



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**  
**January 2013**

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## **Technology and Design**

**Assessment Unit A2 1**

*assessing*

**Product Design and Systems and Control**

**[AV211]**

**FRIDAY 18 JANUARY, MORNING**

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**MARK  
SCHEME**

## **General Marking Instructions**

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

### **Quality of candidates' responses**

In marking the examination papers, examiners will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

### **Flexibility in marking**

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

### **Positive marking**

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected for 17- and 18-year-old candidates. Conversely, marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

### **Types of mark schemes**

Mark schemes for questions which required candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper.

### **Quality of written communication**

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form.

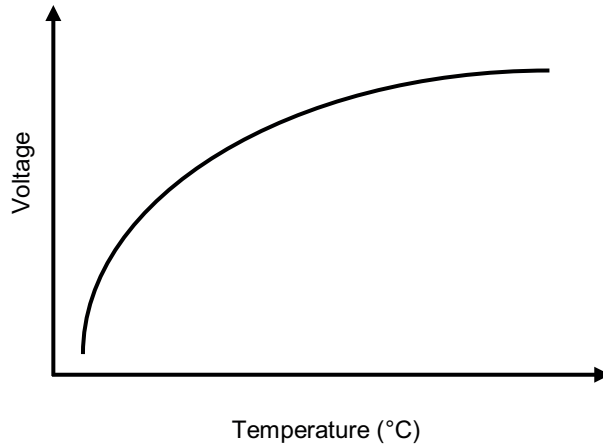
In all cases, correct alternative responses will be given full credit.

AVAILABLE  
MARKS

Section A

1 (a) (i) Main physical property – resistance decreases with rise in temperature [1]

(ii)



Sketch and labelled a graph showing  $V_o$  against temperature. [2]

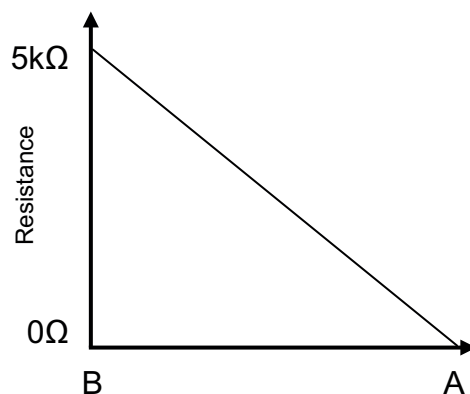
(iii) At  $3.6\text{k}\Omega$   $V_o = 3.68\text{V}$   
At  $4.8\text{k}\Omega$   $V_o = 3.38\text{V}$  [2]

(b) (i) PICs with analogue and digital inputs allow the user to choose between inputs that only read logic signals (logic 1/logic 0) and inputs that can read varying voltage levels. [2]

(ii)  $51 = 1\text{V}$  and  $153 = 3\text{V}$  [2]

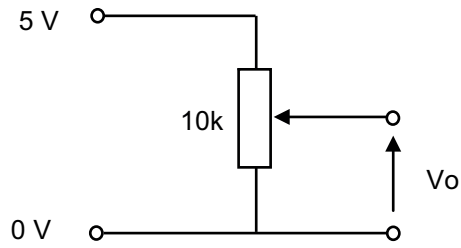
(iii) The digital input will only recognise voltages from voltage divider output  $V_o$  close to  $5\text{V}$  (logic 1) and  $0\text{V}$  (logic 0) i.e. when the resistance of the thermistor is very high or very low. [2]

(c) (i) Graph with labelled axis



[2]

(ii)

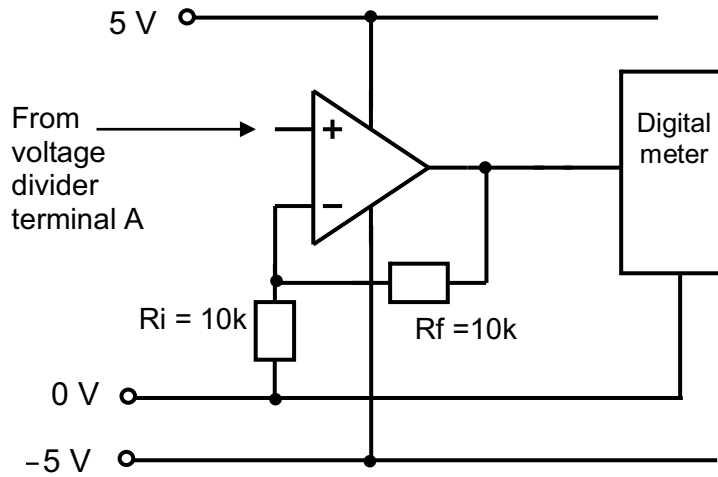


[1]

