

Mark Scheme (Results) Summer 2007

GCSE

GCSE Design and Technology: Systems & Control (Electronics) Higher Tier (1974/3974)

Marking Guidance

Give / State / Name

Normally a one or two word answer, at the very most a short sentence.

Describe

Normally, one or two sentences which form a description, making reference to more than one point. All points must be linked for a complete answer.

Explain

Normally, one or two sentences which form an explanation. This requires a clear or detailed account of something and includes a relevant justification, reason or example.

Evaluate

Normally one or two sentences where the quality, suitability or value of something is judged. This can include both positive and negative points, with each point normally requiring a relevant justification.

The mark scheme contains a range of possible answers for all questions. For some questions it is possible to provide a finite number of acceptable answers. However, in some instances it is not possible to provide every conceivable answer. In these instances objective guidance is provided.

For all answers candidates are not expected to give the exact wording contained in this mark scheme. However, to gain credit their answer must demonstrate the same meaning as detailed in the mark scheme.

It is the examiner's responsibility to apply their professional judgement in determining if what the candidate has written has the same meaning as the answer detailed in the mark scheme. For all answers the '*Key words*' have been written in bold text.

For describe and explain questions, candidates may give a different combination of the marking points listed in the mark scheme. In such instances candidates can be rewarded for the marking points provided that they are suitably linked. However, candidates cannot be rewarded for the same point repeated in two different combinations.

Examiners must mark in red pen using ticks and crosses in the body of the script.

Design & Technology: Systems & Control (Electronics) (1974/2H)
 Full Course Higher Tier Mark Scheme

Question Number	Question		
1974_2H_Q01a	<p>The drawings below show details of a garden lamp. It is powered by solar energy and has a supporting metal stake.</p> <p>Two specification points for the garden lamp are that it must:</p> <ul style="list-style-type: none"> • automatically turn on when it is dark • be able to be installed anywhere in a garden <p>Under each of the following headings, give <u>one</u> more specification point which should be included in the specification for the garden lamp. For each point, give <u>one</u> reason why it should be included.</p>		
	<p>Answer</p> <p>Three each of the following, one under each heading: Specification points Reasons <i>(Do not accept repetition of the specification points given)</i></p> <p><u>Market</u> Point: it must be cost effective / cheap Reason: so that more people buy them</p> <p>Point: it must be appropriate in the garden Reason: so it fits the surroundings / aesthetically pleasing</p> <p>Point: it must be small / take apart Reason: so that it may be stored in the winter</p> <p><u>Quality</u> Point: it must give a good light Reason: to illuminate a large area</p>	<p>Part Mark</p> <p>3x1 3x1</p>	<p>Total Mark</p> <p>(6)</p>

Point: the case must have smooth edges

Reason: to stop cuts to the user

Point: must have low power consumption

Reason: to keep alight for long periods

Point: must be made from waterproof/weatherproof materials

Reason: to be used outside

Point: must be durable/tough

Reason: to withstand outside knocks

Environment

(must relate to materials, components and processes not the environment in which it is to be used)

Point: it must use rechargeable batteries / use materials that can be recycled

Reason: to save on waste/landfill sites

Point: it must use solar power

Reason: to save on other forms of energy

Point: use materials that do not pollute the ground

Reason: flowers may not grow

Some flexibility should be given as some points may cross over descriptions.

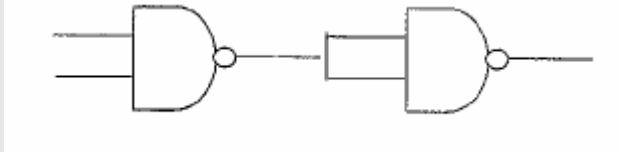
Question Number	Question		
1974_2H_Q01d	<p>The electronics housing and battery case is made from rigid polystyrene using injection moulding.</p> <p>Give <u>two</u> properties of rigid polystyrene that made it suitable for the electronic housing and battery case. For each property give <u>one</u> reason why it makes rigid polystyrene suitable.</p>		
	<p>Answer</p> <p>Two properties and two reasons given:</p> <p>Point: low melting point Reason: easy to mould</p> <p>Point: electrical insulator Reason: prevents short circuits</p> <p>Point: waterproof Reason: keeps electronics away from weather</p> <p>Point: tough Reason: will withstand knocks / will not crack</p>	<p>Part Mark</p> <p>2x1 2x1</p>	<p>Total Mark</p> <p>(4)</p>
1974_2H_Q01e	<p>The electronic housing an battery case is made using black polystyrene.</p> <p>Explain <u>one</u> reason, other than looks, why black polystyrene is used to make the electronic housing and battery case.</p>		
	<p>Answer</p> <p>One reasons explained:</p> <ul style="list-style-type: none"> the black case is between the ultra bright LED and the LDR and therefore stops one affecting the other (only answer) 	<p>Part Mark</p> <p>2x1</p>	<p>Total Mark</p> <p>(2)</p>

