General Certificate of Secondary Education

Design and Technology: Systems and Control Technology

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Specimen Mark Scheme

The Specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of the planned question papers and mark schemes in advance of the first operational exams.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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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Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

Question 1

1 Section A is about an automated sliding carriage door.

(a) (i) Suggest a suitable material for the train door.

A suitable material e.g. Aluminium. *(1 mark)*

(a) (ii) Give one reason why this material is suitable.

A suitable reason e.g. Lightweight, Does not rust *(1 mark)*

(a) (iii) State two advantages of using bioglass for the train door window.

One mark for each suitable reason e.g.
- Never gets mouldy,
- Doesn't need cleaning
- Doesn't show fingerprints

(max 2 marks)

(a) (iv) Suggest a suitable material for the sliding door track.

A suitable material e.g. Steel. *(1 mark)*

(a) (v) Give one reason why this material is suitable.

A suitable reason e.g. Hard wearing, *(1 mark)*

1 (b) Suggest three alternative systems that you could use to open and close the door.

One mark for each suitable system, e.g.
- Double acting cylinder
- Rack and Pinion
- Crank and Slider

(max 3 marks)

1 (c) (i) The simplified diagram shows a sliding train door. It is in the open position.

Add your chosen system to the drawing in space A, that will open and close the door.

Suitable actuator drawn (3 marks)
Actuator able to move door (2 marks)
An attempt at a recognisable device (1 mark)

(max 3 marks)

Suitable mounting of actuator to beam (1

(max 8 marks)

mark)
Suitable mounting of actuator to door (1 mark)
A suitable power supply mentioned (1 mark)
Neat drawings (1 mark)
Clear notes (1 mark)

1 (c) (ii) Describe the operation of the system that you have drawn in space A.

A clear description of the operation (4 marks)
e.g. The passenger operates the push valve, this allows air to flow to the cylinder, this opens the door. A reservoir is used to hold the door open for a short time to allow the passenger to board the train. The air then escapes from the cylinder and the door shuts.

A correct description with some omissions (3 marks)
A description with some errors (2 marks) *(max 4*
An attempt at a description (1 mark) *marks)*

(c) (iii) Give two advantages of your chosen system.

advantage 1: *(1 mark)*
advantage 2: *(1 mark)*
e.g. My pneumatic system has few moving parts

(d) (i) Name a specific component that could be used to sense that the door has hit an obstruction.

A suitable component e.g. push switch. (2 marks) *(Max 2*
An attempt e.g. a switch. (1 mark) *marks)*

(d) (ii) Give two other health and safety issues that should be considered when designing the door system.

Issue 1 e.g. should not open when moving. (1 mark) *(Max 2*
Issue 2 e.g. not able to be opened by children. (1 mark) *marks)*

(e) It was found that the door opened and closed too quickly.

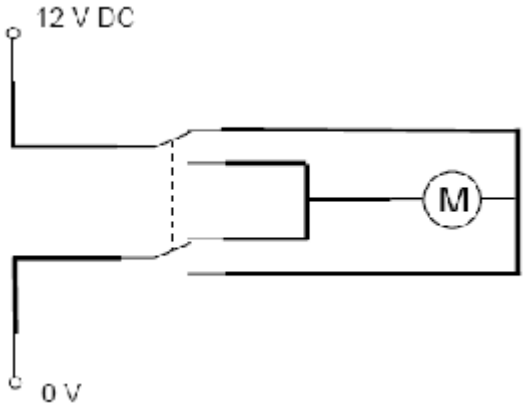
What could be added to your system to slow down the movement of the door?

A suitable mechanism e.g. gearbox, restrictor, flow control valve. (2 marks)
An attempt with no specific component named. (1 mark) *(Max 2 marks)*

1 (f) **A Double Pole Double Throw (DPDT) switch can be used to control the forward and reverse direction of a motor.**

Complete the diagram below to show a reversing circuit.

e.g.



Note – there are other correct solutions. *(Max 6 marks)*
1 mark for each wire correctly connected

(35 marks)

Question 2

2 Question 2 is about constructing circuits and using prototyping systems.

(a) Compare and contrast the suitability of the following circuit construction techniques, making reference to specific strengths and weaknesses in each case.

