

## **Mark Scheme for June 2010**

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

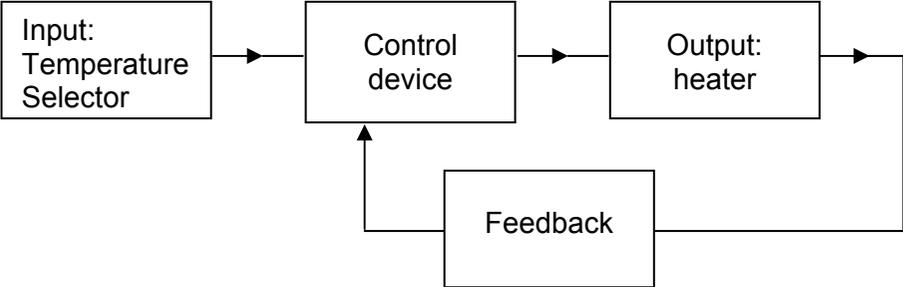
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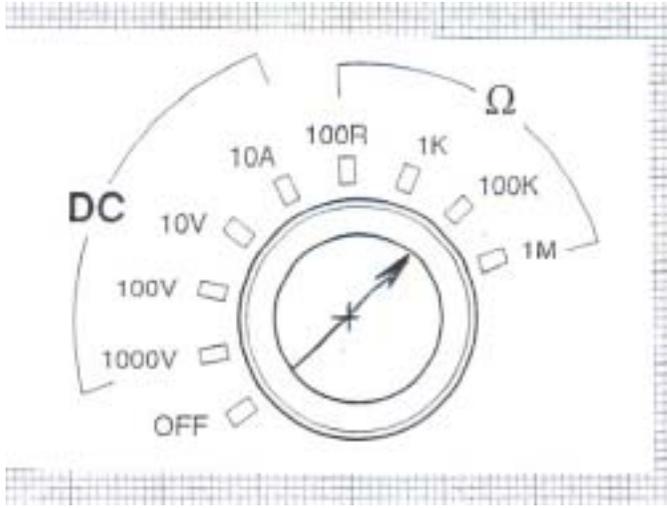
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Question	Expected Answer	Mark	Rationale
<b>Section A</b>			
1	<p>The table in Fig 1 shows some of the components found in a domestic washing machine.</p> <p>Fig 1</p> <p>Complete the table by filling in the empty boxes.</p> <p>Pressure switch – used for measuring the level of the water                      Heating element – output                      Temperature sensor – measures the temperature of the water                      Solenoid valve – controls the flow of the water in the machine                      Programmer – process</p>	<p>[1]                      [1]                      [1]                      [1]                      [1]</p>	<p style="text-align: right;"><b>Total [5]</b></p>
2	<p><b>Draw a block diagram to represent a system that has feedback.</b></p> <p>There are many answers to this question. One example is provided of a positional control system.</p> <p>Accept any correct response. An example is given.</p> <p><b>MS Fig 1</b></p> 		<p>No arrows shown award only 1mark</p>

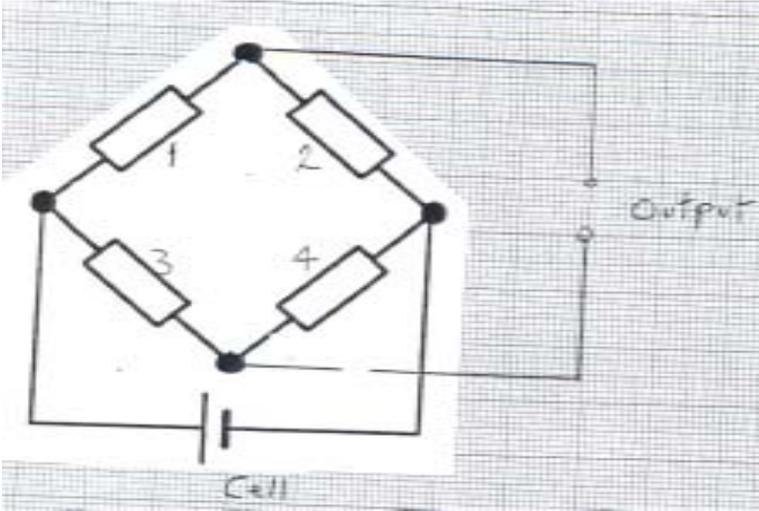
Question	Expected Answer	Mark	Rationale
	Correctly positioned blocks Correct labels	[1] [1]	[Total 2]
3	<p>State which three of the following are passive transducers:                      thermistor, thermocouple, solar cell, strain gauge, light dependent resistor.</p> Thermistor Strain gauge Light dependent resistor	[1] [1] [1]	[Total 3]
4	<p>Part of a digital multi-meter is shown in Fig 2.                      Fig 2                      Draw the pointer on the dial set to the correct position for checking the value of a 10K resistor.                      MS Fig 2</p>  <p>The diagram shows a semi-circular dial with a central pointer. The dial is divided into several sections by curved lines. From left to right, the sections are labeled: DC, 10V, 100V, 1000V, OFF, 10A, 100R, 1K, 100K, 1M, and Ω. The pointer is currently pointing towards the 100R mark.</p>	[1]	

