can about the situation. Investigation therefore involves collecting information from a variety of sources. When you investigate a situation, it is important for you to think about all the things that might affect your product.

Task 2

To help you build up a good background knowledge, investigate the problem using the timer investigation and activity sheets

Specification - Once you have a clear understanding of the problem, you can work out the specification for your Timer. A specification is a list of things that the final design must do. A good specification will list the features in order of importance.

Specifications are an important part of designing because they provide a check list against which you can review your ideas as you are working. They also give you something against which to evaluate your ideas and your finished product.

For example, 'the toy should be painted' does not give the designer enough information. 'The toy should be painted a bright primary colour' is a clear statement without restricting the designer.

Task 3

Write a specification for your Timer.

- **Make a list of all the features you need to include in the design.**
- **Place them in the correct order of importance.**

Timer Investigations

Board Games Timer

Board games might be a suitable area to look into to see if there is a need for a timer. Often the timer included is uninteresting to use or does not make people aware when the time period has elapsed.

There are a large number of board games on the market today. Games like snakes and ladders and chess have been around for hundreds of years, whilst others like 'Who wants to be a Millionaire' are recent.
Games like chess and snakes and ladders are designed for two player's who compete against each other. Chess relies on the skill of the player and a good knowledge of the rules. Snakes and ladders is a game of chance. A player's progress is dependent upon the roll of a dice. Quiz games like 'Who wants to be a Millionaire' focus on a player's ability to answer a series of questions and can be played by a group of people.

Most board games have similar features:

- They all have a playing board often marked out with a route for the players to progress along.
- They contain a series of markers or pieces, which indicate the position on the playing board for each of the players.
- If there is an element of chance, they will have some random method of deciding how far each player should move each turn.
- If the player is given a period of time to make a move or answer a question then the game will include a timer.
- A series of rules or instructions telling you how to play the game.
- If the game is designed to test people's knowledge it will contain a series of question and answer cards.
- A box to hold the board and associated playing pieces securely. The box is also used to advertise the game.

Egg Timer

There are many situations in the kitchen at home that require an accurate timer. When you boil an egg it is important to stop the process at just the right moment to achieve the type of egg you like. Some people like their eggs soft in the centre. This means they require around three minutes cooking time. Those who prefer a slightly harder egg will need to boil them for longer, around four minutes. As you can see the timing is critical.

The traditional method of timing an egg is to use a sand timer. Sand timers have been around for thousands of years. The timer consisting of two clear jars that have their open ends joined. By turning the timer upside down, the sand flows from one jar to the other. Originally sand timers measured a period of one hour and were called hourglasses.

Toothbrushing Timer

We all know the importance of brushing our teeth correctly. The sugars and carbohydrates in our diets form into acids, which if not cleaned away will damage our teeth and gums and cause tooth decay. Brushing teeth after meals to remove trapped food helps to reduce decay.

Our first set of teeth are called our 'milk teeth' and consist of twenty teeth. These milk teeth usually last until we are around four or five when they are replaced by our adult teeth. The adult teeth consist of 32 teeth when all are in place.

It is important for young children to clean their teeth on a regular basis. Parents will use a variety of ways to make this chore as enjoyable as possible. It is also important that when children clean their teeth that they do so for a minimum of three minutes to ensure that all the areas of the mouth have been cleaned properly.

Investigation Tasks

Board Games

Task

Collect together a range of board games (try to select those that use a timer). Working in groups of four, play the games for about ten minutes and then use the following questions to help you evaluate the games.

Questions:

- What age group do you think the game is intended for? How can you tell?
- What is the maximum and minimum number of players that the game is designed for?
- How does a player progress around the board? Give a brief description of the process. Explain how a player wins the game.
- How easy were the instructions to follow? Were there any sections you did not understand?
- How well was the game packaged? Were all the pieces stored carefully? What did you think of the graphics displayed on the box? Was your attention drawn to the package and why?
- What is the time interval each contestant has to answer the question?

Boiled Eggs

Task

Each person has their own personal preferences as to precisely how they like their eggs boiled. Find out how each member of your family likes their boiled eggs. Then work out how long the eggs need to boil to achieve this. Produce a simple chart using the headings below, to show the results of your survey.

Name	Style of egg	Boiling time
Jennifer	Soft in centre	3 minutes

Make sure that you gain permission to experiment in the kitchen. Take great care with boiling water.

Toothbrush

Task

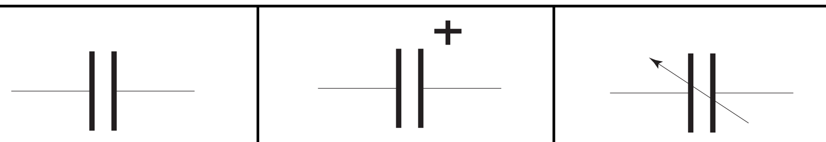
Produce a simple diagram to show the main teeth a child will have. Indicate on your diagram the order in which the teeth appear.

Task

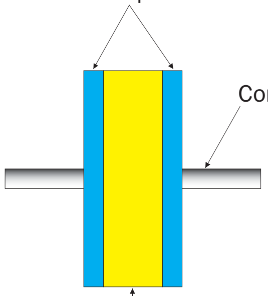
a. **Draw and measure two different styles of toothbrushes from home. Indicate who you think the toothbrushes are designed for.**
b. **List some of the design features that are now being incorporated into the design of toothbrushes in order to improve their effectiveness at cleaning teeth.**
c. **Look at the design of toothbrushes on the market for young children. What features have the designers incorporated in them to make them easy and fun for young children to use? Present your findings as a series of sketches with notes.**

Capacitors

A capacitor is an electronic device that can store electrical charge. It is made from two metal plates separated by an insulator called the dielectric. Most capacitors used in school projects are likely to be measured in Microfarads (μF), Nanofarads (nF) or Picofarads (pF).

