



ADVANCED
General Certificate of Education
January 2014

Technology and Design

Assessment Unit A2 1

assessing

**Systems and Control and
Product Design**

[AV211]

TUESDAY 14 JANUARY, MORNING

**MARK
SCHEME**

General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

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

AVAILABLE MARKS

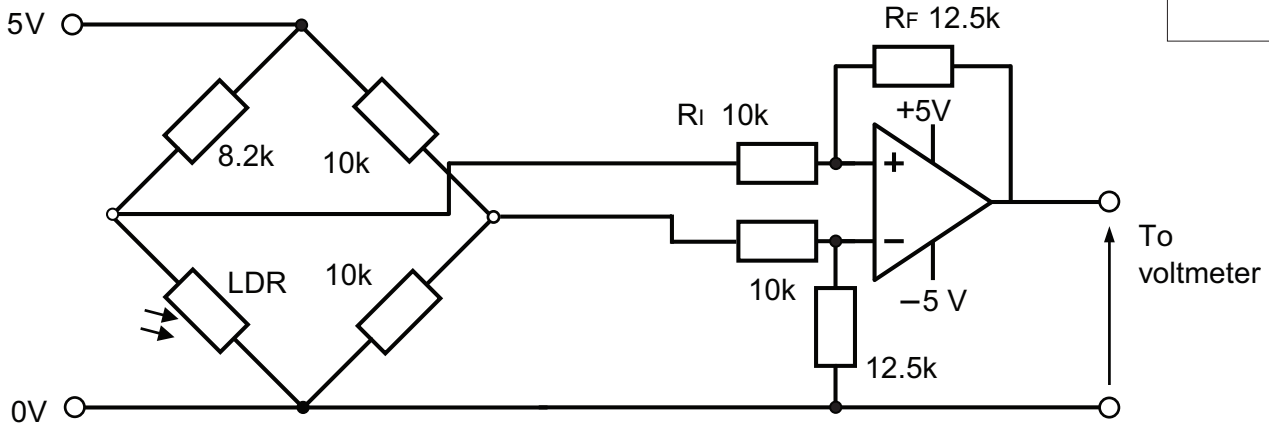
Section A

1 (a) (i) The resistance of an LDR will decrease as the light level increases. [1]

(ii) For LDR resistance 180Ω $V_o = 0.11V$
 For LDR resistance $180k \Omega$ $V_o = 4.8V$ [2]

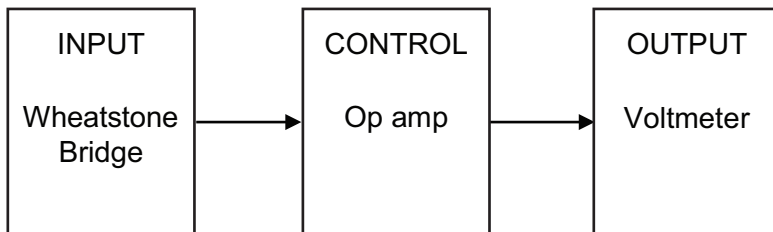
(b) (i) Gain = $1/0.8 = 1.25$ [2]

(ii)



[4]

(iii) Block diagram



[3]

(iv) Consideration to be given to the following:
 • LDRs do not have a linear characteristic.
 • Any ambient light 'contamination' will affect the readings. [2]

(v) Drawing and description of suitable alternative such as an infrared LED and phototransistor.

