

GCSE
Design & Technology
Systems and Control
Technology

Paper 1
Mark scheme

45651
June 2015

Version 1: Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

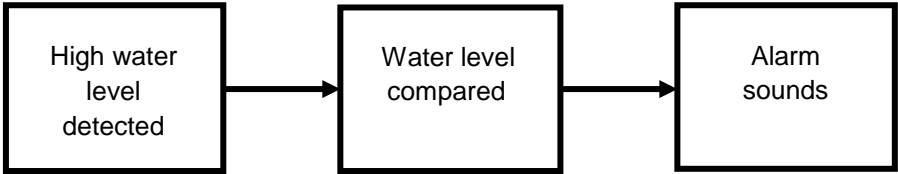
Further copies of this Mark Scheme are available from aqa.org.uk

COMPONENT NUMBER: 45651

**COMPONENT NAME:
GCSE Design and Technology (System and Control Technology)**

FOR EXAMINERS – PLEASE NOTE THAT IF YOU ARE UNSURE HOW TO AWARD A RESPONSE FROM A CANDIDATE, PLEASE SEEK CLARIFICATION OR ADVICE FROM YOUR TEAM LEADER OR THE PRINCIPAL EXAMINER.

Section A

| Qu. | Part | Sub Part | Marking Guidance | Marks |
|-----|------|----------|--|------------------|
| 1 | (a) | | <p>Complete the block diagram below to explain each stage of the water level warning system.</p> <p>Block diagram completed correctly, 1 mark for each correct box.</p> <p>Process Box:</p> <p>Should make reference to a comparison or a component suitable for making a comparison or should reference a threshold being reached or reference a component that will activate at a specific threshold.</p> <p>Output Box:</p> <p>Should make reference to an alarm or a component that will generate a visual or audible output.</p> <p>E.g.</p> <div style="text-align: center;"> <p>Input Process Output</p>  <pre> graph LR A[High water level detected] --> B[Water level compared] B --> C[Alarm sounds] </pre> </div> | (2 marks) |
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| <p>1</p> | <p>(b)</p> | <p>Name two suitable input components for the water level warning system.</p> <p>Give a suitable design advantage for each.</p> <p>Input component 1 (1 mark) Input component 2 (1 mark)</p> <p>Detection input sensor devices:</p> <ul style="list-style-type: none"> • Float switch • Reed switch • Microswitch • Slotted optical • Reflective optical • Tilt switch • Other responses are possible but may require some justification <p>Advantages: 2 mark per advantage for device 1 (2 marks) 2 mark per advantage for device 2 (2 marks)</p> <p>Weak response (1 mark) Eg. Example with little explanation</p> <p>Strong response (2 marks) Eg. Example with explanation</p> <ul style="list-style-type: none"> • Remote • Lightweight • Waterproof • Reliable • Mechanical • Reference to output type (Digital or Analogue) • Low power • Adjustable | <p>(6 marks)</p> |
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| <p>1</p> | <p>(c)</p> | <p>In the box below use notes and sketches to design a product that meets each of the following criteria.</p> <p>It will warn the user when a set water level is reached (2 marks)</p> <p>Weak response with reference to one the following (1 mark)</p> <ul style="list-style-type: none"> • Buzzer, • Bell, • Piezo sounder, • Loudspeaker, • Lamp, • LED • Etc <p>Strong response - Reference to the above, well explained and drawn e.g. A buzzer that sounded in the users office if the water level has risen. (2 marks)</p> <p>It can be adjusted or set for different water levels (3 marks)</p> <p>Weak response but reference to one of the following; (1 mark)</p> <ul style="list-style-type: none"> • Float switch • Reed switch • Moisture sensor • Microswitch / Float • Slotted optical sensor • Tilt switch / Float <p>Good response (2 marks)</p> <p>e.g. Good clear labelled diagram but with omissions or errors</p> <p>Strong Response (3 marks)</p> <p>e.g. Attractive 2D sketch / section view or 3D view that identifies the main parts</p> <p>Accept Mechanical or Electrical solutions</p> <p>e.g. Levers, brackets, hangars, screw-thread, flexible arms, multiple</p> <p>The device is suitable for use outdoors (3 marks)</p> <p>Weak response - Waterproof materials referred to. (1 mark) e.g. may include any plastics or painted metals, battery powered,</p> <p>Good response - Stated suitable materials (2 marks) e.g. Redwood, Pine, ABS, Aluminium</p> | |
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| | | <p>Strong Response – Waterproof features well explained <i>(3 marks)</i></p> <p>A clear understanding of moisture and circuit problems clarified in the sketch and annotation.</p> <p>Reference to any of the following:</p> <ul style="list-style-type: none"> • Gasket • Seal • O-ring • Encapsulated circuit <p>There is a method of switching on and off (2 marks)</p> <p>Weak response with component identified <i>(1 mark)</i> e.g.</p> <ul style="list-style-type: none"> • Switch • Slide switch • Water activated switch • Pressure activated switch • Latching switch <p>Strong response <i>(2 marks)</i></p> <p>e.g. Above component clearly defined and explained by words and or diagram.</p> <p>The product is visually appealing (3 marks)</p> <p>Weak response <i>(1 marks)</i></p> <p>Drawing shows a viable system</p> <p>Good response <i>(2 marks)</i></p> <p>The design considers the case and its appearance – but not fully complete.</p> <p>Strong Response <i>(3 marks)</i></p> <p>The design has the appearance of a commercially viable product. (13 marks)</p> | |
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| 1 | (d) | | <p>In the space below evaluate your design against the criteria given in part (c).</p> <p>General description pointing out features that meet the specification.</p> <p>Description of their design and its operation referenced to the specification (0 – 2 marks)</p> <p>Objective / critical evaluation of the feasibility of all aspects of the system. (3 – 4 marks)</p> | (4 marks) |
| 1 | (e) | (i) | <p>The case for the product is to be produced as a one-off.</p> <p>State a suitable material, manufacturing process and give reasons for your choices.</p> <p>One off material: Should be water resistant E.g. (1 mark)</p> <ul style="list-style-type: none"> • Foamex • Acrylic • PVC • Polystyrene • Resin Cast • Metals – Aluminium, Stainless, etc <p>One off Process: E.g. (1 mark)</p> <ul style="list-style-type: none"> • Vacuum form • Blow mould • Press form • Line bend • Laser cut • Injection Moulding • Fabrication • Hand Tools • 3D Printing <p>One off Reason related to material and process choice: E.g. (1 mark)</p> <ul style="list-style-type: none"> • Low cost • Simple/ easy • Quick/rapid • Prototype so limited need for surface detail <p>Detailed reason - Reference to the above, well explained e.g. Acrylic sheet is readily available and easy to form on a line bender (2 marks)</p> | (4 marks) |