Question Number	Question		
1974_2H_Q01f	<p>The mild steel supporting stake for the garden lamp is finished using plastic dip coating.</p> <p>Explain <u>one</u> reason why plastic dip coating is used to finish the supporting stake.</p>		
	<p>Answer</p> <p>One reason explained:</p> <ul style="list-style-type: none"> mild steel is liable to rust and plastic dip coating helps to prevent this dip coating in black plastic makes the stake match the rest of the lamp steel may contaminate the ground and the dip coating forms a barrier to stop this 	Part Mark	Total Mark
		2x1	(2)
1974_2H_Q01g	<p>Two purposes of the garden lamp are that it must:</p> <ul style="list-style-type: none"> automatically turn on when it is dark be able to be installed anywhere in a garden <p>Explain under the following headings, how the garden lamp achieves these purposes.</p>		
	<p>Answer</p> <p>One purpose explained: automatically turn on when it is dark</p> <ul style="list-style-type: none"> the LDR senses the amount of light and switches the circuit on when the light intensity decreases <i>(only acceptable answer)</i> <p>One purpose explained: be able to be installed anywhere in a garden</p> <ul style="list-style-type: none"> having solar power and rechargeable batteries it does not need to be connected to mains/does not need connecting wires as the supporting stake is made from steel it is strong enough to go into the hardest ground 	Part Mark	Total Mark
		2x1	
		2x1	(4)
		(Total 22 marks)	

Question Number	Question
1974_2H_Q02ai	<p>A designed bicycle alarm contains a combination of logic gates and a timer circuit to make it work.</p> <p>Shown below is a simplified block diagram of the bicycle alarm system.</p> <p>A Quad 2 input NAND gate is needed to create the AND gate and the Bistable.</p> <p>Complete the truth table for a NAND gate.</p>

Answer	Part Mark	Total Mark															
<p>Each correct output given:</p> <table border="1" data-bbox="443 635 896 810"> <thead> <tr> <th>I/P 1</th> <th>I/P 2</th> <th>O/P</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table> <p><i>(Only answers)</i></p>	I/P 1	I/P 2	O/P	0	0	1	0	1	1	1	0	1	1	1	0	4x1	(4)
I/P 1	I/P 2	O/P															
0	0	1															
0	1	1															
1	0	1															
1	1	0															

Question Number	Question
1974_2H_Q02aii	<p>Complete the diagram below to show how two NAND gates in combination can produce an AND gate.</p>

Answer	Part Mark	Total Mark
<p>Correct connection drawn</p>  <p><i>(Only answer)</i></p>	1	(1)

Question Number	Question	Part Mark	Total Mark
1974_2H_Q02aiii	Complete the diagram below to show how two NAND gates in combination can produce a Bistable.		
	Answer		
	Drawing completed: 1 mark for each cross over		
		2x1	(2)

Question Number	Question		
1974_2H_Q02bi	When the output of the AND gate was connected to the buzzer the circuit did not work. Explain the reason why a buzzer connected directly to an integrated circuit will not work.		
	Answer	Part Mark	Total Mark
	The reason explained:		
	<ul style="list-style-type: none"> IC gives a low current output but the buzzer needs a high current input IC output not strong enough to drive the buzzer 	2x1	(2)
Question Number	Question		
1974_2H_Q02bii	Describe <u>one</u> way in which a <u>named</u> interface device may be used to drive the buzzer.		
	Answer	Part Mark	Total Mark
	One way described with the interface device named:		
	<ul style="list-style-type: none"> FET may be connected between the IC and the buzzer Darlington pair / power transistor may be connected to the IC output to give a higher gain Driver IC may be used which is a high current device 	2x1	(2)
Question Number	Question		
1974_2H_Q02ci	The circuit diagram below shows a 555 timer used as an Astable. The circuit needs to be prototyped before batch production. Explain <u>one</u> reason for prototyping the circuit.		
	Answer	Part Mark	Total Mark
	One reason explained:		
	<ul style="list-style-type: none"> check the circuit works/is safe which saves money/materials/time check the physical size of the circuit so that the case may be designed/ it fits inside a case 	2x1	(2)

