



General Certificate of Secondary Education

Design and Technology: (Systems and Control Technology) *Specification*

3546 Higher

Mark Scheme

2006 examination – June series

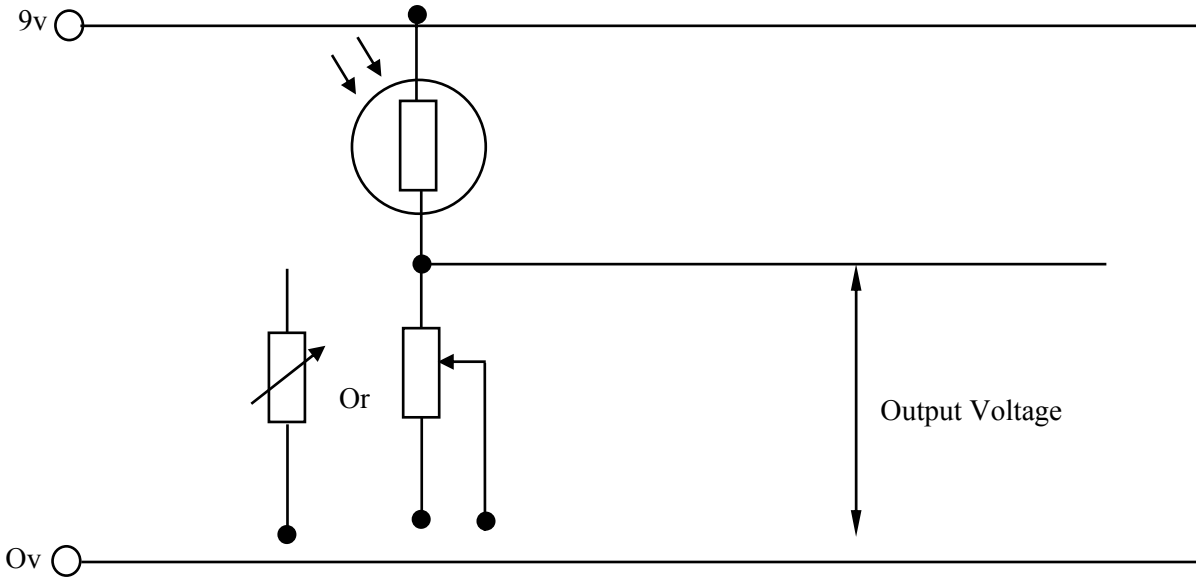
Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination.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

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.

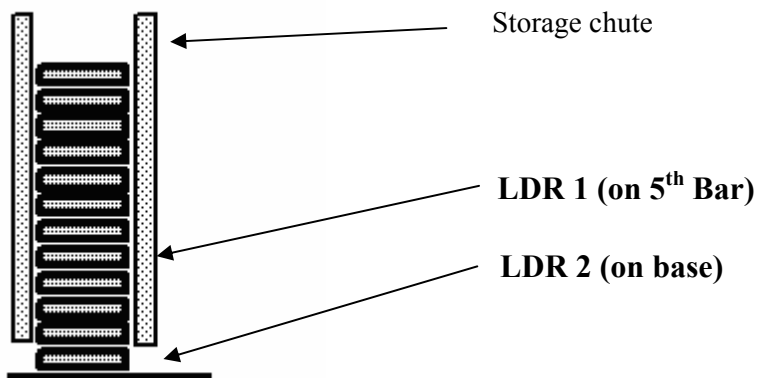
Section A – Mechanisms

Question A1

- (a) LDR symbol correct *1 mark*
 Variable resistor correct (any symbol) *1 mark*
 Correct positions *1 mark* **3 marks**

