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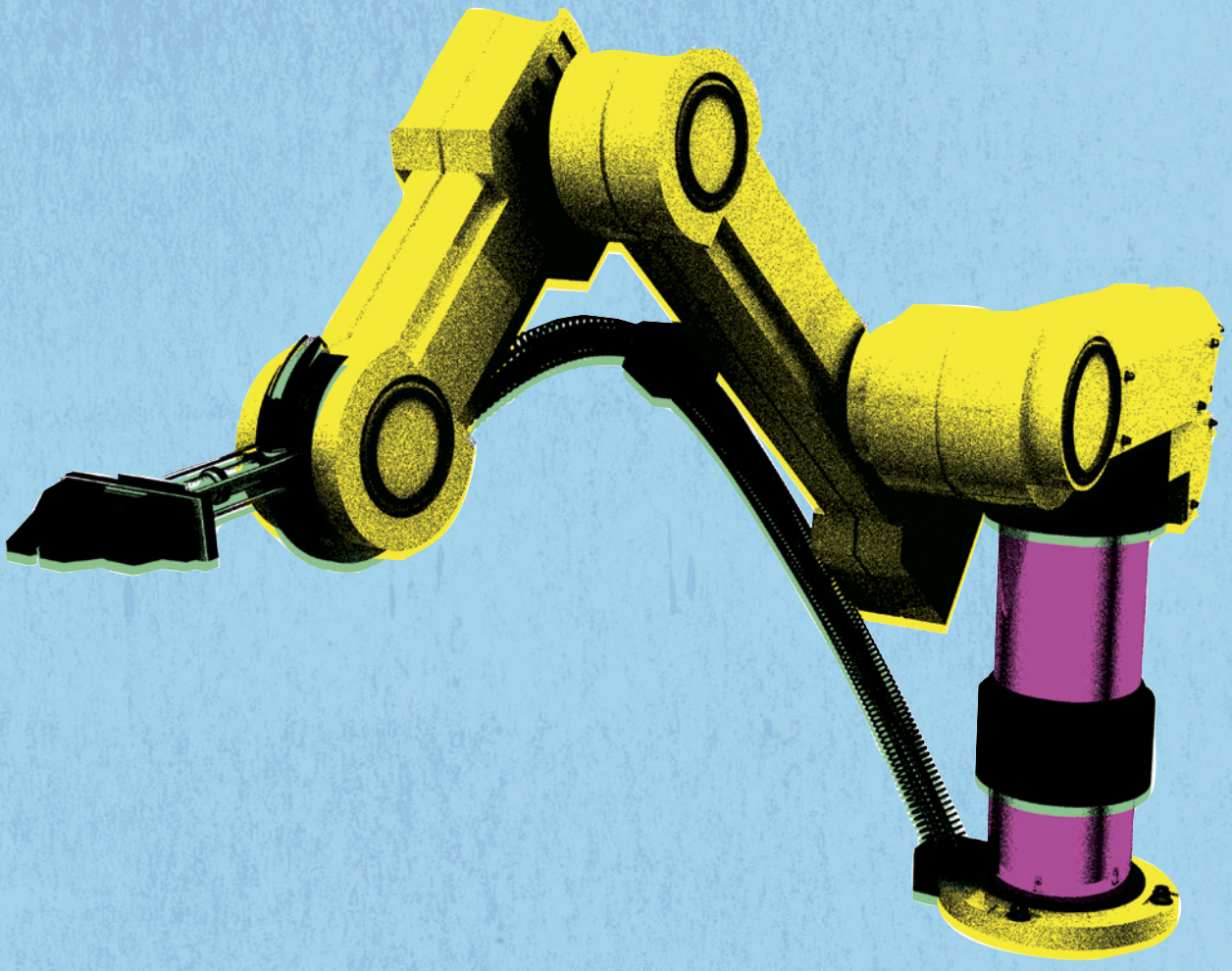
Teacher's Guide

Edexcel GCSE in Design and Technology: Electronic Products



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Contents

Delivery models

The following delivery models highlight just three of the possible strategies that you could use when structuring your course:

- traditional combined design and make activity
- separate design and make activities
- related but separate design and make activities.

Delivery model 1: Traditional combined design and make activity

This model of delivery should be very familiar to centres. In Year 10 an induction period is used to develop basic skills leading to specific investigation, design and make tasks. The investigation task develops product analysis skills, a series of design tasks could be used to develop creativity and working to limited deadlines, and a making task is used to develop modelling skills. All these skills prepare students for the 'major coursework project' in Year 11.

	Autumn term		Spring term		Summer term		
Year 10	Induction tasks	Investigation task(s)	Design task(s)	Making task	Work related learning	Design task(s)	Making task
	Autumn term		**Spring term**		**Summer term**		
Year 11	Unit 1: Combined design and make activity ie security				Unit 2 exam revision	Unit 2 June sitting	Summer vacation

Delivery model 2: Separate design and make activities

This model involves students designing one product and making another. The design activity could be as creative and unrestrained as a student likes, because there is no requirement to manufacture the design proposal, although it should be possible to do so, for example commercially. The make activity would be a fully functioning product and appropriate to the expected levels of response at GCSE. The making task would be challenging enough to demand high-level making skills in order to be successful and have the potential to gain a student high levels of achievement.

	Autumn term		Spring term		Summer term		
Year 10	Induction tasks	Investigation task(s)	Design task(s)	Making task	Work related learning	Design task(s)	Making task
	Autumn term		**Spring term**		**Summer term**		
Year 11	Unit 1: Design activity ie an electronic device to warn when a bicycle is being moved without permission.		Unit 2: Make activity ie an electronic score counter to record 5-a-side football scores.		Unit 2 exam revision	Unit 2 June sitting	Summer vacation

Delivery model 3: Design and make activities related but separate

Here, the make activity is tackled first by all students making, for example, a light chasing circuit using LEDs, an astable sub-system and a decade counter. The manufacturing specification PCB track pattern is given. All students produce a similar outcome that can be used in the design activity later on in the year. The design activity that follows can focus on, for example, uses for this particular circuit, looking at how the same output could be achieved using other circuit designs. For example, astables can be created from logic sub-systems, outputs sequences PICs etc. Students would also design and make the case in which to place the circuitry and would focus their product on a particular user group.

	Autumn term		Spring term		Summer term		
Year 10	Induction tasks	Investigation task(s)	Design task(s)	Making task	Work related learning	Design task(s)	Making task
	Autumn term		**Spring term**		**Summer term**		
Year 11	Unit 2: Make activity ie light chaser		Unit 1: Design activity, ie alternative circuits and cases for a light chaser to be focused on a specific user group		Unit 2 exam revision	Unit 2 June sitting	Summer vacation

Teaching ideas

This section contains some ideas for teaching the content.

The following three tasks focus on how to develop important investigation, design and making skills needed for coursework whilst addressing key examination topics.

Investigation task

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
1	To disassemble a plastic-cased personal attack alarm. Parts to include: circuitry sub-systems, PCB and case production processes. To outline the main factors affecting the specification criteria for the alarm.	**1.2: Research** Present selective and focused research. Students should be discouraged from presenting unnecessary research or 'padding'. Use product disassembly in order to analyse a relevant, existing product's performance, materials and components, processes, quality and sustainability issues. Product analysis is an ideal focused research activity as it enables students to understand the work of professional designers and uncover the problems that they have to solve.	**Topic 3.1: Specification criteria** When analysing a product, students should take into account the following specification criteria: • Form – Why is the product shaped/styled as it is? • Function – What is the purpose of the product? • User requirements – What qualities make the product attractive to potential users? • Performance requirements – What are the technical considerations that must be achieved within the product? • Material and component requirements – How should materials and components perform within the product? • Scale of production and cost – How does the design allow for scale of production and what are the considerations in determining cost? • Sustainability – How does the design allow for environmental considerations?

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
2–3	To discuss the components and materials used in the pesonal attack alarm, and the plastic used in case construction.	**1.2: Research**	**Topic 1.3: Plastics** Working properties, advantages/ disadvantages of the following plastics used in the manufacture of electronic product cases: • high impact polystyrene (HIPS) • acrylic. **Topic 1.4: Input components** Identification, function and application of the following input components used in the production of electronic products: **Switch types** • toggle • key • push to make • push to break • reed. **Topic 1.5: Process components** Identification, function and application of the following process components used in electronic products: • transistor • thyristor • field effect transistor (FET) • operational amplifier (Op-Amp) as a comparator. **Topic 1.8: Output components** Identification, function and application of the following components used in electronic products: • buzzers • light emitting diodes (LEDs) • loudspeakers. **Topic 1.9: Power sources** Function, application and advantages/ disadvantages of the following power sources used in electronic products: • batteries including rechargeable types.

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
4	To discuss the components and materials used in the personal attack alarm, and the plastic used in case construction.	1.2: Research	**Topic 2.1: Scale of production** Characteristics, application and advantages/disadvantages of batch production in the manufacture of electronic products. **Topic 1.15: Circuit construction** Application and advantages/disadvantages of the following circuit construction methods: • prototyping board (breadboard) • printed circuit board (photo etched) • stripboard (veroboard). **Topic 2.2: Forming techniques** Characteristics, preparation, processes, application and advantages/disadvantages of the following methods for the batch and mass production of electronic products: • injection moulding • vacuum forming.
5	To discuss sustainability issues relating to the extraction of materials, production, use and disposal of the products.	1.2: Research	**Topic 6.1: Minimising waste production** Principles, application, advantages/disadvantages to society and the environment of minimising waste production throughout the product life cycle using the following 4 Rs: • reduce materials and energy • reuse materials and products where applicable • recover energy from waste • recycle materials and products or use recycled materials.

Design task

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
1	**Brief:** To design an electronic device or system that will sense a rise in temperature and switch a cooling fan on and off when the temperature exceeds or falls below a pre-set level. To investigate existing similar products to establish components, materials and processes typically used for this type of product. To discuss and develop specification criteria for an automatic fan.	**1.3: Specification** Produce realistic, technical and measurable specification points which address some issues of sustainability for their own product. The specification is an extremely important document as it focuses the designer and enables them to review their design ideas as they progress. Each specification point needs to be fully justified and not simply a statement.	**Topic 4.1: Specification criteria** When designing a product, students should take into account the following specification criteria: • Form – How should the product be shaped/styled? • Function – What is the purpose of the product? • User requirements – What qualities would make the product attractive to potential users? • Performance requirements – What are the technical considerations that must be achieved within the product? • Material and component requirements – How should materials and components perform within the product? • Scale of production and cost – How will the design allow for scale of production and what are the considerations in determining cost? • Sustainability – How will the design allow for environmental considerations?