Question Number	Question		
1974_2H_Q02cii	<p>One method of prototyping the circuit is by using computer modelling.</p> <p>Give <u>three</u> ways in which computer modelling of the circuit can make its design and manufacture more efficient.</p>		
	<p>Answer</p> <p>Three ways given:</p> <ul style="list-style-type: none"> • saves on components • saves time • can be stored • easily adapted • used to produce PCB / direct transfer of design to CAM 	Part Mark	Total Mark
		3x1	(3)
1974_2H_Q02d	<p>The batch produced case for the bicycle alarm would be designed using computer aided design (CAD).</p> <p>Give <u>two</u> ways in which CAD could be used to model the case for the bicycle alarm.</p>		
	<p>Answer</p> <p>Two ways given:</p> <ul style="list-style-type: none"> • the shape/surface holes may be designed • dimensions can be accurate • different materials may be tried • create a virtual case • rotate to see other sides • look at different shapes • test different ergonomic layouts of components 	Part Mark	Total Mark
		2x1	(2)

Have a method of switching on and a method to give an audible signal for starting.

- Evidence that it can be switched on
eg PTB / pressure Pad / light sensing/rocker/membrane switch
- Evidence of audio signal for starting
eg buzzers / speaker / bell / piezo

1

1

Have a method of detecting and giving a visual indication of a false start.

- Evidence of a detecting method
eg Micro switch/ LDR and light / infra-red tx+rec/ radio
- Evidence of a visual indication of a false start
eg Lamp / LED / alpha-numeric display

1

1

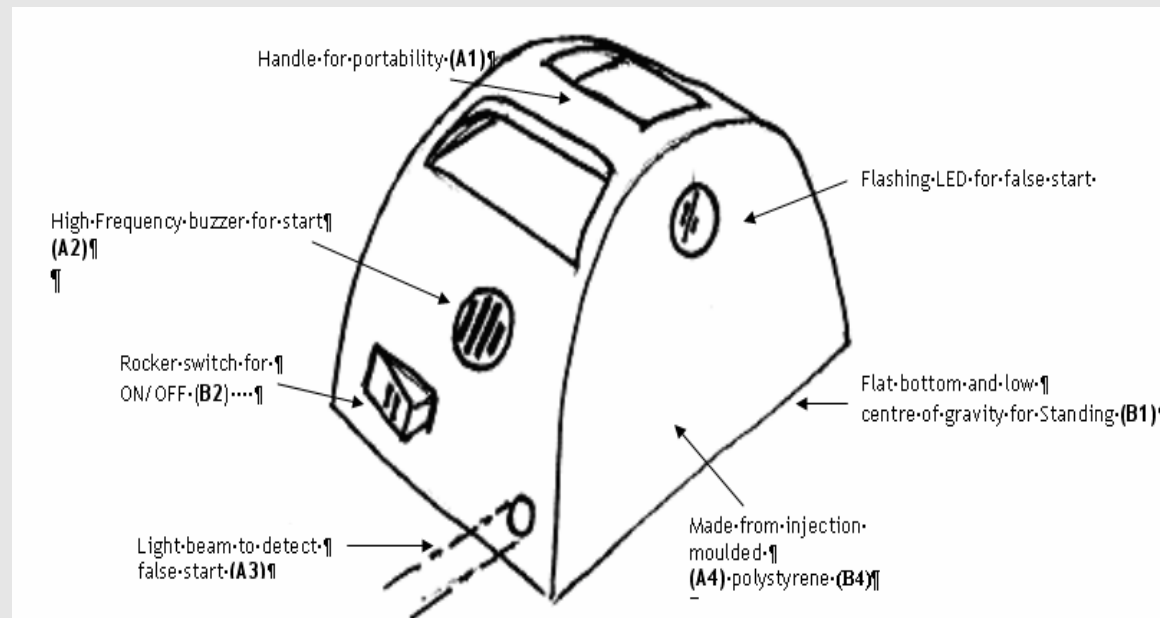
Be made from materials and processes suitable for batch production

- Evidence of suitable material
eg Acrylic / Polystyrene / other named polymer / aluminium
- Evidence of process that could seal the electronics inside
eg Injection moulding / blow moulding / rotational or slush moulding / pressed / folded

1

1

(8)



Design Idea 2

To score a mark for Design Idea 2, each specification point must be resolved again in the second design idea but the second design must be technically / conceptually different in design and construction from the first and simply not a variation on a theme to score a mark