A full analysis and explanation of all features of both circuit construction techniques. Discussion of the positive features of using each, and some of the possible problems that may be encountered. The response should be well structured with good use of appropriate design and technology terminology and showing a good grasp of grammar, punctuation and spelling. *(5-6 marks)*

Some analysis and explanation given of the features in respect of one or both techniques. Some consideration of positive features and possible drawbacks of one or both techniques. The response should be fairly well structured with some use of design and technology terminology with a small number of errors in grammar, punctuation. *(3-4 marks)*

Limited explanation given with one or two advantages or disadvantages. The response will be poorly structured with little or no use of design and technology terminology and with several errors in grammar, punctuation and spelling. *(1-2 marks)*

Examples

Breadboard
(prototype board)

It is easy to change the component
It is easy to change the circuit design
It is fragile when in use
It is complex to construct

PCB

It is compact and takes up minimal space
It is robust as the components are soldered into place
It takes time to design and make
Circuits cannot be changed.

(max 6 marks)

(b) Explain an advantage of modelling circuit designs on a computer rather than building them.

Suitable advantage well explained
e.g. No components are damaged if circuit fails. (2 marks)

Advantage poorly explained
e.g. You don't have to buy components. (1 mark)

(max 2 marks)

(c) **Explain which circuit construction technique would be suitable to test an alarm circuit on a bicycle whilst being ridden.**

Suitable construction well explained
e.g. Strip board - Robust and easy to produce. (2 marks)

Unsuitable construction poorly explained
.g. PCB – Robust (1 mark) *(max 2 marks)*

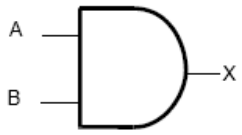
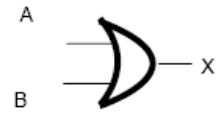
(10 marks)

Question 3

3 Question 3 is about Logic Gates

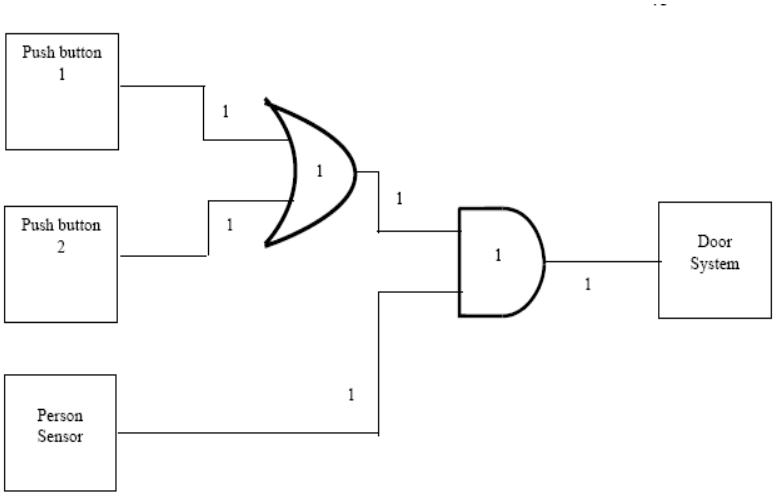
(a) (i) Complete the following table by naming the logic gate shown and adding the missing logic gate symbol. *(2 marks)*

(a) (ii) Complete the truth tables for the two logic gates.

Symbol	Type of Gate	Truth Table
 1	***AND***	A B X 0 0 ***0*** 0 1 ***0*** 1 0 ***0*** 1 1 ***1*** 4
 1	OR	A B X 0 0 ***0*** 0 1 ***1*** 1 0 ***1*** 1 1 ***1*** 4

(8 marks)

3 (b) Construct a logic circuit to open the door using two 2 input logic gates to complete the logic circuit.



(7 marks)

(17 marks)