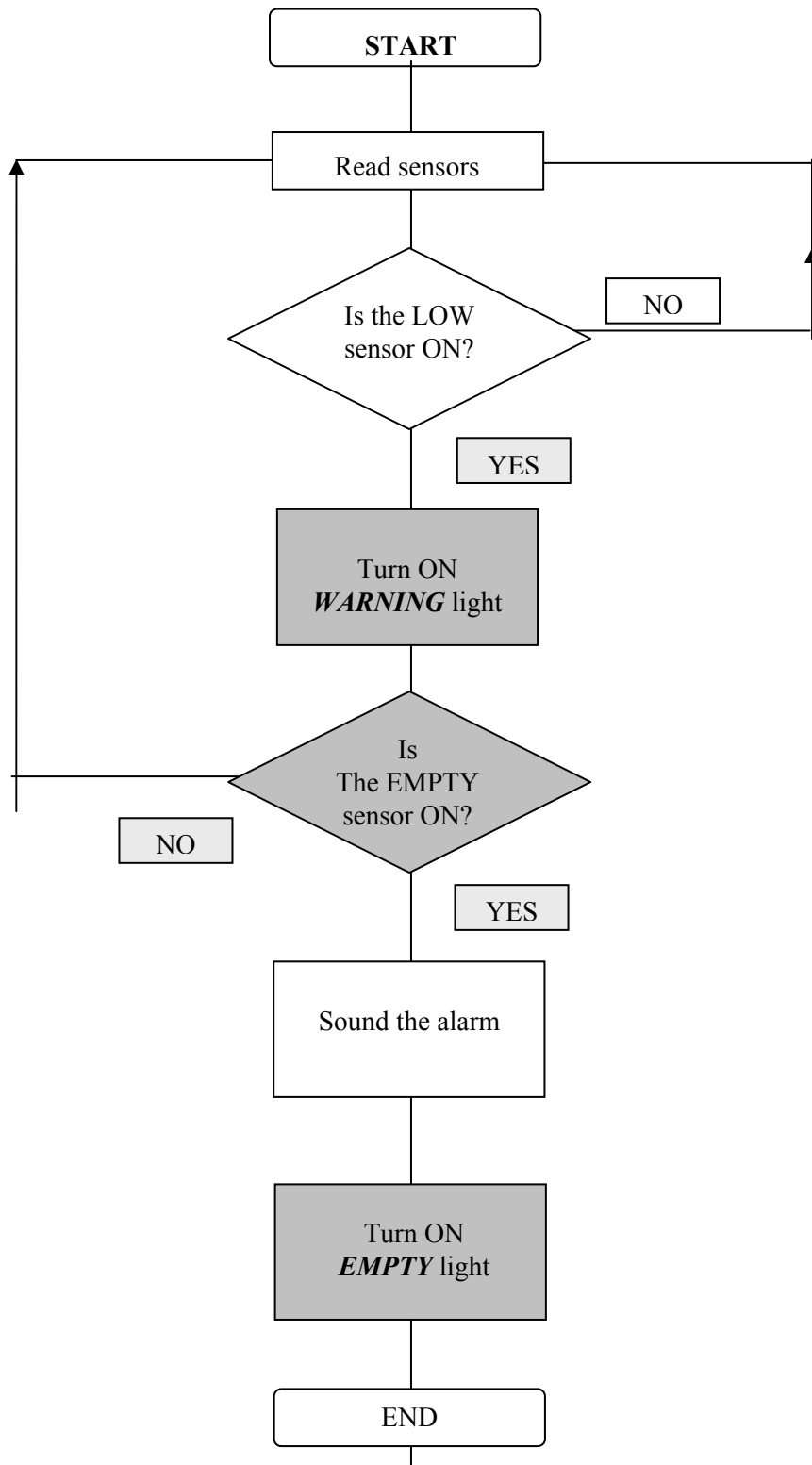


- (b) The designer wants to use LDRs as sensors in two positions
 Position 1 = LDR position should be between top of 4th and bottom of 6th Bar
 Position 2 = LDR on base level



- 1 mark*
1 marks **2 marks**

(c)



1 mark for each box completed correctly **6 marks**

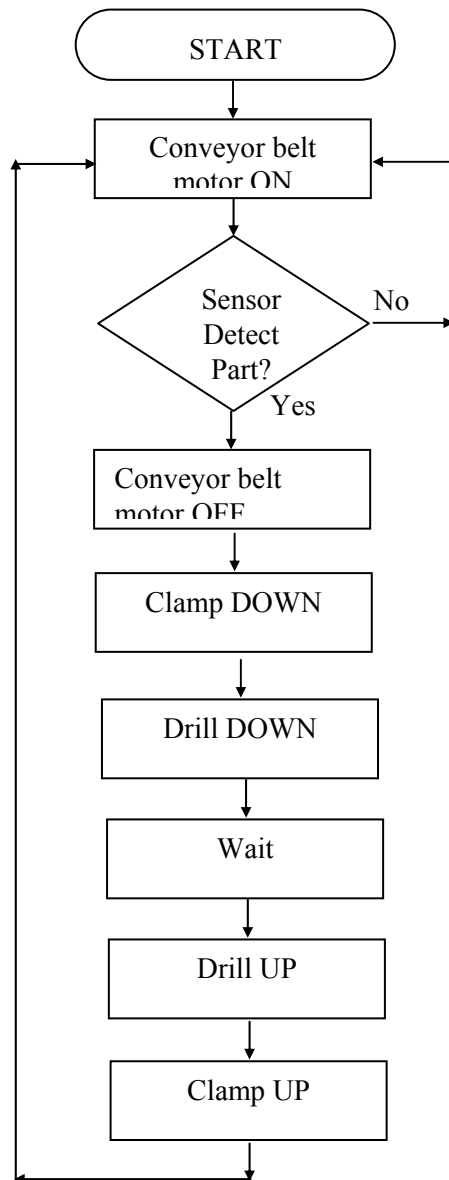
11 marks

Question A2

- (a) Correct sequence (including Wait) *6 marks*
 Correct sequence with minor errors *5 marks*
 Correct sequence with several errors *4 marks*
 Incorrect sequence but most actions present *3 marks*
 Incorrect sequence with some actions present *2 marks*
 An attempt at a sequence *1 mark*

e.g. for 6 marks;

- _____
- Conveyor belt motor ON
- _____
- Sensor detect part YES
- _____
- Conveyor belt motor OFF
- _____
- Clamp DOWN
- _____
- Drill DOWN
- _____
- Wait
- _____
- Drill UP
- _____
- Clamp UP
- _____
- Goto 1
- _____



Correct use of the sensor in correct place *2 marks*
 Mention of sensor in wrong place *1 mark*

Use of a continuous cycle e.g. feedback loop *2 marks*

2 marks
1 mark

2 marks **10 marks**

(b)	Appropriate method of detection e.g. LDR, micro switch	<i>2 marks</i>	
	Poor method of detection e.g. switch	<i>1 mark</i>	
	Well annotated and fully explained	<i>2 marks</i>	
	Poorly annotated and explained	<i>1 mark</i>	
	High quality drawing showing all parts	<i>2 marks</i>	
	Low quality drawing	<i>1 mark</i>	6 marks
(c)	Understanding of the term non-erasable	<i>1 mark</i>	
	Justification for this, e.g. no risk of accidental erasure, cheaper	<i>1 mark</i>	2 marks
(d)	Any two suitable advantages; e.g. Reduce number of components Reprogrammable Ease of designing Less space used Reliability because of reduced soldering	<i>1 mark for each</i>	2 marks
			20 marks

