

**GCSE
DESIGN AND TECHNOLOGY
SYSTEMS AND CONTROL
TECHNOLOGY**

45651
Mark scheme

4565
June 2014

Version 1.0 Final

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.

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COMPONENT NUMBER: 45651

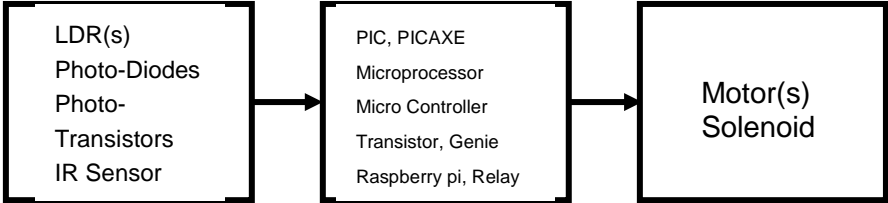
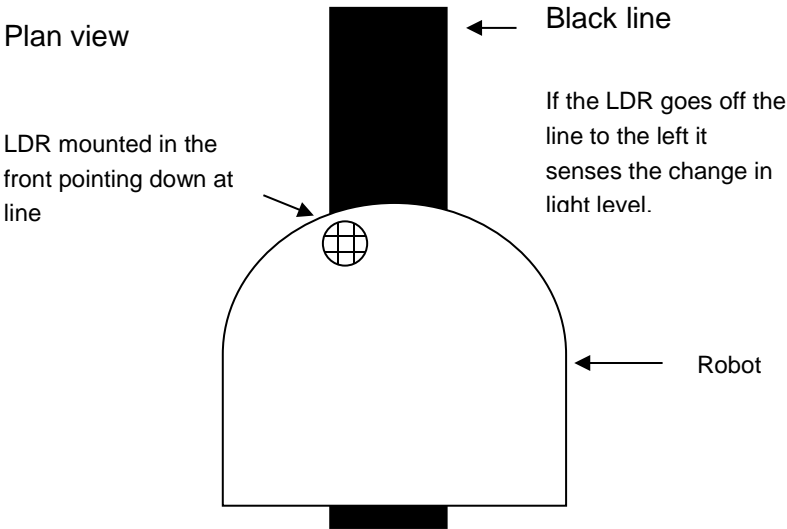
COMPONENT NAME:

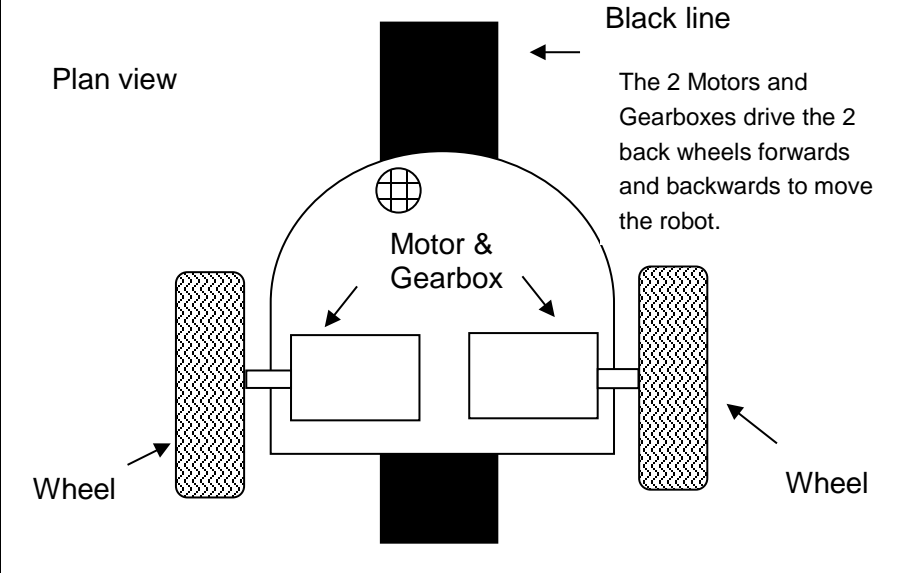
GCSE Design and Technology (System and Control Technology)