(iii) 50 mV for 0.1 mm to give 100 mV therefore Gain = 2

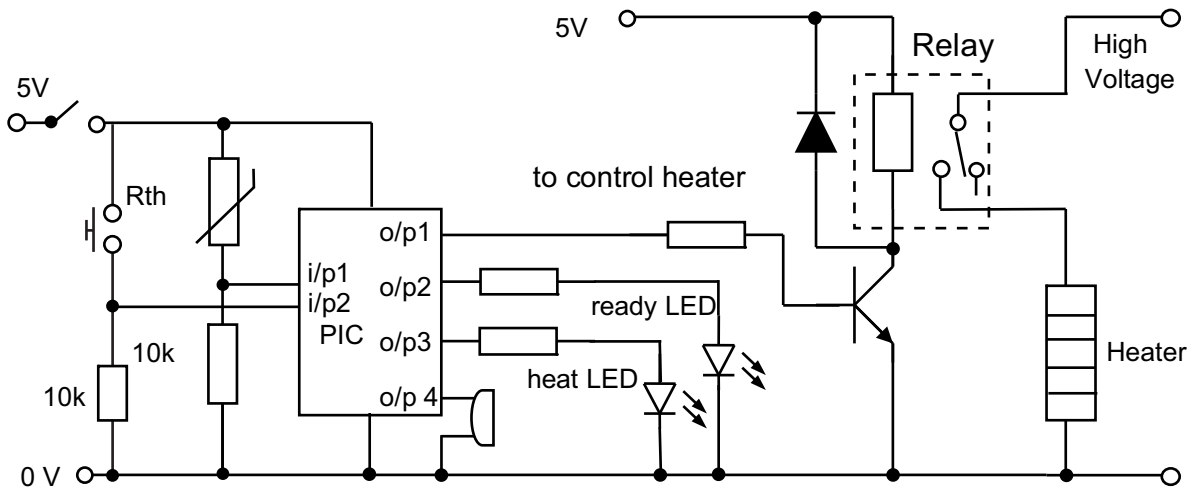
[3]

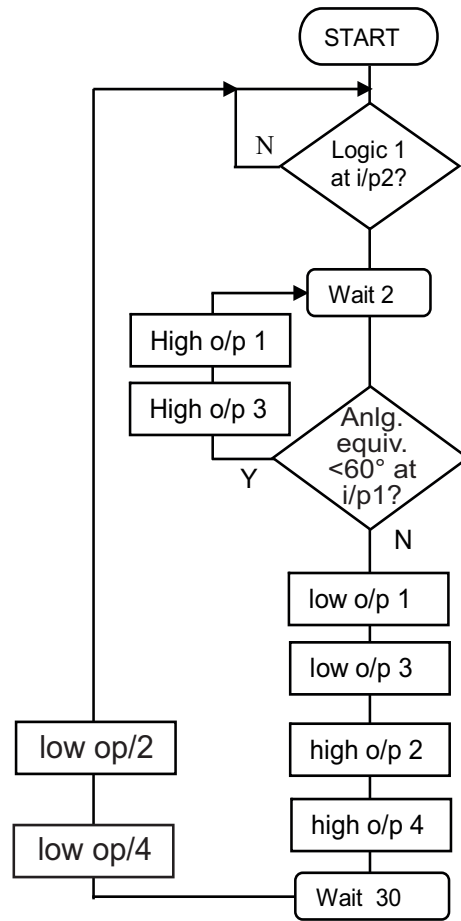
(iv)



[4]

(d) Possible answer





[10]

(e) Answer likely to refer to the following:

Loops:

- are used to direct flow to repeat functions using lines with arrowheads showing the direction of flow.
- will continuously repeat unless an instruction is included to prevent otherwise.

Subroutines:

- can be used to repeat functions that can contain a number of actions.
- can be 'called' at any point in a main program.
- can have any number of subroutines with identifying labels.
- at the end of the subroutines flow can be directed back to main program.

Possible example:

Loop – used to perform repeat checks on an input switch.

Subroutine – reading an analogue input switch out of several several options has been pressed one of a number of different output set up. [5]

Quality of written communication:

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MARKS

Level of response not worthy of credit	[0]
Poor selection and use of a writing form and style appropriate to the content. The content is poorly organised and little use is made of appropriate Technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation is inaccurate.	[1]–[2]
Good selection and use of a writing form and style appropriate to the content. The content is organised and use is made of appropriate Technological vocabulary. The writing is legible and the spelling, grammar and punctuation is accurate.	[3]
Very good selection and use of a writing form and style appropriate to the content. The content is well organised and good use is made of appropriate Technological vocabulary. The writing is clearly legible and the spelling, grammar and punctuation is very accurate.	[4]

[4]

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**2 (a) (i)** Reed switch  
Drawing showing magnet and switch [2]

**(ii)** No requirement for positional or speed control therefore simple directional control circuitry only required.  
No hold current required when motor is not moving therefore more energy efficient. [2]