Question A3

(a) Accept 0V and 9V

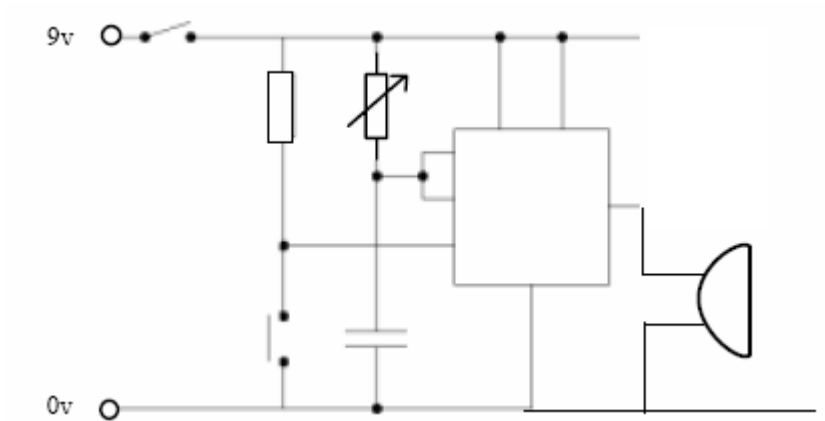
1 mark for each

The variable resistor used to calibrate the timing
(allow pot or preset)

*1 mark for symbol
1 mark for position*

Adding a buzzer to the circuit that will sound during
the time period

*1 mark for symbol
1 mark for position* **6 marks**



(b) (i) Component A is a Diode

1 mark

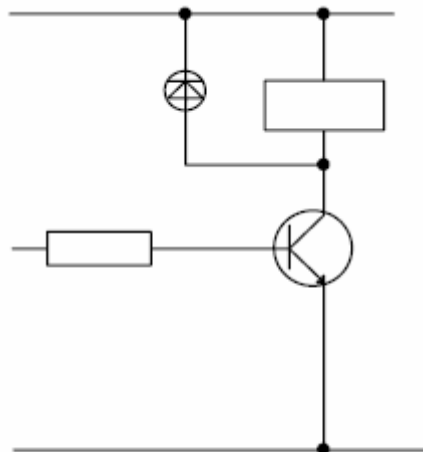
(ii) Inserted correctly

1 mark

(iii) To protect the transistor,
From back EMF or similar

*1 mark
1 mark*

4 marks



10 marks

Question A4

(a) *1 mark for each appropriate rule (No duplicates to be rewarded)*



Keep away from hands and eyes
Handle with tongs
Have eye wash etc. close by

2 marks



Goggles
Machine vice
Stop buttons
Apron

2 marks



Soldering iron stand
Low voltage
Keep hands away
Avoid splashes

2 marks

6 marks

(b) (i) Suitability of mechanism
Appropriate mechanism that will allow grip
A largely inappropriate mechanism

2 marks

1 mark

Appropriate for gripping
Jaws will grip and hold when user releases
Jaws will grip

2 marks

1 mark

Quality of drawing
Good clear attempt
Recognisable as a jaw system

2 marks

1 mark

(ii) Any appropriate reasons for choice

1 mark for each reason

(iii) Any appropriate soft metal – e.g. aluminium or a named plastic e.g. polythene / nylon

1 mark

(iv) Appropriate reason – will not mark the brass, not strong

1 mark

10 marks

Question A5

(a) (i) **Box 1 - suitability of pulley system**

- | | |
|---------------------------|----------------|
| Two Speeds fully workable | <i>4 marks</i> |
| Two speeds possible | <i>3 marks</i> |
| One speed | <i>2 marks</i> |
| An attempt | <i>1 mark</i> |

(ii) **Box 2 –explaining method of attachment to shaft (text or sketch)**

- | | |
|--|----------------|
| Method that would not slip well explained | <i>4 marks</i> |
| Method that will work e.g. key /spline/pin/screw | <i>3 marks</i> |
| A simple method - e.g. weld/braze | <i>2 marks</i> |
| An attempt e.g. glue. | <i>1 mark</i> |

Quality of drawing Box 1 only

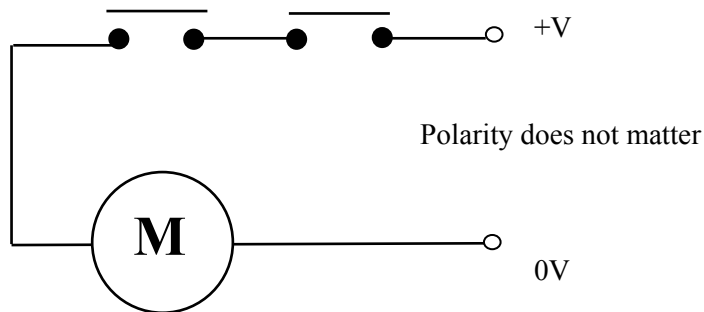
- | | |
|---------------------------------|----------------|
| An understandable drawing | <i>2 marks</i> |
| An attempt which may be unclear | <i>1 mark</i> |

Notes explaining system Box 1 only

- | | |
|---|----------------|
| Appropriate notes and explanation | <i>2 marks</i> |
| Minimum use of notes with vague explanation | <i>1 mark</i> |

12 marks

(b)



- | | | |
|-------------------------------------|---------------|----------------|
| Position of second switch in series | <i>1 mark</i> | |
| Switch joins up to motor | <i>1 mark</i> | |
| Some indication of +V and 0V | <i>1 mark</i> | 3 marks |

- | | | | |
|-----|--|---------------|---------------|
| (c) | To ensure that both hands were used to start the machine | <i>1 mark</i> | 1 mark |
|-----|--|---------------|---------------|