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| 1 | (e) | (ii) | <p>The manufacturing of the case for the product is to be in a batch of 5000.</p> <p>State a suitable material, manufacturing process and give reasons for your choices.</p> <p>Batch of 5000 material: E.g. (1 mark)</p> <ul style="list-style-type: none"> • Polythene • Polystyrene • Nylon • Polyurethane • Polypropylene • Acrylic • PVC • Metals – Aluminium, Stainless, etc <p>Batch of 5000 process: E.g. (1 mark)</p> <ul style="list-style-type: none"> • Injection mould • Rotational cast • Cast • Press formed • Vacuum form • Blow mould • Laser cut • Fabrication <p>Batch of 5000 Reason for material and process choice: E.g. (1 mark)</p> <ul style="list-style-type: none"> • Low cost • Accurate • Complex shape • Easy to reproduce • Surface detail <p>Detailed reason - Reference to the above, well explained and drawn e.g. Polyurethane can be Injection moulded continually once the mould is produced – production size warrants production of moulds or jigs</p> <p style="text-align: right;">(2 marks)</p> | (4 marks) |
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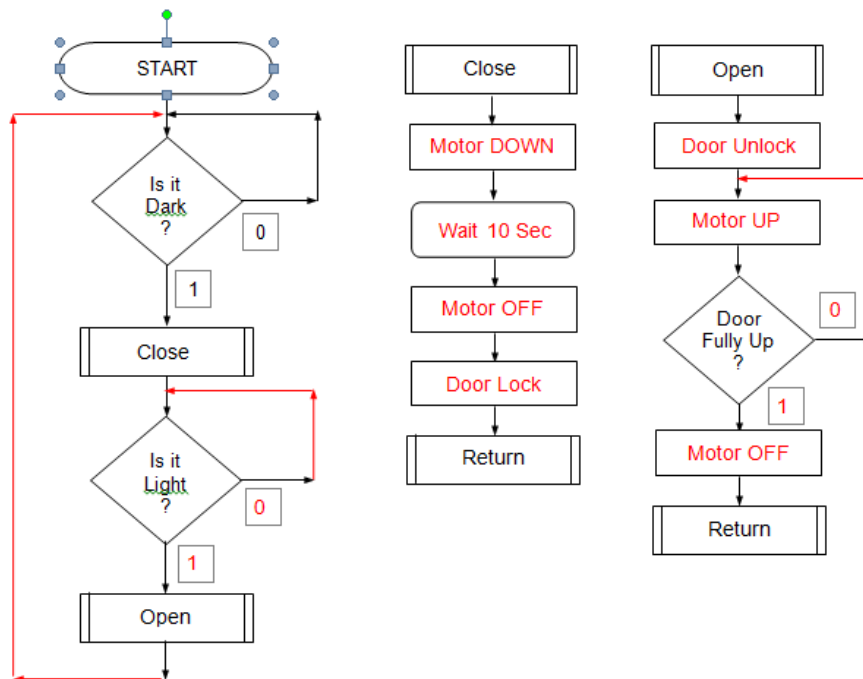
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| <p>3</p> | <p>(a)</p> | <p>This question is about mechanical systems.</p> <p>The entrance to a hen house has a vertically sliding door. A farmer wants the door of the hen house to close and lock automatically at night.</p> <p>Using the block diagram below, name suitable components for each stage of the door closing system.</p> <p>1 mark for each correct component, e.g. (except pneumatic equivalents)</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 40%;">Input component</td> <td>LDR, Photodiode</td> </tr> <tr> <td>Process component</td> <td>PIC, Transistor, Micro Processor, Comparator, OP-Amp, Logic Gate</td> </tr> <tr> <td>Output component</td> <td>Motor, Pneumatic Ram, Solenoid</td> </tr> </table> | Input component | LDR, Photodiode | Process component | PIC, Transistor, Micro Processor, Comparator, OP-Amp, Logic Gate | Output component | Motor, Pneumatic Ram, Solenoid | <p>(3 marks)</p> |
| Input component | LDR, Photodiode | | | | | | | | |
| Process component | PIC, Transistor, Micro Processor, Comparator, OP-Amp, Logic Gate | | | | | | | | |
| Output component | Motor, Pneumatic Ram, Solenoid | | | | | | | | |
| <p>3</p> | <p>(b)</p> | <p>Select the type of motion displayed by the door when it closes.</p> <p>Linear <input checked="" type="checkbox"/></p> | <p>(1 mark)</p> | | | | | | |
| <p>3</p> | <p>(c)</p> | <p>On the diagram below draw and label an automatic mechanical system that could raise and lower the door 300mm when the system senses that it is dark. Please note the door is shown in the lower position.</p> <p>Marks will be awarded for;</p> <ul style="list-style-type: none"> • Naming the correct component(s) • The quality of communication • An explanation of how the system operates. <ul style="list-style-type: none"> • Naming correct component(s) Relevant components named correctly (1 mark) • The quality of sketch • Well drawn sketch showing automatic mechanical system (1 mark) <ul style="list-style-type: none"> • Explanation • Weak response with reference to one the following (1 mark) <ul style="list-style-type: none"> • Mechanism • Door • Motor or Prime Mover <p>Strong response (2 marks)</p> <p>Reference to the above, well explained and drawn e.g. The motor will drive the rack and pinion which will raise the door.</p> | <p>(4 marks)</p> | | | | | | |