**(b) (i)** The clock input to a binary counter controls the frequency of the counter increment. [2]

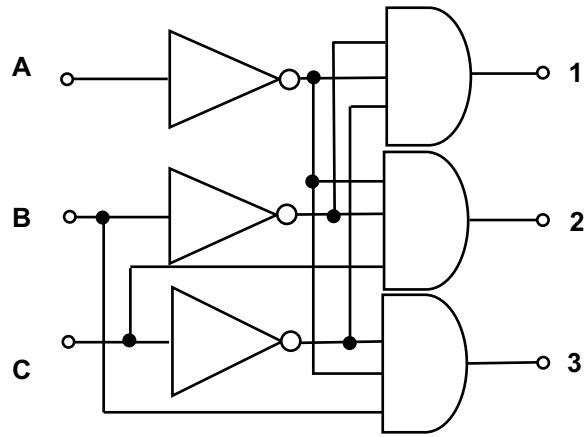
**(ii)** Possible circuits to include a PIC and associated program or an astable timer circuit with appropriate component values. [4]

**(iii)** Truth table

A	B	C	1	2	3
0	0	0	1	0	0
0	0	1	0	1	0
0	1	0	0	0	1
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	0	0	0

[4]

(iv)



[3]

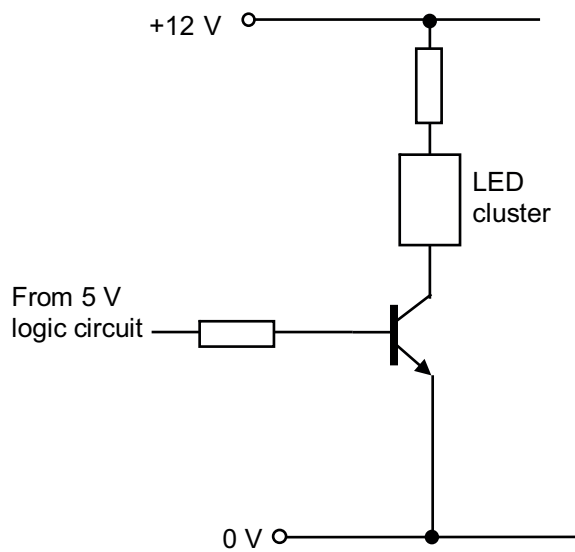
(c) (i)  $12\text{ V} - 4.4\text{ V} = 7.6\text{ V}/20\text{ mA} = 380\text{ ohms}$

[2]

- (ii)
- High visibility required for warning triangle even in bright daylight LEDs perform better than LCDs under these conditions.
  - Triangle will be subjected to shock/knocks – LEDs have good resistance to this type of loading. LCDs require extra layers to protect.
  - LEDs have wide viewing angle – important for the warning triangle. LCDs have limited viewing angle.

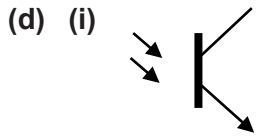
[2]

(iii)

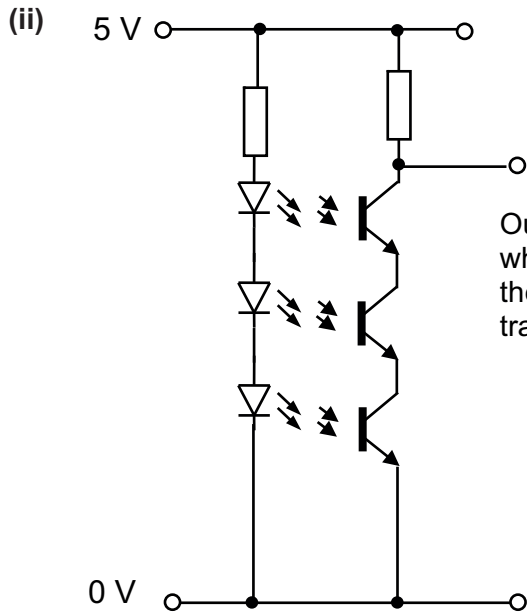


[3]