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
2–3	To produce **three** different initial ideas for circuit and case designs respectively.	**2.1: Initial ideas** Present alternative initial design ideas that are realistic, workable and detailed. This is the opportunity for students to demonstrate their creativity and knowledge and understanding of electronic systems. Demonstrate their understanding of components, electronic sub-systems, materials, processes and techniques applicable to their initial design ideas. Annotation should clearly show students' knowledge and understanding of the function of each electronic idea. Address specification points through their initial design ideas. Annotation should be clearly related to the specification points.	**Topic 4.2: Designing skills** When designing a product, students should be able to respond creatively to design briefs and specification criteria, including: • clear communication of design intentions using notes and/or sketches • annotation which relates to the original specification criteria. **Topic 4.3: Application of knowledge and understanding** When designing a product, students should be able to apply their knowledge and understanding of a wide range of materials and/or components and manufacturing processes to each design idea, including: • the properties of materials and/or components • the advantages/disadvantages of materials and/or components and manufacturing processes • justification of the choice of materials and/or components and manufacturing processes.
2–3	To review all design ideas and select **one** for further development.	**2.2: Review** Present objective evaluative comments against their original specification criteria. Initial design ideas are 'raw' at this stage and it is important to determine which can be developed into workable solutions by testing against specification points. Use user-group feedback and issues of sustainability to evaluate their initial design ideas. All design is concerned with people, and their opinions are extremely useful in gaining another perspective on the further development of ideas.	

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
4–5	To develop **one** idea into a final design proposal.	**3.1: Development** Develop their initial design ideas into a single final design proposal that is significantly different, and improved, to any previous initial design idea. Development should refine technical aspects of the product design and not simply focus on cosmetic changes. Evaluate their ideas against relevant design criteria as they progress.	**Topic 4.2: Designing skills** When designing a product, students should be able to respond creatively to design briefs and specification criteria, including: • clear communication of design intentions using notes and/or sketches • annotation which relates to the original specification criteria. **Topic 4.3: Application of knowledge and understanding** When designing a product, students should be able to apply their knowledge and understanding of a wide range of materials and/or components and manufacturing processes to each design idea, including: • the properties of materials and/or components • the advantages/disadvantages of materials and/or components and manufacturing processes • justification of the choice of materials and/or components and manufacturing processes. **Topic 2.8: Health and safety** • How to understand/describe safe working practices. • How to identify workshop hazards and precautions.
6–8	To model the final design proposal including the use of CAD and/or prototyping board to model and test circuitry, and PCB drawing software to produce a PCB track pattern. Use 3D CAD, where appropriate, to model the final case design.	**3.1: Development** Use modelling in traditional materials, or in 3D CAD, to test important aspects of the design idea as it progresses. Simple mock-ups or block models can be invaluable in determining whether a design is workable. **5.3: Health and safety** Demonstrate a high level of safety awareness throughout all stages of manufacture. No other formal evidence is required.	
9	To produce 'artwork' for a final PCB track pattern and a working drawing of the final case design, including enough information on component values and dimensions to manufacture the product. To outline industrial and commercial applications relating to the final design.	**3.2: Final design** Present a final design proposal in an appropriate format that communicates their design intentions. Present technical details of materials and/or components, processes and techniques relating to their final design proposal. Final drawings should be clearly annotated and dimensioned so that they can be understood by a third party.	

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
10	To test and evaluate the final design proposal objectively against specification criteria.	**6.1: Testing and evaluation** Devise and carry out a range of suitable tests to check the performance and/or quality of the final product. Tests should be measurable and refer to specification points, if appropriate, to determine the product's fitness for purpose. Evaluate their final product objectively with reference to specification points and user-group feedback. No product is ever perfect so students should discuss the positive and negative aspects of their final product. User-group feedback should provide a further perspective.	**Topic 4.1: Specification criteria** When analysing a product, students should take into account the following specification criteria: • Form – How should the product be shaped/styled? • Function – What is the purpose of the product? • User requirements – What qualities make the product attractive to potential users? • Performance requirements – What are the technical considerations that must be achieved within the product? • Material and component requirements – How should materials and components perform within the product? • Scale of production and cost – How will the design allow for scale of production and what are the considerations in determining cost? • Sustainability – How will the design allow for environmental considerations?

Making task

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
1	**Brief**: To make a PIC controlled board game timer that will give out an audible and visual indication that 'time is up'. The time delays should be adjustable between a few seconds and a few minutes. To discuss the design brief to clarify the key design requirements.	**1.1: Analysing the brief** Analyse their design brief in enough detail to be able to clarify design needs. This will involve analysis of key words and phrases that help in understanding the issues related to the chosen/given design task.	
2	To produce a production plan for the manufacture of the board game timer.	**4.1: Production plan** Produce a detailed production plan that considers the stages of manufacture for their product. Charts should communicate clearly the correct order of making and timings. Identify and describe the stages where specific quality control procedures should take place during making. Feedback in charts should state where quality control will take place.	

Lesson	Objectives	Appropriate Unit 1 content	Appropriate Unit 2 content
3–8	To make the board game timer.	**5.1: Quality of manufacture** Attempt a challenging making task involving the manufacture of several different components using a range of materials, equipment, techniques and processes. Students must ensure that their product provides an opportunity to manufacture several different component parts from different materials using different processes. Select tools, equipment and processes, including CAD/CAM where appropriate, for specific uses. Demonstrate a detailed understanding of the working properties of materials selected for a specific use. Students should use their work plan to justify their choices. Demonstrate a wide range of making skills with precision and accuracy. This is an opportunity for students to be rewarded for the range of making skills they demonstrate during the making activity. **5.3: Health and safety** Demonstrate a high level of safety awareness throughout all stages of manufacture. Teachers will award these marks based on their observations of students during the make activity.	**Electronic circuitry manufacture** **Topic 1.4: Input components** Identification, function and application of the following input components used in the production of electronic products: **Switch types** • toggle • rocker • push to make • tilt. **Topic 1.8: Output components** Identification, function and application of the following output components used in electronic products: • buzzers • light emitting diodes (LEDs) • loudspeakers • 7-segment display. **Topic 1.6: Peripheral Interface Controllers (PICs)** • How to use flow charts when programming. • How to switch outputs on/off in response to inputs. • How to use simple routines to control outputs with delays, loops and counts. **Topic 1.15: Circuit construction** • Application and advantages/disadvantages of printed circuit board (photo etched) construction methods **Topic 1.9: Power sources** Function, application and advantages/disadvantages of batteries, including rechargeable types, used in electronic products. Students should identify and understand the practical use of common workshop tools, equipment and components used in making products. **Topic 2.3: Health and safety** • How to understand/describe safe working practices. • How to identify workshop hazards and precautions.
9	To present the final product to the group. To discuss the performance and quality of the final product with peers.	**5.2: Quality of outcome** Produce high-quality components that are accurately assembled and well finished to produce a high-quality product overall. Where products are incomplete, it is the quality of the manufacture of individual components that will gain marks. Produce a completed product that is fully functional as an electronics product. The final product should be fit for purpose.	
10	To test and evaluate the completed model to determine performance and quality factors.	**6.1: Testing and evaluation** Devise and carry out a range of suitable tests to check the performance and/or quality of the final product. Tests should be measurable and refer to specification points, if appropriate, to determine the product's fitness for purpose. Evaluate their final product objectively with reference to specification points and user-group feedback and sustainability issues. No product is ever perfect so students should discuss the positive and negative aspects of their final product. User-group feedback should provide a further perspective.	

Student guide

Is this the right subject for me?

Do you enjoy:

Thinking creatively? ❑
Problem solving? ❑
Designing products of the future? ❑
Making models? ❑
Testing your ideas? ❑

If you have ticked any of the boxes above, then this GCSE Electronic Products course is the ideal subject f or you.

If you have ticked **any** of the boxes above, then this GCSE Electronic Products course is the ideal subject for you.

What do I need to know, or be able to do, before taking this course?

Throughout Key Stage 3 you will have produced a wide range of exciting projects in Design and Technology, including graphics, textiles, food, electronics and RMT. If you particularly enjoyed the creative design side of design and technology then you now have the opportunity to specialise in one of those subject areas and follow a two-year course in GCSE Electronic Products.

What will I learn?

GCSE Electronic Products offers you an opportunity to design and make products using electronic circuitry and some resistant materials. You will learn how to design simple electronic building blocks and how to link these together to produce more complex, useful circuitry to solve electronic problems. As well as working with electronic components, you will use some resistant materials to create protective cases for your circuitry to complete your electronic product.

During your course of study, you will develop a wide range of designing and making skills, technical knowledge and understanding related to electronic products and invaluable transferable skills such as problem solving and time management.

How will I be assessed?

GCSE Electronic Products has two units:

Unit 1	Unit 2
Creative Design and Make Activities	Knowledge and Understanding of Electronic Products
Controlled Assessment	Examination
60%	40%

You can complete the coursework unit in two different ways.

- Through a combined design and make activity where you design a product and then make a model of it. OR
- Through separate design and make activities where you design one product and make another.

The examination will be based on a structured exam paper which your teacher will be able to guide you through. Everything that you need to learn for this unit is set out in the specification so your teacher will know exactly how to prepare you for the exam.

What can I do after I've completed the course?

Many students have enjoyed studying GCSE Electronic Products so much that they go on to study A Level Product Design: Electronic Products for a further two years. However, it is possible to study any Design and Technology related course post-16.

Creative students usually study one or more of the creative subjects, including A Level Art and Design, Media and/or Film, BTEC National Diplomas in Art and Design or Media and the 14-19 Diploma in Creative and Media.

Of course, if post-16 is not for you, employers value this GCSE Electronic Products qualification as it develops creative, technical and transferable skills.

Next steps!

If you want to find more about this GCSE Electronic Products course then you can visit the Edexcel website at **www.edexcel.com**

You should also talk to the Head of Design and Technology at your centre who will be able to describe the course in detail and advise you of what you need to do next when it comes to your options.

Assessment overview

This grid gives you an overview of the assessment for this GCSE Electronic Products course. Edexcel recommends that you make this information available to students to help ensure they are fully prepared and know exactly what to expect in the assessment of Units 1 and 2.

From summer 2014 onwards students will be required to sit all of their examinations at the end of the course. Students may complete the controlled assessment task at any point during the course and controlled assessment work must be submitted for moderation at the end of the course.