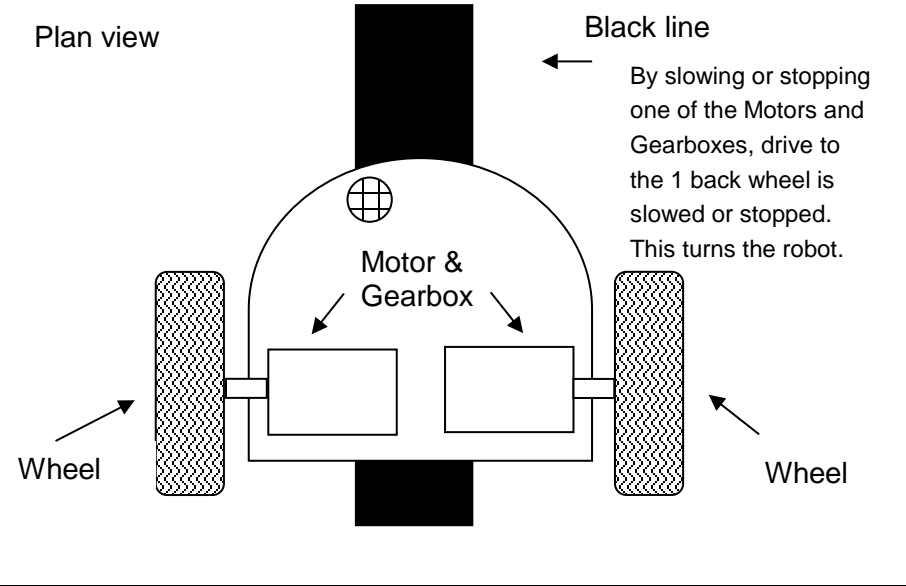
FOR EXAMINERS – PLEASE NOTE THAT IF YOU ARE UNSURE HOW TO AWARD A RESPONSE FROM A CANDIDATE, PLEASE SEEK CLARIFICATION OR ADVICE FROM YOUR TEAM LEADER OR THE PRINCIPAL EXAMINER.

Section A

Qu.	Part	Sub Part	Marking Guidance	Marks																
1	(a)		<p>Name two issues which you need to consider before you begin to design the robot.</p> <p>For each give;</p> <ul style="list-style-type: none"> • Specification point and justify why it is important <p>An example has been given to help you.</p> <p><i>Functional Specification point</i> <i>The robot must follow a line</i></p> <p><i>To demonstrate it is able to follow a set route.</i></p> <p>1. Power Supply Specification point and justification Weak Power Supply Specification point and justification (1 mark) e.g.</p> <table border="1"> <tr> <td>Power Supply Specification point</td> <td>Justification</td> </tr> <tr> <td>Batteries</td> <td>Portable</td> </tr> </table> <p>Good Power Supply Specification point and justification (2 marks) e.g.</p> <table border="1"> <tr> <td>Power Supply Specification point</td> <td>Justification</td> </tr> <tr> <td>It should run on rechargeable batteries</td> <td>To lower the running costs</td> </tr> </table> <p>2. Aesthetic Specification point Weak Aesthetic Specification point and justification (1 mark) e.g.</p> <table border="1"> <tr> <td>Aesthetic Specification point</td> <td>Justification</td> </tr> <tr> <td>It should look like a small animal</td> <td>To appeal to children</td> </tr> </table> <p>Good Specification point and explanation (2 marks)</p> <table border="1"> <tr> <td>Aesthetic Specification point</td> <td>Justification</td> </tr> <tr> <td>The wheels should not show</td> <td>To make it look more like an animal</td> </tr> </table> <p>Do not accept 'Attractive' unless amplified or explained</p>	Power Supply Specification point	Justification	Batteries	Portable	Power Supply Specification point	Justification	It should run on rechargeable batteries	To lower the running costs	Aesthetic Specification point	Justification	It should look like a small animal	To appeal to children	Aesthetic Specification point	Justification	The wheels should not show	To make it look more like an animal	<p>Total (4 marks)</p>
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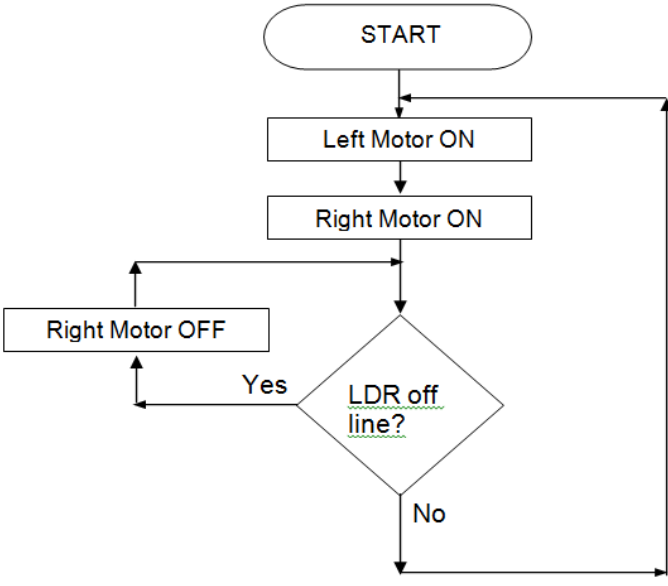
Qu.	Part	Sub Part	Marking Guidance	Marks
1	(b)		<p>Name the main component in each system block for the line following robot.</p> <p>1 mark for each stage correctly identified.</p> <p>e.g.</p> <p>one of;</p> <div style="display: flex; justify-content: space-around; text-align: center;"> <div>Input</div> <div>Process</div> <div>Output</div> </div> 	<p>Total (3 marks)</p>
1	(c)	(i)	<p>Using notes and sketches design a system in the boxes below that meets each of the criteria.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>(i) The robot can sense the line (3 marks)</p> <p>An attempt that would work - sense the line (1 mark) Good attempt well explained - at robot can sense the line (2 marks) Good attempt well explained with materials / components identified (3 marks)</p> <p>e.g.</p> <div style="display: flex; justify-content: space-between;"> <div>Plan view</div> <div>Black line</div> </div>  <div style="margin-top: 10px;"> <p>If the LDR goes off the line to the left it senses the change in light level.</p> </div> </div>	<p>Total (3 marks)</p>



