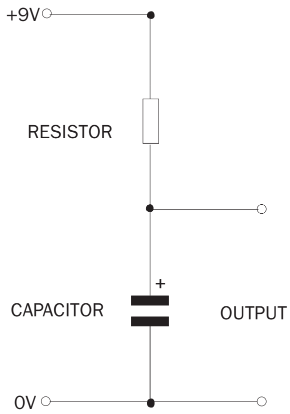


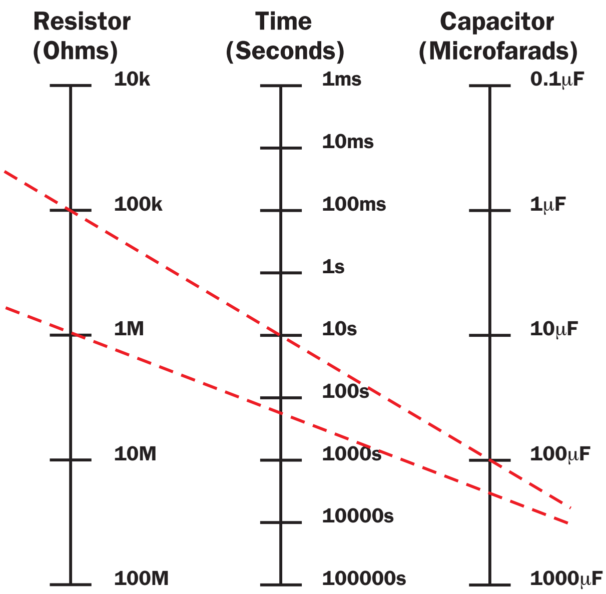
Non-polarised capacitor | Polarised capacitor | Variable capacitor



Often capacitors are used in conjunction with a resistor. If the resistor is low in value the current will flow quickly into the capacitor. If the resistor is high in value, the current will take longer to flow into the capacitor.

A capacitor and resistor connected in this way is like a tap filling a bucket with water. The amount of water flowing into the bucket depends on how much the tap is open. The speed at which the bucket fills with water is also dependant on the size of the bucket. A larger bucket will take longer to fill with water.





T(sec)=C×R

The diagram to the left will enable you to estimate the value of resistor and capacitor to select to achieve the desired time delay. Remember the time delay is the time taken to reach $^2/_3$ of the supply voltage. If the supply voltage is 9V it will be the time taken to reach six volts.

CAUTION
Electrolytic capacitors should only be used within the voltages printed on the case. They must also be connected the correct way round. The positive leg must be connected towards the positive side of the circuit.

Types of capacitors

Like resistors, capacitors use a code to represent their value.

470pF = 471
6800pF = 682

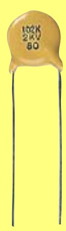
The first two digits are the significant figures whilst the third figure is the number of zeros to be added.

A more comprehensive conversion chart is available on the back of the Rapid Resistor Colour Codes Card.

Metallised ceramic capacitor

Variable capacitor

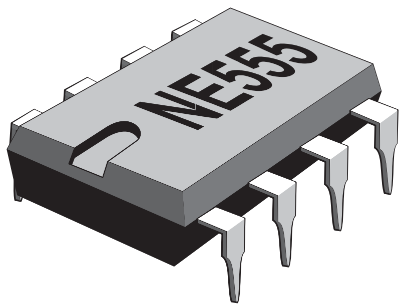
Electrolytic capacitor



Ceramic capacitor

Polyester capacitor

NE555 Monostable Timer

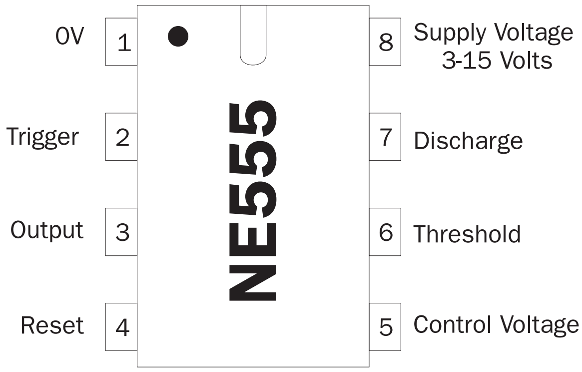


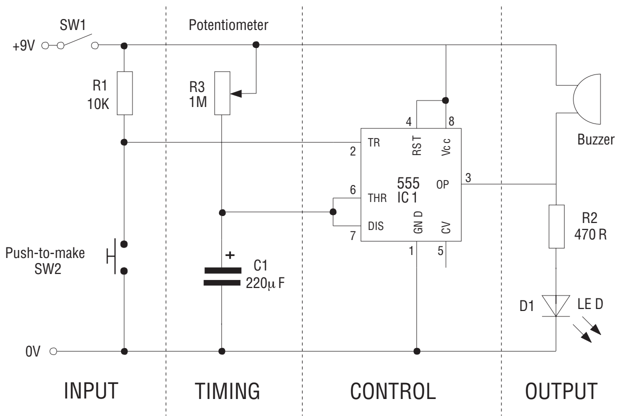
The NE555 is an 8 pin IC (integrated circuit). Inside it contains resistors, capacitors and transistors.
It has 8 legs and these are numbered 1 to 8 as shown in the diagram below. The spot or notch in the plastic case next to it identifies pin 1.
The NE555 is a very useful chip for school projects. There are a number of ways of using the NE555, however its main use is as an astable or monostable timer.

Monostable

Monostable means that the circuit has one stable state. When the timer is triggered, it will turn on for a period of time and then turn off, returning to its stable state.

The timing period of the NE555 can be altered by adjusting the values of the resistor and capacitor in the timing section of the circuit connected to pins 6&7. The larger the value of the resistor, the longer the timing period. A variable resistor is normally used so that the timing period can be easily adjusted.





How it works

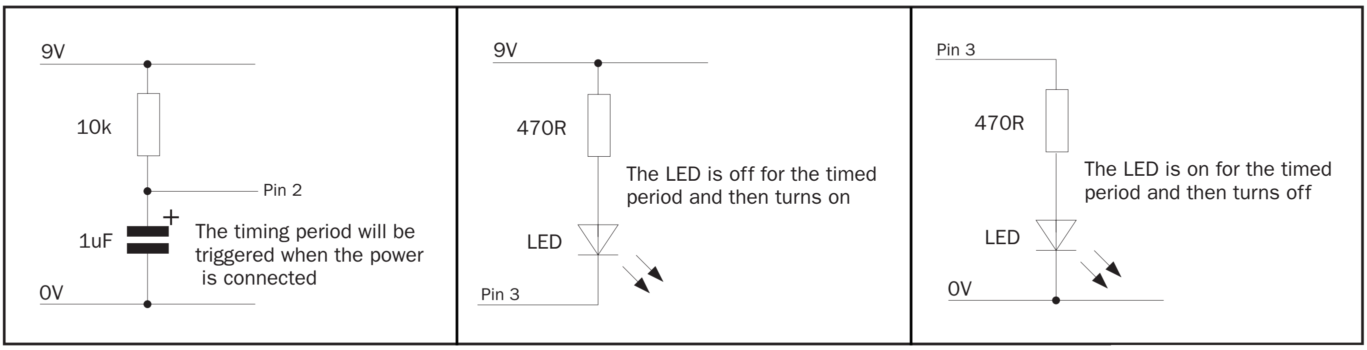
Pressing the push-to-make switch turns on the LED and turns off the buzzer starting the timing period.

When the capacitor has charged to two thirds of the supply voltage = 6V, the LED will turn off and the buzzer will turn on.

