



## General Certificate of Secondary Education

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

*3546 Foundation*

## 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)



Name of component **Resistor**

Circuit symbol for component

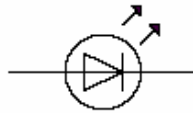


2 marks



Name of component **LED or Light Emitting Diode**

Circuit symbol for component, e.g.



2 marks 4 marks

(b)

(i)	Transistor	F
(ii)	Diode	B
(iii)	Thermistor	A
(iv)	Variable resistor	D or A

1 mark for each correct 4 marks

8 marks

### Question A2

(a)

(i) **Rotary**

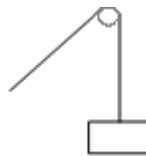
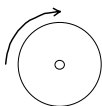
1 mark

(ii)

**Linear**

1 mark

2 marks



(b) (i) Direction must be anti-clockwise (Any suitable arrow)

1 mark

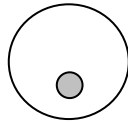
(ii) Rises slowly/falls quickly or drops  
(Up and down only)

2 marks  
1 mark

(iii) Snail Cam sharp rise would cause jam or similar

1 mark 4 marks

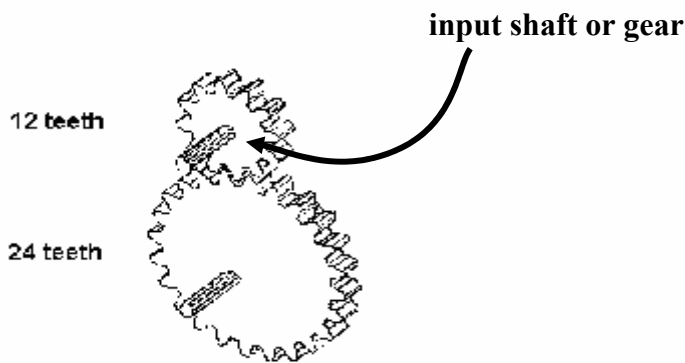
- (c) A cam that would give smooth up and down motion in a forward and backward direction e.g. Eccentric/pear cam 3 marks  
 A cam that has obvious lift up and down 2 marks  
 A cam that would not turn or would not give lift (snail cam) 1 mark **3 marks**



- (d) (i) Bearing/ball race/roller bearing/ball bearing 1 mark  
 (ii) Any reference to reducing friction or allowing rotation OR axial and radial loads 1 mark **2 marks**
- 11 marks**

**Question A3**

(a)



*1 mark* **1 mark**

(b) Simple gear train *1 mark* **1 mark**

(c) Formula  $\text{Gear Ratio} = \frac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}}$  *1 mark*

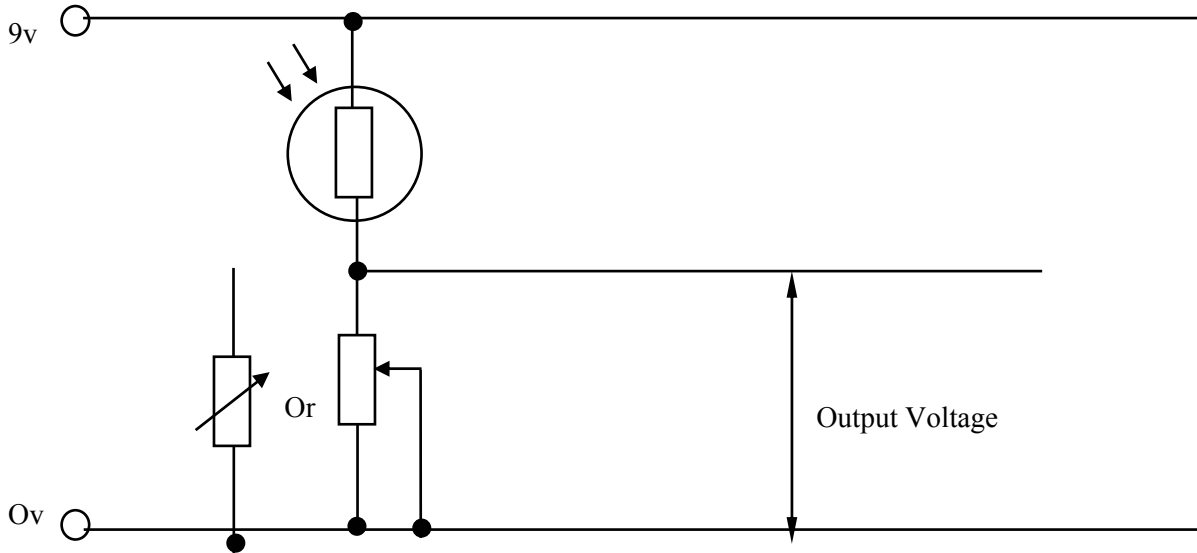
Correct substitution of values  $\text{Gear Ratio} = \frac{24}{12}$  *1 mark*