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MARKS



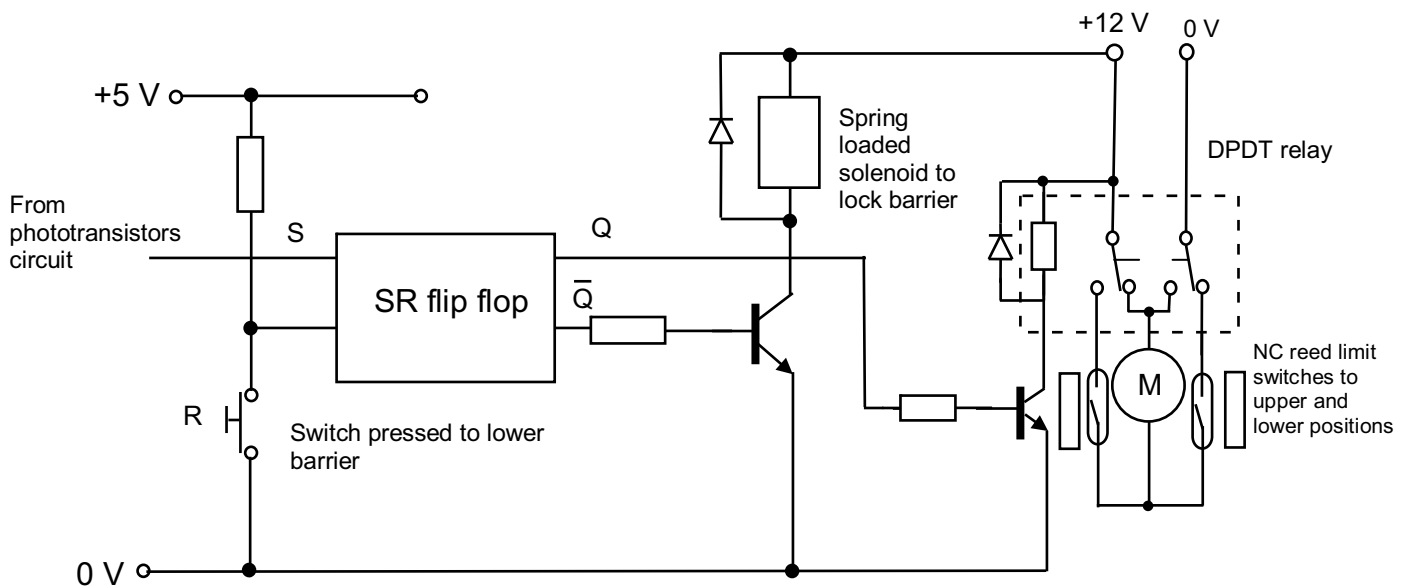
[1]



Output will go low only when IR light falls on the base of all 3 transistors.

[5]

(e) Possible circuit:



[10]

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AVAILABLE MARKS



**Section B: Mechanical**

**AVAILABLE  
MARKS**

**3 (a) (i)** Knife edge [1] Sketch [1]  
**Or** Roller [1] Sketch [1]  
**Or** Offset [1] Sketch [1] [2]

**(ii)**  $P = T\omega$   
 $\omega = 2\pi \times 180/60 = 18.84 \text{ rad/s}$  [1]  
 $P = 18.84 \times 2.25 = 42.39 \text{ W}$  [2] [3]

**(b) (i)** Static Friction – before something slides the friction force is at maximum limited friction. Before sliding the force trying to cause sliding and the friction force remain equal to each other.

Dynamic Friction – the friction force required to maintain movement is less than the static friction. [2]

**(ii)** Annotation  
 Outer drum and brake lever.  
 Inner linings and brake shoes.  
 Spring and activation method. [4]

**(c)** Explanation of how lubricants are classified, e.g. by various groups and viscosity index [1]

Factors when selecting a lubricant – any **two** from the following:

- Viscosity.
- Operating conditions/Environment.
- Transmission of Power.
- Temperature.
- Or other suitable answer. [2]

Specific Applications – any **two** from the following:

- Engine Oil.
- Gearbox Oil.
- Brake Fluids.
- Hydraulic Oil.
- 2-Stroke Oil for smaller Motors.
- Or other suitable answer. [2]

Quality of written communication

Level of response not worthy of credit	[0]
Poor selection and use of a writing form and style appropriate to the content. The content is poorly organised and little use is made of appropriate Technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation is inaccurate.	[1]–[2]
Good selection and use of a writing form and style appropriate to the content. The content is organised and use is made of appropriate Technological vocabulary. The writing is legible and the spelling, grammar and punctuation is accurate.	[3]
Very good selection and use of a writing form and style appropriate to the content. The content is well organised and good use is made of appropriate Technological vocabulary. The writing is clearly legible and the spelling, grammar and punctuation is very accurate.	[4]

[4]

- (d) (i)
- 0–150 rise 60 mm with uniform acceleration and retardation
  - 150–240 fall by 20 mm with uniform velocity
  - 240–360 fall 40 mm with simple harmonic motion