Question	Expected Answer	Mark	Rationale
5	<p><b>Give three advantages of watching a video that simulates a production line, over visiting a factory that produces motor cars on an automated production line.</b></p> <p>Do not waste time in travelling  Expenses are reduced ie no travel costs  Safer than being exposed to a production line  Probably see more detail on the video as compared to the visit  Allows access to activities which would otherwise be difficult to experience  Overcomes the need for specialised and expensive equipment  No matter what size the system is, it can be produced as a video  Learners can us the packages at any time</p> <p>Accept any <b>three</b> correct responses.</p>	[3]	
6	<p><b>State two difficulties encountered when transmitting signals using wires when the frequency of the system increases above 2500 MHz.</b></p> <p>The fields spread out around the wires ie are not concentrated  Signal power may be reduced or lost  Wires will tend to act like an aerial and therefore radiate some of the power involved  Resistance of wire increases which causes signal weakening</p> <p>Accept any two correct responses.</p>	[2]	

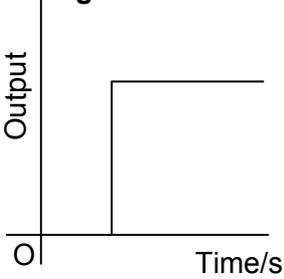
Question	Expected Answer	Mark	Rationale
7	<p><b>Explain how a logic probe is used in the testing of a circuit.</b></p> <p>A logic probe is a slender instrument with two LEDs near the tip. The probe gets its power from the circuit under test.</p> <p>The probe is positioned at a point in the circuit under test. The green LED indicates logic 0 (low) and the red LED indicates logic 1 (high)</p> <p>The readings give the logic state of each pin of an integrated circuit. This can help find a faulty IC in a digital circuit and determine which part of the circuit is faulty</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>	<p>[Total 3]</p>
8	<p><b>State the formula for overall gain in a system using negative feedback.</b></p> <p>Overall gain <math>G = A/(1 + \beta A)</math>[1]</p>	[1]	
			<b>Section A: TOTAL 20 marks</b>