Question 4

4 **Question 4 is about constructing a flowchart to control a lift door.**

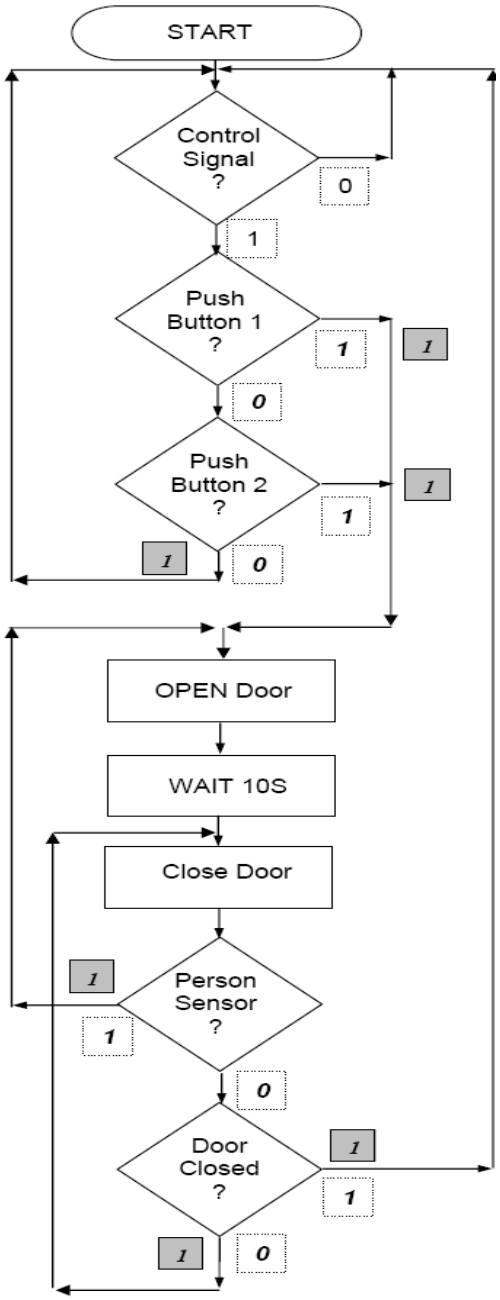
Complete the flowchart. Add the missing lines with arrowheads and the states to the decision box outputs to the flowchart on this page.

Marks will be awarded for each correct output state and each correct connecting line drawn.
Accept 1 or 0, yes or no, tick or cross etc.

8 marks for statement.

6 marks for line.

line must start and finish for mark



(14 marks)

(14 marks)

Question 5

5 Question 5 is about a drive system for a pillar drill.

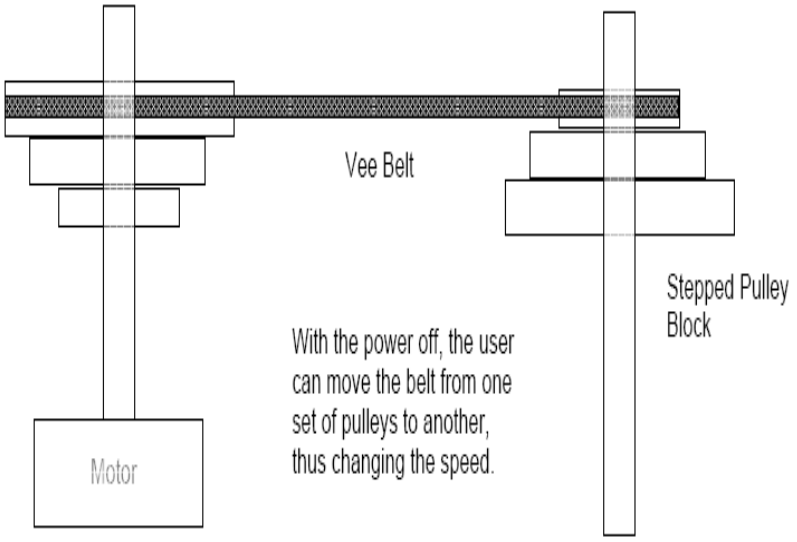
(a) On the diagram below add notes and sketches to show a drive system that will:

- **Transfer drive from shaft A to shaft B**
- **Enable the operator to choose between two different speeds of operation.**

Able to transfer drive from shaft A to shaft B. (2 marks)
A recognisable drive system with errors. (1 mark)
(max 2 marks)

Able to change speeds, well explained. (3 marks)
Able to change speed, poorly explained. (2 marks)
A recognisable method of changing speed with errors. (1 mark)
(max 3 marks) *(5 marks)*

e.g.



5 (b) (i) State an advantage of this latching circuit, rather than the toggle switch to control a pillar drill.

Suitable advantage, e.g. resets when power turned off, able to have multiple stop buttons.

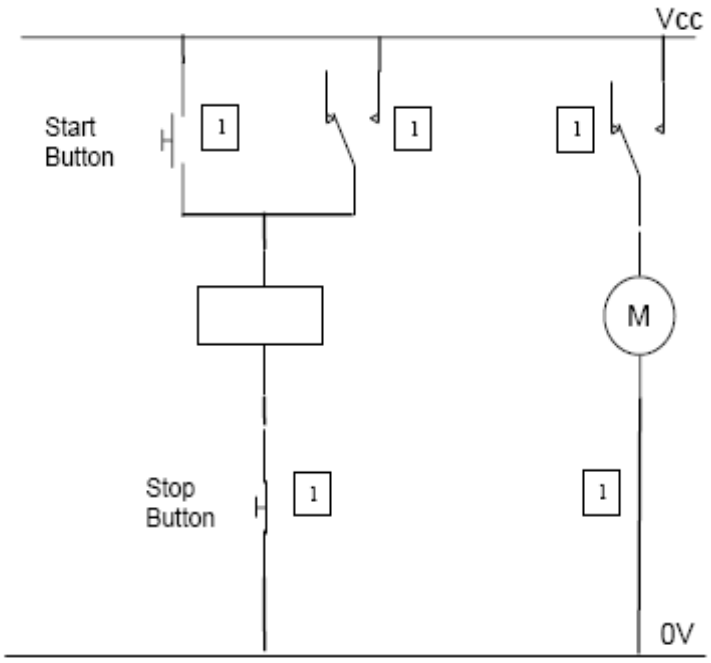
(1 mark)