Have a different method of being portable

1

Have a different method of standing on the side of the pool

1

Have a different method of switching on

1

Have a different method of audio signal starting

1

Have a different method detecting a false start

1

Have a different visual indication of a false start

1

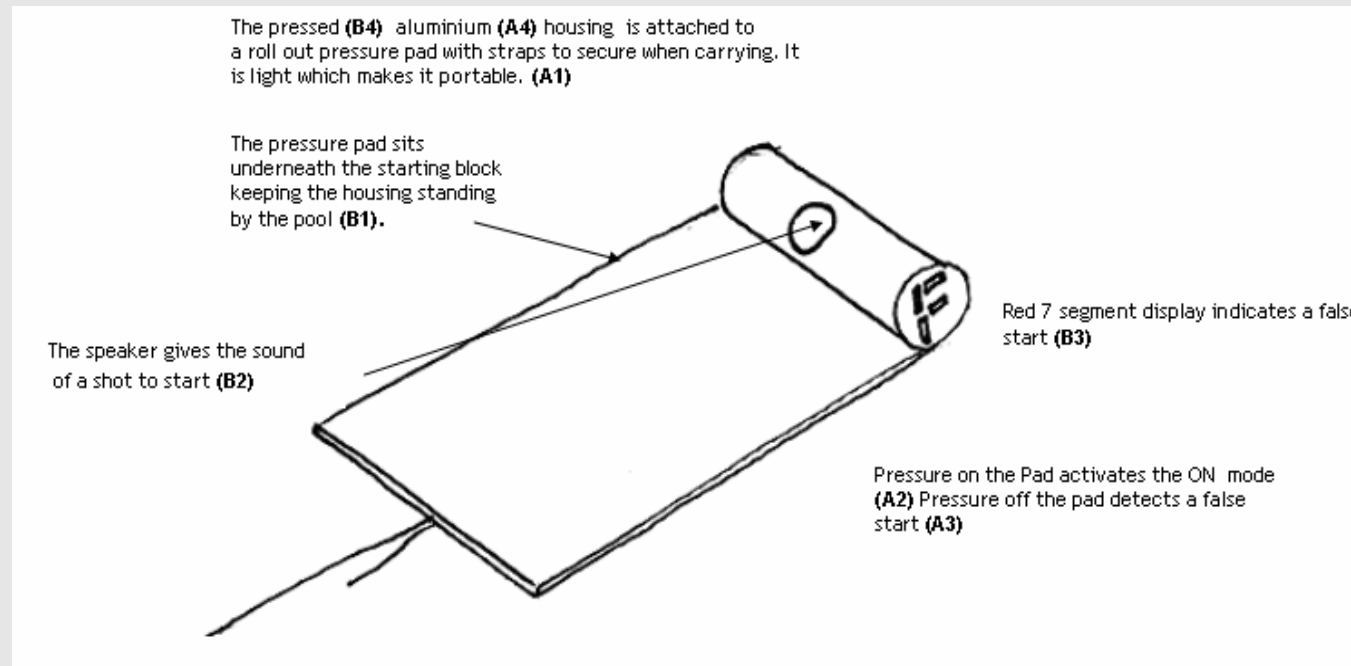
Have a different appropriate material

1

Have a different method of appropriate manufacture

1

(8)



Question Number	Question		
1974_2H_Q03b	<p>Three of the original specification points are repeated below.</p> <p>Evaluate how <u>one</u> of your design ideas succeeds or fails to meet each of these specification points.</p> <p>(i) The swimmers' training system must be housed in a portable casing that will stand on the side of the pool.</p> <p>(ii) The swimmers' training system must have a method of switching on and a method to give an audible signal for starting.</p> <p>(iii) The swimmers' training system must have a method of detecting and giving a visual indication of a false start.</p>		
	Answer	Part Mark	Total Mark
	<p>Each point clearly evaluated:</p> <p>If a candidate has indicated design Idea 1 and then evaluates design idea 2 for all or part of (i), (ii), & (iii) then the idea in greater evidence should be marked.</p> <p>The evaluation of the design must contain reference to either positive or negative aspects not simply a description of the design.</p> <p>Award 1 mark for a correct evaluation / justification relating to each design feature and how it succeeds or fails.</p> <p>Repetition of original spec scores 0.</p> <p>(i) Evaluation of: Be housed in a portable casing that will stand on the side of the pool: Positive or negative statements relating to:</p> <ul style="list-style-type: none"> • The portable housing • Method of standing on the side of the pool <p><i>eg The handle could get in the way of the swimmer but the flat bottom and low centre of gravity make it very stable</i></p> <p>(ii) Evaluation of: The method of switching on and a method to give an audible signal for starting: Positive or negative statements relating to:</p> <ul style="list-style-type: none"> • The method of switching on • The audible system for starting <p><i>eg The two tone buzzer is easy to understand (1) but the rocker switch may short circuit if the</i></p>	<p>2x1</p> <p>2x1</p>	

swimmer is wet

- (iii) Evaluation of: Has a method of detecting and giving a visual indication of a false start:
Positive or negative statements relating to:
- Detecting the false start
 - The visual indication of a false start
- eg the PTM may not work if the swimmer is not standing directly on it (1) but the flashing red light is a clear indication requiring the swimmer to stop (1)*