Unit 1	Percentage	Marks	Time	Availability
Creative Design and Make Activities This unit is internally assessed under controlled conditions. Students must complete a design and make activity. These activities can be linked (combined design and make) or separate (design one product, make another).	60%	100	40 hours Controlled assessment External moderation	June
Unit 2	**Percentage**	**Marks**	**Time**	**Availability**
Knowledge and Understanding of Electronic Products This unit is assessed through an examination paper set and marked by Edexcel. The examination paper will consist of multiple-choice, short-answer and extended-writing type questions.	40%	80	1 hour 30 minutes External assessment	June

Description	Knowledge and skills
The development of student design folders and manufacture of products must take place under controlled conditions. Students must be supervised by a teacher at all times. Student work must be collected in at the end of the lesson and handed back at the beginning of the next lesson. Student work must be produced individually. Centres will be given a list of five broad themes for task setting. Suggested electronic products 1. **Security**, for example: • An electronic device to warn when a bicycle is being moved without permission. • An alarm system to protect a garden shed from being broken into. 2. **Recording**, for example: • An electronic score counter to record scores between teams in a 5-a-side football or netball match. • An electronic die for use when playing board games. 3. **Environmental control**, for example: • A sensing system to warn when soil in a greenhouse becomes too dry. • A sensing system that turns on a fan automatically when it is too hot. 4. **Indicators**, for example: • A safety warning lighting system for use by pedestrians on roads in dark conditions. • Flashing/chasing bike lighting system for use in dark conditions. 5. **Entertainment**, for example: • A board game timer that will record times between a few seconds and a few minutes. • An electronic moneybox that rewards the user for saving. Centres can contextualise the task(s) to best suit their specific circumstances, including the availability of, and access to, resources. See controlled assessment on *page* 36 for more information.	The Assessment Objectives covered in this unit are: Recall of knowledge and understanding **AO1**: 6% Application of knowledge and understanding **AO2**: 45% Product analysis **AO3**: 9% Students will follow the basic creative design process. This includes research, product development, communication skills, application of knowledge and understanding of electronic products (materials, processes etc), planning and making a high-quality product, and testing and evaluating.

Description	Knowledge and skills
• This unit is assessed through a 1-hour and 30-minute examination paper set and marked by Edexcel. The examination paper: • will be structured in the same way each year so that it is accessible to all students • will be a question and answer booklet and all questions are compulsory • consists of multiple-choice, short-answer and extended-writing type questions. The total number of raw marks available is 80.	The Assessment Objectives covered in this unit are: **AO1**: 24% **AO2**: 8% **AO3**: 8% Students will develop a knowledge and understanding of a wide range of materials and processes used in design and technology. Students will learn about industrial and commercial practices and the importance of quality checks, and the health and safety issues that have to be considered at all times. The knowledge and understanding students develop in this unit can be easily applied to **Unit 1: Creative Design and Make Activities**.

Understanding Unit 1

Applying the assessment criteria

To support you in accurately and confidently applying the assessment criteria, Edexcel has written the mark bands like a mark scheme with key trigger points.

The table below shows how the descriptors in each mark band have been broken up into their individual marking points (denoted by bullet points). The marking points within each mark band are equally weighted. Edexcel suggests that you look at your students' work for each of the criteria holistically and place it into the appropriate mark band. You must then determine the actual mark you wish to award.

For example:

b) Research	Level of response not worthy of credit.	0
	• Research is **superficial** and does not focus on the needs identified in the analysis. (1) • Analysis of existing products is **insufficient** to aid the writing of specification criteria. (1)	1-2
	• Research is **general**, focusing on some of the needs identified in the analysis. (1) • Product analysis is used to inform the writing of **some** specification criteria. (1)	
	• Research is **selective** and focuses on the needs identified in the analysis. (1) • The performance, materials, components, processes, quality and sustainability issues of relevant existing products are explored in **sufficient detail** to aid the writing of specification criteria. (1)	5-6

1. Initially, I think the student's research is selective and worthy of the 'high' mark band.

2. However, I don't think that the student's product analysis is strong enough to warrant a high mark – more 'medium'.

Where a student's work does not fit perfectly to the descriptor statements in a band, a holistic (best fit) decision must be taken by the teacher when deciding on the final mark. Look at the example above. The teacher cannot award the full 6 marks for research as the student has not fully met the criteria in the top band with one aspect (product analysis) achieving a level better described in the middle band. In this case the student is awarded 5 marks. If the product analysis was better described by the lowest band descriptor then the holistic decision taken by the teacher would be that the work was more appropriate to the middle band overall and would therefore be awarded 4 marks.

Design activity (50 marks)

Investigate (15 marks)

Sub-sections	Descriptor	Mark range
a) Analysing the brief	Level of response not worthy of credit.	0
	Analysis is **superficial** leading to unclear design needs.	1
	Analysis is **limited** with some design needs clarified.	2
	Analysis is **detailed** with most design needs clarified.	3
b) Research	Level of response not worthy of credit.	0
	Research is **superficial** and does not focus on the needs identified in the analysis. Analysis of existing products is **insufficient** to aid the writing of specification criteria.	1-2
	Research is **general**, focusing on some of the needs identified in the analysis. Product analysis is used to inform the writing of **some** specification criteria.	3-4
	Research is **selective** and focuses on the needs identified in the analysis. The performance, materials, components, processes, quality and sustainability issues of relevant existing products are explored in **sufficient detail** to aid the writing of specification criteria.	5-6
c) Specification	Level of response not worthy of credit.	0
	Specification points are **superficial**. Specification points are **not justified**.	1-2
	Some specification points are realistic and measurable. **Some** specification points are developed from research but are not justified.	3-4
	• **Most** specification points are realistic, technical, measurable and address some issues of sustainability. • Specification **fully** justifies points developed from research.	5-6

Design (20 marks)

Sub-sections	Descriptor	Mark range
d) Initial ideas	Level of response not worthy of credit.	0
	Alternative design ideas are **similar**. Ideas are **simplistic**. Ideas are **superficial** and **limited** research is used. **Limited** specification points are addressed.	1-4
	Alternative design ideas are **realistic**. Ideas are **workable**. Ideas are **detailed** and **relevant** research is used. Ideas address **most** specification points.	5-8
	Alternative design ideas are **realistic**, **workable** and **detailed**. Ideas demonstrate **detailed** understanding of materials, processes and techniques. Ideas are **supported** by research information. Ideas address **all** key specification points.	9-12

Sub-sections	Descriptor	Mark range
e) Review	Level of response not worthy of credit.	0
	General and **subjective** comments against **some** specification points. **Limited** use of user-group feedback.	1-2
	Objective evaluative comments, against **most** specification points. Evaluation considers **user-group** feedback and issues of **sustainability**.	3-4
f) Communication	Level of response not worthy of credit.	
	Use of a **range** of communication techniques, including ICT where appropriate. Demonstrate **sufficient** skill to convey an understanding of design ideas.	1-2
	Use of a **range** of communication techniques and media, including ICT and **CAD** where appropriate. Demonstrate **precision** and **accuracy**.	3-4

Develop (15 marks)

Sub-sections	Descriptor	Mark range
g) Development	Level of response not worthy of credit.	0
	Developments from alternative design ideas are **minor** and **cosmetic**. **Simple** modelling is used. Test **an** aspect of the final design proposal against **a** design criterion.	1-3
	Developments are **appropriate** and use **details** from alternative design ideas to change, refine and improve the final design proposal. Modelling using traditional materials and/or **3D computer modelling** is used. Test **some** aspects of the final design proposal against **relevant** design criteria.	4-6
	Development is used to produce a final design proposal that is **significantly different** and **improved** compared to any previous alternative design ideas. Modelling to **scale** using traditional materials or 2D and/or 3D computer simulations is used. Test **important** aspects of the final design proposal against **relevant** design criteria. **User-group** feedback is used in final modifications.	7-9
h) Final design	Level of response not worthy of credit.	0
	Final design proposal includes **limited** consideration of materials and/or component parts, processes and techniques.	1-2
	Final design proposal includes **details** of **some** materials and/or component parts, processes and techniques.	3-4
	Final design proposal includes **technical details** of **all** materials and/or component parts, processes and techniques.	5-6

Make activity (50 marks)

Plan (6 marks)

Sub-sections	Descriptor	Mark range
a) Production plan	Level of response not worthy of credit.	0
	Superficial **production** plan that outlines some stages of manufacture. Plan shows **limited** reference to quality control.	1-2
	Limited production plan that considers the **main** stages of manufacture for a range of products. Plan shows **some** reference to **appropriate** forms of quality control.	3-4
	Detailed production plan that considers stages of manufacture in the **correct sequence** for a range of products. Plan includes **specific** forms of quality control.	5-6

Make (38 marks)

Sub-sections	Descriptor	Mark range
b) Quality of manufacture	Level of response not worthy of credit.	0
	Tools are selected **with guidance**. Equipment is selected **with guidance**. Processes, including CAD/CAM where appropriate, are selected **with guidance**. **Limited** understanding of the working properties of materials when selecting for manufacturing a product. The task is **undemanding**. A **limited** range of skills is used. A **limited** range of processes is used. **Little** attention to detail in the use of skills and processes.	1-8
	Tools are selected with **some** guidance. Equipment is selected with **some** guidance. Processes, including CAD/CAM where appropriate, are selected with some guidance. **Some** understanding of the working properties of materials used when selecting for manufacturing a product. The task offers **some** challenge. A **range** of skills is used. A **range** of processes is used. **Attention to detail** in the use of skills and processes.	9-16
	Tools are selected for specific uses **independently**. Equipment is selected for specific uses **independently**. Processes, including CAD/CAM where appropriate, are selected for specific uses **independently**. An **appropriate** understanding of the working properties of materials used when selecting for manufacturing a product. The task is **challenging**. A **wide range** of skills is used. A **wide range** of processes is used. **Precision** and **accuracy** in the use of skills and processes.	17-24

Sub-sections	Descriptor	Mark range
c) Quality of outcome	Level of response not worthy of credit.	0
	Product includes the manufacture of **some** good quality component parts. Product remains either unassembled or **poorly** assembled. Product/components are **poorly** finished. Completed product functions **poorly**.	1–4
	Product includes the manufacture of **good** quality component parts. Product is generally **well** assembled Product/components are generally **well** finished. Completed product functions **adequately**.	5–8
	Product includes the manufacture of **high-quality** component parts. Product is **accurately** assembled. Product/components are **well** finished. Completed product is **fully functional**.	9–12
d) Health and safety	Level of response not worthy of credit.	0
	Demonstrate an awareness of safe working practices for most specific skills and processes.	1
	Demonstrate a high level of safety awareness throughout all aspects of manufacture.	2

Test and evaluate (6 marks)

Sub-sections	Descriptor	Mark range
e) Testing and evaluation*	Level of response not worthy of credit.	0
	One or **more simple** tests carried out to check the performance and/or quality of the final product. Evaluative comments are **subjective** and reference a **few** specification points **superficially**.**	1–2
	A **range** of tests carried out to check the performance and/or quality of the final product. Evaluative comments are **objective** and reference **most** specification points.***	3–4
	A **range** of tests carried out to check the performance and/or quality of the final product with **justifications**. **Objective** evaluative comments, including **user-group** evaluation, consider most relevant, measurable specification points in **detail** including **sustainability** issues.****	5–6

Notes

* Opportunity for students to be assessed on Quality of Written Communication: strand (iii) – organise information clearly and coherently, using specialist vocabulary when appropriate.