16 marks

Question A6

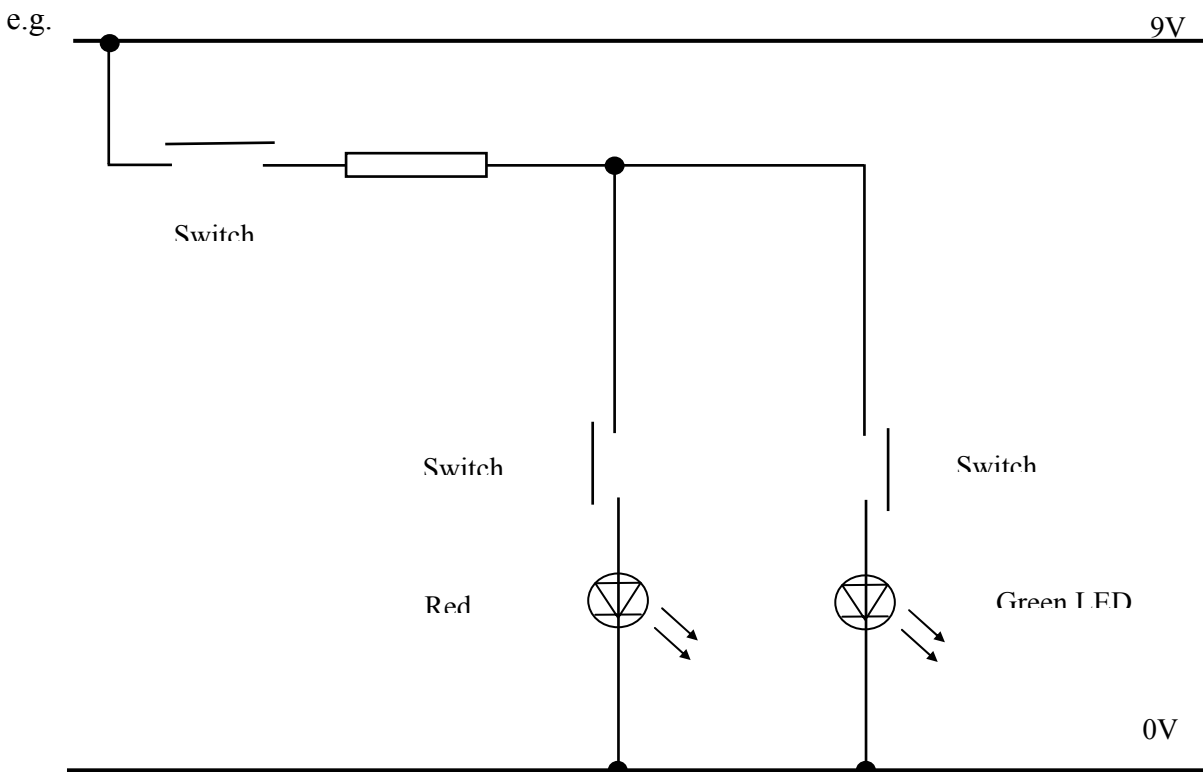
- (a) 2 suitable advantages *1 mark*
 e.g. increase torque give a mechanical advantage *1 mark* **2 marks**
- (b) Formula *1 mark*
 $VR1 = \text{Driven /Driver} = 20/10 = 2:1$ *1 mark for each ratio*
 $VR2 = \text{Driven /Driver} = 20/10 = 2:1$ *1 mark for each ratio*
 Total VR = $VR1 * VR2 = 2:1 * 2:1 = 4:1$ *1 mark for combination*
 Speed of final gear = 50rpm *1 mark for answer*
1 mark for units **6 marks**
- (c) Any two from *2 marks* **2 marks**
 Direct drive, no slippage, durable
- (d) Suitable example e.g. drilling machine *1 mark* **1 mark**

11 marks

Question A7

- Switch A (1 for Push to Make switch– 1 for appropriate position) *2 marks*
 Switch B (1 for Push to Make switch – 1 for appropriate position) *2 marks*
 Switch C (1 for Push to Make switch – 1 for appropriate position) *2 marks*
 Red LED (1 for Symbol - 1 for appropriate position) *2 marks*
 Green LED (1 for Symbol - 1 for appropriate position) *2 marks*
 Any necessary resistors (value not needed) *2 marks* **12 marks**

2 marks if used to restrict current to LEDs and correct symbol
 1 mark if wrong position but correctly drawn



Question A8

(a)	(i)	Well explained use of modelling/testing An attempt at explaining modelling/testing e.g. allows circuits to be tested easily in safety.	<i>2 marks</i> <i>1 mark</i>	
	(ii)	Well explained advantage An attempt at explaining an advantage e.g. Allows you to test the function of the circuit	<i>2 marks</i> <i>1 mark</i>	4 marks
(b)		A suitable reason for using a symbol library e.g. Standard components available e.g. Drag and drop onto circuit designs	<i>2 marks</i>	2 marks
(c)	(i)	PCB track routing worked out automatically by computer or similar	<i>2 marks</i>	
	(ii)	Quicker - More precise or similar	<i>2 marks</i>	
	(iii)	Acetate, OHP film, tracing paper, clear plastic, etc.	<i>1 mark</i>	5 marks
(d)		Any two from Repeatability, consistent output, ease of modification, or other suitable NOT more accurate unless qualified	<i>2 marks</i>	2 marks
				13 marks

Question A9

Marking to focus on the **opening and closing**

A good attempt at describing how mechanism opens and closes	<i>4 marks</i>
Very good attempt at describing either opening or closing	<i>3 marks</i>
Reasonable attempt at describing either opening or closing	<i>2 marks</i>
Little more than labelling of mechanism	<i>1 mark</i>

Showing paths of travel

Clear arrows showing paths of movement of parts	<i>2 marks</i>
Reasonable attempt at showing the path of moving parts	<i>1 mark</i>

Showing how the mechanism attaches to a suitable power source

A clear system showing how the gripper is driven	<i>2 marks</i>
Reasonable attempt at describing how the gripper is driven	<i>1 mark</i>