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| <p>3</p> | <p>(d)</p> | <p>On the diagram below draw and label a system or component (that is different to the one you used in part c) that could lock the door closed when the system senses that it is dark.</p> <p>Marks will be awarded for;</p> <ul style="list-style-type: none"> • Naming correct component(s) • The quality of communication • Ability to lock • Explanation of how the system operates. <ul style="list-style-type: none"> • Relevant components named correctly (1 mark) • The quality of sketch Well drawn sketch showing locking system (1 mark) • Ability to lock A working design that would lock the door (1 mark) • Explanation (1 mark) Reference to the above, well explained and drawn e.g. The solenoid will activate the bolt across which will lock the door. | <p>(4 marks)</p> |
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3 (e)

Operation of hen house door system;

- The following statements are in the correct Process Boxes (7 marks)
 - Motor OFF
 - Motor OFF
 - Motor UP
 - Motor DOWN
 - Door Lock
 - Door Unlock
 - Wait 10 Seconds
- Each correct connecting line, is present (3 marks)
- Each correct output state of the decision boxes (4 marks)
- Use 1 for Yes and 0 for No



(14 marks)

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| 3 | (f) | <p>The hen house is in a field with no mains electricity.</p> <p>Suggest a renewable energy source that could operate the hen house door closer and explain why this energy source is suitable.</p> <p>Suitable energy source suggested, e.g. (1 mark)</p> <ul style="list-style-type: none"> • Water Power • Solar Panel • Wind Turbine <p>Explain why this energy source is suitable</p> <p>Weak response with reference to why it is suitable: (1 mark)</p> <p>Strong response (2 marks)</p> <p>Reference to the above, well explained with reference to storage of energy or that the door only operates in the daytime so solar panel appropriate.</p> <p>e.g. A wind turbine will charge a battery to power the motor even when it is not windy.</p> | (3 marks) |
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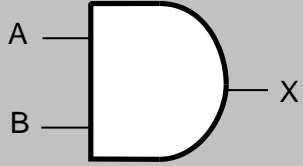
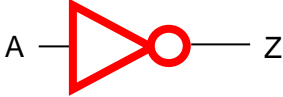
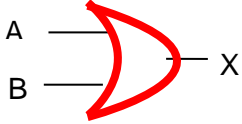
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| 4 | | <p>On the diagram below draw and label a mechanical system which could oscillate the lawn sprinkler.</p> <p>Marks will be awarded for;</p> <ul style="list-style-type: none"> • Naming the correct component(s) • Continuous operation • The quality of communication • An explanation of the system. <p>The system must be a mechanical oscillating system – not a transmission system requiring additional control circuitry.</p> <ul style="list-style-type: none"> • Naming correct component(s) Relevant components named correctly (1 mark) • Continuous operation A working design that would continuously operate (1 mark) • The quality of sketch Well drawn sketch showing mechanism capable of producing oscillatory motion. (1 mark) • Explanation of the system Strong response - Reference to the above, well explained and drawn (1 mark) <p>e.g. The water wheel will turn the crank and lever to oscillate the sprinkler.</p> | (4 marks) |
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| 5 | (a) | <p>Give an advantage and disadvantage for each of the following circuit construction techniques. Do not repeat any of your responses.</p> <table border="1"> <thead> <tr> <th></th> <th>Advantage</th> <th>Disadvantage</th> </tr> </thead> <tbody> <tr> <td>Bread board</td> <td>Eg. Easy to change components (1 mark)</td> <td>Eg. Fragile / poor connections (1 mark)</td> </tr> <tr> <td>Veroboard</td> <td>Eg. More robust than breadboard (1 mark)</td> <td>Eg. Larger than PCB / difficult to plan circuit / joined tracks (1 mark)</td> </tr> <tr> <td>PCB</td> <td>Eg. Compact, Durable, repeatable, easier to fault find (1 mark)</td> <td>Eg. Takes time to design and make (1 mark)</td> </tr> </tbody> </table> | | Advantage | Disadvantage | Bread board | Eg. Easy to change components (1 mark) | Eg. Fragile / poor connections (1 mark) | Veroboard | Eg. More robust than breadboard (1 mark) | Eg. Larger than PCB / difficult to plan circuit / joined tracks (1 mark) | PCB | Eg. Compact, Durable, repeatable, easier to fault find (1 mark) | Eg. Takes time to design and make (1 mark) | (6 marks) |
|-------------|--|--|------------------|-----------|--------------|-------------|---|--|-----------|---|---|-----|--|---|------------------|
| | Advantage | Disadvantage | | | | | | | | | | | | | |
| Bread board | Eg. Easy to change components (1 mark) | Eg. Fragile / poor connections (1 mark) | | | | | | | | | | | | | |
| Veroboard | Eg. More robust than breadboard (1 mark) | Eg. Larger than PCB / difficult to plan circuit / joined tracks (1 mark) | | | | | | | | | | | | | |
| PCB | Eg. Compact, Durable, repeatable, easier to fault find (1 mark) | Eg. Takes time to design and make (1 mark) | | | | | | | | | | | | | |
| 5 | (b) | <p>Give two advantages of modelling circuit designs on a computer instead of building them.</p> <p>Suitable advantages e.g.</p> <ul style="list-style-type: none"> • You don't need all the components / cost effective • Easily edited / modified • Can be tested / monitored • Allows planning of component layout • Links to PCB design • No components are damaged if circuit fails. • Quicker as you don't need to find the components | (2 marks) | | | | | | | | | | | | |
| 5 | (c) | <p>Give two disadvantages of modelling circuit designs on a computer instead of building them.</p> <p>Suitable disadvantages e.g.</p> <ul style="list-style-type: none"> • The computer may not be as accurate • More expensive as you need a PC • Need for appropriate software • Not all components available • Higher level of skill needed to operate the PC • Not true representation of all components • No indication of physical size | (2 marks) | | | | | | | | | | | | |