** The student uses basic language and the response lacks clarity and organisation. Spelling, punctuation and the rules of grammar used with limited capacity.

*** The student uses some design and technology terms and shows some focus and organisation. Spelling, punctuation and the rules of grammar used with some accuracy. Some spelling errors may still be found.

**** The student uses a range of appropriate design and technology terms and shows good focus and organisation. Spelling, punctuation and the rules of grammar used with considerable accuracy.

Examination questions

This exam question guide looks at the style of questions your students will be faced with when they sit the written paper. Those of you already familiar with the current format of the Edexcel GCSE D and T paper will recognise the style of most of the questions in the sample assessment material although, to comply with QCA regulations, there are some differences, notably introduction of questions that require some extended writing. It should be highlighted that this change is a small percentage of the examination and therefore its impact on students should be minimal. Another change is the inclusion of some multiple-choice questions to give students confidence at the start of the paper.

The examination paper is 'ramped' and within each question the sub-questions are ramped as well. The advantage of ramping the whole paper is that the questions at the beginning of the paper are accessible to the whole ability range, thereby easing the student into the paper and allowing them to work with confidence. As they work through the paper, the questions will get progressively more challenging as they move through the grade range G–A*.

Students are advised to attempt all questions as there will be opportunities to gain marks throughout the paper.

The examination paper contains different types of questions:

- multiple choice
- short answer
- design questions
- extended writing.

Each exam paper will be structured in the following way.

Questions 1–10	Question 11 (a)	Question 11 (b) – (f)	Question 12	Question 13	Question 14
Multiple choice.	Name and give the use of tools and equipment	Knowledge and understanding of electronic products. Structured questions based on a theme.	Designing products.	Analysing products.	Knowledge and understanding of electronic products. Short-answer and extended-writing type questions.
10 marks	4 marks	19 marks	16 marks	16 marks	19 marks
				TOTAL	80 marks

Command words

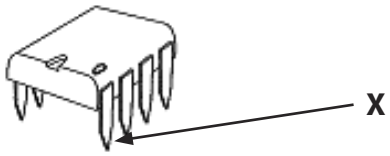
Students should be reminded to always read each question carefully before they respond. They should look at the amount of marks awarded for each question in brackets. This will give them a good indication of how many points need to be raised in their response. As a rule of thumb, look at the following command words and what students have to do in order to gain the marks.

Command word	Marks awarded	Description
Give/State/Name	(1 mark)	These types of questions will usually appear at the beginning of the paper or question part and are designed to ease students into the question with a simple statement or short phrase.
Describe/Outline	(2+ marks)	These types of questions are quite straightforward. They ask students to simply describe something in detail. Some questions may also ask students to use notes and sketches, therefore, they can gain marks with the use of a clearly labelled sketch.
Explain/Justify	(2+ marks)	These types of questions are asking students to respond in detail to the question – no short phrases will be acceptable here. Instead, students will have to make a valid point and develop/justify it to gain full marks.
Evaluate/Discuss/ Compare	(4+ marks)	These types of questions are designed to stretch and challenge students. They will always be awarded the most amount of marks because they require students to make a well-balanced argument, usually involving both advantages and disadvantages.

Questions 1-10: Multiple choice (10 marks)

New to D and T exam papers. This paper starts off with 10 multiple-choice questions which become gradually more demanding. These questions can cover any part of the specification. For example:

1 The number of the pin marked by the letter X is:



Please mark a cross ☒ in the correct box.

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

Answer

A 1

Examiner comment

Students simply have to enter a cross into the relevant box to record their response.

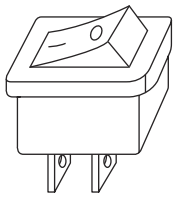
An extremely straightforward question which applies knowledge and understanding from Topic 1.5 Process components.

Question 11(a): Name and give the use of tools and equipment (4 marks)

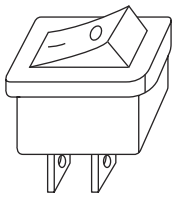
Question 11 starts with 4 marks awarded to students for either naming or giving the use of tools and equipment related to electronic products. The tools and equipment will be laid out in a table format, for example:

The table below shows some tools and components.

Complete the table below by giving the missing names and uses.

Tools/Components	Name	Use
	Rocker switch	(1)

Answer

Tools/Equipment	Name	Use
	Rocker switch	To switch circuits on or off

Examiner comment

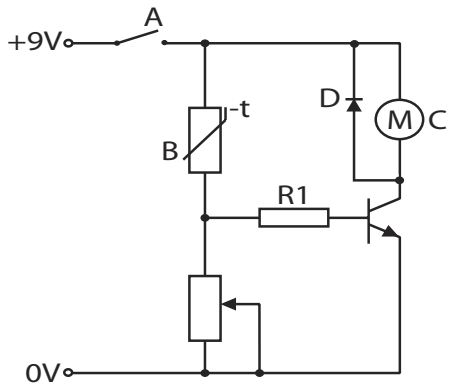
Students have to write clearly within the relevant box.

In this response, the student has stated what a rocker switch is for and would gain the mark, but we would recommend that because the name 'switch' was given, it should not appear again in this answer. 'Turning' circuits on or off would be better. Students should be familiar with a wide range of switches and their uses as specified in Topic 1.4: Switch types.

Question 11(b) – (f): Knowledge and understanding of electronic products (15 marks)

Subsequent questions comprise part questions combined to produce structured questions on a theme, for example:

A student is making a desk fan using the circuit shown below.



Component D is a diode.

Describe the function of a diode in the circuit.

(2 marks)

Answer

To protect (a transistor) from back EMF/trapped current.

Examiner comment

This type of question is quite straightforward. It asks students to simply describe something in detail with two linked points.

Note that 'triggers' are indicated in brackets showing where the examiner has awarded marks that relate to the mark scheme.

This question focuses on Topic 1.12: Diodes. Students need to learn about the function and application of components such as diodes.

Question 12: Designing products (16 marks)

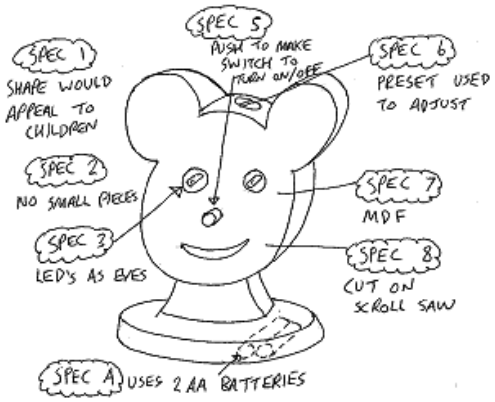
Question 12 enables students to respond creatively to a given need and detailed specification, for example:

You have been asked to design a child's night light that gives out light as darkness falls.
The specification for the child's night light is that it must:

- have a casing that will appeal to children
- be safe for children to use
- give out light
- be battery operated
- be able to be turned on/off
- be able to be adjusted so that it can be turned on at different levels of darkness
- be made from materials available in a school workshop
- be made by a process available in a school workshop.

(16 marks)

Answer



Examiner comment

Students must use annotated sketches in the boxes provided in order to design a product that satisfies the criteria outlined in the design specification.

Here, the student has used sketches to convey their design idea. No drawing equipment needs to be provided for this exam, as clear, annotated sketches are sufficient. The annotation is extremely important for showing the examiner how the design idea satisfies each of the specification criteria.

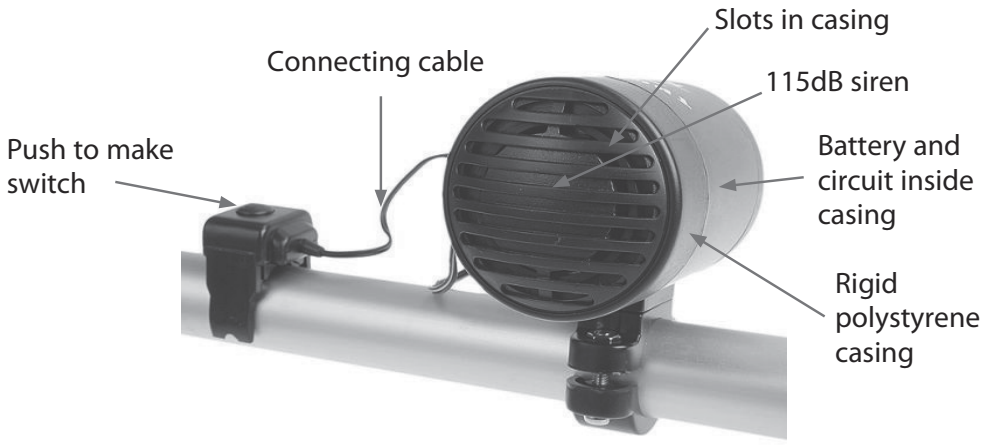
The annotation is succinct and covers all specification points, supporting the clear sketches.

Question 13: Analysing products (16 marks)

In question 13, students will be given a labelled diagram of a specific product and are required to answer a series of questions relating to it, for example:

The drawing below shows details of a bicycle horn. It is used to warn other road users and pedestrians of the bicycle's presence.

It is operated by pressing a push to make switch.



Explain why the bicycle horn is successful in meeting the following specification point:

(i) The circuit and battery are protected from the weather.

(2 marks)

Answer

(i) The casing has slots in the front and therefore the sound will be able to pass through without restriction.

Examiner comment

An 'explain' type question requires a statement followed by a justification to gain full marks. Therefore, this answer is awarded 2 marks.

This question requires students to apply their knowledge and understanding of Topic 3: Product analysis.

Question 14: Knowledge and understanding of electronic products including extended-writing style questions (19 marks)

Some part questions will require an extended-writing response. This is designed to stretch and challenge students, for example:

> A company manufacturing PCBs is closing down its UK factory and moving the manufacture abroad where labour is much cheaper and people work longer hours.
>
> Discuss the possible effects of the company moving its manufacturing abroad.
>
> **(6 marks)**

Answer

Existing employees could lose their jobs after years of loyal service and become unemployed. New workers may be exploited by receiving poor pay for long working hours. The move could bring employment, wealth and training to new employees and improve their life.

More energy could be used exporting and importing the components and that is bad for the environment. More energy would be used as workers and executives travel between the UK base and the factory abroad and more fuel and earth's resources will be used. Less energy may be used abroad as human labour may be used instead of machines.

Examiner comments

This 'discuss' question requires students to write an extended-writing response. This question has a levels mark scheme. The student response clearly fits into Level 3 (5–6 marks).