Correct answer  $\text{Gear Ratio} = 2:1$  ( $\frac{1}{2}$  or 1:2 acceptable) *1 mark*  
 2 with no calculations **3 marks**

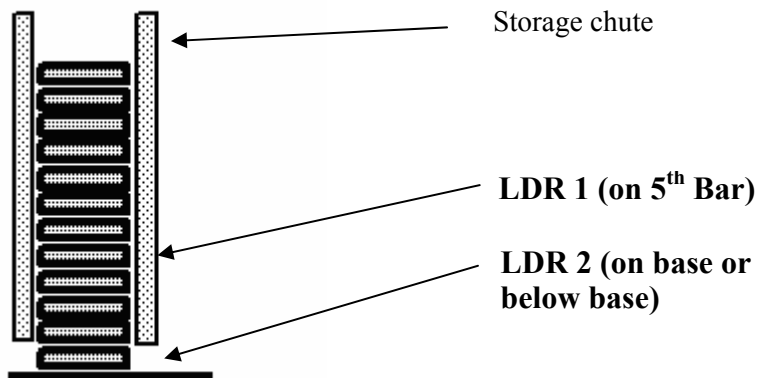
**5 marks**

**Question A4**

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



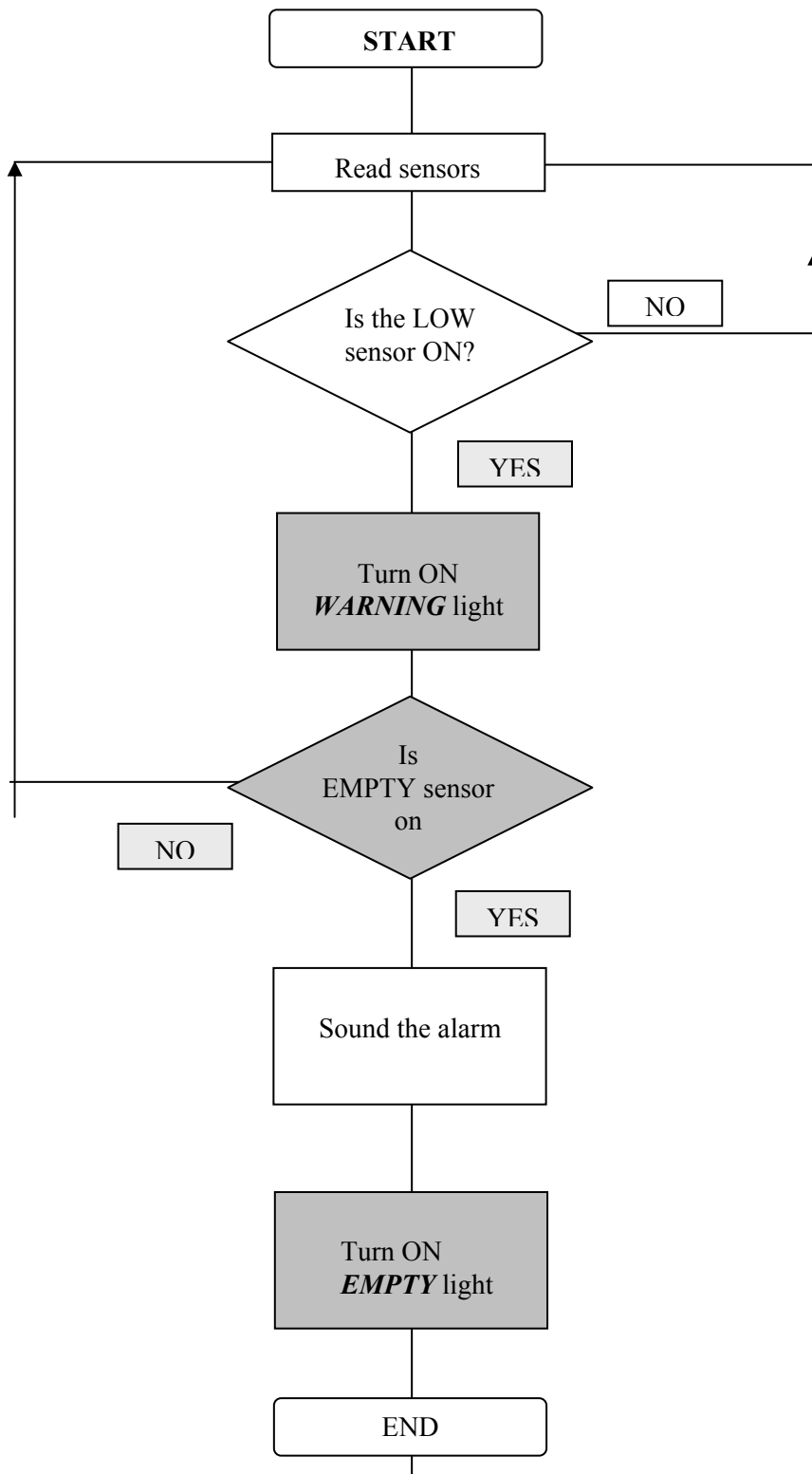
- (b) The designer wants to use LDRs in two positions  
 Position 1 = LDR position drawn between top of 4<sup>th</sup> and bottom of 6<sup>th</sup> bar  
 Position 2 = LDR on base level or below base