It is difficult to calculate an accurate timing period for the monostable circuit, so by using the variable resistor, the correct time period can be achieved. A rough guide is that 10kΩ and 100µF give about a one second timing period. By increasing the values of either capacitor or resistor you can increase the timing period. The NE555 monostable can be used for time periods up to a maximum of 20 minutes. However, it is best suited to timing periods of no more than 5 minutes. The timing period is dependant upon temperature and quality of the components.

Input/Output alternatives

The diagrams below show an alternative method of triggering the timing period and the result of altering the position of the LED on the output.



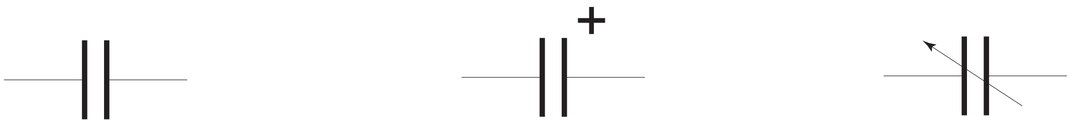
Component Activity

Capacitors

1. What is the capacitor code for the following values of capacitor?
   10pF, 0.1μF, 4.7nF, 470nF, 1500pF

2. Work out the value of the following capacitors from their capacitor code:
   100, 471, 682, 473, 224

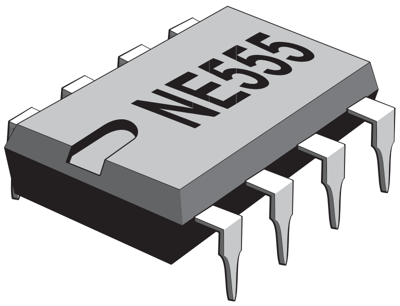
3. What do the following symbols represent?



4. Draw a simple diagram to show how the negative leg of an electrolytic capacitor is identified.

5. Calculate the time constant from the following values of resistor and capacitor
a. C=100μF R=100k
b. C=220μF R= 10k
c. C=10μF R=10M

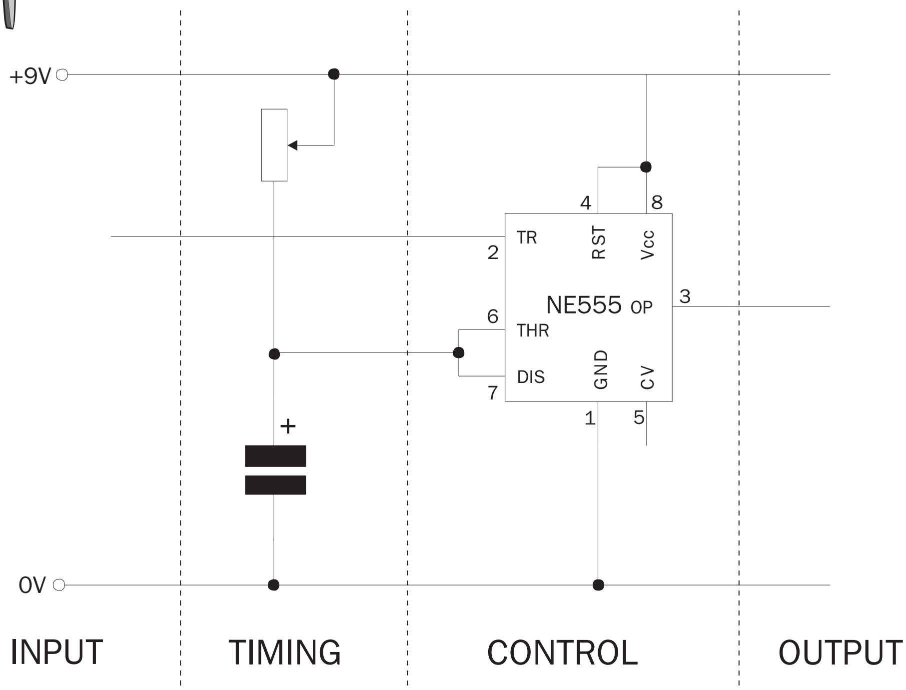
NE555



1. Draw and label a diagram of the pin layout for a NE555 timer.

2. Explain two methods used to identify where pin 1 is located on the NE555.

3. Complete the input section of the diagram below to show how the circuit can be designed to operate when the power is turned on.



4. Complete the output section of the diagram to turn on an LED when the timing period is over.

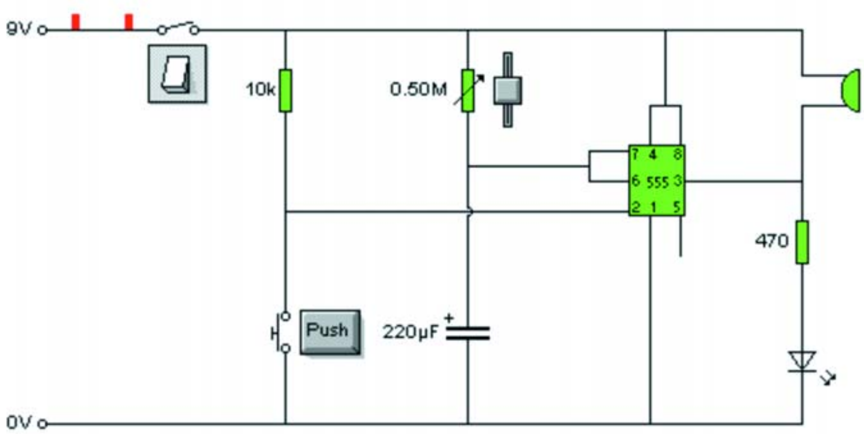
5. Explain how this new circuit works.

Circuit Investigation

Crocodile Clips

PLEASE NOTE: Some of the following examples may cause damage to the components. It is therefore recommended to only try these using Crocodile Clips© software.

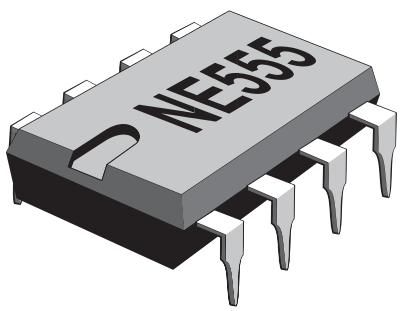
The diagram below shows the universal timer circuit. Set up the circuit on Crocodile Clips© software and use it to answer the following questions;



1. What happens to the length of the timing period if you increase the value of the variable resistor?

2. What happens to the length of the timing period if you reduce the value of the capacitor?

3. Which values of capacitor and resistor can be used to achieve the following time periods:
a. 30 seconds
b. 1 minute
c. 3 minutes



4. What happens if the 470R resistor is removed from above the LED? (Only attempt this using Crocodile Clips simulation).