The student identifies a range of impacts with associated developments showing a detailed understanding of the impacts. Writing communicates ideas effectively, using a range of appropriately selected D&T terms and organising information clearly and coherently. The student spells, punctuates and uses the rules of grammar with considerable accuracy.

Controlled assessment

About controlled assessment

Controlled assessment is similar to coursework except that controls have been added to ensure that all of the work is the student's own.

The level of control for each activity in each subject is specified by QCA. This section explains the level required for each activity and what it means for teachers and students, and the frequency of change.

Task setting

What is the level of control?

High.

What does this mean?

Tasks will be set by Edexcel and centres will choose from a list available on our website in September at the start of each academic year. Centres can contextualise the task(s) to best suit their specific circumstances, which includes the availability of, and access to, resources. Suggested electronic products tasks are given on *pages 10–17.*

How often will the tasks change?

Edexcel will review the tasks every two years. Edexcel will look at the tasks in the light of student performance and make any amendments necessary to make the tasks clearer.

Students wanting to retake the controlled assessment unit will need to use the one available for the session in which they are retaking it, regardless of the task they did originally.
If students are taking the same task, they must start from scratch, and do the whole task again.

Task taking

The task taking controls have been designed to ensure that the task is carried out by the student and that all work is their own. This means that students cannot carry out work at home and bring it to the classroom.

The task is split into two phases:

- initial research
- design and make tasks.

The levels of control and the effect are different for each part.

What is the level of control?

Initial research

Low.

Design and make tasks

Medium.

Task taking (continued)

What does this mean?

Initial research

Students can undertake research to locate sources outside of the classroom without supervision. They can locate as many sources as they wish to take into the write-up phase.

Design and make tasks

The student must complete the following under classroom supervision:

- write up of their portfolio
- making of their product.

However, students are allowed to use the following to help them complete their task:

- their initial research they have undertaken outside of the classroom to produce focused selective research for their portfolio
- sources the centre provides.

A student can bring in additional research notes at any time provided the write up of their research is carried out under the same supervised conditions.

Students cannot take any information away from the classroom to complete. They can make an outline plan for the task beforehand and bring it to the classroom.

You will need to monitor the student in the classroom to ensure the whole of the task is their own work. You can answer questions but you must not guide students along a particular path or advise them on how to approach the task.

This stage is not an exam and requires supervision not invigilation. There is no need to set up the room like an exam or for the room to be silent. The key requirement is that students are supervised at all times.

The task must be taken during curriculum time.

Task marking

This is similar to the current arrangements, so will be familiar.

What is the level of control?

Medium.

What does this mean?

You will mark all the tasks. You then fill in a form to show all the marks achieved. Edexcel will ask for a sample of the work to moderate, including student work with the highest and lowest scores.

Edexcel will moderate the work and you will receive a summary report on results day.

Training courses on marking tasks will be available to help you mark the work effectively.

Our specification experts can also provide support, just email www.edexcel.com/asktheexpert

Controlled assessment exemplars

Centres will appreciate that no student has actually submitted controlled assessment work under the new specification at the time of publication. Existing examples of students' GCSE Electronic Products work have been modified by the Principal Moderator for illustrative purpose.

Suggested timings

As a guideline only, we have suggested times for each of the stages in the design and make activities. Obviously, you as a teacher will be best suited to gauge the times needed to complete each task as you know your students best.

Design activity

Stage	Tasks	Suggested times
1. Investigate	1.1 Analysing the brief	1 hour
	1.2 Research	3 hours
	1.3 Specification	1 hour
2. Design	2.1 Initial ideas	5-6 hours
	2.2 Review	1 hour
	2.3 Communication	Evidenced throughout
3. Develop	3.1 Development	5-6 hours
	3.2 Final design	1-2 hours

Make activity

Stage	Tasks	Suggested times
4. Plan	4.1 Production plan	1-2 hours
5. Make	5.1 Quality of manufacture	16 hours
	5.2 Quality of outcome	
	5.3 Health and safety	Evidenced throughout
6. Test and evaluate	6.1 Testing and evaluation	1-2 hours

Student outcomes

The following examples of student work for some tasks are to show indicative content. As no student has actually submitted coursework under the new specification at the time of publication, existing examples of students' GCSE Electronic Products work have been modified by the Principal Moderator for illustrative purposes.

Investigate

TASK 1.2: Research

Problem
I am often out on my bike at night and I am nearly invisible to traffic, which means that I am in a dangerous position .I have a simple back light but I often forget to turn it on.

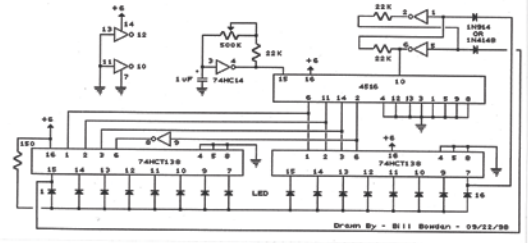
Need
I need an electronic device that will switch on automatically at a pre-set level of darkness and will display a bright sequence of LEDs that will warn other road users that I am out and about.

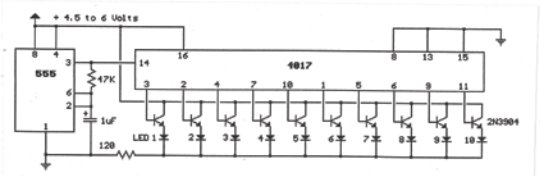
Brief
I will design and make an electronic bike light, which will turn on automatically at a pre-set level of darkness. The light output must drive a sequence of LEDs that should be clearly visible for at least 50 meters.

Target Market
I would aim to sell this product to cyclists, but it would be suitable for anyone who is out at night and needs to be seen by traffic, for instance mothers out with children in push-chairs.

Before I started my designing, I looked around to see if there were any automatic bike lights available to buy, but I found none. I did find these attractive safety lights that are switched on by the user. They are all made from polystyrene and acrylic and they are all injection moulded. The circuitry will be based on a dedicated IC that will be programmed to flash superbright LEDs in a sequence that attracts attention from a long distance away. I really like the clamp that fixes the light to the bike seat post; this will be injection moulded as well. The circuitry is very small and surface mounted components are used to make it very small

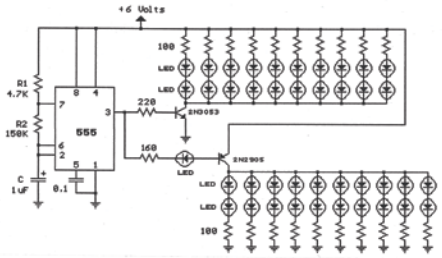
The bi-directional sequencer uses a 4 bit binary up/down counter (CD4516) and two "1 of 8 line decoders" (74HC138 or 74HCT138) to generate the popular "Night Rider" display. A Schmitt Trigger oscillator provides the clock signal for the counter and the rate can be adjusted with the 500K pot. Two additional Schmitt Trigger inverters are used as a SET/RESET latch to control the counting direction (up or down). Be sure to use the 74HC14 and not the 74HCT14, the 74HCT14 may not work due to the low TTL input trigger level. When the highest count is reached (1111) the low output at pin 7 sets the latch so that the UP/DOWN input to the counter goes low and causes the counter to begin decrementing. When the lowest count is reached (0000) the latch is reset (high) so that the counter will begin incrementing on the next rising clock edge. The three lowest counter bits (Q0, Q1, Q2) are connected to both decoders in parallel and the highest bit Q3 is used to select the appropriate decoder. The circuit can be used to drive 12 volt/25 watt lamps with the addition of two transistors per lamp as shown below in the section below titled "Interfacing 5 volt CMOS to 12 volt loads"





The 4017 is a CMOS decade counter with 10 decoded outputs. Inputs include a CLOCK (pin 14), a RESET (pin 15), and a CLOCK INHIBIT (pin 13). The clock input drives an internal schmitt trigger circuit for pulse shaping and allows for unlimited clock rise and fall times. The counter is advanced one count at the rising edge of the clock signal if the CLOCK INHIBIT line is low. A high RESET signal resets the counter to the zero count. The circuit may be configured for counts less than 10 by connecting RESET to an output pin one above the desired count. Thus, a five channel sequencer could be made by connecting pin 15 to pin 1. A CARRY-OUT signal (pin 12) may be used to clock subsequent stages in a multi-device counting chain (ones, tens, hundreds, etc.) Small signal NPN transistors are used to increase the output current for the LEDs to about 20 ma which is set by the common 120 ohm resistor. Other NPN transistors may be substituted for the 3904. The 555 timer generates the clock signal, the frequency being determined by the 1uF capacitor and 47K resistor which is approximately = 1.44 / 2RC = 10 Hz.

The 555 circuit below is a flashing bicycle light powered with four C,D or AA cells (6 volts). Two sets of 20 LEDs will alternately flash at approximately 4.7 cycles per second using RC values shown (4.7K for R1, 150K for R2 and a 1uF capacitor). Time intervals for the two lamps are about 107 milliseconds (T1, upper LEDs) and 104 milliseconds (T2 lower LEDs). Two transistors are used to provide additional current beyond the 200 mA limit of the 555 timer. A single LED is placed in series with the base of the PNP transistor so that the lower 20 LEDs turn off when the 555 output goes high during the T1 time interval. The high output level of the 555 timer is 1.7 volts less than the supply voltage. Adding the LED increases the forward voltage required for the PNP transistor to about 2.7 volts so that the 1.7 volt difference from supply to the output is insufficient to turn on the transistor. Each LED is supplied with about 20 mA of current for a total of 220 mA. The circuit should work with additional LEDs up to about 40 for each group, or 81 total. The circuit will also work with fewer LEDs so it could be assembled and tested with just 5 LEDs (two groups of two plus one) before adding the others.



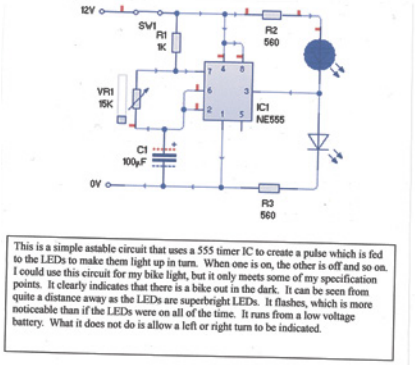
I looked on the internet to see if I could find any circuit diagrams to help me with my project and I found quite a few that were like the ones I have shown here. I do not think that these are of much use, because they a bit complicated.
The circuit that uses the 4017 decade counter is one I could use. The pulses are created by the 555 timer which is an astable circuit and these operate the decade counter to make a chasing sequence of LEDs. I would need to find out how to link a light sensitive circuit to the chaser, but I think that would be easy to do.