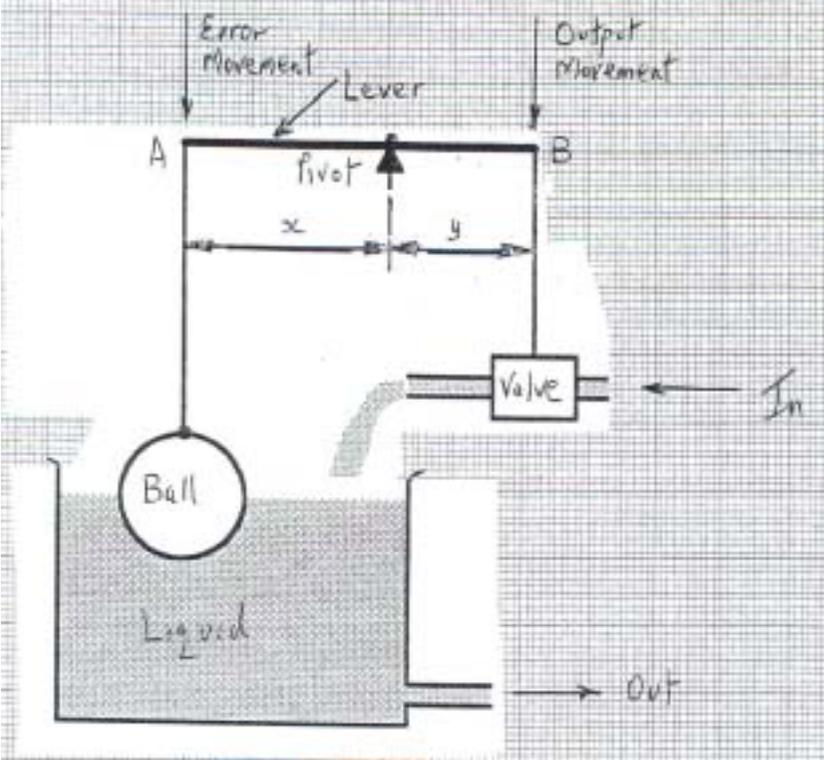
## Section B

Question		Expected Answer	Mark	Rationale
1	(a)	<p><b>Give two practical applications of a strain gauge.</b></p> <p>Measurement of strain in:  Packaging – process control/strain gauging of components/general weighing/repair and calibration  Engineering – test rig force monitoring/robotic/weighing of components/specialised load cells/machine control  Chemical – press force monitoring/silo weighing/load cells  Automotive – component test rigs/crash tests/production quality processes/special sensors</p> <p>Accept any two correct responses.</p>	[2]	
	(b)	<p><b>Explain why it is necessary to measure strain.</b></p> <p>Strain is measured to check that a system is not being overworked.  The strain gauge measures change which is recorded.  Any change that is detrimental to the system can be dealt with.</p>	[1] [1] [1]	

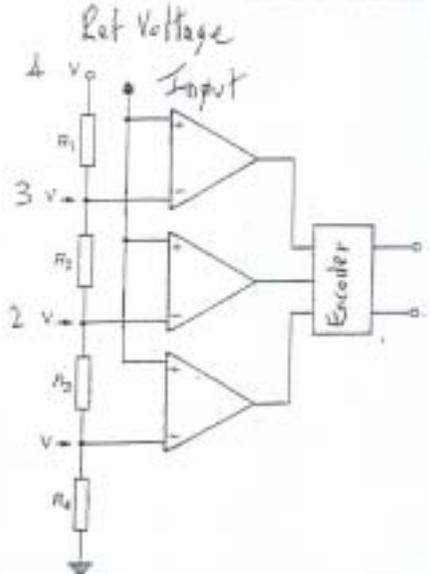
Question	Expected Answer	Mark	Rationale
	<p>(c) Describe, in detail, with the aid of a labelled diagram, how a strain gauge can be used in a control system.</p> <p>A number of different correct descriptions and diagrams can be given as a solution to this question. An example is provided below: <b>MS Fig 3</b></p>  <p>Correct diagram Correct labels Temperature compensation Strain gauges are used with other sensors such as diaphragm pressure gauges or load cells but temperature compensation is required.</p>	<p>[1] [1] [1]</p>	

Question		Expected Answer	Mark	Rationale
		<p>Four strain gauges are used connected in the form of a Wheatstone bridge. Gauges 1 and 2 are attached so that the applied force is in tension. Gauges 3 and 4 are in compression. Gauges 1 and 2 will increase in resistance and Gauges 3 and 4 will decrease in resistance. As all the gauges and so all arms of the bridge will be equally affected by any temperature change the arrangement is temperature compensated.</p> <p>Any control system that is using this method will not be affected by temperature change within that system.</p>	<p>[1]</p> <p>[1]</p>	<p>[Total 10]</p>
2	(a)	<p><b>Give two practical applications of the use of a proportional controller.</b></p> <p>Float level Control of temperature batch controller handling weighed, pulsed or timed feeds</p> <p>Accept any two correct responses.</p>	[2]	