2x1

(6)

(Total 22 marks)

Question Number	Question	Part Mark	Total Mark
1974_2H_Q04ai	The circuit, shown below, is the control system for an air conditioning unit. Give <u>one</u> reason for using VR1 in the circuit.		
	Answer One reason given: <ul style="list-style-type: none">• sets potential difference / voltage• temperature control	1	(1)
Question Number	Question	Part Mark	Total Mark
1974_2H_Q04aii	Describe the action of the thermistor (TH1) in the circuit when the temperature becomes colder.		
	Answer The action described: <ul style="list-style-type: none">• resistance increases and the voltage across it increases/voltage at + gets bigger <i>(This is the only acceptable answer but it may be given in a different way)</i>	2x1	(2)

Question Number	Question	Part Mark	Total Mark
1974_2H_Q04aiii	Describe the action of the operational amplifier (OpAmp) in the circuit when the voltage applied to its non-inverting input (+) is larger than that applied to the inverting input (-).		
	Answer		
	The action described:		
	<ul style="list-style-type: none"> if + is greater than - the OpAmp saturates/switches on and gives maximum output <i>(This is the only acceptable answer but it may be given in a different way)</i>	2x1	(2)
Question Number	Question	Part Mark	Total Mark
1974_2H_Q04aiv	Calculate the current passing through R1 if the voltage at the inverting input (-) of the OpAmp is set at 1V.		
	Answer		
	Current calculated:		
	<ul style="list-style-type: none"> 80μA 0.08mA 0.00008A <i>Correct number; no units (1 mark)</i> <i>Correct number; wrong units (1 mark)</i> <i>Correct number ; correct units (2 marks)</i>	2x1	(2)

Question Number	Question		
1974_2H_Q04av	VR2 and R2 are in parallel and are used to set the voltage at the inverting input (-) of the OpAmp. Calculate the total resistance of VR2 and R2 when VR2 is adjusted to its maximum value. Use the formula: $\frac{R1 \times R2}{R1 + R2}$		
	Answer Resistance calculated: <ul style="list-style-type: none"> • 5K / 5KΩ / 5Kohms • 5000R / 5000Ω / 5000ohms <i>Correct number; no units (1 mark)</i> <i>Correct number; wrong units (1 mark)</i> <i>Correct number ; correct units (2 marks)</i>	Part Mark 2x1	Total Mark (2)
Question Number	Question		
1974_2H_Q04avi	Explain the reason for using R3 in the circuit.		
	Answer The reason explained: <ul style="list-style-type: none"> • the 9V output from the Op Amp would blow the LED without the R3 protection <i>(This is the only acceptable answer but it may be given in a different way)</i> 	Part Mark 2x1	Total Mark (2)

Question Number	Question		
1974_2H_Q04bi	<p>The manufacturers of the air conditioning unit control system also make control systems for other domestic appliances. The manufacturers are considering redesigning their control circuits using Programmable ICs (PICs).</p> <p>Explain <u>two</u> advantages of using PICs for electronic control systems.</p>		
	<p>Answer</p> <p>Two advantages explained:</p> <ul style="list-style-type: none"> • only one basic circuit so less set-up costs/easier to fault find • only one control board needed therefore saves production time/costs / storage space • less components / small control board therefore saves space in the product • PIC is versatile/same PIC can control different products because control is by program 	<p>Part Mark</p> <p>2x1 2x1</p>	<p>Total Mark</p> <p>(4)</p>
1974_2H_Q04bii	<p>Explain <u>one</u> disadvantage of using PICs for electronic systems.</p>		
	<p>Answer</p> <p>One disadvantage explained:</p> <ul style="list-style-type: none"> • PIC has lots of legs actual circuit could be bigger • PICs are more expensive so individual circuits could be more expensive / replacement control boards more expensive • PICs need to be programmed therefore specialist training needed/ specialist hardware/software needed 	<p>Part Mark</p> <p>2x1</p>	<p>Total Mark</p> <p>(2)</p>