- 1 mark*  
*1 mark*     **2 marks**

(c)

1 mark for each box completed correctly 6 marks



11 marks




### Question A5

- (a) Mechanism that moves forward and returns (in proportion) *4 marks*  
Mechanism that will move forward and return eg. Crank & Slider *3 marks*  
Mechanism that will move one way e.g. Rack and Pinion /Cam without spring return *2 marks*  
An attempt at a mechanism attached to the drawer *1 mark*
- Quality of communication (words and/or drawings) Excellent *2 marks*  
Good *1 mark* **6 marks**
- (b) (i) Any suitable suggestion e.g. chewing gum *1 mark*  
(ii) Any realistic advantage e.g. available 24/7 *1 mark* **2 marks**
- (c) The safety of the **USER** should always be considered when designing a powered mechanism.
- Guards should ensure that you cannot **START** the mechanism until they are in position.
- Most guards use a **SENSOR** to detect whether they are in position.
- A belt drive can be safer for powering a mechanism because it will **SLIP** if something jams. *1 mark for each appropriate response*
- A **GEAR** driven system will continue to exert force if there is a jam and this can result in a breakage. *5 marks*
- 13 marks**

**Question A6**

- (a) (i) **Box 1 - suitability of pulley system**  
 Two speeds fully workable pulley system with details of speed change *4 marks*  
 Two speeds possible may be other mechanisms *3 marks*  
 One speed eg. belt on shafts only *2 marks*  
 An attempt that links the shafts *1 mark*
- (ii) **Box 2 –explaining method of attachment to shaft (text or sketch)**  
 A secure method that would not slip well explained e.g. taper key/pin, grub screw, rivet, cotterpin *4 marks*  
 Method that will work with possible movement e.g. parallel key/pin splines *3 marks*  
 A simple method - e.g. weld/braze. *2 marks*  
 An attempt e.g. glue. *1 mark*
- Quality of drawing Box 1 only**  
 An understandable drawing *2 marks*  
 An attempt which may be unclear *1 mark*
- Notes explaining system Box 1 only**  
 Appropriate notes and explanation *2 marks*  
 Minimum use of notes with vague explanation *1 mark*
- 12 marks**
- (b)
- Polarity does not matter
- Position of second switch in series *1 mark*  
 Switch joins up to motor *1 mark*  
 Some indication of +V and 0V *1 mark*
- 3 marks**
- (c) Safety response e.g. to ensure that both hands were used to start the machine *1 mark*
- 1 mark**
- 16 marks**