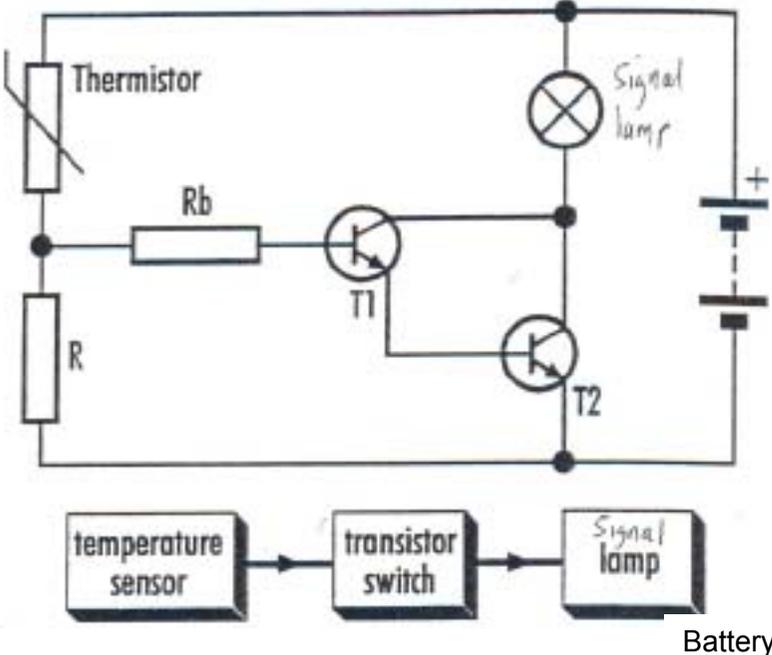
Question	Expected Answer	Mark	Rationale
(b)	<p>The error input to a controller is shown in Fig 3. Sketch a graph of the output for a proportional controller.</p> <p>MS Fig 4</p>  <p>Shape of graph Correct position of vertical Correct position of horizontal</p>	<p>[1] [1] [1]</p>	

Question	Expected Answer	Mark	Rationale
(c)	<p>Describe, in detail, with the aid of a labelled diagram, a float-lever proportional controller.</p> <p><b>MS Fig 5</b></p>  <p>Correct diagram                      Correct labels                      The control mode is determined by the use of a lever.                      The error signal is the input to the ball at point A on the lever                      The output is the movement of the other end of the lever at point B</p>	<p>[1]                      [1]                      [1]</p>	

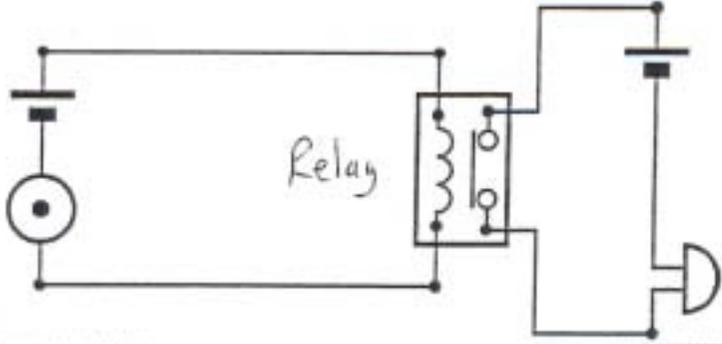
Question	Expected Answer	Mark	Rationale
<p>3</p> <p>(a)</p> <p>(b)</p>	<p>Therefore output movement = error. <math>(x/y)</math>                      The output is proportional to the error and the gain is <math>x/y</math>                      The output from the controller is 0% when the valve is closed and 100% when the valve is open.</p> <p><b>Show, with the aid of block diagrams, the difference between a digital-to-analogue (D to A) converter and an analogue-to-digital (A to D) converter.</b></p> <p><b>MS Fig 6</b></p>  <p>Block diagrams                      The A to D converter has an analogue signal applied to its input terminals which is sampled at regular intervals, and an equivalent digital signal is generated to appear at the output terminals. In an opposite manner, the D to A converter converts an n-bit input digital signal into the corresponding analogue signal.</p> <p><b>Explain why a multiplexer is used with an analogue to digital converter.</b></p> <p>A multiplexer is needed when measurements to be sampled are coming from more than one location.                      A number of analogue signals go into the multiplexer which is fundamentally a switching device with an analogue to digital converter. Each input is considered in turn and then sent to the A to D converter.</p>	<p>[1] [1]</p> <p>[1] [1]</p> <p>[1] [1] [1]</p>	<p>[Total 10]</p> <p>Understanding shown of difference between analogue and digital signals - Award 1 mark</p>