Qu.	Part	Sub Part	Marking Guidance	Marks
1	(c)	(ii)	<p>(ii) The robot can move (3 marks)</p> <p>An attempt that would work - robot can move (1 mark) Good attempt well explained with materials / components identified (2 marks) Good attempt well explained with materials / components identified with speed reduction (3 marks)</p> <p>e.g.</p> <div style="text-align: center;">  <p>The diagram is a plan view of a robot chassis. It features a central body with two rectangular motor and gearbox units. Two wheels are attached to the sides. A black line is drawn across the top and bottom of the chassis. Arrows point to the wheels and the motor/gearbox units. Labels include 'Plan view', 'Motor & Gearbox', 'Wheel', and 'Black line'.</p> </div> <p style="text-align: right;">The 2 Motors and Gearboxes drive the 2 back wheels forwards and backwards to move the robot.</p>	<p>Total (3 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
1	(c)	(iii)	<p>(iii) The robot can turn (3 marks)</p> <p>Weak attempt at robot can turn (1 mark)</p> <p>Good attempt at robot can turn (2 marks)</p> <p>Good attempt with materials / components identified (3 marks)</p> <p>e.g.</p> <p>Plan view</p>  <p>Black line</p> <p>By slowing or stopping one of the Motors and Gearboxes, drive to the 1 back wheel is slowed or stopped. This turns the robot.</p>	<p>Total (3 marks)</p>
				<p>Total (16 marks)</p>