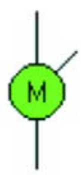
5. What is the purpose of the 10k resistor placed above the switch? Explain how this section of the circuit works.

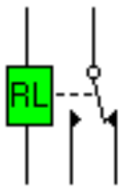
6. What happens if you swap the positions of the LED and resistor with the buzzer in the circuit?

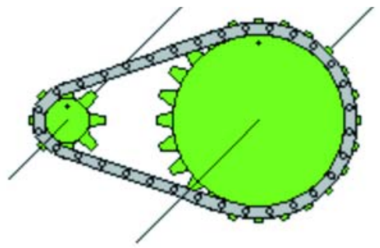
7. Design a new input circuit that will trigger the timer as soon as the power is turned on. Draw or print out a circuit diagram to show how you have changed the circuit.

8. Find out a simple method for resetting the timer. You may need to add a push to make switch in the circuit.

9. A manufacturer has asked you to design a circuit that will switch on a motor to open an automatic garage door. The circuit should turn a motor on for one minute and then turn it off again. Use the circuit diagram at the top of the page as your starting point. You will need to replace some components and you may need to use some of the components below. Print out a copy of your final design.







Initial Ideas

Once you have written a specification, the next stage is to draw some initial ideas. Designers try to come up with as many ideas as possible. Even if you think the idea might be a little silly, you should include it because it may be useful later.

Your specification will act as a guide for your ideas. Try to think of the main features you need to include whilst you are drawing.

Task

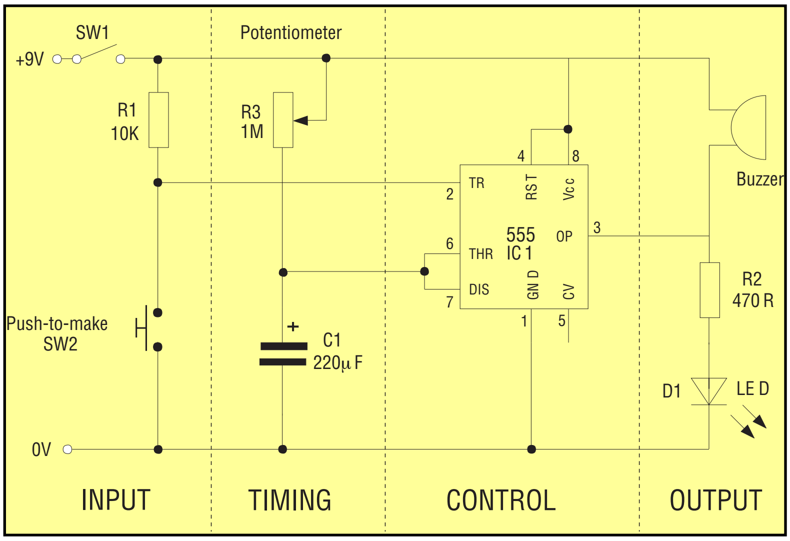
Draw a range of ideas for the casing design of your timer project.

Do not make your designs too complicated with lots of small cut and turns. This will prove difficult for you to cut out.

Circuit Construction

The circuit diagram to the right is the circuit for your timer. It is based on a NE555 monostable circuit.

- The timer starts when the switch is closed producing a pulse to the trigger input.
- The output from pin 3 switches to 9V and the LED will light indicating the timer is in operation.
- The capacitor is also charging via the potentiometer. The higher the value of resistance the longer it will take to charge the capacitor.
- When the voltage from the capacitor reaches 6 volts, the output from pin 3 goes to 0V, the buzzer will sound and the LED goes out.

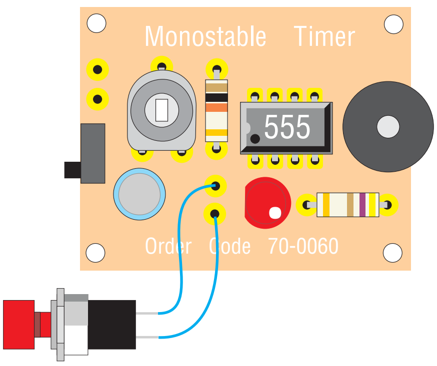


Construction of circuit

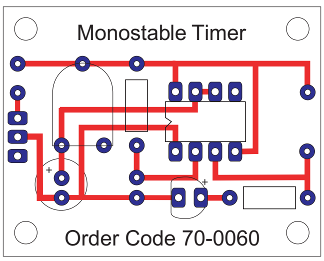
You will need to collect together the following equipment before you start construction of your circuit:

- Soldering equipment set
- Printed circuit board
- Components: IC ME555, 8 pin IC holder
  R1 10k resistor (brown, black, orange).
  R2 470R resistor (yellow, violet, brown)
  SW1 slide switch, SW2 push-to-make switch
  R3 1M potentiometers, C1 220µF capacitor
  D1 5mm LED, 12V buzzer, PP3 battery clip

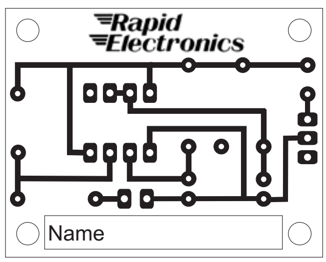
Component side



Transparent view



Track side



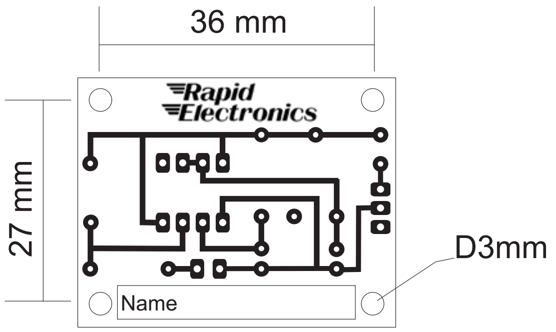
Procedure for construction

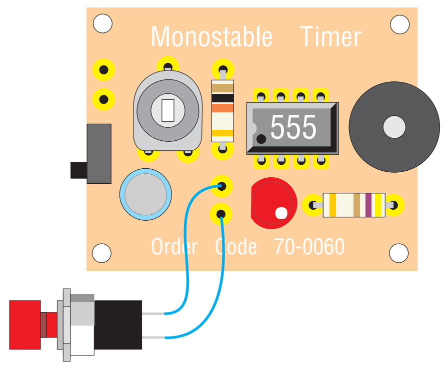
1. Solder the resistors in place.
2. Solder the capacitors in place (making sure you get the legs the correct way round).
3. Solder the LED in position so that it sits 20mm above the circuit board. It is important to connect it the correct way round or it will not light.
4. Solder the variable resistor in place.
5. Solder the buzzer into the circuit board.
6. Solder the IC holder (taking care not to solder between the legs).
7. Solder the slide switch into the circuit board.
8. Solder the push-to-make switch onto the wires and then into position on the circuit board.
9. Solder the battery clip in place.
10. Place the NE555 timer chip into the holder, making sure to insert it the correct way round.