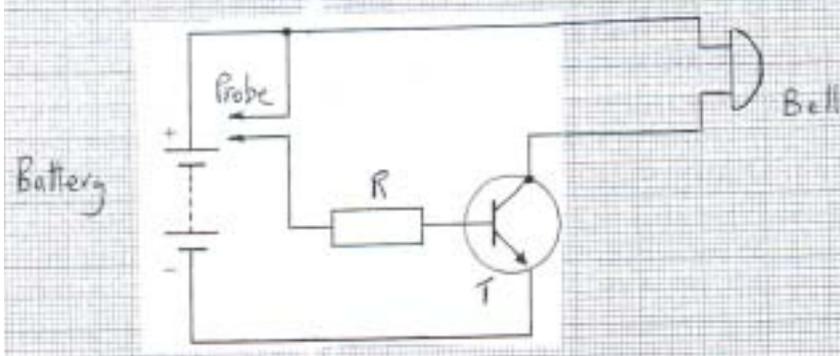
Question	Expected Answer	Mark	Rationale
(c)	<p>Describe, in detail, with the aid of a labelled diagram, the principles of a parallel analogue to digital converter that uses three operational amplifiers in its circuit.</p> <p>MS Fig 7</p>  <p>Correct diagram Correct labels A to D converter also known as a simultaneous or flash converter with a fast operating speed. The three op amps are used as comparators. The threshold voltages are applied to the inverting inputs through a potential divider chain using resistors R1 to R4.</p> <p>The +4 volts is the input or reference voltage to the chain which is the full scale or maximum of input level.</p>	<p>[1] [1]  [1]  [1]</p>	

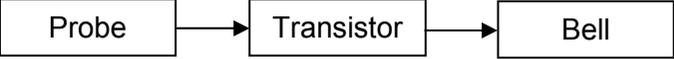
Question		Expected Answer	Mark	Rationale
		<p>When in use, each comparator compares the analogue input voltage with its own particular reference voltage.            The output of each comparator will go high if the input voltage on its positive input is greater than the reference level.            The output is not binary so an encoder is used to convert the data to binary.</p>	[1]	[Total 10]
4	(a)	<p><b>Give two practical applications for a thermistor in a control circuit.</b></p> <p>Fire alarms            industrial heater control            workshop temperature control</p> <p>Accept any two correct responses</p>	[2]	
	(b)	<p><b>The characteristics of a thermistor are shown in the graph in Fig 4.</b>  <b>Fig 4</b></p>		
	(i)	<p><b>Use the graph to read off the resistance of the thermistor at +30 C and -30 C.</b>            1k<math>\Omega</math>            10k<math>\Omega</math></p>	[1] [1]	
	(ii)	<p><b>Use the graph to read off the temperature of the thermistor at 4k<math>\Omega</math>.</b>            0 C</p>	[1]	

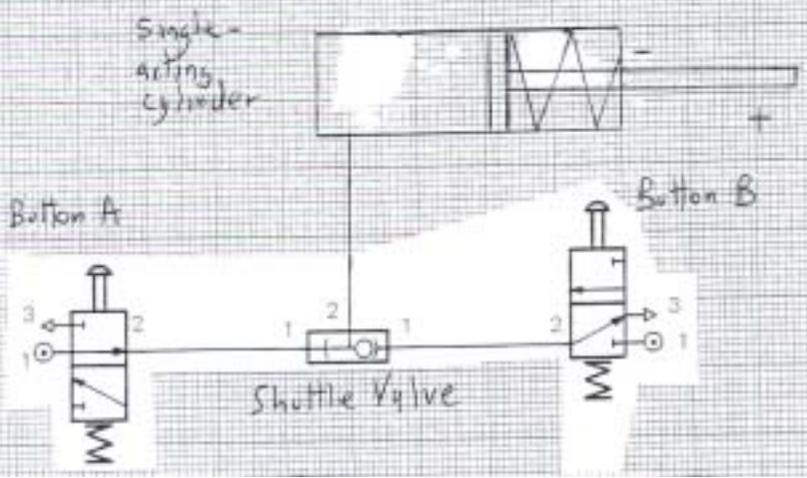
Question	Expected Answer	Mark	Rationale
(c)	<p>Describe with the aid of a labelled block diagram and a labelled circuit diagram how a thermistor can be used in a control circuit. A number of different correct descriptions and diagrams can be given as a solution to this question. An example is provided below:  <b>MS Fig 8</b></p>  <p>Correct block diagram                      Correct circuit diagram                      The resistance of the thermistor NTC decreases when it gets hot.                      Resistor R has a high value.                      During hot conditions the thermistor resistance goes low. Resistance R is high.</p>	<p>[1]                      [1]                      [1]                      [1]</p>	