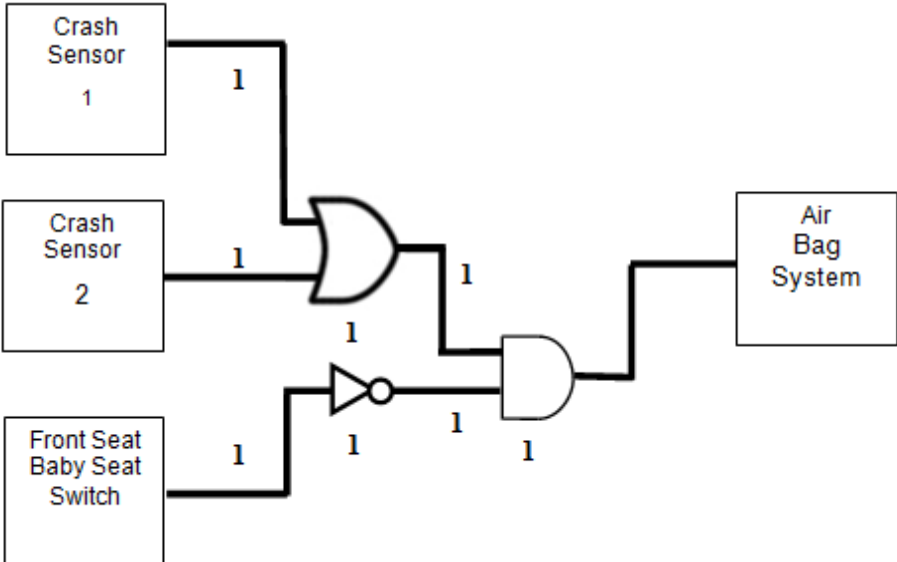
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| 6 | (a) | <p>State how an inventor could protect their design against illegal copying.</p> <p>Mention of one of the following,</p> <ul style="list-style-type: none"> • Patent, • Trademark, • Copyright, • Registered Design <p>Weak response (1 mark) Use of term</p> <p>Good response Use of term and indication of how this provides protection (2 marks)</p> | (2 marks) |
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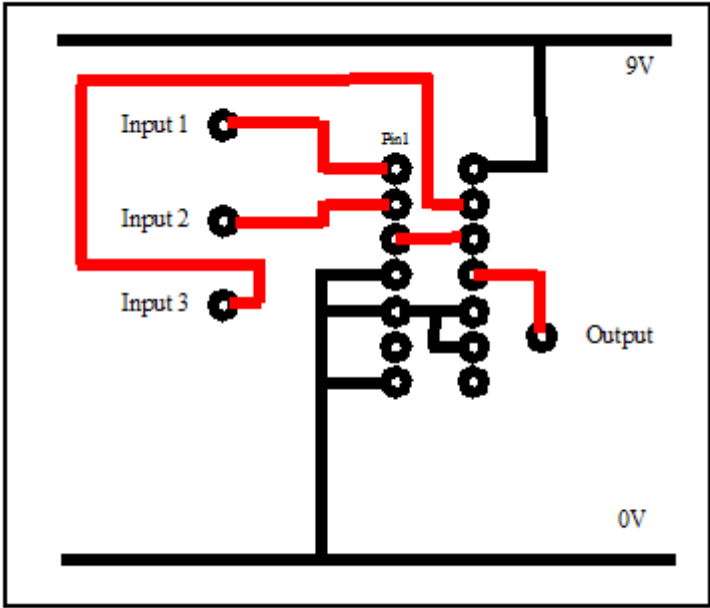
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| 6 | (b) | <p>Unscrupulous companies can break design protection laws by copying or forgery.</p> <p>Explain the effect that this can have on manufacturers and what they and the authorities can do to prevent this.</p> <p>You will be tested for Quality of Written Communication in this part of the question.</p> <p>Reference points: Sales – Profits – Share Price – Company reputation – R & D Budget – Viability – Copyright – Patent – Trading Standards – Identification Marks – Legal redress- Etc.</p> <p>A high level response with a full and comprehensive explanation of all aspects of a suitable process. Response well-structured with good use of appropriate design and technology terminology and showing a good grasp of grammar, punctuation and spelling. (7– 8 marks)</p> <p>A medium level response with a good explanation of a suitable process, however with some aspects of the process omitted. Response fairly well structured with some use of design and technology terminology with a small number of errors in grammar, punctuation. (5 - 6 marks)</p> <p>A low level response with a limited explanation of one part of the process with several errors. Response poorly structured with little or no use of design and technology terminology and with several errors in grammar, punctuation and spelling. (3 - 4 marks)</p> <p>An attempt at a response, no relevant description presented. No use of design and technology terminology and multiple errors in grammar, punctuation and spelling.</p> | |
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| | | | <p style="text-align: right;">(1 - 2 marks)</p> <p><i>e.g. An 8 Mark response;</i></p> <p>Manufacturers and Designers lose money when their goods and designs are copied or counterfeited. There is also a loss of brand quality as often the fake goods cannot be distinguished by the public from the genuine article but are often of inferior quality. Manufacturers can protect their products by taking out patents, trademarks, copyright etc, but this costs time and money to do. It also has to be done in each country that it is required to apply to. Even when protection is gained the manufacturers have to be vigilant to spot the pirated goods and then find the manufacturer and press charges. Often this involves working across international boundaries which also adds to the difficulty and cost.</p> | <p>(8 marks)</p> |