Case Construction

The picture to the right shows the circuit board and the battery together. Also shown is the background shape.

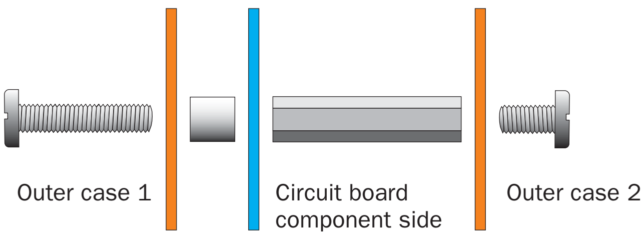
The diagram below shows the position of the location holes needed to cover the battery and circuit.

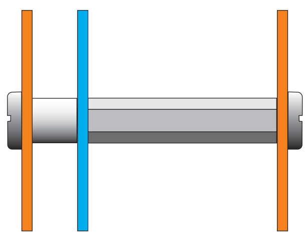


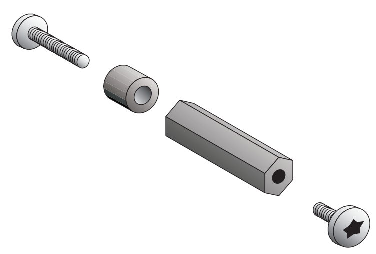


Process for production

1. Attach the two pieces of outer case material together using double-sided tape.
2. Attach your design template.
3. Cut around the template of the design taking care to ensure that you have left sufficient material to cover the circuit board and the battery that will be placed behind it.
4. Smooth the edges by filing, and with glasspaper.
5. Place the circuit board onto the outline shape and drill through the four marked holes with a 3mm drill. Take care not to damage the circuit board whilst you are doing this.
6. Separate the two sides of the case.
7. Mark and drill a 7mm diameter hole in the front panel of the case for mounting the push-to-make switch.
8. Solder the components into the circuit board.
9. Assemble case and circuit board using the spacers.







The circuit will require four spacer arrangements to ensure the circuit board is held securely in place.
Each student will require the following:

- 4 of M3 6mm pan head slotted screws (33-1500)
- 4 of M3 12 mm pan head slotted screws (33-1510)
- 4 of M3 spacer 4mm (33-3610)
- 4 of 18mm threaded spacers (33-3535)

Development

Task

In the box below draw and colour your final design for the outline of your timer case. Take care not to make the design too complicated since this will prove difficult to cut out. Use the 'Case Construction' activity sheet for guidance on positioning the circuit.

Evaluation

Evaluation is an important part of the design process. It is used by designers to check they have produced an effective design with all the features they identified in the specification. When you are evaluating a product you are trying to find out both its good and poor features.

Your own opinions are important, but you must also get some other people's opinions as well. They may notice qualities you are not aware of.

Task

Evaluate your Timer project by establishing if it meets your specification.
Look at your specification and write down in the boxes below two features to establish the quality of your Timer.

1.

2.

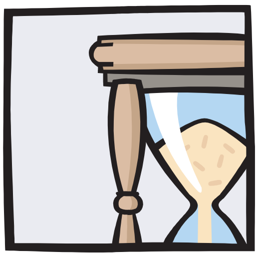
Task

Sketch how your final Timer design could be improved.

Procedure Chart

Task

Draw a procedure chart, using a series of pictures to describe how you have manufactured your Timer. Make sure that your diagrams show the important detail.



Product Development

A manufacturer is interested in your design, however market research has indicated that the timer must be activated automatically when it is tilted or moved. Using the following information and the Switch Information extract sheet show how your circuit could be developed to start automatically.

The timer currently uses a mini slide switch mounted on the edge of the circuit board to turn on the timer from the battery. The timer also uses a push-to-make switch to trigger the timer. The manufacturer would like to reduce the number of switches in the design since they add to the cost of the product. They would also like to make it easier to use.

You will need to consider the following:
- The minimum number of switches required
- The cost of the replacement components
- Safety of children using the device
- Conservation of power when not in use

Task

Sketch your ideas in the space below. Include with your sketches a series of notes to help explain your designs. Your drawings should show all the essential detail to make the necessary changes to the design.

Switch Information

The following information is an extract from a Rapid Electronics Catalogue. Use the information to help you with your designs for an alternative switch in your timer project.

Subminiature V4 microswitches — NTE

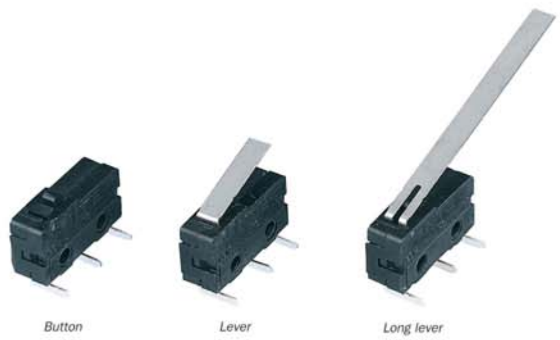
Type V4 miniature microswitches with SPDT switching and a long life coil spring mechanism. The range is available in five standard actuator forms and with PCB pins or solder terminals.

Technical specification					
Contact rating	5A 250V AC				
Mechanical life	3 x 10^6 operations				
Temperature range	-20°C to +70°C				
	Type 00	**Type 01**	**Type 02**	**Type 05**	**Type 08**
Operating force	150.0	42.0	27.0	42.0	15.0
Release force	75.0	12.0	5.0	10.0	10.0
Pre-travel max.(mm)	0.6	2.6	5.4	2.6	7.5
Movement differential (mm)	0.1	0.6	0.9	0.6	1.7
Over-travel min.(mm)	0.5	1.0	1.6	1.0	5.0

Solder terminal	Order code	1+	25+	100+	250+
00A button	**78-2400**	**0.45**	**0.35**	**0.31**	**0.29**
01A 14.5mm lever	**78-2402**	**0.48**	**0.37**	**0.33**	**0.31**
02A 22.6mm lever	**78-2404**	**0.48**	**0.37**	**0.33**	**0.31**
05A 14.5mm roler lever	**78-2406**	**0.51**	**0.40**	**0.35**	**0.325**
08A 43mm lever	**78-2408**	**0.51**	**0.40**	**0.35**	**0.325**
PCB termination					
00C button	**78-2410**	**0.45**	**0.35**	**0.31**	**0.29**
01C 14.5mm lever	**78-2412**	**0.48**	**0.37**	**0.33**	**0.31**
02C 22.6mm lever	**78-2414**	**0.48**	**0.37**	**0.33**	**0.31**
05C 14.5mm roller lever	**78-2416**	**0.51**	**0.40**	**0.35**	**0.325**
08C 43mm lever	**78-2418**	**0.51**	**0.40**	**0.35**	**0.325**

Subminiature 90° V4 microswitches — Camden

Type V4 miniature microswitches with SPDT switching and a long life coil spring mechanism. The range is available in three standard actuator forms and with PCB pins for 90° right angle mounting.