Section B

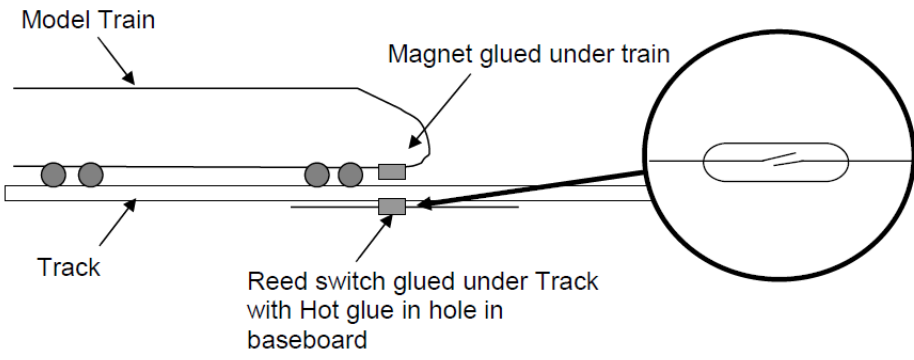
Qu.	Part	Sub Part	Marking Guidance	Marks
2	(a)		Feedback is often used in control systems. Explain what feedback is. Weak explanation, e.g. feeding back information into the system (1) Good explanation, e.g. the sending of information back into the system to control the process (2) Response must relate to Control Systems Do not accept explanation of Evaluation feedback or Teacher Marking as feedback	Total (2 marks)
2	(b)	(i)	Feedback can be both an advantage and a disadvantage. Give an example of where feedback is useful Weak example e.g. greenhouse vent (1) Good example e.g. to control temperature in a greenhouse by opening / closing the vent. (2)	Total (2 marks)
2	(b)	(ii)	Give an example of where feedback is a disadvantage Weak example e.g. Rock Concert Music Feedback (1) Good example e.g. When the sound from the speakers feeds back at a concert into the microphones and gets amplified again. (2)	Total (2 marks)
2	(c)		Explain how designers can use feedback to control a robot following a line. Weak explanation (1) e.g. When the robot goes off line it could be steered back on it. Good explanation, (2) e.g. Sensors could look at the line and when they sense moving off the line they could feedback this information to the processor which could stop steer the robot back onto the line. Good explanation, with components referenced (3)	

		<p>g.g.</p> <p>LDR's could look at the line and when they sense moving off the line they could feedback this information to the PIC processor which could stop or slow one of the motors to one of the wheels to steer the robot back onto the line.</p>	<p>Total (3 marks)</p>
<p>2</p>	<p>(d)</p>	<p>Draw a flowchart to show how the robot you have designed follows the black line.</p> <p>1 mark for each of the following</p> <ul style="list-style-type: none"> • Sensing the line (or the lack of it) • Decision Box – Off Line • Decision feedback arrow. • Changing direction and returning to straight • Continuous Running • Correct flowchart symbols <p>e.g.</p>  <pre> graph TD Start([START]) --> Left[Left Motor ON] Left --> Right[Right Motor ON] Right --> LDR{LDR off line?} LDR -- Yes --> RightOff[Right Motor OFF] RightOff --> LDR LDR -- No --> Left </pre>	<p>Total (6 marks)</p>
			<p>Total (15 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks																												
3	(a)		<p>Give the Component Name and the electronic building block it would be used, for the following electronic components.</p> <table border="1"> <thead> <tr> <th>No.</th> <th>Photo</th> <th>Component Name</th> <th>Electronic building block</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td>LED or Red LED</td> <td>Output</td> </tr> <tr> <td>2</td> <td></td> <td></td> <td>Process</td> </tr> <tr> <td>3</td> <td></td> <td>Switch or Push Switch</td> <td>Input</td> </tr> <tr> <td>4</td> <td></td> <td>Motor</td> <td>Output</td> </tr> <tr> <td>5</td> <td></td> <td>Relay</td> <td></td> </tr> <tr> <td>6</td> <td></td> <td>Buzzer or Sounder</td> <td>Output</td> </tr> </tbody> </table>	No.	Photo	Component Name	Electronic building block	1		LED or Red LED	Output	2			Process	3		Switch or Push Switch	Input	4		Motor	Output	5		Relay		6		Buzzer or Sounder	Output	<p>Total (10 marks)</p>
No.	Photo	Component Name	Electronic building block																													
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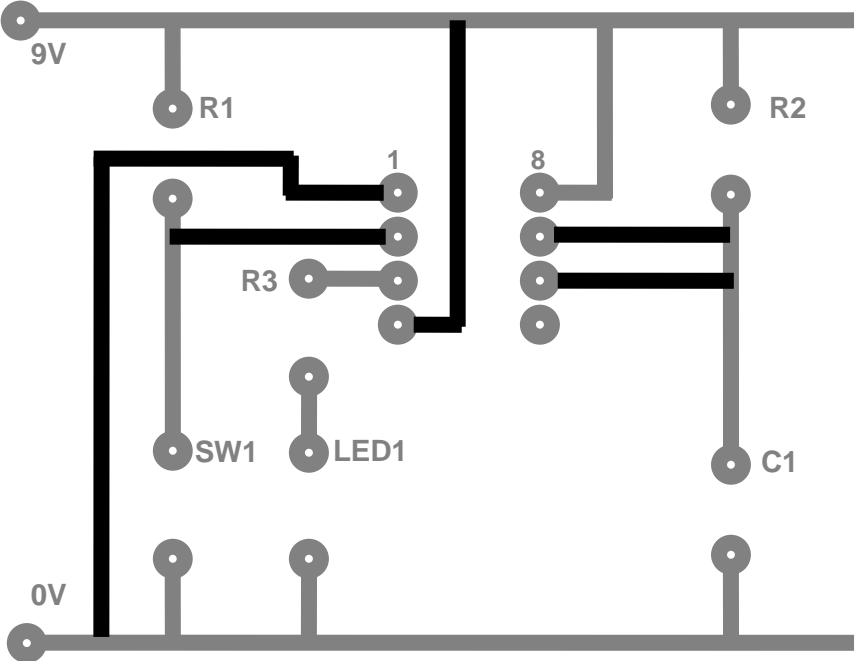
Qu.	Part	Sub Part	Marking Guidance	Marks
3	(b)	(i)	<p>The circuit below is a heat sensor.</p> <p>Name component A</p> <p>Thermistor</p>	Total (1 mark)
3	(b)	(ii)	<p>Name component B</p> <p>Variable resistor</p> <p>Also accept 'Potentiometer'.</p>	Total (1 mark)
3	(c)		<p>The resistance of the component A is 10k and component B is 20k.</p> <p>Calculate the output voltage (V_2) when the supply voltage (V_s) is 9 volts.</p> <p>Formula $V_2 = \frac{R_2}{R_1 + R_2} \times V_s$ (1)</p> <p>Calculation $V_2 = \frac{20K}{10K + 20K} \times 9$ (1)</p> <p>Answer $V_2 = 6 \text{ V or } 6 \text{ Volts}$</p> <p style="text-align: right;">6 = (1) Volts or V = (1)</p>	Total (4 marks)
				Total (16 marks)