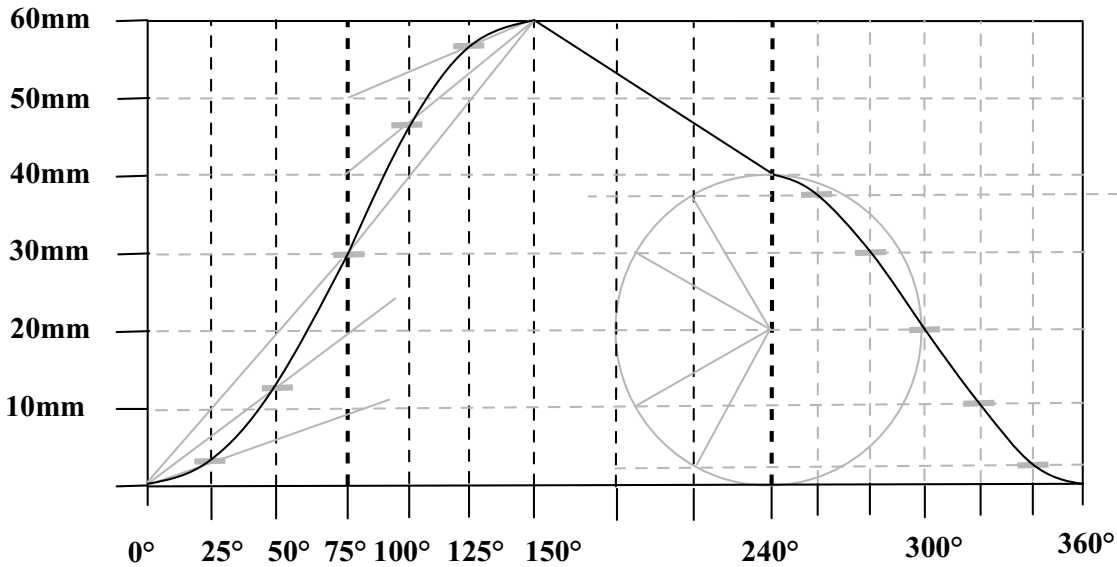


Fig. 3(d)(i) [5]

(ii) See pro forma sample answer Fig. 3(d)(ii) [5]

- (e) Sample Answer:  
 Taper Bearing – sketch and annotation showing the key features of the bearing and housing design.  
**Or**  
 Double Taper Bearing – sketch and annotation showing the key features of the bearing and housing design.  
 Fixing to chassis member. [5]

Sample Answer:  
 Universal Joint – sketch and annotation showing the key features of the joint and details of securing to shaft. [5]

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- 4 (a) Any **two** from the following:  
 • Air pipes not secured.  
 • Air leaks.  
 • Hands/fingers trapped in moving parts. [2]

(b) (i) The circuit operates as follows:  
 When Valve A is activated a signal is sent to the 1:4 side of the 5PV which sends the DAC positive. The exhaust air from DAC activates Valve B by overriding the force created at the 12 side of the 3PV to allow air to flow to the 12 side of 5PV which is operated. [4]

(ii)  $W = F \times L$   $300 \times 0.20 = 60 \text{ J} - (20\%) = 48 \text{ J}$ . [2]

(iii)  $F = P \times A$  Total force = 3799.38 N  
 $3799.38 \text{ N} = 0.4 \times A$   
 $9498.45 = A$   
 55 mm = radius. [4]

- (iv) A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

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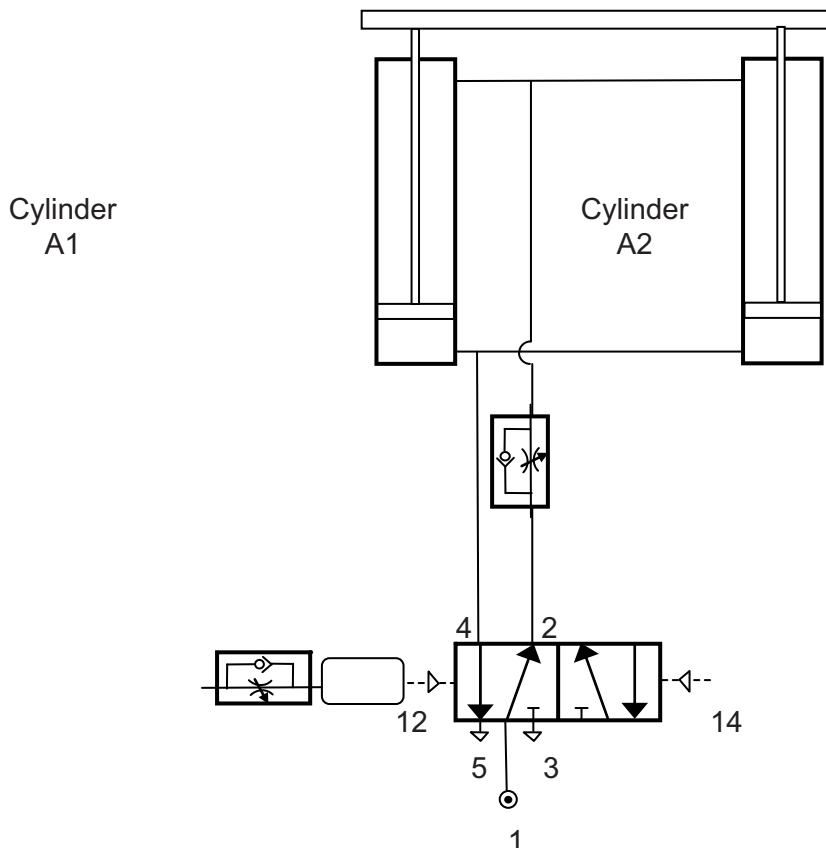
Suitable Application: Motion Sensor [2]