**Question A7**

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



**Question A8**

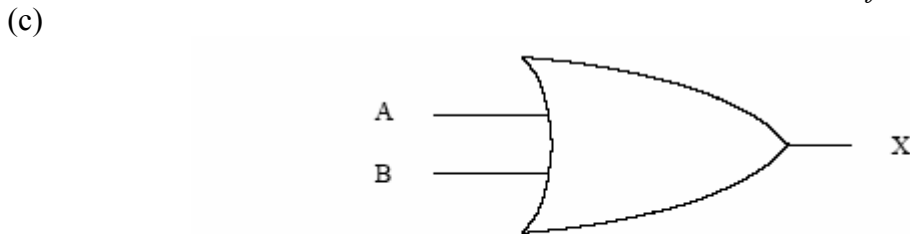
(a)	monostable	<i>1 mark</i>	<b>1 mark</b>
(b)	R1 C1 resistor 1 or capacitor	<i>2 marks</i>	<b>2 marks</b>
(c)	SW2	<i>1 mark</i>	<b>1 mark</b>
(d)	Any two appropriate methods – e.g. visit companies, use the internet, catalogues, ask other makers, etc.	<i>2 marks</i>	
	Any two appropriate advantages – e.g. usually time and reliability	<i>2 marks</i>	<b>4 marks</b>
(e)	(i) 9v lamp (A)	<i>1 mark</i>	
	(ii) Correct voltage for circuit, low cost or similar	<i>2 marks</i>	<b>3 marks</b>
(f)	<b>Vac Forming process</b> e.g.		
	1. Place former in Vac Former		
	2. Place and clamp sheet plastic in Vac Former		
	3. Turn on heat		
	4. Raise platen and former		
	5. Turn on Vacuum		
	6. Remove heat		
	7. Turn of Vacuum		
	8. Lower Platen		
	Allow making of former (max 2 marks)	<i>1 mark for each relevant stage</i>	<b>8 marks</b>
			<b>19 marks</b>

**Question A9**

(a)	Activity	CAD or CAM	
	Using computer software to create a circuit layout	<b>CAD</b>	<i>1 mark</i>
	Using a milling machine to produce a PCB	<b>CAM</b>	<i>1 mark</i>
	Using software to test a circuit on a computer	<b>CAD</b>	<i>1 mark</i> <b>3 marks</b>

(b)	A	B	X
	0	0	<b>0</b>
	0	1	<b>1</b>
	1	0	<b>1</b>
	1	1	<b>1</b>

*1 mark for each correct response*      **4 marks**



Symbol      *1 mark*  
 Labels Inputs and output      *1 mark*      **2 marks**



*1 mark for each correct response*  
*Accept arrows or text*      **4 marks**

(e)	Two suitable reasons e.g. Do not get tired, can lift heavier weights, reliable, do not claim for injuries		
	Or other suitable reason	<i>2 marks</i>	<b>2 marks</b>
(f)	Two appropriate production uses for a robot e.g. hazardous environment or high skill	<i>2 marks</i>	
	Two appropriate justifications e.g. expendable or more precise/cheaper to run	<i>2 marks</i>	<b>4 marks</b>
(g)	(i) Two appropriate advantages for workers eg. safer, reduce workload, workers able to do more interesting tasks	<i>2 marks</i>	
	(ii) Two appropriate advantages for consumers e.g. better quality/lower priced goods	<i>2 marks</i>	
	(iii) One appropriate disadvantage e.g. higher start up costs, unemployment, maintenance costs, more highly skilled workforce	<i>1 mark</i>	<b>5 mark</b>
(h)	Any appropriate advantage e.g. able to be reprogrammed, more outputs	<i>1 mark</i>	
	Any appropriate advantage e.g. smaller component count	<i>1 mark</i>	<b>2 marks</b>
			<b>26 marks</b>
			<b>Paper Total 125 Marks</b>

## Section B – Pneumatics

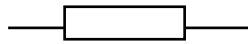
### Question B1

(a)



Name of component **Resistor**

Circuit symbol for component

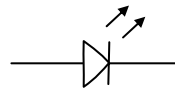
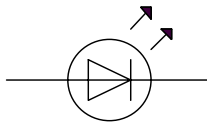


*2 marks*



Name of component **LED or Light Emitting Diode**

Circuit symbol for component, e.g.