Moderator comments

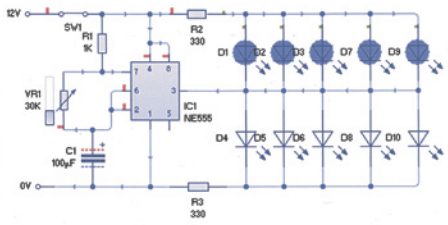
Teachers should encourage students to gather research that is focused and selective, avoiding useless padding that has no currency value. Areas for useful research include analysis of similar products to establish materials and manufacturing processes used, the context in which the product will be used, market research to determine potential user preferences and relevant materials research. Selectivity, relevance and succinct presentation are key to effective research. In the example shown, the student investigates existing products to learn about the materials and processes used, and looks at existing circuitry that could be of help when designing alternative electronic circuits.

Design

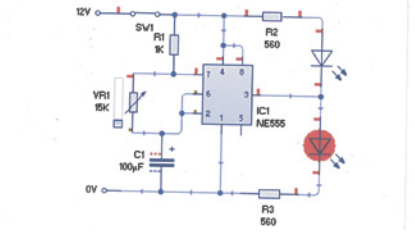
TASK 2.1 Initial ideas

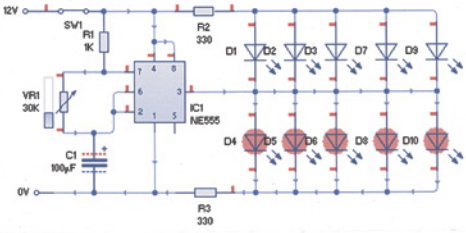


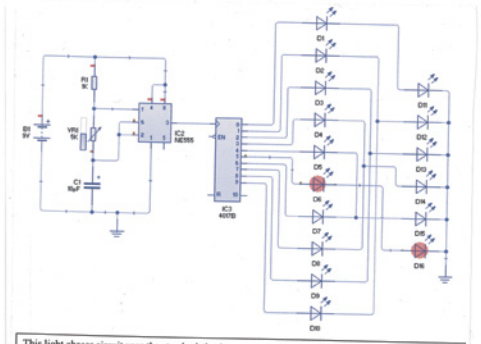
This is a simple astable circuit that uses a 555 timer IC to create a pulse which is fed to the LEDs to make them light up in turn. When one is on, the other is off and so on. I could use this circuit for my bike light, but it only meets some of my specification points. It clearly indicates that there is a bike out in the dark. It can be seen from quite a distance away as the LEDs are superbright LEDs. It flashes, which is more noticeable than if the LEDs were on all of the time. It runs from a low voltage battery. What it does not do is allow a left or right turn to be indicated.



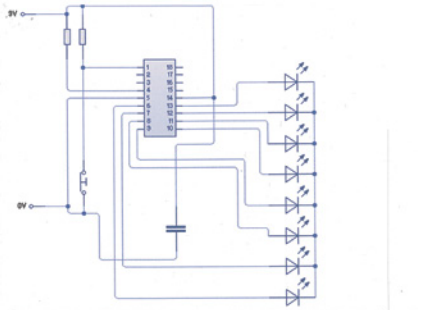
In this circuit, I have added multiple LEDs which flash on and off alternately. The circuit is still the basic astable 555 timer circuit, but in order to run all of these LEDs I have had to specify a 12V supply. Each LED uses about 2V, so I can run 5 on each side of the astable quite comfortably. I could remove the limiting resistor and add a couple more LEDs, but the more I add, the shorter the life of the power supply will be. This circuit meets some of my specification points. It indicates clearly that I am out at night on the roads. It flashes, which makes it more noticeable than just being on. The frequency of flashes is adjustable by the VR. If I built two of these circuits, I could control them separately and use them to indicate when I was turning.



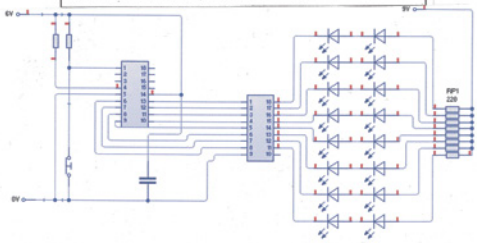




This light chaser circuit uses the standard chasing sequence, but also gives a back and forward action using the 6 LEDs to the right of the diagram. This would be very noticeable when attached to a bike and would be fine if I just wanted a straightforward bike warning light. To get this circuit to act as a left and right indicator light as well, would be very difficult.
This circuit meets some of my specification points, as it acts as a night light, but it does not give me much control over how its outputs work.



This circuit uses a PIC to control the LEDs. This system is ideal for my needs, as each LED can be controlled separately by programming the output it is attached to behave any way I want it to. There are 8 outputs on a PIC, so I am limited to that many LEDs. I would like to have more LEDs, but the output current from a PIC is low, about 15 mA, which is only enough to drive a single LED per output.



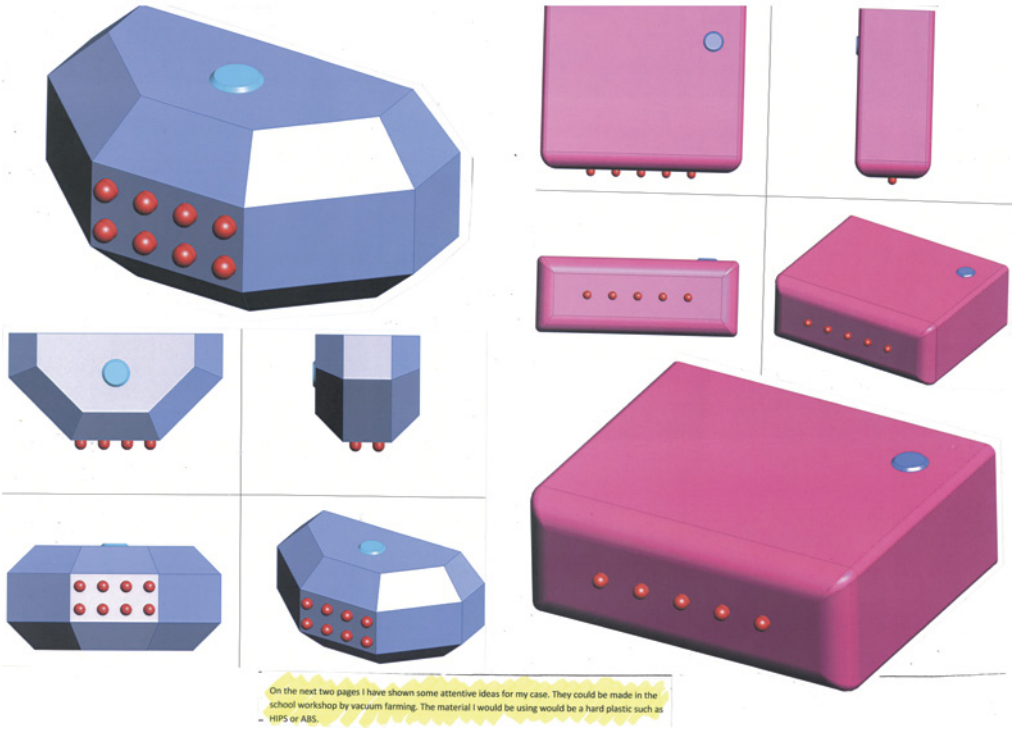
This circuit design is near to what I want as a final solution to my problem. I have added a an amplifying IC which is an Octal Darlington driver IC. It has 8 pairs of transistors inside it and is a very neat package that I can use to amplify the current coming from the PIC so that I can drive as many LEDs as I like. I have added limiting resistors so that too much current is not allowed to flow through the LEDs and damage them. I need to add a couple of switches to use as inputs to the PIC, so that I can write a program that will control some LEDs to operate as left and right indicators and control all of the LEDs to act as bike flasher/chasers to warn motorists that I am on the road.

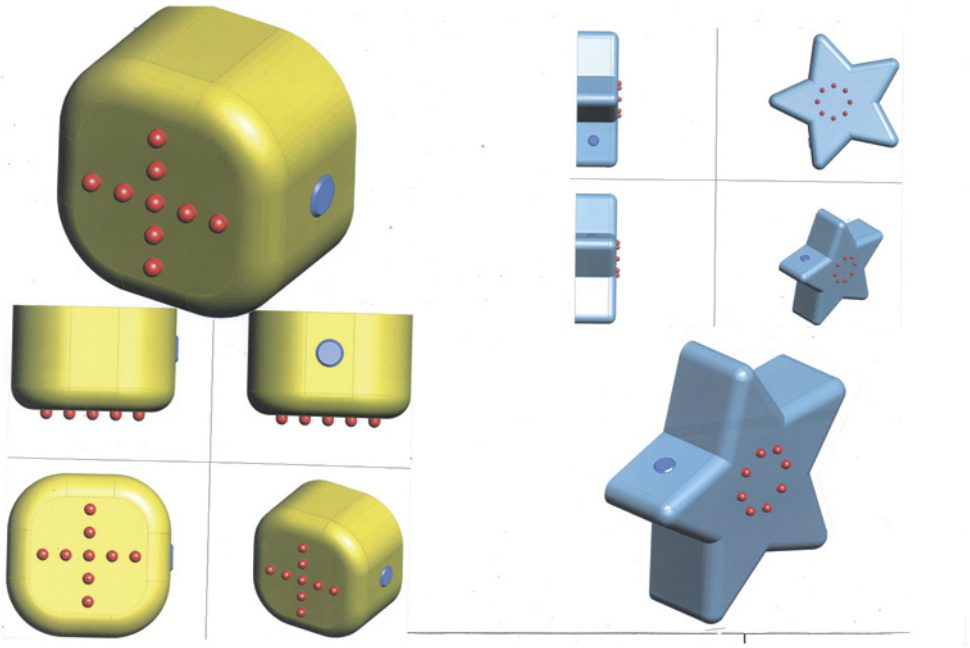
Moderator comments

In this assessment criterion, it is expected that students will produce a range of alternative ideas that reflect their knowledge and understanding of the needs of the product specification.

In electronic products, ideas are not expected to be original, but to be put together using existing electronic building blocks. In the example shown on these busy sheets, the student has produced a range of ideas based on simple building blocks that answer the electronic product specification.