Question	Expected Answer	Mark	Rationale
	Current will flow through Rb into the base of the first transistor, through the emitter into the base of transistor 2, out of the emitter and to the negative of the battery. The current has been amplified so it will light the signal lamp.	[1]	[Total 10]
5	<p><b>State two features that you would expect to find on an alarm system that is protecting a factory unit.</b></p> <p>Easy to programme alarm panel            LCD remote keypad            Yes or No screen prompts to programme individual settings            Factory preset programming should suit 90% of purposes            Uncomplicated system for adding on any other PIRs or door contacts that might be needed            Accept any two correct responses.</p>	[2]	
(b)	<p><b>Explain why it is often necessary to include a security camera in an alarm System.</b></p> <p>Evidence suggests that a properly installed and managed security camera system can dramatically reduce crime levels.            Drops as high as 90% have been recorded. From the camera a record of the time of an attempted burglary can be found and faces are often seen            which can lead to the arrest of a person and a subsequent court case.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>	

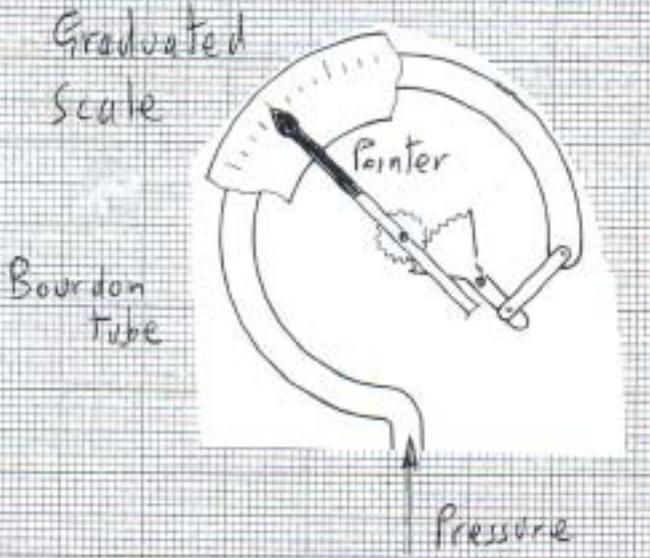
Question	Expected Answer	Mark	Rationale
(c)	<p><b>Describe, in detail, with the aid of a circuit diagram, how an alarm system would operate when a sensor is activated.</b>                      A number of different correct explanations and diagrams can be given as a solution to this question.</p> <p>An example is provided below:</p> <p><b>MS Fig 9</b></p>  <p>Correct diagram                      Correct labels                      When the push is pressed a current flows through the relay coil.                      The coil creates a magnetic field and the iron armature is attracted to it.                      The other end of the armature hits one of the contact terminals and forces it against the other contacts. The circuit is completed and the bell rings.</p>	<p>[1]                      [1]                      [1]                      [1]                      [1]</p>	<p>[Total 10]</p>
6	<p><b>(a) Give the meaning of the term open loop control.</b>                      Open loop control is a linear system and does not have feedback</p>	<p>[1]                      [1]</p>	

Question	Expected Answer	Mark	Rationale
(b)	<p><b>Explain, using examples, the advantages of closed loop control system over an open loop control system.</b></p> <p>With closed loop control:  an operator does not have to intervene in the process once the system has been set up in a negative feedback system the control action is always in the direction to return the system to its desired states  available any undesirable changes in the output are automatically dealt with  positive feedback is sometimes used to improve performance the control action is designed to act against a deviation from the desired value  care must be taken that over compensation does not take place because this could lead to instability within the system</p> <p>Accept any three correct responses.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>	
(c)	<p><b>Describe, with the aid of a labelled block diagram and a labelled circuit diagram how an open loop system can be used as a water level alarm.</b></p> <p>A number of different diagrams can be given as a solution to this question  An example is provided below:  <b>MS Fig 10</b></p> 		