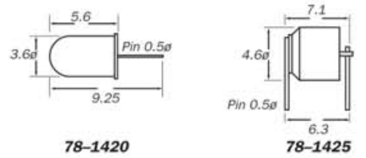
Technical specification			
Contact rating	5A 250V AC		
Mechanical life	3 x 10^6 operations		
Temperature range	-20° to +70°C		
	Type 00	**Type 01**	**Type 08**
Operating force	150.0	42.0	15.0
Release force	75.0	12.0	10.0
Pre-travel max (mm)	0.6	2.6	7.5
Movement differential (mm)	0.1	0.6	1.7
Over-travel min (mm)	0.5	1.0	5.0
Manfr. part No.	**CSM3500D**	**CSM3510D**	**CSM3580D**

Type	Order code	1+	25+	100+	250+
00 button	**78-2730**	**0.42**	**0.35**	**0.32**	**0.29**
01 lever	**78-2732**	**0.47**	**0.40**	**0.36**	**0.32**
08 long lever	**78-2738**	**0.59**	**0.51**	**0.46**	**0.42**

Extracts taken from Rapid Electronics Catalogue October 1999 - March 2000
Please see latest catalogue for current pricing.

Microminiature mercury tilt switches — Assemtech Europe

Hermetically sealed mercury tilt switches designed to switch on or off when tilted from the horizontal position. The robust metal housings are gas filled and hermetically sealed for long life and high reliability.
The CM1800-01 is very sensitive to movement and vibration.



Technical specification			
		CM1600-0	**CM1800-1**
Contacts		Single pole normally open	
Contact rating	switching voltage	24V DC	120V AC
	switching current	0.15A	0.1A
	switching capacity	3VA	3VA
Differential angle			5°
Contact resistance		5| max.	
Operating temperature		-37 to +100°C	

Type	Order code	1+	25+	100+	250+
CM1600-0	**78-1420**	**2.00**	**1.73**	**1.47**	**1.30**
CM1800-1	**78-1425**	**2.00**	**1.73**	**1.47**	**1.30**

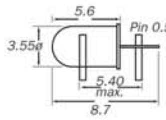
Miniature tilt switch

A miniature tilt switch consisting of a mercury bubble in small glass envelope. Overall dimensions 18 x 5mm diameter. Contacts rated at 1A 14V DC. Switch will operate at tilt angle at 10°.
Caution - this switch contains mercury and should NEVER be broken open.

	Order code	1+	25+	100+
Tilt switch	**78-0790**	**0.50**	**0.40**	**0.35**

Miniature non mercury tilt switch — Assemtech Europe

The compact CW1600 weighing just 0.9 grams is a non mercury tilt switch approved for keyfobs and miniature transmitters. Hermetically sealed enclosure with a moving contact mechanism.

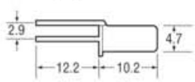


Technical specification		
Contacts		Single pole normally open
Switch rating:	voltage	60V AC max.
	current	0.25A max.
	capacity	3VA max.
Differential angle		15°
Contact resistance		100m| max.
Operating temperature		-37° to +100°C

	Order code	1+	25+	100+	250+
CW1600-1 non mercury	**78-1440**	**2.40**	**2.08**	**1.73**	**1.56**

Non-mercury tilt switch — Assemtech Europe

A gas filled hermetically sealed tilt switch employing non toxic materials in a miniature completely mercury free sealed metal package.
Normally open contacts which will close when tilted more than 10° from the horizontal. Suited to a wide range of applications including toys, games, automotive and water treatment equipment. ***Assemtech type CW1300-1.***



Technical specification	
Contact arrangement	Single pole normally open
Contact rating	3VA max.
Switching current	0.25A max.
Switching voltage	60V AC or DC max
Contact resistance	30| max.at 15° tilt
Temperature range	-40° to +150°C

	Order code	1+	25+	100+	500+
Non-mercury tilt switch	**78-0760**	**0.95**	**0.84**	**0.72**	**0.63**

Progress Diary

Each week, write a short paragraph about the work you have done. As well as commenting on good aspects of the lesson, try to comment on work that has not gone so well, or that you did not fully understand.

When designing, it is also important to think ahead. Write down in the second section what work you anticipate doing next week on your project.