Quality of drawing/idea

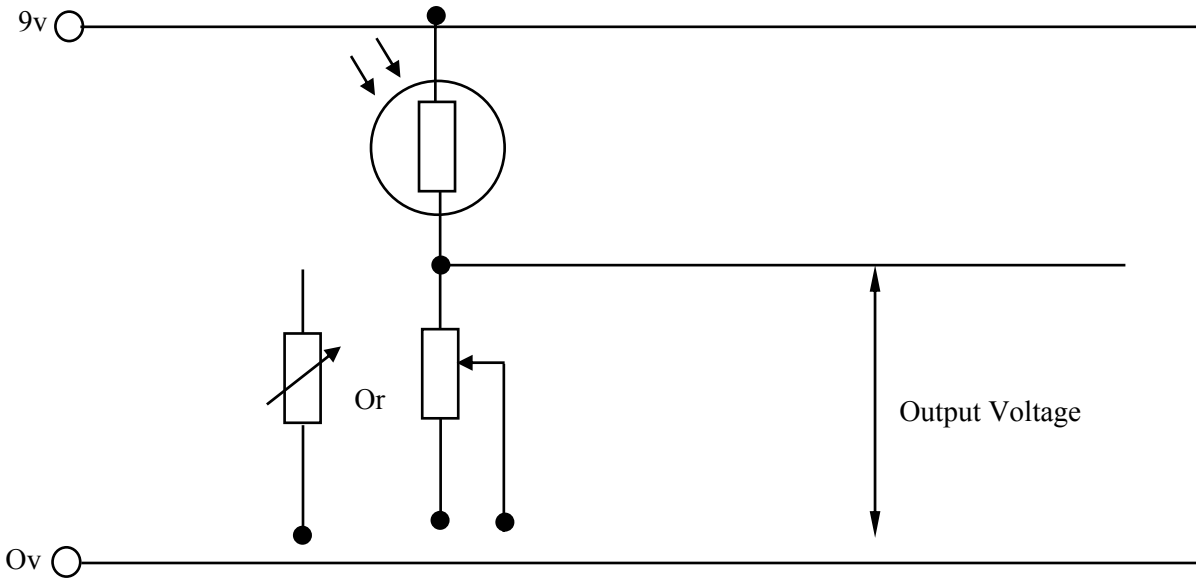
Very good quality drawing showing the mechanism	<i>4 marks</i>	
Good quality drawing attempting to show the mechanism	<i>3 marks</i>	
Reasonable drawing – lacks detail in mechanism	<i>2 marks</i>	
An attempt at drawing a gripper	<i>1 mark</i>	12 marks

Paper Total 125 Marks

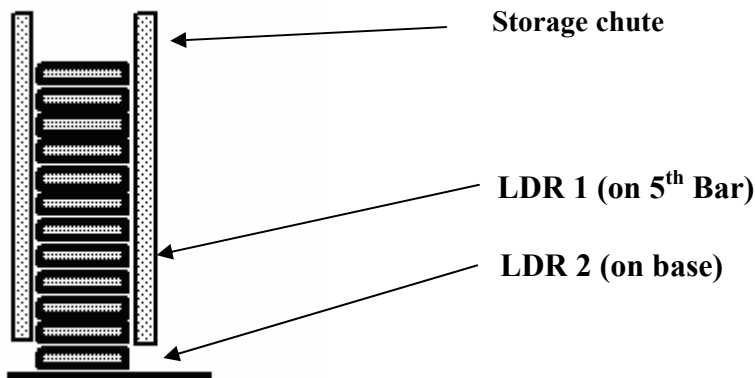
Section B – Pneumatics

Question B1

- (a) LDR to 9V rail *1 mark*
 LDR to midpoint *1 mark*
 Correct variable resistor *1 mark* **3 marks**