*2 marks* **4 marks**

(b)

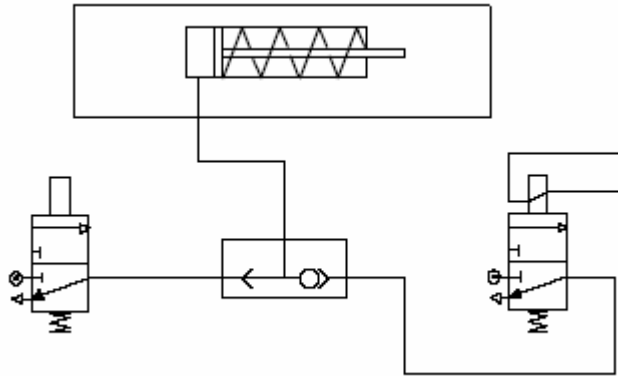
(i)	Transistor	F
(ii)	Diode	B
(iii)	Thermistor	A
(iv)	Variable resistor	D

*1 mark for each correct* **4 marks**

**8 marks**

**Question B2**

- |     |                     |   |         |                |
|-----|---------------------|---|---------|----------------|
| (a) | Reservoir           | Spring return                             | 2 marks | <b>2 marks</b> |
| (b) | Store and hold air  | Push the valve back to the start position | 2 marks | <b>2 marks</b> |
| (c) | Cylinder and piston |   | 1 mark  |                |
|     | Spring return       |   | 1 mark  |                |
|     | Correct connection  |   | 1 mark  | <b>3 marks</b> |



- |     |                         |        |                |
|-----|-------------------------|--------|----------------|
| (d) | Inlet air at A          | 1 mark |                |
|     | Outlet at B             | 1 mark |                |
|     | Inlet air at D          | 1 mark |                |
|     | Ball C moves blocking A | 1 mark | <b>4 marks</b> |

**11 marks**

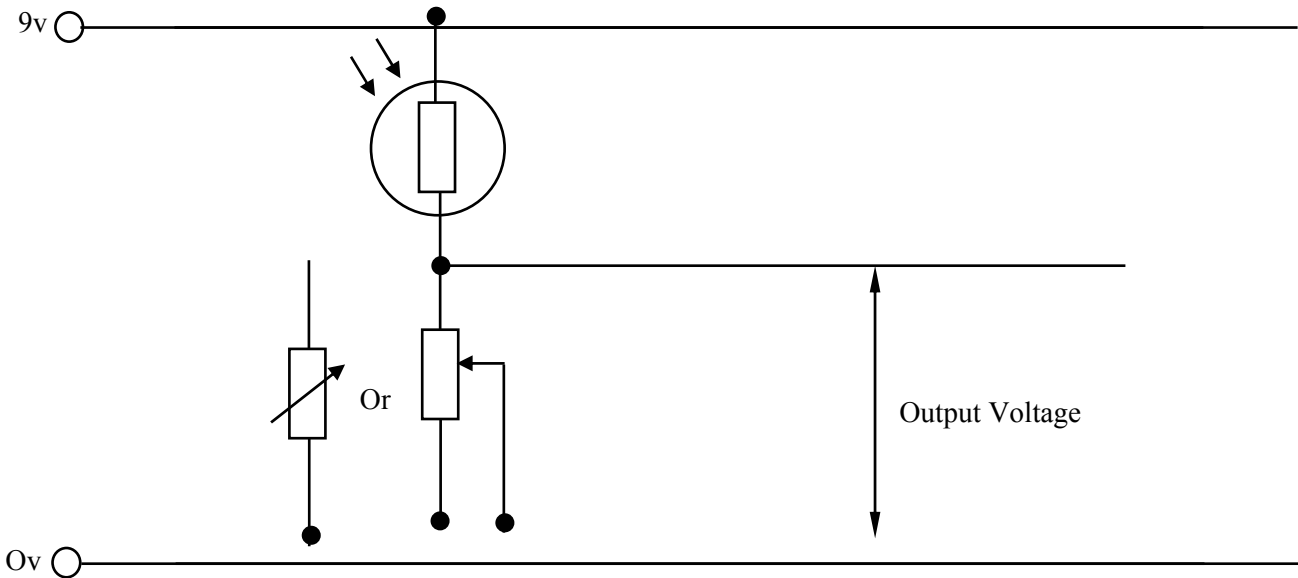
**Question B3**

- |     |  |                                   |                |
|-----|--|-----------------------------------|----------------|
| (a) | Cylinder B is the right hand cylinder  | 1 mark                            | <b>1 mark</b>  |
| (b) | To clamp the material before a bend is applied   | 1 mark                            | <b>1 mark</b>  |
| (c) | Piston out   | 1 mark                            | <b>1 mark</b>  |
| (d) | Suitable methods<br>e.g. Electro pneumatic solution<br>Pistons not operated until guards are in place<br>Use sensors to pick up obstructions and break circuit<br>AND operation for safety | 1 mark for each identified method | <b>2 marks</b> |