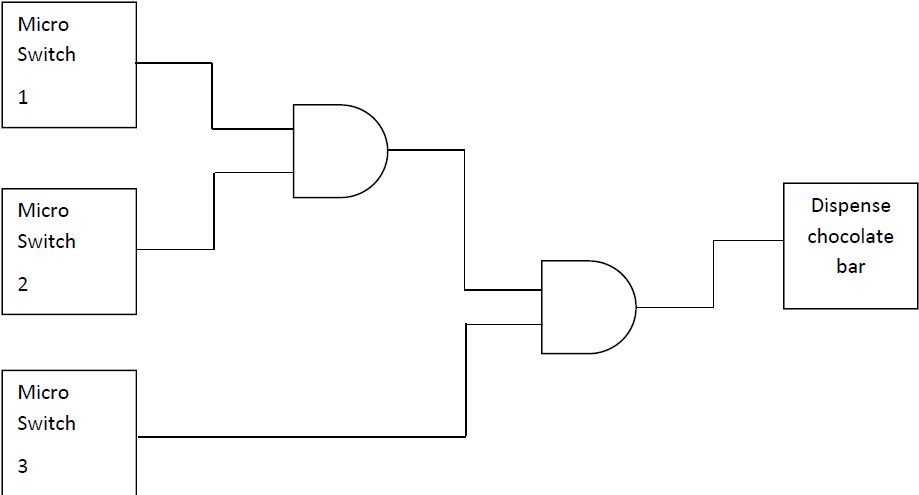
Qu.	Part	Sub Part	Marking Guidance	Marks
4	(a)	(i)	<p>Suggest a suitable material for the model barrier</p> <p>Suitable material given, e.g. Redwood, Pine, ABS, Aluminium. Do not accept – wood, metal, plastic.</p>	Total (1 mark)
4	(a)	(ii)	<p>Explain why the material that you have selected is suitable</p> <p>Weak explanation, e.g. It is easily found. <i>(1 mark)</i></p> <p>Good explanation e.g. It is from a sustainable source. It has a high strength to weight ratio. <i>(2 marks)</i></p>	Total (2 marks)
4	(b)	(i)	<p>Suggest a suitable component to sense that a model train is present.</p> <p>Suitable component, e.g. LDR, Reed switch, Micro Switch, Photo-Diode, Photo-Transistor</p>	Total (1 mark)
4	(b)	(ii)	<p>Describe how your system senses a train</p> <p>Weak explanation, e.g. the Reed switch senses the train above it <i>(1 mark)</i></p> <p>Good explanation with components referenced e.g. the Reed switch under the tracks operates when the magnet on the train is above it. <i>(2 marks)</i></p>	Total (2 marks)