- (c) (i) Start base of SPV [1]  
 Method of activating cylinder A1 A2+ [1]  
 Method of activating cylinder B1 B2+ [1]  
 Method of activating cylinder C1 C2+ [1]  
 Method of activating Time Delay and Cylinder G- [4]  
 Method of activating cylinder A1 A2- [1]  
 Method of activating cylinder B1 B2- [1]  
 Method of activating cylinder C1 C2- [1]  
 Method of activating Cylinder G+ [1]  
 Emergency Stops and relevant pipes [3]  
 Piping of cylinders in tandem [1]

(See sample answer below).

- (ii) • A time delay and speed control on each box as it was discovered that they were emptying too fast, thus damaging the potatoes. The answer must involve the minimum number of components. [4]

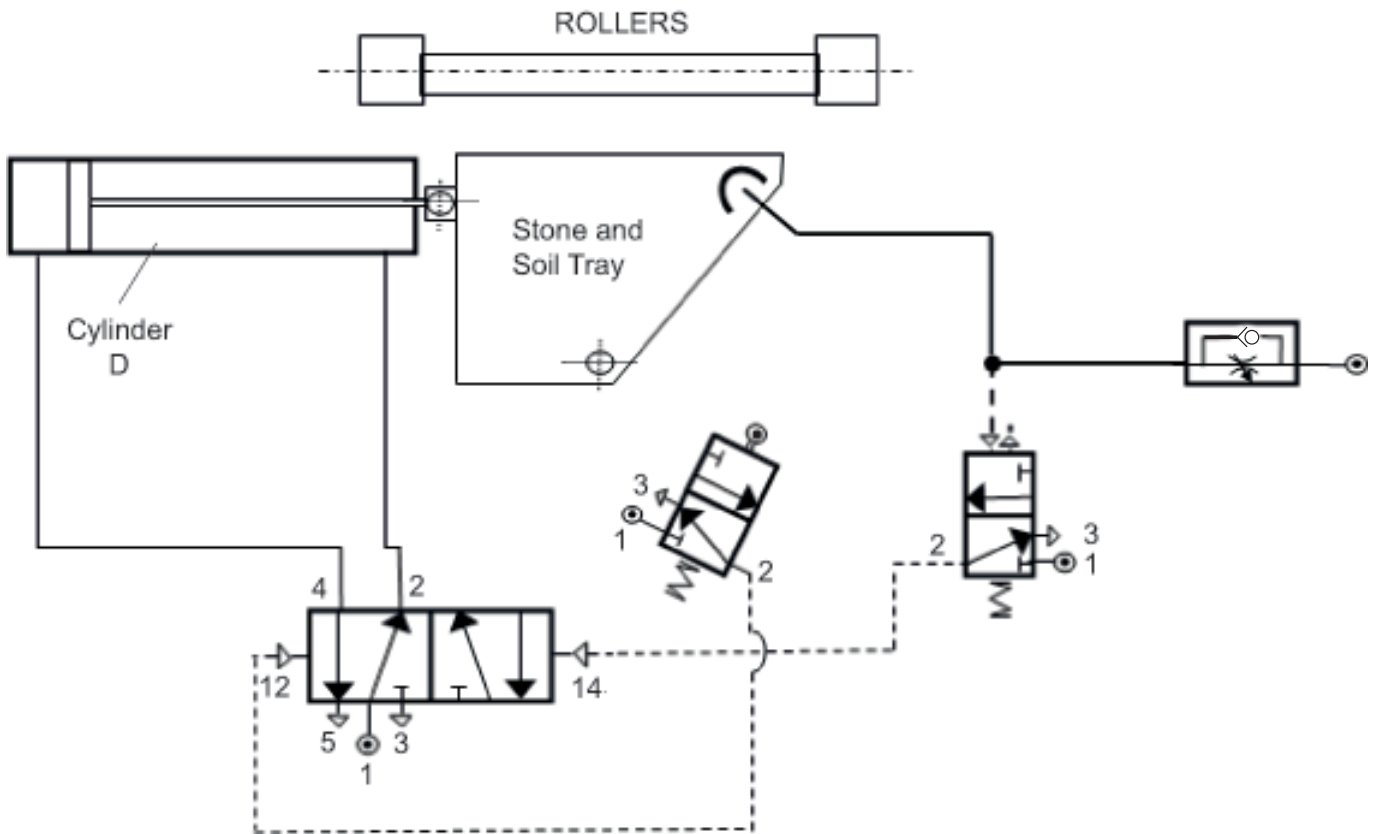
Sample answer:



- A pneumatic system that automatically detects that the stone and soil tray is full, then automatically empties the tray leaving it in position for future use. [6]

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Sample answer:



## Section C

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MARKS

- 5 (a)** A fad product has a short life cycle. The introduction, growth, maturity and decline happens over a short period of time. It is typically a style that is adopted by a particular sub-culture or younger demographic group in this short period of time. [2]  
Other suitable answers considered.
- (b) (i)** Aspects of a product which represent a significant leap forward in the use of materials or processes or systems, e.g. The introduction of Hybrid car/electric/petrol. [2]  
Other suitable answers considered.
- (ii)** Stepped changes or improvements or additional features, e.g. Mobile phone – incremental developments – camera/Internet/MP3 and MP4. [2]  
Other suitable answers considered.
- (c) (i)** The main aspects associated with a product clinic:  
  
A product clinic is an office or allocated space where potential purchasers/consumers are asked to meet to discuss and evaluate the features and attributes of an existing product or a prototype of a proposed product. [2]  
Other suitable answers considered.  
  
The main aspects associated with a fixed consumer panel:  
  
Fixed consumer panels are a selected group of people, male and female, representing the product's target audience. This panel will not change in personnel and will give feedback on existing and proposed new products. [2]  
Other suitable answers considered.
- (ii)** The main factors associated with cost-plus:  
  
This involves estimating the average cost of producing and marketing a product (designing, manufacturing, packaging) and adding a mark-up for profit. [2]  
Other suitable answers considered.  
  
The main factors associated with Contribution pricing:  
  
This involves similar steps outlined in the cost-plus but is a much more sophisticated version. This is because it takes account of the variation in costs of production at different levels. Charts are used to show the break-even at various levels of sales. [2]  
Other suitable answers considered.  
  
The main factors associated with perceived value:  
  
Perceived value is a pricing method based on market research. This research will establish what customers think a product is worth drawn from comparison with other products and the range of functions which it offers. [2]  
Other suitable answers considered.

(d) Example: Smart car

Description and justification as follows:

- Components designed to be recycled or reused.
- Application of green and efficient technology to the car reducing emissions.
- Design of components to be dual purpose reducing component count saving on materials and processes.
- Use of non-toxic materials – kinder to the environment.
- Improvements on manufacturing processes and methods of assembly improving efficiency.
- Minimise transportation of materials to plant – reducing carbon footprint.
- All processes and assembly regionally based – reducing carbon footprint.
- Product life-cycle consideration of life time use and eventual disposal/ recycling reducing material use and improving efficiency. [5]

Other suitable answers considered.

Quality of written communication:

Level of response not worthy of credit	[0]
Poor selection and use of a writing form and style appropriate to the content. The content is poorly organised and little use is made of appropriate Technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation is inaccurate.	[1]–[2]
Good selection and use of a writing form and style appropriate to the content. The content is organised and use is made of appropriate Technological vocabulary. The writing is legible and the spelling, grammar and punctuation is accurate.	[3]
Very good selection and use of a writing form and style appropriate to the content. The content is well organised and good use is made of appropriate Technological vocabulary. The writing is clearly legible and the spelling, grammar and punctuation is very accurate.	[4]

[4]

(e) Any **five** from the following:

- James Dyson is one of the most successful products designers in the UK.
- Emphasis on the importance of prototyping with over 5000 prototypes for the world’s first bagless vacuum cleaner.
- An expanding product range to include washing machine, fans, dryers and ballbarrows.
- Adopt technologies from other disciplines to incorporate into new products.
- Focus on form/function/ergonomics and aesthetics in order to develop consumer products.
- His designs have inspired and influenced other manufacturing in product designs.
- Created a design foundation with a focus on design education. [5]

Other suitable answers considered.

(f) On the blank A3 pro forma provided (answer number **5(vii)**) produce one suitable solution for each of the following:

- An annotated rendered sketch of an innovative and appealing design for the front of the box which would communicate to the customer that one minute of wind-up provides twenty minutes of playback.

Level of response not worthy of credit	[0]
Sketches lacking detail, rendering and annotation. Difficulties in deciding if the proposal is appropriate.	[1]
Sketches, rendering and annotation is limited. The design is appropriate but does not fully represent an innovative and appealing proposal.	[2]
Detailed rendered sketches and appropriate annotation. The design represent an innovative and appealing proposal.	[3]–[4]

[4]

- Annotated sketches of a modification to the design above which would minimise the packaging material and wasted packaging space but still provide adequate protection to the product. In your answer provide a justification for your design and explain how the environmental impact of producing the packaging could be minimised.