TASK 2.1: Initial ideas



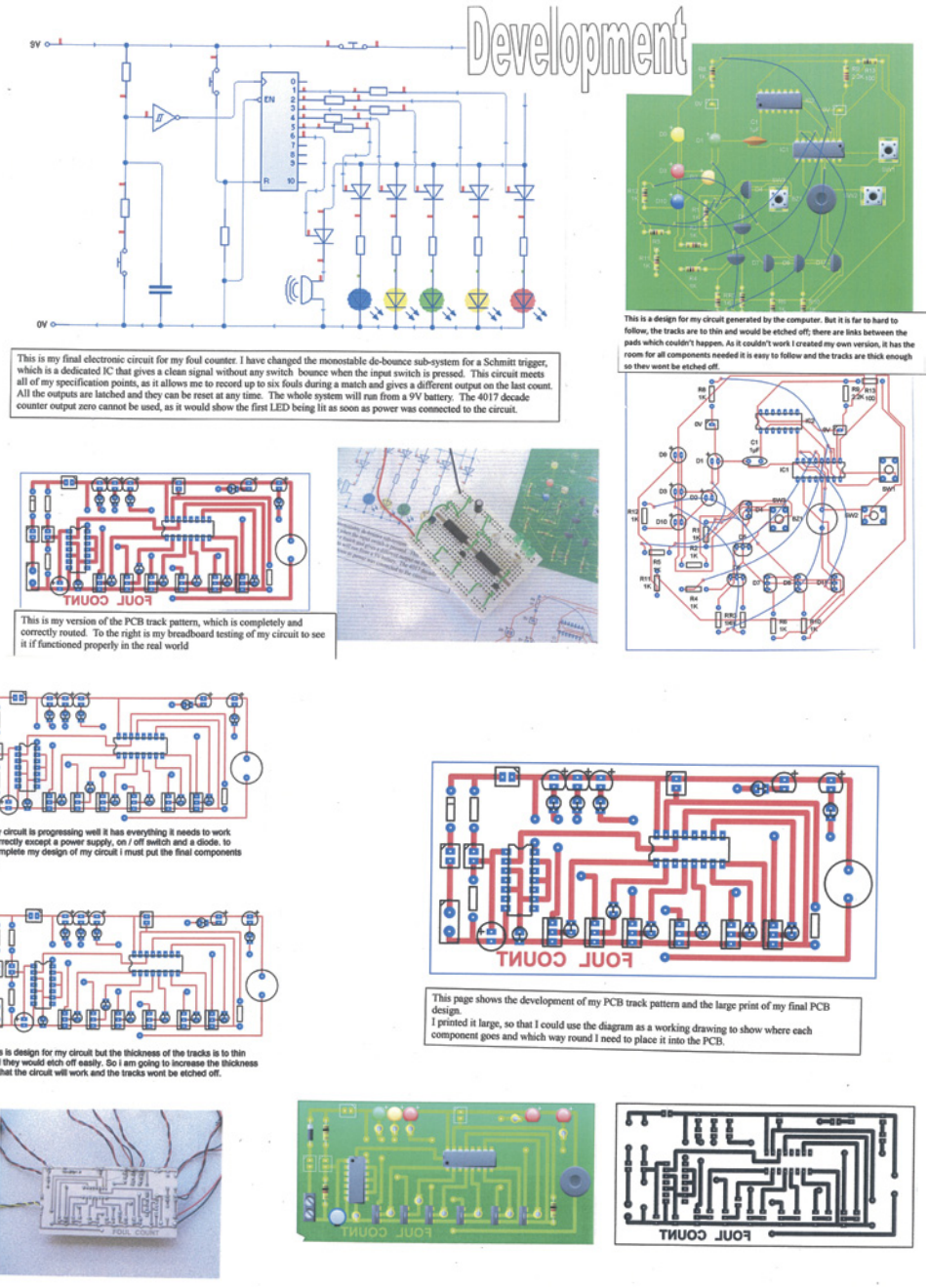


Moderator comments

As well as producing alternative circuit designs, students are asked to present designs for cases in which to house their circuitry. Case design carries less currency value than electronic circuit design and is worth about one third of making marks. In the examples shown, the student has used 3D CAD to design a range of possible cases and has annotated the sheets briefly to describe materials and processes from which they could be made.

Develop

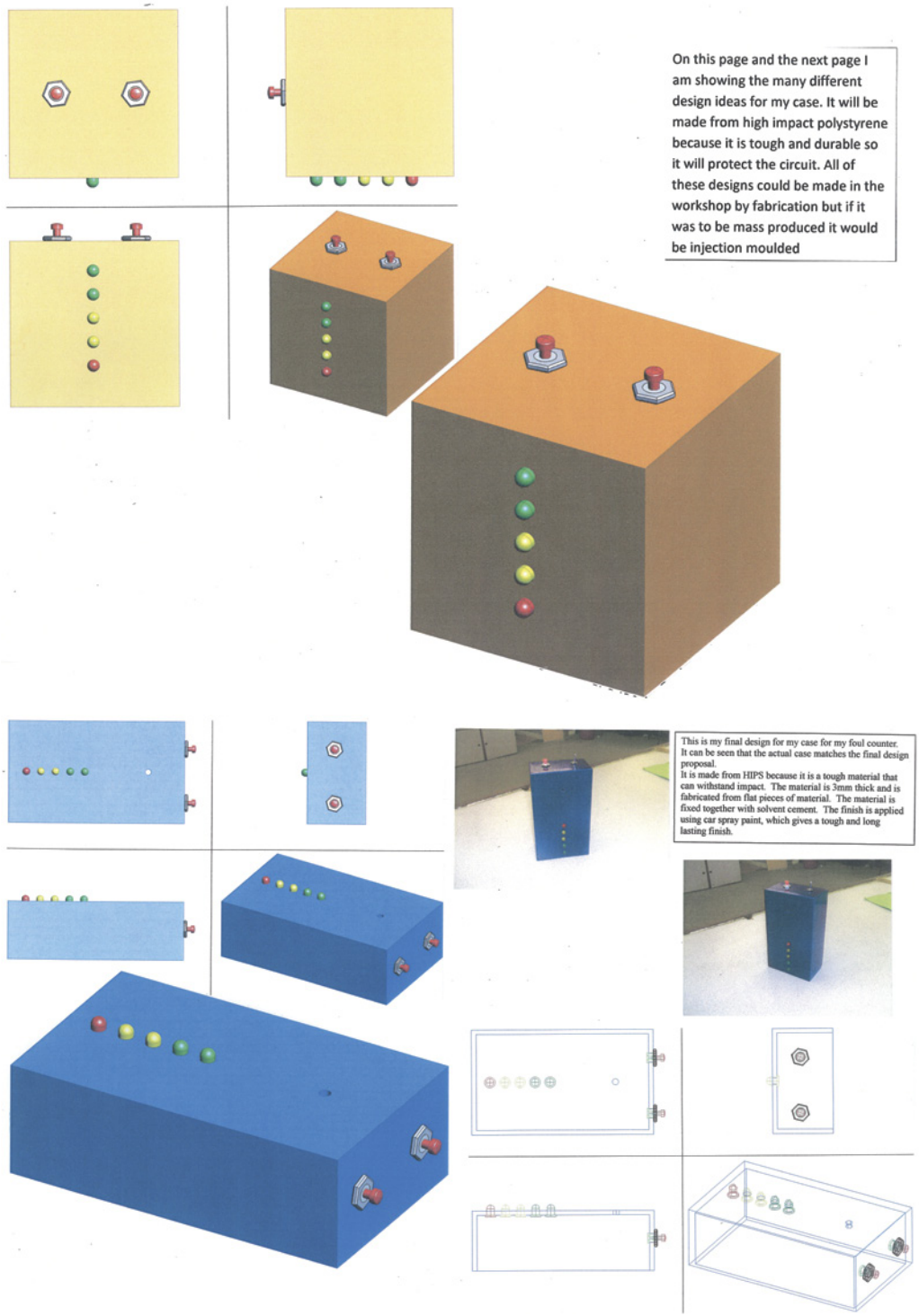
TASK: 3.1 Development



Moderator comments

The development of an electronic product involves taking the most appropriate electronic building blocks and combining them to produce a final design proposal that meets the product specification. Modelling is important in development and this can include 2D and 3D computer modelling as well as that using resistant materials. There should be a point to modelling, such as testing component values, proportions, materials etc. In the example shown, the student has produced a final 'virtual' circuit design proposal that works in theory. The circuit has been modelled in the 'real world' using prototyping board and then the PCB track pattern design has been developed using PCB design software.

TASK 3.1 : Development

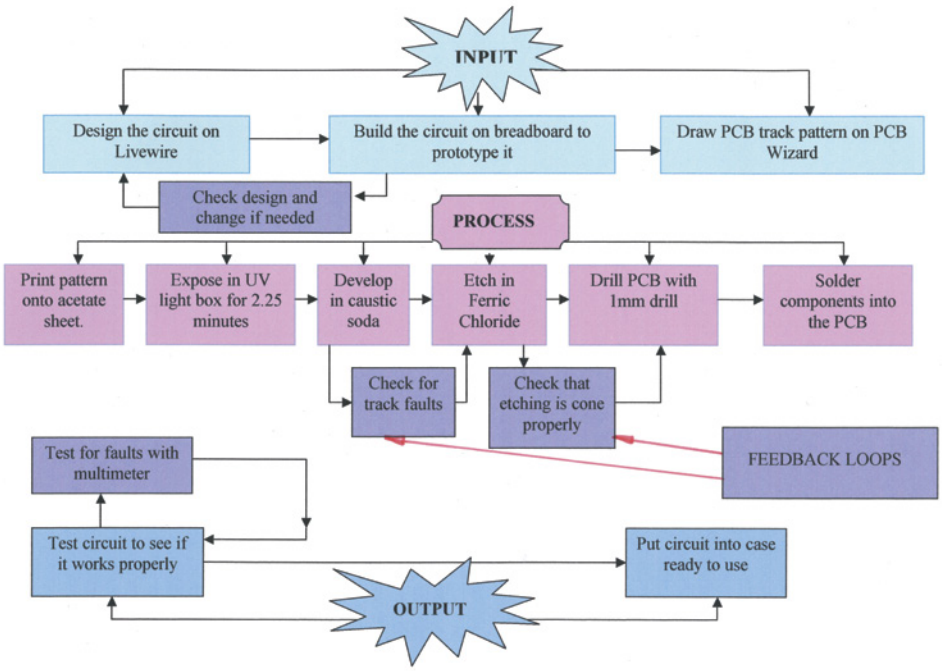


Moderator comments

As well as circuit development, students need to develop a final design proposal for the case in which to place their circuitry. The final case design can be quite simple as the majority of marks are focused on the electronics content of design and development, but students who strive for high marks in electronic products will produce high-quality work in all aspects of design and development. In the example shown, the student has developed a final design for the case and has presented succinct and informative annotation to accompany the illustrations.