Week 1	Today ________
	Next Lesson

Week 2	Today ________
	Next Lesson

Week 3	Today ________
	Next Lesson

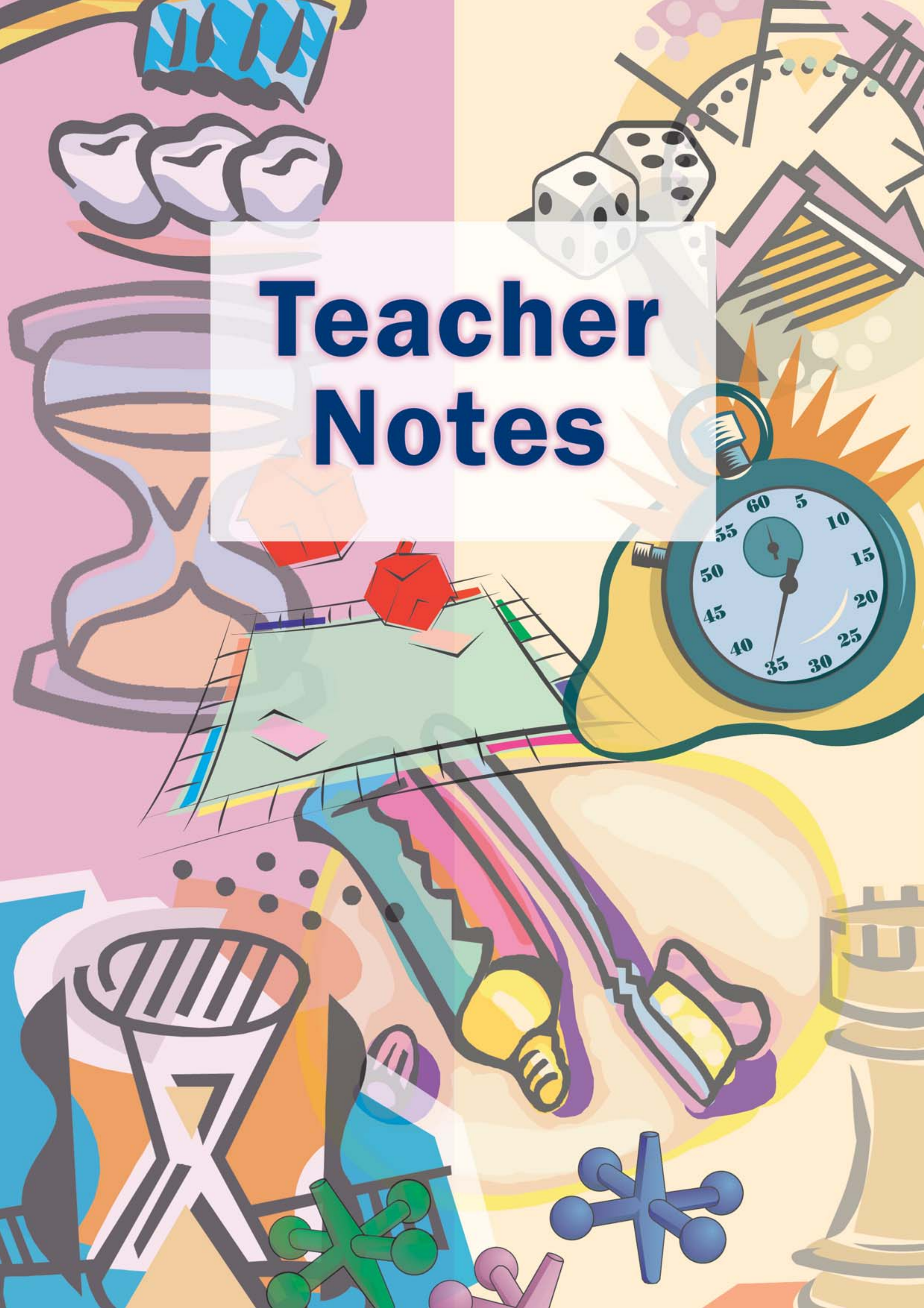
Week 4	Today ________
	Next Lesson

Week 5	Today ________
	Next Lesson

Week 6	Today ________
	Final comment:

Teacher comments:

Teacher Notes



Teacher notes

Introduction

The Timer project is designed to introduce students to the use of resistors/capacitor timing circuits and the NE555 monostable. The project is designed for KS3/KS4 to design and make in electronics. Emphasis has been placed on providing students with a complete design solution at the end of the project, a quality product of which students can be proud.

A key feature of the teaching material is that in addition to providing a student resource, it also contains detailed teacher support notes for guidance. The teaching pack has been designed to be **photocopied**. A number of the activity sheets can be used in isolation from the project. Included in the material are a series of structured homework assignments to support the work in class.

A series of lesson plans have been included based on teacher experience. However, the detailed project organisation will depend upon timetable, facilities and student needs.

Aims and objectives

The project is intended for use with mixed ability year 9/10 students. The practical work should be possible in a typical secondary based workshop.

AIMS AND OBJECTIVES

The project is to design and make an electronic timer for use in the home. The project will enable students to experience the design and manufacture of simple electronic circuits.

CONCEPTS:

- Electronic circuits.
- Design and manufacture.
- Evaluation.

OBJECTIVES:

Pupils should understand:

- The need to investigate the background to a problem.
- How to select appropriate components to build simple electronic circuits.
- The importance of planned manufacture.
- How to improve a product by evaluation.

SCIENCE OPPORTUNITIES:

- Understanding of circuit theory.
- Resistance/ Ohms law.
- Theory of capacitance and units.

MATHS OPPORTUNITIES:

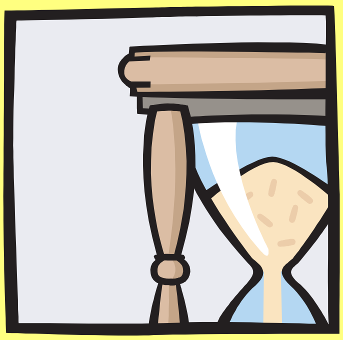
- Accurate measurement and marking out.
- SI units of measurements.

IT OPPORTUNITIES:

- Use of Crocodile Clips© software to develop and test circuit ideas.
- Graphic packages to help generate design ideas.

OTHER OPPORTUNITIES:

- Product styling.



Project plan

Week 1 - Introduction and Investigations

Aim:
- Introduce and discuss the background to the problem of timers in the home.
- Write Design brief.
- Write Specification.
- Investigate use of timers in the home and identify suitable areas for focus work.

Student:
- Write Design brief.
- Write Specification.
- Investigate timer situations.

Teacher:
- Help identify suitable areas for a timer design through background discussions.
- Assist in the writing of the design brief and specification.
- Advice on organisation of information gained from project investigation tasks.

Demonstrations:
- Timers currently used at home.

Resources:
- Examples of timers, clocks, games and toothbrushes (if available).
- Example of a completed Timer project.
- "Timer Project" sheet.
- "Timer Investigations" information and activity sheets.
- Access to library/books/Internet for child development info etc.

Homework:
- Research possible design situations for use of an electronic timer.
- Selected questions from Timers activity.
- Diary record.

Week 2 - Components and circuits

Aim:
- Revise knowledge of voltage divider.
- Develop concept of resistor/capacitor circuit to provide a time delay.
- Understand use of NE555 in monostable mode.
- Experiment with building electronic circuits.

Student:
- Testing variety of timer circuits using Crocodile Clips© software.
- Questions based on activity sheets.

Teacher:
- Discussion on capacitors.
- Discussion on capacitor/resistor circuit to provide time delays.
- Guidance on building and testing circuits.
- Assistance with work on capacitor/NE555 activity sheets.

Demonstrations:
- Construction of circuits.
- How to establish values on small capacitors.

Resources:
- "Capacitors" activity sheet.
- "NE555" activity sheet.
- Crocodile Clips software worksheet.
- Electronic components for testing.
- Access to computers for classwork.

Homework:
- Selected questions from activity sheet on capacitors and NE555.
- Diary record.

Project plan

Week 3 - Design ideas

Aim:
- Generate initial ideas and develop final solution.
- Develop graphical communication and presentation skills.

Student:
- Draw range of initial ideas.
- Develop chosen idea and present final solution.

Teacher:
- Guide students through generation and development of ideas.
- Advice on presentation techniques and layout of work.

Demonstrations:
- Graphical presentation based on coloured pencil work or computer graphics.