Qu.	Part	Sub Part	Marking Guidance	Marks
4	(b)	(iii)	<p>Sketch on the diagram below how this component you have named senses a model train.</p> <p>Award marks for;</p> <ul style="list-style-type: none"> • Component mounted correctly (1 mark) • Able to Sense that a train is present (1 mark) • A good quality labeled sketch of the component (2 marks)  <p>The diagram illustrates a sensor setup for a model train. A horizontal track is shown with a model train above it. The train has two wheels on each side. A small rectangular magnet is attached to the bottom of the train, labeled 'Magnet glued under train'. Below the track, a reed switch is mounted in a hole in the baseboard, labeled 'Reed switch glued under Track with Hot glue in hole in baseboard'. A circular inset provides a magnified view of the reed switch, showing its internal components and the gap between the magnet and the switch.</p>	<p>Total (4 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
4	(c)		<p>Operation of a model barrier system;</p> <ul style="list-style-type: none"> The following statements to the correct Process Boxes (6 marks) Motor OFF Motor OFF Motor DOWN Motor UP Wait 5 Seconds Wait 30 Seconds Each correct connecting line, there are 3 missing lines (3 marks) Each correct output state of the decision boxes (4 marks) Use 1 for Yes and 0 for No 	
				<p>Total (13 marks)</p> <p>Total (23 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
5	(a)		<p>One method to test that a circuit will work before building a PCB.</p> <p>Recognisable method (1) e.g Temporarily build the circuit, use computer simulation</p> <p>Fully described (2) e.g The circuit could be built and tested on Breadboard.</p> <p>Fully described with components / tool referenced (3) e.g.The circuit could be built and tested on Breadboard. This is a board that the components can be temporary placed in to connect them together without soldering. Components can be easily swapped and reused.</p>	Total (3 marks)
5	(b)		<p>Explain two advantages for using CAD to design PCBs.</p> <p>Recognisable advantage (1) e.g Quicker than Breadboard to build. e.g Easier to edit.</p> <p>Well explained (2) e.g Quicker than Breadboard to build as all components are stored in the system. e.g Easier to edit, share and archive as electronic medium.</p> <p style="text-align: right;">2 x (2) (4)</p>	Total (4 marks)
5	(c)		<p>List the five main stages in a PCB production process. Marks for;</p> <ul style="list-style-type: none"> • Listing 5 of the main stages 5x1 (5) <p>e.g.</p> <ul style="list-style-type: none"> • Expose UV Light box • Develop • Etch • Rinse • Drill Holes <p>Or</p> <ul style="list-style-type: none"> • Load PCB in CNC Mill • Open drawing on computer • Run program to mill unwanted copper away • Run program to drills • Remove from CNC Mill 	Total (5 marks)