Level of response not worthy of credit	[0]
Sketches lacking detail and no explanation. Difficulties in deciding if the design is appropriate in trying to minimise material/space and provides protection	[1]–[2]
Sketches and explanation are limited. The design is appropriate but does not fully minimise material/space and provides protection	[3]–[4]
Detailed sketches and an appropriate explanation. The design minimises material/space and provides protection	[5]–[6]

[6]

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Points to consider:

- Reducing size of polystyrene housing for the radio.
- Battery removed and placed in radio housing with non contact ribbon.
- Reduce the micron of the box (sleeve).
- Remove box and replace with sleeve.
- Reduced A4 and colour to A5 black and white.
- Use recycled and locally sourced whiteboard.
- Use environmentally friendly inks and printing processes.

Other suitable answers considered.

- 6 (a) (i) Research needs to be valid, reliable and representative to ensure that there is a need for the product, that the designer will design what the customer needs/wants and that the product can be produced and sold at a suitable price and quantity to meet the requirements of all parties concerned. [2]  
Other suitable answers considered.
- (ii) Market analysis – This involves monitoring and forecasting sales, identifying target markets, defining the characteristics of the market and looking for new ideas. [2]  
Other suitable answers considered.
- Product research – Involves assessing the products acceptance, determining what the customers preferences are and carrying out packaging trials. [2]  
Other suitable answers considered.
- Distribution research – This research identifies the best sales outlets and monitors sales through the distribution channels used. [2]  
Other suitable answers considered.
- (b) Any **four** from the following:
- CAD used to provide a 3D view of the product for customer viewing.
  - CAD used to produce technical details for production.
  - CAD used in virtual modelling for consumer panel views.
  - CAD used to determine aesthetics quality.
  - CAD used to determine ergonomics. [4]
- Other suitable answers considered.
- (c) (i) • Publicity – adverts on television, articles in magazines and promotion on the Internet could help promote the product. Press releases and sponsored events may also be used
- Personal selling – Individuals could be used to call with shops, retailers to promote and provide literature on the product.
  - Sales promotion – introductory offers for wholesalers and retailers. Discount on quantity, free in-store promotional and display material.
  - Exhibitions and trade fairs – The product could be promoted at exhibition (Ideal Home) or trade fairs across the country at relevant venues. [4]
- Other suitable answers considered.
- (ii) Any **two** from the following:
- Geographical markets – internationally and regional.
  - Standards and regulations can be a barrier to some international trade areas.
  - Different cultures have preference in different countries.
  - Physical placing – getting the product to the customer when it is required. [4]
- Other suitable answers considered.



**(d) Example 1:**

Plug kettle in the wall outlet, pour the water up to minimum mark, turn the kettle on. Verify that the kettle auto turned off and the water temperature is equal to or greater than 100 °C. Repeat for maximum mark level. This should be repeated a number of times in ensure accuracy of results.

**Example 2:**

Pour water up to the maximum level in the kettle, then transfer water into external measured container to verify that maximum mark indicates the correct litres according to specification. Repeat the exercise for each of the intervals shown on the scaled window of the kettle.

**Example 3:**

Plug kettle in the wall outlet, pour water into the kettle up to the maximum mark, turn it ON. Repeat 100 times. Verify that on average it boils the water in the time recorded in the specification. Different water supply temperature could be used to gain data.

**Example 4:**

Plug kettle in the wall outlet, remove kettle from the foundation and drop base into the water container. Verify that fuse box disconnected electricity, again no fire, electric shock, etc. [4]

Other suitable answers considered.

**(e) (i) Example 1:**

Car seats – national government introduce legislation regarding the need for child seats and buster seats and the way they needed to be connected into the existing seat belt arrangement.

**Example 2:**

Car design – legislation on exhaust emissions has resulted in the design and fitting of catalytic converters. [4]

Other suitable answers considered.

**(ii) Example:**

Eco-labelling – consumer product, e.g. fridges, washing machines. This system rates the energy efficiency of the product and uses a sticker or label on the product for the consumer to clearly see. [2]

Other suitable answers considered.

(f) (i) Explanation on the production [5]

Level of response not worthy of credit	[0]
Sketches lacking detail and annotation. Difficulties in deciding if the design is appropriate for manufacture in plastic in very large numbers	[1]–[2]
Sketches and explanation are limited. The design will allow the user to remove the plug and can be manufactured	[3]
Detailed sketches and an appropriate explanation. The design clearly enables the user to remove the plug and is suitable for manufacture in large numbers	[4]–[5]

- Annotated sketches to show what changes you would make to the prototype kettle tipper so that it could be manufactured in plastic in very large numbers. [5]

Level of response not worthy of credit	[0]
Sketches lacking detail and no explanation. Difficulties in deciding if the design is appropriate for the plug and manufacture	[1]–[2]
Sketches and explanation are limited. The design will allow the user to remove the plug and can be manufactured	[3]
Detailed sketches and an appropriate explanation. The design clearly enables the user to remove the plug and is suitable for manufacture	[4]–[5]

AVAILABLE MARKS

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**Total**

**80**