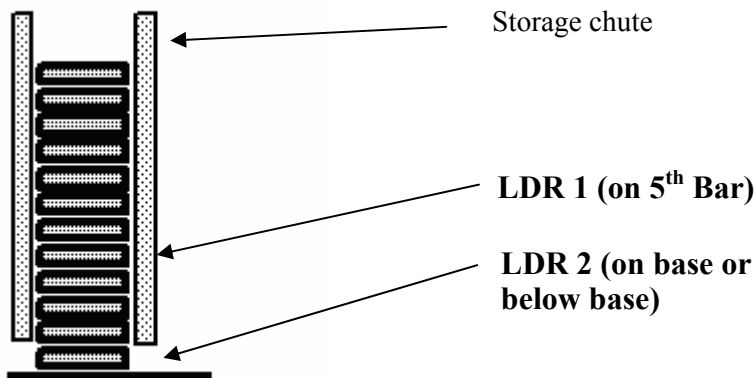
**5 marks**

**Question B4**

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



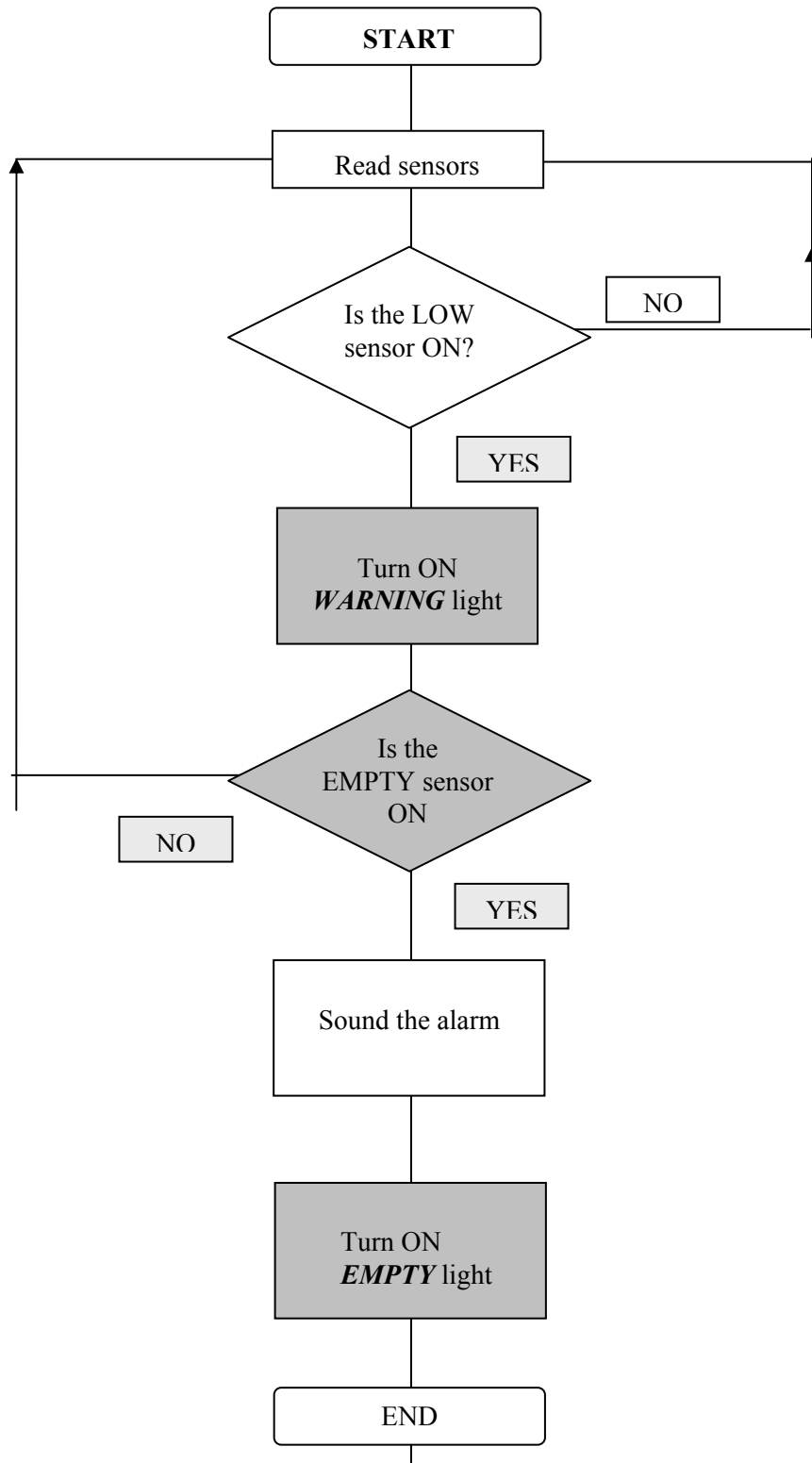
- (b) The designer wants to use LDRs as sensors in two positions  
 Position 1 = LDR position drawn between top of 4<sup>th</sup> and bottom of 6<sup>th</sup> bar  
 Position 2 = LDR on base level or below base