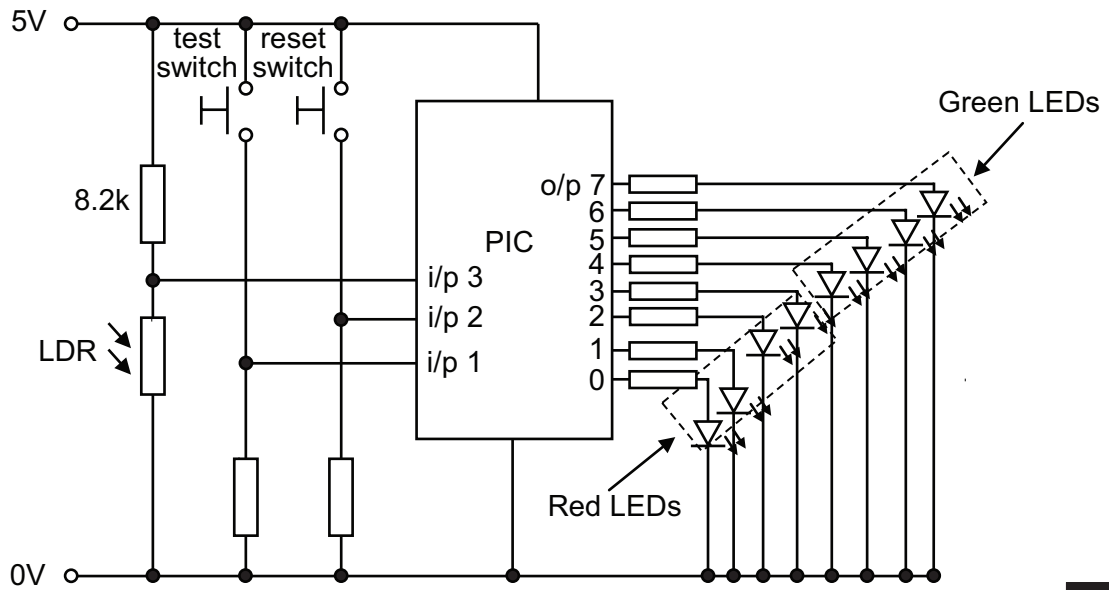
drawing [2]
 description [1] [3]

(c) (i) Analogue I/O refers capacity for input pins of a PIC to operate with analogue signals. Digital I/O refers to signals that are either Logic 1 or Logic 0. [2]

(ii) At 1.6 volts digital value will be 163
 At 1.8 volts digital value will be 184 [2]

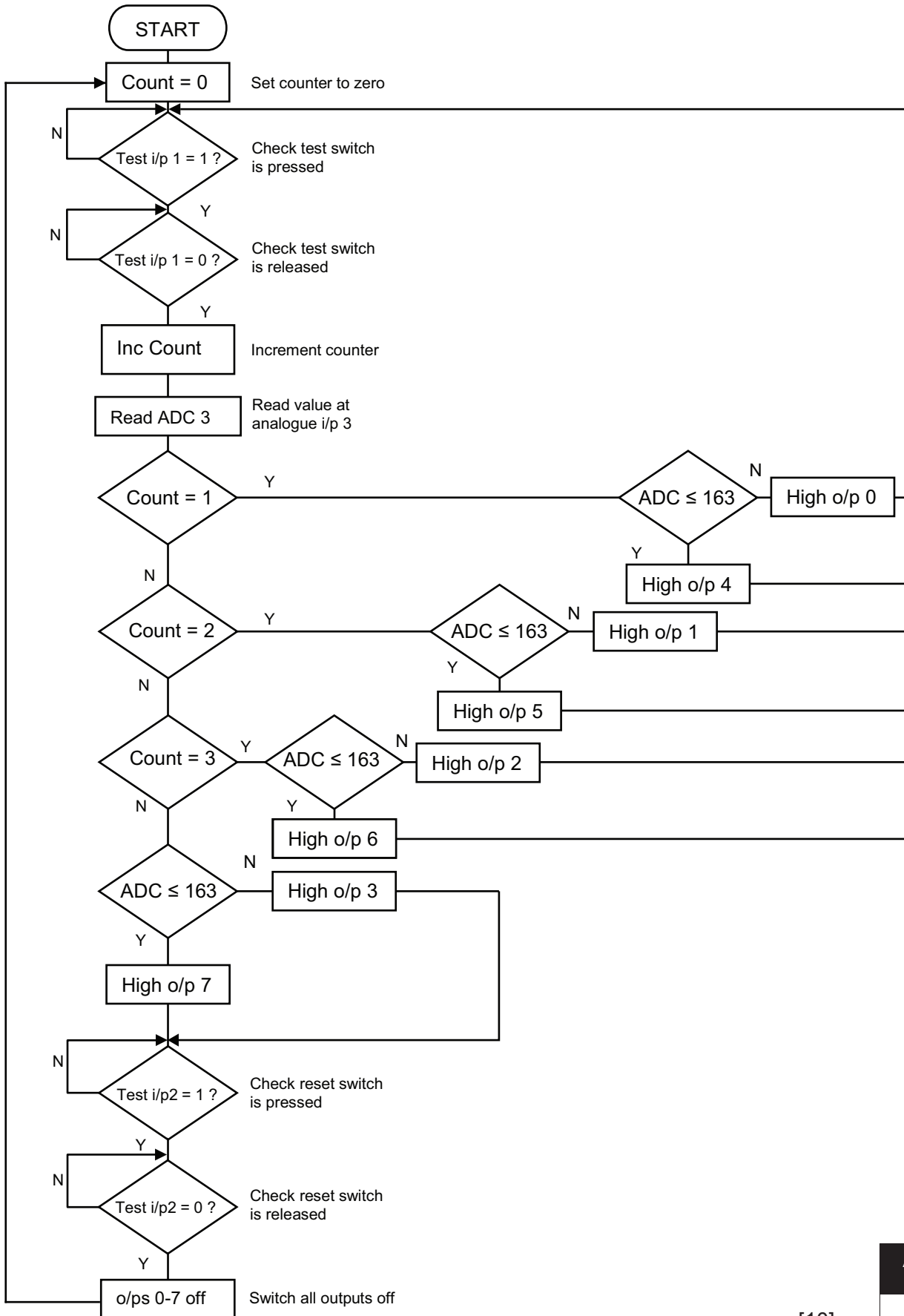
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(d) Sample answer