Qu.	Part	Sub Part	Marking Guidance	Marks
5	(d)		<p>Circuit Diagram</p> <p>One mark for each end of a track correctly connected without crossing or touching incorrect track. 1 x 5 = 5 marks</p> <p>E.g.</p> 	<p>Total (5 marks)</p>
5	(e)		<p>Describe one method of testing a PCB after it is completed</p> <p>Recognisable method (1) e.g. Check for Short Circuits and Breaks</p> <p>Fully described (2) e.g. Visibly check for Short Circuits and Breaks in the track and correct component values and component orientation.</p> <p>Fully described with components / tools referenced (3)</p> <p>Check for Short Circuits and Breaks in the tracks with a Multi-meter and visibly check correct components values and component orientation.</p>	<p>Total (3 marks)</p>
				<p>Total (20 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
6	(a)		<p>Using two 2 input logic gates, construct a logic circuit in the space below to join the 3 Micro switches to the 'Dispense chocolate bar' to give the required output.</p> <p>Marks will be awarded for</p> <ul style="list-style-type: none"> • Logic Gates symbols (2 marks) • Inputs to gates (4 marks) • Output to Vend System (1 mark) • Quality of drawing (1 mark) 	<p style="text-align: right;">Total (8 marks)</p>
6	(b)	(i)	<p>State the type of motion that the output of a solenoid moves in.</p> <p>Linear OR Reciprocating</p>	<p style="text-align: right;">Total (1 mark)</p>
6	(b)	(ii)	<p>State one advantage of using solenoids in systems</p> <p>Weak advantage, e.g. Cheap to buy (1)</p> <p>Good advantage e.g. Small and reliable and easy to power (2)</p>	<p style="text-align: right;">Total (2 marks)</p>
6	(b)	(iii)	<p>State one disadvantage of using solenoids in systems</p> <p>Weak disadvantage, e.g. Can be weak (1)</p> <p>Good disadvantage e.g. Short throw / Electrical interference / Noisy (2)</p>	<p style="text-align: right;">Total (2 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
6	(c)		<p>Name a component that could sense that the machine was being tipped.</p> <p>Suitable component e.g. Tilt Switch, Mercury Switch Do NOT accept 'Tilt Sensor'</p>	Total (1 mark)
6	(d)		<p>Vending machines systems often need to use a delay in their processes, for example, to allow a cup to fill or a snack to fall.</p> <p>State two methods that a delay in the process could be achieved.</p> <p>Name the specific components.</p> <p>Method 1</p> <p>Weak explanation with no components stated (1) Strong explanation with components stated (2)</p> <p>Method 2</p> <p>Weak explanation with no components stated (1) Strong explanation with components stated (2)</p> <p>Weak e.g.</p> <ul style="list-style-type: none"> • Using a capacitor • Using a 555 timer • Using a WAIT command <p>Strong e.g</p> <ul style="list-style-type: none"> • Using a capacitor and resistor in Series • Using a 555 timer as a Monostable • Using a WAIT command in a micro-processor 	Total (4 marks)

Qu.	Part	Sub Part	Marking Guidance	Marks
6	(e)		<p>Health & safety is very important when providing systems for the general public to use</p> <p>Give two Health & Safety issues that would need to be considered in the Design Specification of an actual vending machine.</p> <p><i>Example – The system should not fall on the user if tipped.</i></p> <p>Issue 1</p> <p>Weak Issue (1) e.g. prevent electric shock</p> <p>Good Issue (2) e.g. The vending machine should meet all of the relevant electrical safety guidelines to prevent electrocuting a user</p> <p>Issue 2</p> <p>Weak Issue, (1) e.g. prevent trapped finger</p> <p>Good Issue well explained (2) e.g. The vending machine should meet all of the relevant safety guidelines to prevent trapping a user's hand or arm</p>	<p>Total (4 marks)</p>

Qu.	Part	Sub Part	Marking Guidance	Marks
6	(f)		<p>There have been cases where users have toppled vending machines on to themselves and been injured or killed.</p> <p>Discuss whether this is the responsibility of the vendor and give examples of how manufacturers can design safety into a vending machine.</p> <p><i>You will be tested for quality of written communication in this part of the question.</i></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. (1- 2 marks)</p> <p><i>Although it may look as though it is the user's fault if they topple a drinks vending machine onto themselves, it could be argued that the design of the drinks machines was partly to blame. As well as being sued for damages there is the added issue of bad publicity for the drinks company even if they are found innocent of any wrong doing. It is usually better for any company to prevent the tragedy occurring than win the legal battle following it. The design of the vending machine could prevent this happening by simply having the ability to be bolted to the wall or by being so stable that it couldn't be toppled. There is an urban myth that these machines give out a free vend when tipped, this could be stopped by having a 'nudge' alarm similar to a pinball machine that puts the vending machine into stealth mode if it is shaken, let alone tipped up.</i></p>	<p>Total (8 marks)</p>
				<p>Total (30 marks)</p>