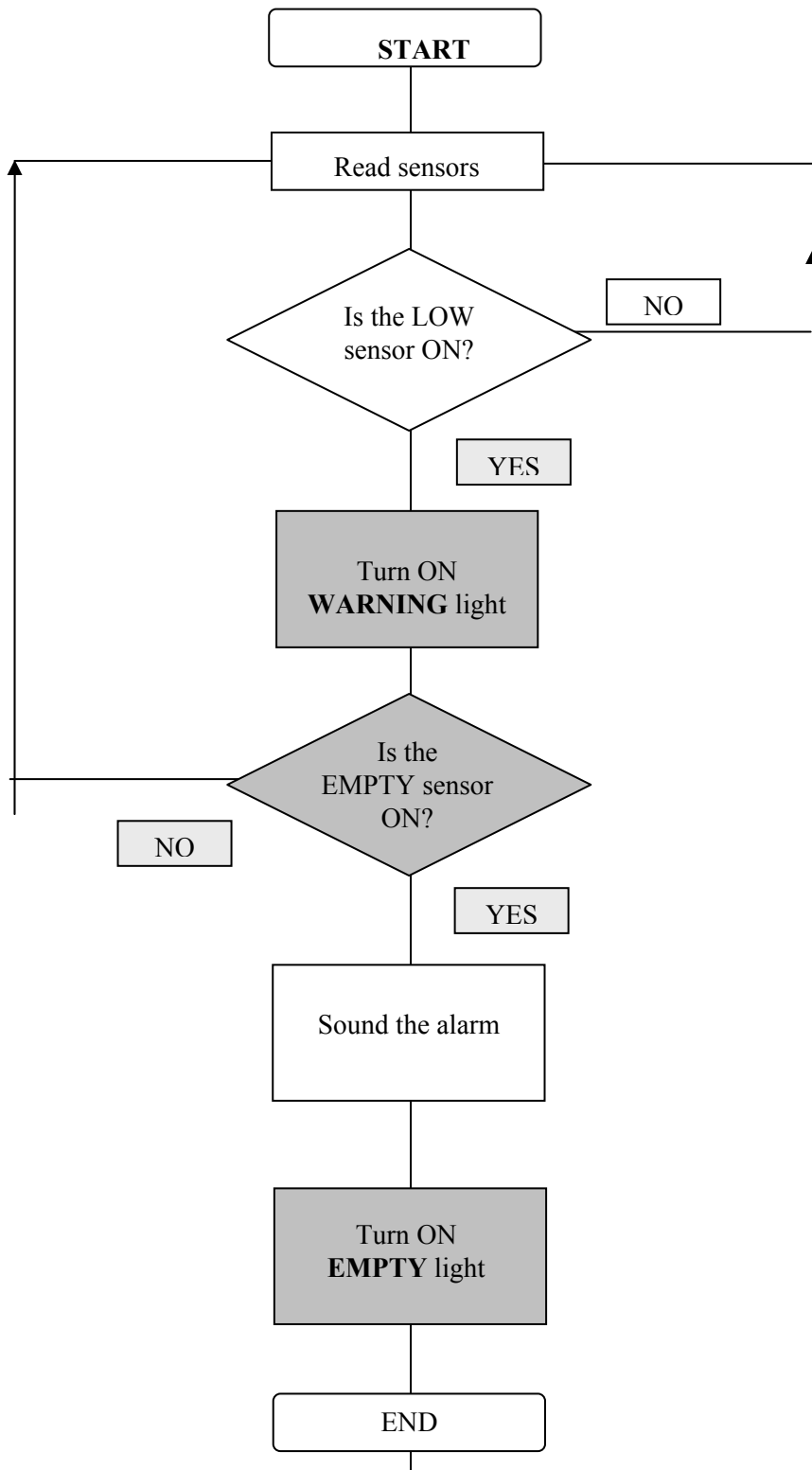


- (b) The designer wants to use LDRs as sensors in two positions
 Position 1 = LDR position should be between top of 4th and bottom of 6th Bar
 Position 2 = LDR on base level



- 1 mark*
1 mark **2 marks**

(c)



1 mark for each box completed correctly **6 marks**

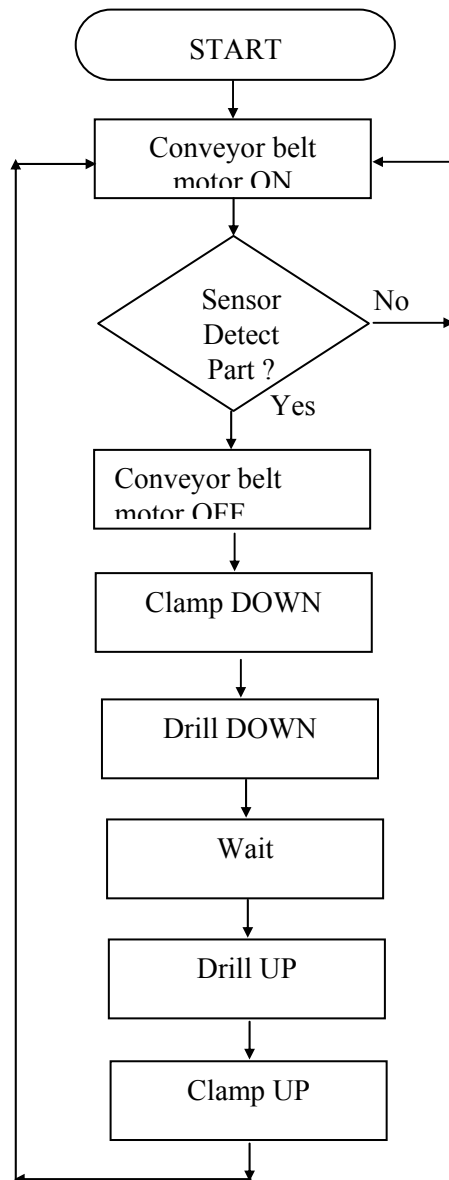
11 marks

Question B2

- (a) Correct sequence (including Wait) *6 marks*
 Correct sequence with minor errors *5 marks*
 Correct sequence with several errors *4 marks*
 Incorrect sequence but most actions present *3 marks*
 Incorrect sequence with some actions present *2 marks*
 An attempt at a sequence *1 mark*

e.g. for 6 marks;

- | | |
|----|-------------------------|
| 1. | Conveyor belt motor ON |
| 2. | Sensor detect part YES |
| 3. | Conveyor belt motor OFF |
| 4. | Clamp DOWN |
| 5. | Drill DOWN |
| 6. | Wait |
| 7. | Drill UP |
| 8. | Clamp UP |
| 9. | Goto 1 |



Correct use of the sensor in correct place *2 marks*
 Mention of sensor in wrong place *1 mark*

Use of a continuous cycle e.g. feedback loop *2 marks*

2 marks
1 mark

2 marks **10 marks**

(b)	Appropriate method of detection e.g. LDR, micro switch, push switch.	<i>2 marks</i>	
	Poor method of detection e.g. switch	<i>1 mark</i>	
	Well annotated and fully explained	<i>2 marks</i>	
	Poorly annotated and explained	<i>1 mark</i>	
	High quality drawing showing all parts	<i>2 marks</i>	6 marks
	Low quality drawing	<i>1 mark</i>	
(c)	Understanding of the term non-erasable, Justification for this, e.g. no risk of accidental erasure, cheaper.	<i>1 mark</i> <i>1 mark</i>	2 marks
(d)	Any two suitable advantages; e.g. Reduce number of components Ease of designing Less space used Reliability because of reduced soldering	<i>1 mark for each</i>	2 marks
			20 marks

Question B3

(a) Accept 0V and 9V

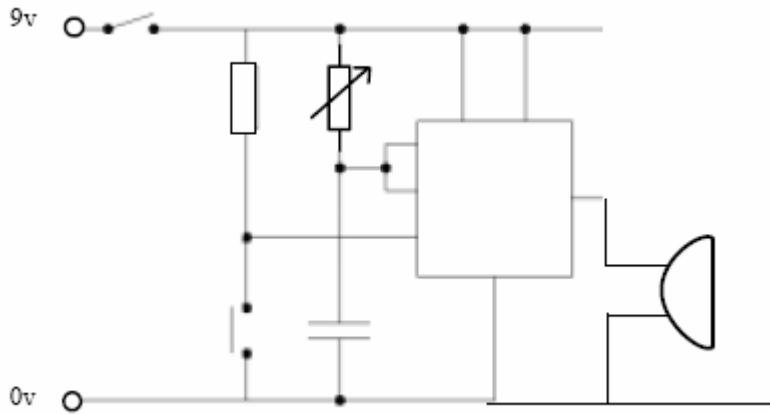
1 mark for each

The variable resistor used to calibrate the timing
(allow pot or preset)

