

General Certificate of Secondary Education

Design and Technology (Systems and Control Technology) 3546

Foundation Tier

Mark Scheme

2007 examination - June series

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(3546) Foundation

Section A

This question is about component recognition and sensing. (a) Complete the following table by naming the components and drawing their symbols

Name of component	Symbol
Resistor	
	(1 mark)
LED	
(1 mark)	(1 mark)
Potentiometer or Variable Resistor	(1 mark)

(5 marks)

(b) Complete the table below to show what each potential divider circuit is sensing.

Give an example of a product which could be used.

Potential Divider Circuit	Used to sense	Could be used in this product	
9v	Moisture	e.g. in a boat (1 mark)	
9v	Temperature (1 mark)	e.g. in an electric fire (1 mark)	
9v	Light	e.g. Lamp post	
0v	(1 mark)	(1 mark)	(5 marks

10 marks

2 This question is about prototyping circuits.

3

(a) Give a different advantage and disadvantage for each of the following circuit construction techniques.

	Breadboard Advantage – e.g. easy to change components Disadvantage – e.g. fragile, complex			(1 mark) (1 mark)
	Veroboard Advantage – e.g. more robust, good for prototype Disadvantage – e.g. larger than PCB, complex			(1 mark) (1 mark)
	PCB	Advantage – e.g. compact, robust, custom o Disadvantage – e.g. takes time to design ar expensive for one off, difficult to correct error	design nd make, ors.	(1 mark) (1 mark)
		Ensure that each answer is different.		(6 marks)
(b) (i)	Give two ad computer ra	vantages of modelling circuit designs on a ther than building them.	9	
	Suitable adva	antages, e.g.		
	You don't ne	ed all the components.	(1 mark)	
	No compone	nts are damaged if circuit fails.	(1 mark)	(2 marks)
(ii)	Give one dis computer ra	advantage of modelling circuit designs of the than building them.	na	
	Suitable disa	dvantage, e.g.		
	Computer no expensive, tr	t guaranteed to produce working cct, comput aining required.	er	(1 mark)
				9 marks
This qu The do bottom (a)	uestion is abo or opens and of the doorw	out an automated train carriage door. closes using wheels on tracks at the top ray.	and	
(i)	Give one rea	ason why the train door is made from alun	ninium.	
	Suitable reas	on, e.g. lightweight/Easy to form	(1 mark)	
(ii)	Give one rea	ason why the door wheels are made from s	steel.	
	Suitable reas	on, e.g. hardwearing.	(1 mark)	
(iii)	Suggest a s	uitable material for the door track.		
	Suitable mate No – Metal, F	erial, e.g. Steel, brass, stainless steel, nylon Plastic, Wood	(1 mark)	(3 marks)

(b)	 The simplified diagram shows a sliding train carriage door. It is in the open position. Design a suitable system that will open and close the carriage door. Your design must show A suitable mounting system to close and open the door Suitable mounting of the system to the beam Suitable mounting of the system to the door A suitable power source Labelled components and mountings. 			
	A system capable of opening and closing the door A system capable of moving the door	(3 marks) (2 marks)		
	An attempt at a system	(1 mark)	(Max 3 Marks)	
	Suitable mounting of system to the fixed beam	(1 mark)		
	Suitable mounting of system to the door	(1 mark)		
	A suitable power source	(1 mark)		
	Correctly labelled components and mountings.	(2 marks)	(8 marks)	
(c)	Describe how the system you have drawn in Space A clear description of the operation An attempt at a description mentioning a component e.g. The motor rotates the crank which makes the conn open the door.	A operates. (2 marks) (1 mark) necting rod	(2 marks)	
(d) (i)	Give two reasons for your choice of system. Reason 1 – e.g. reference to - reliable, strength, function	on (1 mark)		
	Reason 2 – e.g. it moved the door both ways	(1 mark)	(2 marks)	
(ii)	Name a specific component that could be used to s the door has hit an obstruction.	ense that		
	A suitable component, e.g. push switch, LDR	(2 marks)		
	An attempt, e.g. switch, light / dark sensor	(1 mark)	(2 marks)	
(iii)	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)		
	Issue 2 e.g. moving parts covered	(1 mark)	(2 marks)	



One mark for each correct connection. Accept other solutions.