- 1 mark*  
*1 mark*    **2 marks**

(c)

1 mark for each box completed correctly 6 marks



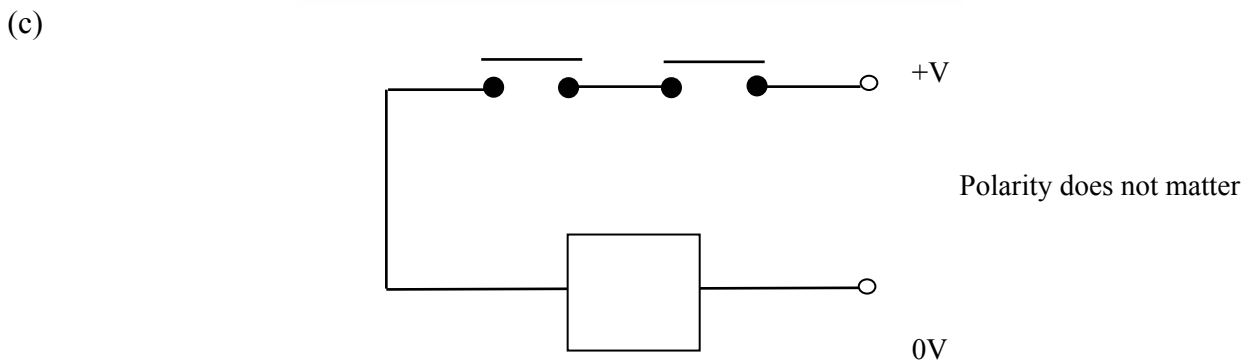
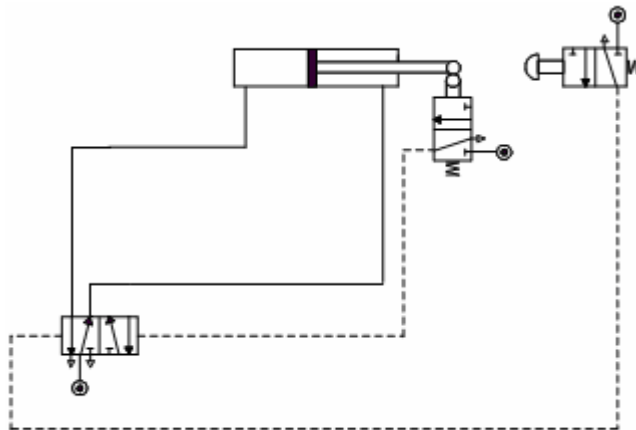
11 marks





**Question B6**

- (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 – 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*  
 No spring inside – double acting *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**



- Position of second switch in series *1 mark*  
 Switch joins up to solenoid *1 mark*  
 Some indication of +V/0V *1 mark* **3 marks**
- (d) So that they could not be operated unless both hands were used *1 mark* **1 mark**

**16 marks**

**Question B7**

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



- Keep away from hands and eyes
  - Handle with tongs
  - Rubber gloves
  - Have eye wash etc. close by
- 2 marks*



- Goggles
  - Machine vice
  - Stop buttons
  - Apron
- 2 marks*



- Soldering iron stand
  - Low voltage if possible
  - Keep hands away
  - Avoid splashes
- 2 marks*