Resources:
- "Initial ideas" activity sheet.
- "Development" activity sheet.
- Coloured pencils and associated drawing materials.
- Access to computers.

Homework:
- Completion of unfinished design work.
- Diary record.
- Draw template for case design.

Week 4 - Manufacturing

Aim:
- Review of safe working practices in the workshop.
- Students to start manufacturing Timer project.

Student:
- Manufacture Timer project.

Teacher:
- Go through safety in the workshop with students based on equipment to be used.
- Provide assistance to students to start manufacturing Timer designs.

Demonstrations:
- Demonstrate methods and tools for manufacture.
- Safe soldering.

Resources:
- Student:
  - Class set for five students, order code **70-0050** which includes:-
    – 470R & 10k resistor – 5mm LED – 8 pin IC holder – NE555 – 4mm circ. spacers
    – push to make switch – slide switch – 220µ 16V cap – 12V buzzer – 12mm pan screws
    – 1M potentiometer – battery clip – 18mm spacers – 6mm pan screws.
  - Class set of 5 printed circuit boards (pre-drilled, order code **70-0060**).
  - PP3 battery (order code **18-1020**)
  - 100mm solid core wire.
  - Solder, soldering tools.
  - Workshop tools.

Homework:
- Procedure chart for manufacture.
- Diary record.

Project plan

Week 5 - Completion of Manufacturing

Aim:
- Complete manufacturing of any unfinished Timer PCBs.
- Design and manufacture casing for PCB.
- Assemble Timer.

Student:
- Complete any unfinished construction of Timer PCB.
- Cut out and shape case for circuit.
- Assemble Timer.

Teacher:
- Provide support to help students finish the construction of their PCB.
- Assist students in the construction of their case designs and assembly of project.

Demonstrations:
- How to manufacture case designs and assemble project.

Resources:
- Examples to use in demonstrations for case manufacture.
- Blank material for case sides.
- Workshop tools for cutting and shaping and finishing (suggest using drilling template).
- Support pillars for assembling project.

Homework:
- 3D view of final project in colour.
- Diary record.

Week 6 - Evaluation

Aim:
- Completion of Timer assembly.
- Evaluation of Timer project and student progress.
- Extension exercise based on product development.

Students:
- Completion of Project assembly.
- Evaluation against specification.
- If sufficient time - Product development activity.

Teacher:
- Help with final project assembly.
- Discussion on important features to include in project evaluations.
- Guidance on Product development activity.

Demonstrations:
- Alternative types of switches for extension activity.

Resources:
- "Evaluation" activity sheets.

Homework:
- Diary record and final project evaluation.
- Product development activity.

National Curriculum 2000

Design & Technology
Programme of Study Key Stage 3

During key stage 3 pupils use a wide range of materials to design and make products. They work out their ideas with some precision, taking into account how products will be used, who will use them, how much they cost and their appearance. They develop their understanding of designing and making by investigating products and finding out about the work of professional designers and manufacturing industry. They use computers, including computer-aided design and manufacture (CAD/CAM) and control software, as an integral part of designing and making. They draw on knowledge and understanding from other areas of the curriculum.

Knowledge, skills and understanding

Developing, planning and communicating ideas

1 Pupils should be taught to:
   a. Identify relevant sources of information, using a range of resources including ICT
   b. Respond to design briefs and produce their own design specifications for products
   c. Develop criteria for their designs to guide their thinking and to form a basis for evaluation
   d. Generate design proposals that match the criteria
   e. Consider aesthetics and other issues that influence their planning
   f. Suggest outline plans for designing and making, and change them if necessary
   g. Prioritise actions and reconcile decisions as a project develops, taking into account the use of time and costs when selecting materials, components, tools, equipment and production methods
   h. Use graphic techniques and ICT, including computer-aided design (CAD), to explore, develop, model and communicate design proposals

Working with tools, equipment, materials and components to produce quality products

2. Pupils should be taught:
   a. To select and use tools, equipment and processes, including computer-aided design and manufacture (CAD/CAM), to shape and form materials safely and accurately and finish them appropriately
   b. To take account of the working characteristics and properties of materials and components when deciding how and when to use them
   c. To join and combine materials and ready-made components accurately to achieve functional results
   d. To make single products and products in quantity, using a range of techniques, including CAD/CAM to ensure consistency and accuracy
   e. About the working characteristics and applications of a range of modern materials, including smart materials.

Evaluating processes and products

3. Pupils should be taught to:
   a. Evaluate their design ideas as these develop, and modify their proposals to ensure that their product meets the design specification
   b. Test how well their products work, then evaluate them
   c. Identify and use criteria to judge the quality of other people's products, including the extent to which they meet a clear need, their fitness for purpose, whether resources have been used appropriately, and their impact beyond the purpose for which they were designed

Knowledge and understanding of materials and components

4. Pupils should be taught:
   a. To consider physical and chemical properties and working characteristics of a range of common and modern materials
   b. That materials and components can be classified according to their properties and working characteristics
   c. That materials and components can be combined, processed and finished to create more useful properties and particular aesthetic effects
   d. How multiple copies can be made of the same product.

Knowledge and understanding of systems and control

5. Pupils should be taught:
   a. To recognise inputs, processes and outputs in their own and existing products
   b. That complex systems can be broken down into sub-systems to make it easier to analyse them, and that each sub-system also has inputs, processes and outputs
   c. The importance of feedback in control systems
   d. About mechanical, electrical, electronic and pneumatic control systems, including the use of switches in electrical systems, sensors in electronic switching circuits, and how mechanical systems can be joined together to create different kinds of movement
   e. How different types of systems and sub-systems can be interconnected to achieve a particular function
   f. How to use electronics, microprocessors and computers to control systems, including the use of feedback
   g. How to use ICT to design sub-systems and systems.

Knowledge and understanding of structures

6. Pupils should be taught:
   a. To recognise and use structures and how to support and reinforce them
   b. Simple tests and appropriate calculations to work out the effect of loads
   c. That forces of compression, tension, torsion and shear produce different effects.

Breadth of study

7. During the key stage, pupils should be taught the knowledge, skills and understanding through:
   a. Product analysis
   b. Focused practical tasks that develop a range of techniques, skills, processes and knowledge
   c. Design and make assignments in different contexts. The assignments should include control systems, and work using a range of contrasting materials, including resistant materials, compliant materials and/or food.

Acknowledgments

Rapid Electronics would like to thank the many teachers who have helped in the development and evaluation of this project. In particular we would like to thank Jim Neale, Head of Technology at St Columbas College in St Albans for the initial idea and Chris Brown, Head of Electronics at Sprowston High School for his guidance in the development of the teaching material.

If your school has a project it is willing to share, or would like to help us test and evaluate new project ideas, then please contact the Education Section at Rapid Electronics.