Question Number	Question	Part Mark	Total Mark
1974_2H_Q04c	Give <u>one</u> environmental advantage of using control systems in domestic appliances.		
	Answer		
	One environmental advantage given:		
	<ul style="list-style-type: none"> • less energy used • always at the correct temperature/setting • less natural resources used to produce the energy • reduces carbon footprint 	1	(1)
Question Number	Question	Part Mark	Total Mark
1974_2H_Q04d	Describe <u>two</u> ways in which old electronic control system circuits may be recycled or reused.		
	Answer		
	Two ways described:		
	<ul style="list-style-type: none"> • ICs or PICs could be removed and used in other circuits / re-programmed • whole circuit could be removed and used for different domestic appliances • PCB with components removed may be used as a fuel for power generation 	2x1 2x1	(4)
			(Total 22 marks)
TOTAL FOR PAPER: 88 MARKS			

Design & Technology: Systems & Control (Electronics) (3974/2H)
Short Course Higher Tier Mark Scheme

Question Number	Question		
3974_2H_Q01a	<p>The drawings below show details of a garden lamp. It is powered by solar energy and ha a supporting metal stake.</p> <p>Two specification points for the garden lamp are that it must:</p> <ul style="list-style-type: none"> • automatically turn on when it is dark • be able to be installed anywhere in a garden <p>Under each of the following headings, give <u>one</u> more specification point which should be included in the specification for the garden lamp. For each point, give <u>one</u> reason why it should be included.</p>		
	<p>Answer</p> <p>Three each of the following, one under each heading: Specification points Reasons <i>(Do not accept repetition of the specification points given)</i></p> <p><u>Market</u> Point: it must be cost effective / cheap Reason: so that more people buy them</p> <p>Point: it must be appropriate in the garden Reason: so it fits the surroundings / aesthetically pleasing</p> <p>Point: it must be small / take apart Reason: so that it may be stored in the winter</p> <p><u>Quality</u> Point: it must give a good light Reason: to illuminate a large area</p>	<p>Part Mark</p> <p>3x1 3x1</p>	<p>Total Mark</p> <p>(6)</p>

Point: the case must have smooth edges
 Reason: to stop cuts to the user
 Point: must have low power consumption
 Reason: to keep alight for long periods

Point: must be made from waterproof/weatherproof materials
 Reason: to be used outside

Point: must be durable/tough
 Reason: to withstand outside knocks

Environment

(must relate to materials, components and processes not the environment in which it is to be used)

Point: it must use rechargeable batteries / use materials that can be recycled
 Reason: to save on waste/landfill sites

Point: it must use solar power
 Reason: to save on other forms of energy

Point: use materials that do not pollute the ground
 Reason: flowers may not grow

Some flexibility should be given as some points may cross over descriptions.

Question Number	Question	Part Mark	Total Mark
3974_2H_Q01b	The reflecting dome of the garden lamp is made from clear acrylic. It is waterproof. Give <u>two</u> other reason why clear acrylic is a suitable material from which to make the reflecting dome.		
	Answer Two reasons given: <ul style="list-style-type: none"> • light shines out • rigid • easily moulded to shape • inexpensive 	2x1	(2)

Question Number	Question		
3974_2H_Q01c	<p>The reflecting dome is manufactured by blowing moulding.</p> <p>Give <u>two</u> reasons why blowing is a suitable process to manufacture the reflecting dome.</p>		
	<p>Answer</p> <p>Two reasons given:</p> <ul style="list-style-type: none"> • dome shape easy to produce / simple mould • repeatable • little waste • cheaper than injection moulding <p><i>(Do not accept 'cheap' on its own)</i></p>	2x1	(2)
3974_2H_Q01d	<p>The electronics housing and battery case is made from rigid polystyrene using injection moulding.</p> <p>Give <u>two</u> properties of rigid polystyrene that made it suitable for the electronic housing and battery case. For each property give <u>one</u> reason why it makes rigid polystyrene suitable.</p>		
	<p>Answer</p> <p>Two properties and two reasons given:</p> <p>Point: low melting point Reason: easy to mould</p> <p>Point: electrical insulator Reason: prevents short circuits</p> <p>Point: waterproof Reason: keeps electronics away from weather</p> <p>Point: tough Reason: will withstand knocks / will not crack</p>	2x1 2x1	(4)