Plan

TASK 4.1: Production plan



Schedule

Week number 1 week = 3 hours	1	2	3	4	5	6	7	8	9	10	11	12	13
Design a circuit in livewire, test if I will work. If it does not work rearrange or change parts of your circuit.													
Use prototyping board (bread board) to ensure your circuit works before fitting components. If it does not work try different tracks.													
Use p.c.b wizard to design a track.													
Print out p.c.b design onto acetate to make p.c.b. Check all tracks are in order and have not being printed wrong.													
Use p.c.b drill with 1mm drill, solder components into place using a soldering iron and solder.													
Check the circuit, make sure there are not breaks in the track or bridges. Use a millimetre to test voltages to find the Problem.													
Design case with sketches by hand with pro Desk-top.													
Mark and cut plastic using a circular saw then use a strip heater and bend to shape, glue together using solvent cement. Ensure correct measurements.													
File to perfect shape, drill holes for sensor, bulb and switch. Use steel rules and file a couple of strokes at a time.													
Use wet and dry paper to get a smooth finish, spray with primer and final colour. Make sure paint does not run.													
Fit circuit into the box attaching bulb, switch and sensor. Try making a clip for your battery.													
Test finished product against specification to see if it is what you wanted													

Moderator comments

The production plan should show the correct sequence of operations undertaken during a student's intended product manufacture and this can be done well through a flow chart that covers the stages of production and identifies where quality checks can be made. Planning requires time consideration and this can be done through a Gantt chart, which can be used to map time against task

The example here shows a flow chart and a Gantt chart that map the planned progress of production and include a sequence of tasks, timings and quality control.

Make

TASK: 5.1 Quality of manufacture and 5.2 Quality of outcome

Moderator comments

> It is essential that students provide evidence of them making their product and this should be done through a series of clear photographs that illustrate the processes and skills involved. Photographs of making in progress and the final outcome are the only evidence a moderator will see, so it is essential that images are detailed in order to show what a student has done. In the images shown here, students have provided evidence of a range of skills and processes that support the final product. In electronic products, it is essential that a clear view of the solder-side of circuitry is shown as well as the completed product.

Test and evaluate

TASK: 6.1 Quality of manufacture and 5.2 Quality of outcome

Testing

While I was creating my project, I carried out several tests and checks to ensure that I was progressing well.

First I created a prototype circuit using breadboard. I did this to test that the circuit actually worked, which would save time later. My first attempt did not work, so I tested the prototype with a multimeter. After examining the prototype I discovered the problem. I had not created a link from pin 3 of the chip to the output, so there was no signal being sent to power the output. After I had created this link the prototype circuit worked well.

Once I had created the final circuit, I needed to check that it worked. I connected the circuit to a battery and then plugged it into the wall. I then plugged an output into it. The circuit did not work. So I had to check that there was power on the PCB. First of all I checked that the battery was powering the circuit, which was fine. I then noticed that when I was providing an input for the circuit, I could hear the relay switching. This meant that the problem was with the output. As there is a plug connected directly to the relay, which powers the output socket, I decided to test the fuse in it. After changing the fuse, the device worked so I had fixed the problem.

After I had fixed the circuit and the device worked properly, I needed to carry out tests on performance. I had to tweak the circuit to make sure that it was not triggered by unintentional noise. To test this I placed the circuit in a room and generated a range of different noises. At first, the circuit responded to things such as music or television and even a conversation. So I needed to alter the sensitivity of the circuit. After decreasing the sensitivity of the device I carried out the same tests. This time around the circuit only triggered under extremely loud noises. I then needed to change the sensitivity so that the device would trigger under a noise that was somewhere in between the previous two. After playing around with the circuitry for a while, I finally developed a precise range of noise to trigger the circuit. The circuit did not trigger under television, radio, conversation or any other day-to-day noises, but it did not take an extremely loud noise to trigger it. A single clap was sharp enough to trigger the device. I carried out these tests from a range of two meters, because this is the maximum distance that the device will need to be heard from.

This is the test using the breadboard and the multimeter.

This shows me changing the fuse.

This is one of the tests that I carried out to tune the sensitivity of the device. It shows the device rigged up to an output and I have placed a ringing mobile phone approximately 1 meter from the device.

Once the device was tweaked and tested, I took it to my client and tested it in the intended environment. The device did switch on a lamp from a range of two meters under an audible input (clap). The device did not trigger under our conversation or my clients TV and radio. Overall it worked as it was supposed to.

Evaluate product

Evaluation

Now I have finished my foul counter I will test to see if it meets all of the specification points. I have already tested three of my specification points they were:

- It must have a de-bounce switch to stop double counts because then it will count evenly and it will show the correct number of fouls are committed.
- The buzzer must be able to be heard by the referee at least 15 meters away because that will be the furthest distance he will be away from the scores table.
- The buzzer should buzz for at least 20 seconds because it gives the referee plenty of time to hear it and stop the game.

I will now test the reaming specification points these are:

- It must be able to count to five so that recording is accurate because then there wont be any miss counts or arguments over if they have committed that number of fouls.
- The power supply should be supplied by a PP3 battery because it is small and compact.
- It should be made using PCB.

The first point I will test will be, It must be able to count to five so that recording is accurate because then there wont be any miss counts or arguments over if they have committed that number of fouls. I will test it by setting up my counter as it is going to be used in a real match and test the foul counter over and over to make sure it works correctly.

The next point I will test will be power supply should be supplied by a PP3 battery because it is small and compact. I tested this by using a pp3 battery and it powers the circuit for a long time and it is small and compact. There is only one problem with it and that is that you have to remove the back each time you need to replace the batteries.

The final point I will test will be It should be made using PCB. My circuit was made using PCB, I used PCB because it will be easier and cheaper to batch produce because you only need one mask to make several different PCB's.

Now that I have finished my foul counter I gave it to my friend to test and review it. He said that overall it was a good design, It is a sturdy design, big enough size and works well in a game situation but there are still a few things I could improve on. This being it is hard for the players to see the number of fouls they are on during a match when they have to look at small LED's. Also I could improve it by making the buzzer louder so that everyone will defiantly hear it and instantly stop and realise what has happened. Finally the battery ran out in the middle of a match and he needed a screw driver to remove the back and put a new battery in.

Modifications

Modifications

During the third party evaluation I found that there were a few things on my design that could be improved to make the product even better.

One of them was the size of the LED's. They are so small the players cannot see them from everywhere on the court so to improve this I will change the size of the LED. From normal 5mm LED's to super bright LED's to make it easier for the players to see exactly how many fouls they are on and so there are no mistakes made.

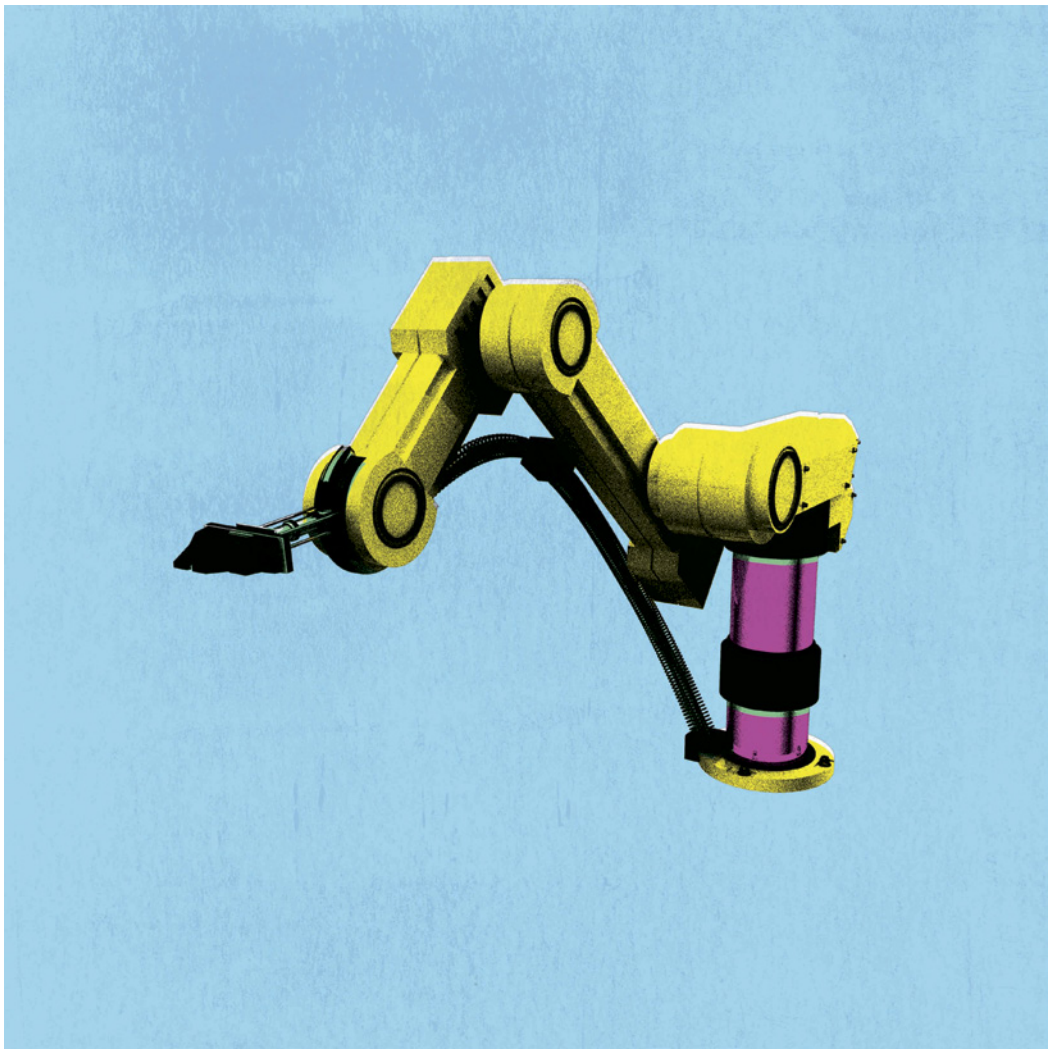
The second thing that I would modify would be the speaker because at the moment the speaker is fairly loud. But some people take a little time to realise that the buzzer has went and to stop playing. So to improve this I would increase the speaker to make the buzzer louder so that everyone can hear it and instantly realise what has happened and stop the game.

The final thing I would modify would be the battery storage. In the middle of my product being evaluated the battery ran out. To change the battery they would have to remove the bottom of the box with a screwdriver and they didn't have a screwdriver with them so they couldn't change the battery. To improve this I would make a battery draw which the battery would go in and could just be pulled out when the battery needed to be changed and then reinserted.

Moderator comments

It is important that final products are tested and evaluated to establish whether or not they have been successful. In the example shown, the student has completed an integrated design and make activity, so the original product specification can be used to measure the performance and quality of the product.

If separate design and make activities had been set, a manufacturing specification would have been given to students and this would have been used to test the performance of the product. Students can also set their own test criteria, as long as they are able to use it to test the performance and quality of their work objectively.



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