(6 marks)

27 marks

4 This question is about a timing circuit for an automatic sliding door. The diagram shows a timing circuit that, once operated, keeps (a) the train door open for five seconds. (i) Circle the type of timing circuit shown. Monostable. (1 mark) (1 mark) (ii) Name a specific component that when added in position will allow the user to trigger the 555 timer. e.g. Push switch, relay, transistor (not - switch) (1 mark) (1 mark) (iii) Add the symbol for the component in the space on А the diagram above. (1 mark) (1 mark) (iv) Name the component marked RL in the timing circuit above. (1 mark) Relay (1 mark) (b) Complete the diagram by naming the colour of the bands for a 10K resistor. Brown Black Orange (3 marks) (c) Complete the PCB layout for the circuit diagram shown on page 12. Pin numbers, 1, 4, 5 and 8 of the 555 integrated circuit have been labelled for you. The positions of the other components have been labelled. Add the following tracks: Pin 2 to junction of R1 and component A Pin 4 to 9V Pin 6 to junction of R2 and C1 Pin 7 to junction of R2 and C1 Pin 8 to 9V

Ensure that your tracks are neat and of a reasonable size.

9V			
٥v		RI P	Rt C1
Pin 2 to $R1 - c$	component A	link	(1 mark)

	(T many)
Pin 4 to 9V	(1 mark)
Pin 6 to Rt – C1 link	(1 mark)
Pin 7 to Rt – C1 link	(1 mark)
Pin 8 to 9V	(1 mark)

Note Crossing track – no mark Alternative correct routes allowed

Neat tracks – straight/horizontal/vertical	(1 mark)	
Tracks a reasonable thickness.	(1 mark)	(7 marks)

14 marks

5 This question is about constructing a flowchart to control a simple railway crossing signal.

A signal has the following sequence. When an approaching train is sensed, a flashing Amber light turns ON for 10 seconds. Then the flashing Amber light turns OFF and a Red light turns ON for 40 seconds. Then the Red light turns OFF and the system waits for the next train. Complete the flowchart on the opposite page to control the sequence above. Marks will be awarded for

adding Yes and No to the dotted outputs of the decision boxes (2 marks)

Completing the flowchart by adding the statements below in the correct boxes.

Flashing Amber light OFF	(1 mark)
Flashing Amber light ON	(1 mark)
Wait 40 seconds	(1 mark)
Red light OFF	(1 mark)
Red light ON	(1 mark)
Wait 10 seconds	(1 mark)
Adding feedback loops to the diagram.	(2 marks)

1 mark awarded for each correct output state

1 mark awarded for each correct statement in the correct order

1 mark awarded for each correct feedback loop in the correct place.

Note - the statements do not have to be in the boxes.

Question 5 Continues on next Page



10 Marks

This is a question about using logic gates to control a train door.

(a)

6

- (i) Complete the following table by naming the logic gates shown.
- (ii) Complete the truth tables for the three logic gates. HIGH = 1

LOW = 0				
Logic Gate symbol	Name of Logic Gate	Truth	Table	
A	AND	A 0 0 1 1	B 0 1 0 1	X 0 0 0 1
	(1 mark)		(2	2 marks)
A	NOT (1 mark)	A 0 1	X 1 0 (2	2 marks)
	OR (1 mark)	A 0 1 1	B 0 1 0 1 (X 0 1 1 1 3 marks)
	, , , , , , , , , , , , , , , , , , ,		(

(10 marks)

(b) It has been decided to operate the train door using push button switches.
Three push button switches (driver and two passengers) operate this system.
The process block controls the system.
The door device opens the door.
The door should open when either of the passenger push buttons are pressed and the driver's push button is pressed.

Complete the System Diagram at the bottom of the page by labelling the blocks drawn below, adding connecting lines and labelling the stages.