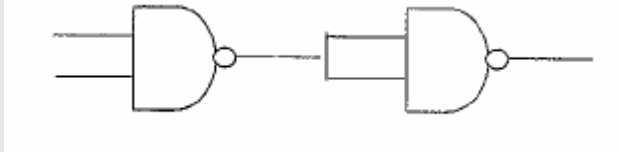
Question Number	Question		
3974_2H_Q01e	The electronic housing an battery case is made using black polystyrene. Explain <u>one</u> reason, other than looks, why black polystyrene is used to make the electronic housing and battery case.		
	Answer	Part Mark	Total Mark
	One reasons explained: <ul style="list-style-type: none"> the black case is between the ultra bright LED and the LDR and therefore stops one affecting the other <i>(only acceptable answer)</i> 	2x1	(2)
Question Number	Question		
3974_2H_Q01f	The mild steel supporting stake for the garden lamp is finished using plastic dip coating. Explain <u>one</u> reason why plastic dip coating is used to finish the supporting stake.		
	Answer	Part Mark	Total Mark
	One reason explained: <ul style="list-style-type: none"> mild steel is liable to rust and plastic dip coating helps to prevent this dip coating in black plastic makes the stake match the rest of the lamp steel may contaminate the ground and the dip coating forms a barrier to stop this 	2x1	(2)

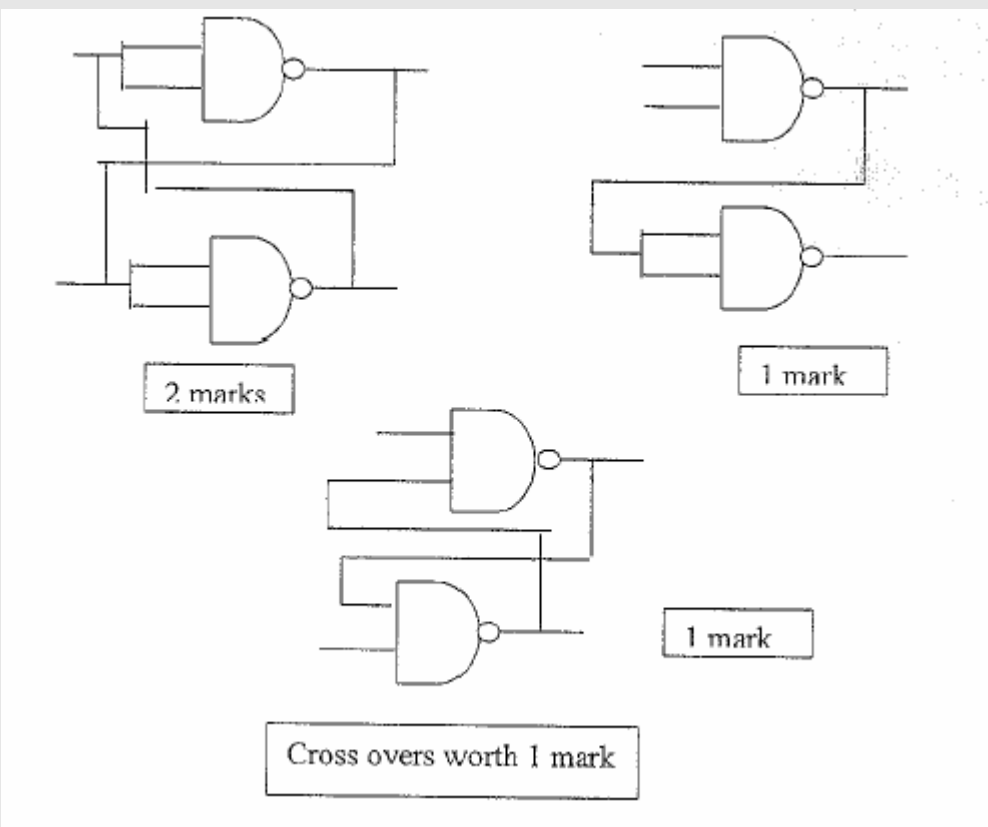
Question Number	Question		
3974_2H_Q01g	<p>Two purposes of the garden lamp are that it must:</p> <ul style="list-style-type: none"> • automatically turn on when it is dark • be able to be installed anywhere in a garden <p>Explain under the following headings, how the garden lamp achieves these purposes.</p>		
	<p>Answer</p> <p>One purpose explained: automatically turn on when it is dark</p> <ul style="list-style-type: none"> • the LDR senses the amount of light and switches the circuit on when the light intensity decreases <i>(only acceptable answer)</i> <p>One purpose explained: be able to be installed anywhere in a garden</p> <ul style="list-style-type: none"> • having solar power and rechargeable batteries it does not need to be connected to mains/does not need connecting wires • as the supporting stake is made from steel it is strong enough to go into the hardest ground 	<p>Part Mark</p> <p>2x1</p> <p>2x1</p>	<p>Total Mark</p> <p>(4)</p>
(Total 22 marks)			