**6 marks**

(b) (i) Suitability of pneumatic system

A pneumatic system that will allow grip *2 marks*

An attempt at a pneumatic system *1 mark*

Appropriate for gripping brass bar *2 marks*

Jaws will grip and hold when user releases *1 mark*

Jaws will grip

Quality of drawing *2 marks*

Good clear attempt *1 mark*

Recognisable as a jaw system

(ii) Any appropriate reasons eg. non slip/justify grip method *1 mark for each reason*

(iii) Any appropriate soft metal – e.g. aluminium or named plastic e.g. polythene/nylon *1 mark*

(iv) Appropriate reason e.g. softer so should not mark brass *1 mark* **10 mark**

**16 marks**

**Question B8**

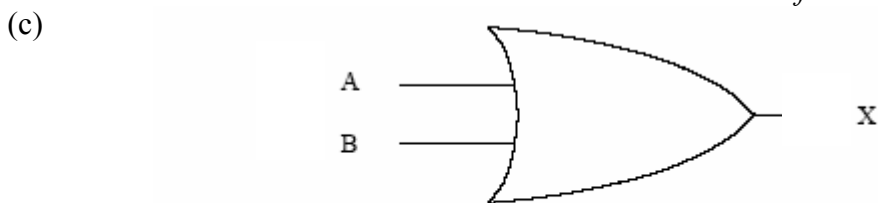
(a)	monostable	<i>1 mark</i>	<b>1 mark</b>
(b)	R1 C1 resistor 1 or capacitor	<i>2 marks</i>	<b>2 marks</b>
(c)	SW2	<i>1 mark</i>	<b>1 mark</b>
(d)	Any two appropriate methods – e.g. visit companies, use the internet, catalogues, ask other makers, etc.	<i>2 marks</i>	
	Any two appropriate advantages – e.g. usually time and reliability	<i>2 marks</i>	<b>4 marks</b>
(e)	(i) 9v lamp (A)	<i>1 mark</i>	
	(ii) Correct voltage for circuit, low cost or similar	<i>2 marks</i>	<b>3 marks</b>
(f)	<b>Vac Forming process</b> e.g. 9. Place former in Vac Former 10. Place and clamp sheet plastic in Vac Former 11. Turn on heat 12. Raise platen and former 13. Turn on Vacuum 14. Remove heat 15. Turn of Vacuum 16. Lower Platen	<i>1 mark for each relevant stage</i>	<b>8 marks</b>
	Allow making of former (max 2 marks)		<b>19 marks</b>

**Question B9**

(a)	Activity	CAD or CAM	
	Using computer software to create a circuit layout	<b>CAD</b>	<i>1 mark</i>
	Using a milling machine to produce a PCB	<b>CAM</b>	<i>1 mark</i>
	Using software to test a circuit on a computer	<b>CAD</b>	<i>1 mark</i> <b>3 marks</b>

(b)	A	B	X
	0	0	<b>0</b>
	0	1	<b>1</b>
	1	0	<b>1</b>
	1	1	<b>1</b>

*1 for each correct response*      **4 marks**



Symbol      *1 mark*  
 Labels Inputs and output      *1 mark*      **2 marks**



*1 mark for each correct response*  
*Accept arrows or text*      **4 marks**

(e)	Two suitable reasons e.g. Do not get tired, can lift heavier weights, reliable, do not claim for injuries Or other suitable reason	<i>2 marks</i>	<b>2 marks</b>
(f)	Two appropriate uses for a robot e.g. hazardous environment or high skill Two appropriate justifications e.g. expendable or more precise/cheaper to run	<i>2 marks</i>	<b>4 marks</b>
(g)	(i) Two appropriate advantages for workers e.g. safer, reduce workload, workers able to do more interesting tasks	<i>2 marks</i>	
	(ii) Two appropriate advantages for consumers e.g. better quality/lower priced goods	<i>2 marks</i>	
	(iii) One appropriate disadvantage e.g. higher start up costs, unemployment, maintenance costs, more highly skilled workforce.	<i>1 mark</i>	<b>5 marks</b>
(h)	Any appropriate advantage e.g. able to be reprogrammed more outputs	<i>1 mark</i>	
	Any appropriate advantage e.g. smaller component count	<i>1 mark</i>	<b>2 marks</b>
			<b>26 marks</b>
			<b>Paper Total 125 marks</b>