(ii)	Give two reasons for your answer. 2 suitable reasons, e.g. perceived as more modern/luxury trains leave on time/safer – as all doors controlled	(2 marks)	
(c)	Suggest how passengers could escape from the train automatic door system fails. Full description or list 3 methods, e.g. Emergency exits / well signed exits / break glass hamme lights etc help to get out. In case of impact, all doors ope automatically	n if the ers/floor n (3 marks)	
(d)	State two maintenance requirements of the automati door system. Two requirements given, e.g. adjustment, lubrication / ele mechanical checks	c train ectrical / (2 marks)	
(e)	Give two reasons why electric trams are more environed friendly than most cars. Two reasoned arguments, e.g. less energy, less pollution congestion, quieter.	n mentally n, less (2 marks)	
(f)	A local council wants to encourage car drivers to use trams. Suggest two ways that they could do this. Two suggestions e.g. subsidise fares, congestion charge, pedestrian areas accept any reasonable answer.	e trains or (2 marks)	15 marks

Section B

8

- This question is about mechanisms and mechanical components.
- (a) Complete the table by naming the type of drive mechanism and stating what it does.

Type of Drive Mechanism	What it does
Crank and Slider Crank or Slider	Converts reciprocating motion to rotary motion
Lever	Gives mechanical advantage.
Cam and Follower (accept Cam)	Converts rotary motion into reciprocating / linear motion
Pulley	Transfers drive between two shafts. Rotary
Rack and Pinion (accept Rack)	Converts rotary motion into linear motion
Worm and Wheel Gear (accept Worm)	Transfers drive by 90 degrees. Gives mechanical advantage.

(10 marks)

- (b) This part of the question is about a winch for a railway crane.
 - (i) Using notes and sketches complete the diagram by adding a mechanism that could be used to prevent the load dropping when the winch stops.
 Marks will be awarded for
 Adding a suitable mechanism (4 marks)
 Adding notes and sketches. (2 marks)

	Fully working device that lowered Fully working device that A device that would slow An attempt at a device	would hold the load and allow i would hold the load the load when dropped	it to be 4 marks 3 marks 2 marks 1 mark	
	Suitable notes Suitable sketches		1 mark 1 mark	
(ii)	Or 2 marks for excellent s State how your system	sketches would allow the load to be lo	wered.	
	A clear explanation of a s The ratchet could be mov An attempt at a system th	ystem that would work, e.g. red from the pawl nat would work	2 marks 1 mark	(2 marks)
(iii)	State a suitable mechar winch with an electric n A clear explanation of a s	hism that could be used to op hotor. suitable mechanism, e.g.	perate the	
	Worm and Wheel An attempt at a suitable r	nechanism	2 marks 1 mark	(2 marks)
	This question is shout	anaumatia components and d	virouito	20 marks
(a)	Complete the table by n component and stating Reservoir	aming the type of pneumatic what each component does. fills up with air and can be u	used as a	
	Shuttle valve	allows air in line to be obtai alternative sources.	ned from	
	Single acting cylinder	piston moves with air, spring i	return.	
	Double acting Cylinder	moves left and right when pov air.	vered by	
	Flow regulator/ unidirectional flow control	restricts the flow of air in one	direction.	
	Solenoid operation	allows electrical control of a v	alve.	
	1 mark for each correct c marks.	omponent and what it does. M	ax 10	(10 marks)
(b)	Draw all of the connect extends when valve A A Ensure that you connec	ons in the diagram so that th ND valve B OR valve C are o t the air lines to the correct p	e cylinder perated. ports.	
	Marks will be awarded f Each air line that is conner Neatness.	or ected correctly	(5 marks) (1 mark)	(6 marks)

Air supply



(c)	Identify a possible problem if the above circuit was used to open a train door. A suitable problem, well described, e.g. door would close when		
	hand removed.	(2 marks)	
	An attempt at a problem	(1 mark)	(2 marks)
(d)	Explain why a pneumatic system may be preferred to an electrical system.		
	A suitable reason why pneumatic may be preferred, e.g. does not		
	crush passenger	(2 marks)	
	An attempt at a reason	(1 mark)	(2 marks)
			20 marks