Question Number	Question
3974_2H_Q02ai	<p>A designed bicycle alarm contains a combination of logic gates and a timer circuit to make it work.</p> <p>Shown below is a simplified block diagram of the bicycle alarm system.</p> <p>A Quad 2 input NAND gate is needed to create the AND gate and the Bistable.</p> <p>Complete the truth table for a NAND gate.</p>

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I/P 1	I/P 2	O/P															
0	0	1															
0	1	1															
1	0	1															
1	1	0															

Question Number	Question
3974_2H_Q02aii	<p>Complete the diagram below to show how two NAND gates in combination can produce an AND gate.</p>

Answer	Part Mark	Total Mark
<p>Correct connection drawn</p>  <p><i>(Only answer)</i></p>	1	(1)

Question Number	Question	Part Mark	Total Mark
3974_2H_Q02aiii	Complete the diagram below to show how two NAND gates in combination can produce a Bistable.		
	Answer		
	Drawing completed: 1 mark for each cross over		
		2x1	(2)

Question Number	Question		
3974_2H_Q02bi	When the output of the AND gate was connected to the buzzer the circuit did not work. Explain the reason why a buzzer connected directly to an integrated circuit will not work.		
	Answer	Part Mark	Total Mark
	The reason explained:		
	<ul style="list-style-type: none"> IC gives a low current output but the buzzer needs a high current input IC output not strong enough to drive the buzzer 	2x1	(2)
Question Number	Question		
3974_2H_Q02bii	Describe <u>one</u> way in which a <u>named</u> interface device may be used to drive the buzzer.		
	Answer	Part Mark	Total Mark
	One way described with the interface device named:		
	<ul style="list-style-type: none"> FET may be connected between the IC and the buzzer Darlington pair / power transistor may be connected to the IC output to give a higher gain Driver IC may be used which is a high current device 	2x1	(2)
(Total 11 marks)			
Question Number	Question		
3974_2H_Q03a	The circuit, shown below, is the control system for an air conditioning unit. Give <u>one</u> reason for using VR1 in the circuit.		
	Answer	Part Mark	Total Mark
	One reason given:		
	<ul style="list-style-type: none"> sets potential difference / voltage temperature control 	1	(1)

Question Number	Question	Part Mark	Total Mark
3974_2H_Q03b	Describe the action of the thermistor (TH1) in the circuit when the temperature becomes colder.		
	Answer		
	The action described:		
	<ul style="list-style-type: none"> resistance increases and the voltage across it increases/voltage at + gets bigger <i>(This is the only acceptable answer but it may be given in a different way)</i> 	2x1	(2)
Question Number	Question	Part Mark	Total Mark
3974_2H_Q03c	Describe the action of the operational amplifier (OpAmp) in the circuit when the voltage applied to its non-inverting input (+) is larger than that applied to the inverting input (-).		
	Answer		
	The action described:		
	<ul style="list-style-type: none"> if + is greater than - the OpAmp saturates/switches on and gives maximum output <i>(This is the only acceptable answer but it may be given in a different way)</i> 	2x1	(2)
Question Number	Question	Part Mark	Total Mark
3974_2H_Q03d	Calculate the current passing through R1 if the voltage at the inverting input (-) of the OpAmp is set at 1V.		
	Answer		
	Current calculated:		
	<ul style="list-style-type: none"> 80μA 0.08mA 0.00008A <p><i>Correct number; no units (1 mark)</i> <i>Correct number; wrong units (1 mark)</i> <i>Correct number ; correct units (2 marks)</i></p>	2x1	(2)

Question Number	Question		
3974_2H_Q03e	VR2 and R2 are in parallel and are used to set the voltage at the inverting input (-) of the OpAmp. Calculate the total resistance of VR2 and R2 when VR2 is adjusted to its maximum value. Use the formula: $\frac{R1 \times R2}{R1 + R2}$		
	Answer	Part Mark	Total Mark
	Resistance calculated:		
	<ul style="list-style-type: none"> 5K / 5KΩ / 5Kohms 5000R / 5000Ω / 5000ohms <i>Correct number; no units (1 mark)</i> <i>Correct number; wrong units (1 mark)</i> <i>Correct number ; correct units (2 marks)</i>	2x1	(2)
Question Number	Question		
3974_2H_Q03f	Explain the reason for using R3 in the circuit.		
	Answer	Part Mark	Total Mark
	The reason explained:		
	<ul style="list-style-type: none"> the 9V output from the Op Amp would blow the LED without the R3 protection <i>(This is the only acceptable answer but it may be given in a different way)</i>	2x1	(2)
		(Total 11 marks)	
		TOTAL FOR PAPER: 44 MARKS	