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| 7 | (a) | Symbol | Type of Gate | Truth Table | | | | | | | | | | | | | | | |
|---|------------|--|--------------|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | |  | AND | <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td style="color: red;">0</td> </tr> <tr> <td>1</td> <td>0</td> <td style="color: red;">0</td> </tr> <tr> <td>1</td> <td>1</td> <td style="color: red;">1</td> </tr> </tbody> </table> | A | B | X | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| | | A | B | X | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | | | | | | | | | | | | | | | | | |
| 0 | 1 | 0 | | | | | | | | | | | | | | | | | |
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| 1 | 1 | 1 | | | | | | | | | | | | | | | | | |
|  | NOT | <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td style="color: red;">0</td> </tr> </tbody> </table> | A | X | 0 | 1 | 1 | 0 | | | | | | | | | | | |
| A | X | | | | | | | | | | | | | | | | | | |
| 0 | 1 | | | | | | | | | | | | | | | | | | |
| 1 | 0 | | | | | | | | | | | | | | | | | | |
|  | OR | <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td style="color: red;">0</td> </tr> <tr> <td>0</td> <td>1</td> <td style="color: red;">1</td> </tr> <tr> <td>1</td> <td>0</td> <td style="color: red;">1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table> | A | B | X | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | | |
| A | B | X | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | | | | | | | | | | | | | | | | | |
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| 1 | 1 | 1 | | | | | | | | | | | | | | | | | |

(10 Marks)

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| 7 | (b) | <p>Front seat car passengers are protected by air bags in the event of a crash.</p> <p>In a car the air bag should only activate;</p> <ul style="list-style-type: none"> • when there is no baby seat on the front seat • and either of the crash sensors is activated. <p>1 mark for each correct input line to a gate (5 marks) 1 mark for each correct logic symbol in the correct position (3 marks)</p>  <p>Alternative symbols or labels for logic gates are acceptable.</p> | (8 marks) |
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| <p>7</p> | <p>(c)</p> | <p>Complete the PCB layout for the logic circuit below using the information provided above.</p> <p>Please note that the PCB Layout is viewed from the component side.</p> <p>1 mark for each track (5 marks) (Drawn tracks only receive marks if they do not touch additional pads or other tracks)</p> <p>1 mark for neat tracks the correct thickness (1 mark)</p> <p>E.g.</p>  | <p>(6 marks)</p> |
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