Question	Expected Answer	Mark	Rationale
	 <p>Labelled block diagram Labelled circuit diagram There are three basic blocks. The input device is a moisture probe. The control device is a transistor. The output device is a bell. The input device reacts to changes in the level of the water and when it reaches the predetermined height the control device responds to the change at the input, and reacts by controlling the output. The output device then provides an audible warning.</p>	<p>[1] [1] [1] [1] [1] <b>Total [10]</b></p>	
7	<p><b>(a)</b> <b>State two practical applications that uses a single acting pneumatic cylinder.</b></p> <p>Operating a micro-switch Clamping work to a machine table Opening a valve Door opener – useful at a Zoo with wild animals Removing components from a conveyor belt Holding a rotating shaft brake in the off position</p> <p>Accept any two correct responses.</p>	<p>[2]</p>	
	<p><b>(b)</b> <b>Describe the difference between a single acting cylinder and a double acting cylinder.</b></p> <p>A single acting cylinder has a port at one end only. When compressed air enters the port, the piston rod is pushed out, it goes positive.</p>	<p>[1]</p>	

Question	Expected Answer	Mark	Rationale
	<p>When the air is allowed to escape, the piston rod goes back, it goes negative. The double acting cylinder has a port at each end.</p> <p>When compressed air is allowed to enter the rear port, it moves the piston forward and the rod goes positive.</p> <p>Air in the front port exhausts out of the front port.</p> <p>Likewise, if compressed air is injected through the front port, the piston rod moves back into the cylinder. It goes negative.</p> <p>Air behind the piston exhausts through the rear port</p>	<p>[1]</p> <p>[1]</p>	
<p>(c)</p>	<p><b>Describe, in detail, with the aid of a labelled diagram, how a single-acting cylinder can be controlled from two positions.</b> <b>MS Fig 11</b></p>  <p>Correct diagram Correct labels</p>	<p>[1]</p> <p>[1]</p>	

Question		Expected Answer	Mark	Rationale
		<p>The single acting cylinder is controlled by two 3-port valves and a shuttle valve.</p> <p>When button A is pressed and held down the shuttle valve sends the air from valve A to the single-acting cylinder and closes off the air to the exhaust port of valve B.</p> <p>Inside the shuttle valve is a disc.</p> <p>When an air signal arrives at one side of the shuttle, the disc moves to the opposite side and seals the other inlet.</p> <p>If valve A was released and valve B pressed, the disc in the shuttle would seal the inlet valve and allow air into the single-acting cylinder from valve B.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[Total 10]</p>	
8	(a)	<p><b>Give two practical industrial applications where you may find the uses of a pressure gauge.</b></p> <p>Boiler house system</p> <p>Monitoring the elastic deformation of diaphragms, bellows and tubes</p> <p>Moving the slider of a potentiometer</p> <p>Placed in situations that need a robust instrument</p> <p>For Gases and Low-Viscosity Liquids up to 60 C</p> <p>For corrosive process fluids and atmospheres</p> <p>Accept any two correct applications.</p>	[2]	
	(b)	<p><b>Explain the difference between absolute pressure and gauge pressure.</b></p> <p>Absolute pressure is the pressure measured with respect to zero pressure.</p> <p>Gauge pressure is the pressure as measured by a gauge. That is, the pressure which is in excess of the pressure of the atmosphere.</p> <p>Absolute pressure = gauge pressure + atmospheric pressure.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>	

Question	Expected Answer	Mark	Rationale
(c)	<p>Describe, in detail, with the aid of a diagram, the construction and action of a pressure gauge of your choice.</p>		
	<p>A number of different pressure gauges can be given as a solution to this question.                      An example is provided below:  <b>MS Fig 12</b></p>  <p>Correct diagram                      The Bourdon tube is made from stainless steel or phosphor bronze and is elliptical in cross-section.                      With a circular C shaped tube, when the pressure inside the tube increases the closed end of the C tube opens out. The displacement of the closed end becomes a measure of the pressure.                      The movement of the tube causes a gear wheel to move. On the gear wheel is a pointer.                      The pointer movement is in a direct relationship with the displacement of the tube thus measuring pressure on a graduated scale.</p>	<p>[1]                      [1]                      [1]                      [1]                      [1]  <b>[Total 10]</b></p>	

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