*1 mark for recognition
1 mark for quality*

Adding a buzzer to the circuit that will sound during
the time period

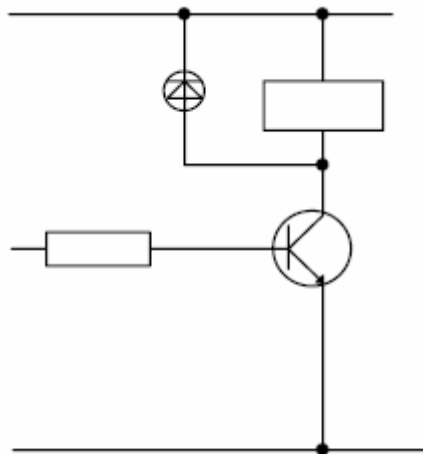
*1 mark for recognition
1 mark for quality* **6 marks**



(b) (i) Component A is a Diode
(ii) Inserted correctly
(iii) To protect the transistor
From back EMF or similar




*1 mark
1 mark
1 mark
1 mark*

4 marks



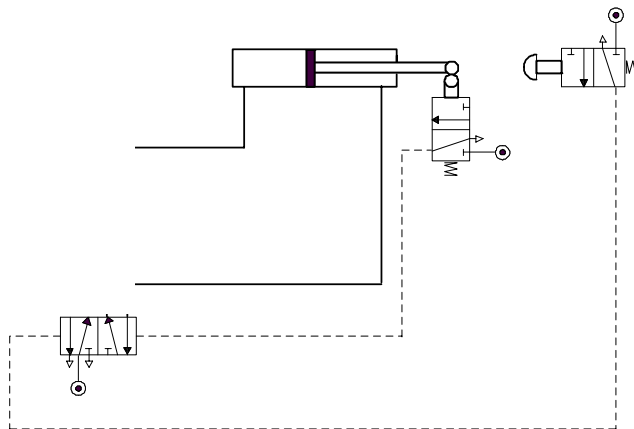
10 marks

Question B4

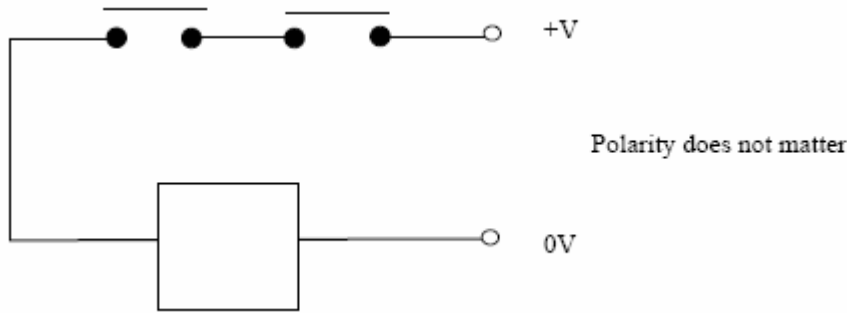
- (a) *1 mark for each appropriate rule (No duplicates to be rewarded)*
- | | | | |
|---|---|----------------|----------------|
|  | <p>Keep away from hands and eyes
 Handle with tongs
 Have eye wash etc. close by</p> | <i>2 marks</i> | |
|  | <p>Goggles
 Machine vice
 Stop buttons
 Apron</p> | <i>2 marks</i> | |
|  | <p>Soldering iron stand
 Low voltage
 Keep hands away
 Avoid splashes</p> | <i>2 marks</i> | 6 marks |
- (b)
- | | | | | |
|-------|---|-------------------------------|-----------------|--|
| (i) | <p>Suitability of Pneumatic System
 Appropriate system that will allow grip
 A largely inappropriate pneumatic system</p> | <i>2 marks</i> | <i>1 mark</i> | |
| | <p>Appropriate for gripping
 Jaws will grip and hold when user releases
 Jaws will grip</p> | <i>2 marks</i> | <i>1 mark</i> | |
| | <p>Quality of drawing
 Good clear attempt
 Recognisable as a jaw system</p> | <i>2 marks</i> | <i>1 mark</i> | |
| (ii) | <p>Any appropriate reasons for choice</p> | <i>1 mark for each reason</i> | | |
| (iii) | <p>Any appropriate soft metal – e.g. aluminium or
 named plastic e.g. polythene / nylon</p> | <i>1 mark</i> | | |
| (iv) | <p>Appropriate reason – e.g. will not mark the brass</p> | <i>1 mark</i> | 10 marks | |

Question B5

- (a) **Attaching cylinder to hacksaw frame**
 Wholly appropriate method of fixing clevis/pin, bolt screw/ rivet *1 mark*
 An attempt at fixing cylinder or piston braze/weld not glue *1 mark* **2 marks**
- (b) **Suitable ends for the 3 port valves**
 Roller valve – first valve *1 mark*
 Button or similar – second valve *1 mark*
 Drawn correctly *1 mark*
- Correctly completed cylinder**
 Piston in position to activate both valves *1 mark*
 Suitable end to piston *1 mark*
 Double acting cylinder used *1 mark*
 Quality of drawing *1 mark*
- Correct connections**
 Connection from LHS of cylinder to 5PV *1 mark*
 Connection from RHS of cylinder to 5PV *1 mark*
 Both connections to the same window *1 mark* **10 marks**



(c)



Position of second switch in series	<i>1 mark</i>	
Switch joins up to solenoid	<i>1 mark</i>	
Some indication of +V/0V	<i>1 mark</i>	3 marks

(d)	So that they could not be operated unless both hands were used	<i>1 mark</i>	1 mark
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16 marks