5 (b) (ii) Using the components below, draw a circuit in Box A that will give the above operation.

Labelling each push switch correctly. *(2 marks)*

Each correct connection *(5 marks)*

e.g.



(13 marks)

Question 6

6 Question 6 is about Quality Control and Testing.

(a) You have been asked to perform a quality control check on a completed circuit board. Give an explanation of what you would do.

A high level response with a full and comprehensive explanation of all aspects of a suitable quality control check. Response well structured with good use of appropriate design and technology terminology and showing a good grasp of grammar, punctuation and spelling. -	*(6– 7marks)*	
A medium level response with a good explanation of a suitable quality control check, 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.	*(4 -5 marks)*	
A low level response with a limited explanation of one part of the quality control check with several errors in the process. Response poorly structured with little or no use of design and technology terminology and with several errors in grammar, punctuation and spelling.	*(2-3 mark)*	
An attempt at a response, no relevant evaluation presented. No use of design and technology terminology and multiple errors in grammar, punctuation and spelling.	*(1 mark)*	***(max 7 marks)***

e.g. of 7 mark response
I would first visually check the circuit board by picking it up and looking closely at the soldering of the joints and checking that the components were the correct ones and were inserted correctly.
If this was OK, I would then connect power and check that the circuit performed as it should. The circuit should be tested against the original specification.
If it worked in the test room, I would then take it outside and test it in its intended environment. For maximum benefit this should be done for several hours / days. Data logging equipment could be used to record the parameters of the circuit over time.
Any errors would be recorded so that someone else would be able to reproduce them

(b) Explain why measuring and test equipment use only very high tolerance resistors.

Good explanation e.g. More accurate value giving more accurate readings.	*(2 marks)*	***(max 2 marks)***
Weak explanation e.g. More accurate.	*(1 mark)*	

(c) **A multimeter is often used to check circuits.**
Name two checks that can be made using this device.

2 checks e.g. 2 of voltage, current, resistance, continuity, capacitance.

(2 marks)

(d) **Many electronic devices use a modular construction using several small circuit boards. Give two advantages of having several small boards rather than one large one.**

2 advantages e.g.

- Less to replace if part of the product fails,
- easier to upgrade.

(2 marks)

(13 marks)

Question 7

7 Question 7 is about a Garage Door Lock

(a) Complete the system diagram.

Keypad / Logic check / Driver Circuit / Solenoid
1 mark for each in the correct position *(3 marks)*

(b) (i) Label the diode on the diagram.

Diode identified *(1 mark)*

(ii) Explain the purpose and operation of the diode in the circuit above.

Protection diode.	(1 mark)	
Protects the transistor.	(1 mark)	
From back emf / voltage.	(2 marks)	*(4 marks)*

(c) The diagram below shows 2 shafts inside the lock that move the lock bolt.
By adding gears to the diagram, show one method of ensuring that a small force at A will be converted into a large force at B.

Correct use of given axles	(1 mark)	
Workable gear system	(1 mark)	
Use of a correct gear ratio / small to large	(2 marks)	*(4 marks)*

(d) (i) An alternative method of moving the locking bolt is to use a pulley system with a toothed belt. If pulleys of 150mm diameter on shaft A and 30mm diameter on shaft B are used, what would be the velocity ratio of the pulley system.

Formula.	(1 mark)	
Working out.	(1 mark)	
Correct answer 150:30 or 30:150.	(1 mark)	
In Lowest form (5:1 or 1:5).	(1 mark)	
		(4 marks)

(ii) Give one advantage of using gears rather than pulleys.

Good explanation e.g.Higher torque / force due to Non-slip.	(2 marks)	
Weak explanation e.g. More durable.	(1 mark)	*(max 2 marks)*

(18 marks)