Question B6

(a)	Area of piston	= $3.14 * 25 * 25$	Calculation of area	<i>1 mark</i>	
		= 1962.5 mm^2	Correct answer	<i>1 mark</i>	
	Force	= Pressure * Area	Formula	<i>1 mark</i>	
		= $8 * 1962.5$	Substitution	<i>1 mark</i>	
		= 15700N	Correct answer	<i>1 mark</i>	
			Correct units	<i>1 mark</i>	6 marks

(b)	Any two operating advantages				
	E.g. less moving parts, easily maintained, smooth motion		<i>2 marks</i>		2 marks

(c)	Suitable safety advantage				
	E.g. can be low pressure and stall when jammed		<i>1 marks</i>		1 mark

(d)	Description of flow control to reduce speed by variable restriction		<i>2 marks</i>		
	An attempt at describing a flow control valve		<i>1 mark</i>		2 marks

11 marks

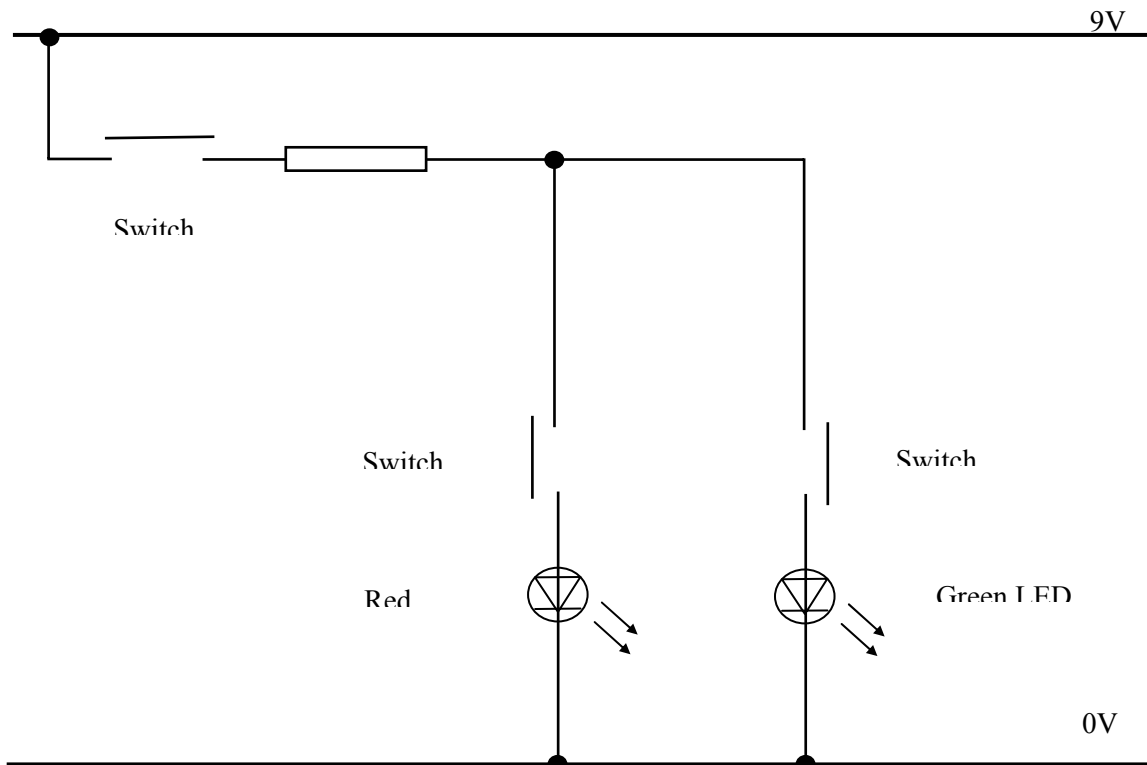
Question B7

Switch A (1 for Push to Make switch – 1 for appropriate position) *2 marks*
 Switch B (1 for Push to Make switch – 1 for appropriate position) *2 marks*
 Switch C (1 for Push to Make switch – 1 for appropriate position) *2 marks*

Red LED (1 mark if not correct convention) *2 marks*
 Green LED (1 mark if not correct convention) *2 marks*

Any necessary resistors (value not needed) *2 marks* **12 marks**
 2 marks if used to restrict current to LEDs and correct symbol
 1 mark if wrong position but correctly drawn

e.g.



Question B8

(a)	(i)	Well explained use of modelling/testing An attempt at explaining modelling/testing	<i>2 marks</i> <i>1 mark</i>	
	(ii)	Allows you to test the function of the circuit	<i>2 marks</i>	4 marks
(b)		Standard components available Drag and drop onto circuit designs	<i>2 marks</i>	2 marks
(c)	(i)	PCB track routing worked out automatically by computer or similar	<i>2 marks</i>	
	(ii)	Quicker - more precise or similar	<i>2 marks</i>	
	(iii)	Acetate	<i>1 mark</i>	5 marks
(d)		Any two from Repeatability, consistent output, ease of modification, or other suitable NOT more accurate	<i>2 marks</i>	2 marks
				13 marks

Question B9

Marking to focus on the **opening and closing**

A good attempt at describing how pneumatic system opens and closes	<i>4 marks</i>
Very good attempt at describing either opening or closing	<i>3 marks</i>
Reasonable attempt at describing either opening or closing	<i>2 marks</i>
Little more than labelling of pneumatic system	<i>1 mark</i>

Showing paths of travel

Clear arrows showing paths of movement of parts	<i>2 marks</i>
Reasonable attempt at showing the path of moving parts	<i>1 mark</i>

Showing how the pneumatic system attaches to a suitable power source

A clear system showing how the gripper is driven	<i>2 marks</i>
Reasonable attempt at describing how the gripper is driven	<i>1 mark</i>

Quality of drawing/idea

Very good quality drawing showing the pneumatic system	<i>4 marks</i>	
Good quality drawing attempting to show the pneumatic system	<i>3 marks</i>	
Reasonable drawing – lacks detail in pneumatic system	<i>2 marks</i>	
An attempt at drawing a claw	<i>1 mark</i>	12 marks

Paper Total 125 Marks