AVAILABLE MARKS

Sample flow chart



[10]

AVAILABLE MARKS

- (e) Sample answer to include a structured and coherent written discussion with reference to any three of the following factors:
- 1 Output current capacity which is typically limited to under 40 mA will necessitate the use of a transistor or transistor and relay to switch high current output components.
 - 2 The supply voltage is typically between three and five volts which requires the design of secondary circuits to drive output components requiring higher voltages.
 - 3 PIC inputs tend to float and therefore require pull down or pull up resistors when using switches as inputs.
 - 4 Output components with high 'start up' current loads can cause a PIC to reset therefore 'reservoir' capacitors are required at the power supply.
- [3]

Two specific examples [2] [5]

For a 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 are 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 are 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 are very accurate.	[4]

Quality of written communication [4]

40

2 (a) (i)

A	B	C	Green	Red
0	0	0	1	0
1	0	0	1	0
0	1	0	1	0
1	1	0	1	0
0	0	1	1	0
1	0	1	0	1
0	1	1	1	0
1	1	1	0	1

[3]

(ii)

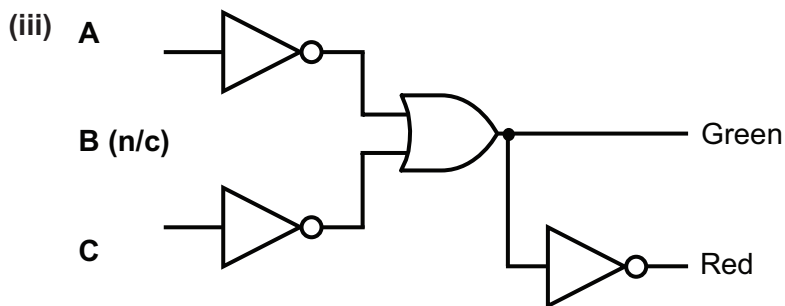
AB \ C	00	01	11	10
0	1	1	1	1
1	1	1	0	0

Green = $\bar{C} + \bar{A}$

AB \ C	00	01	11	10
0	0	0	0	0
1	0	0	1	1

Red = AC

[4]

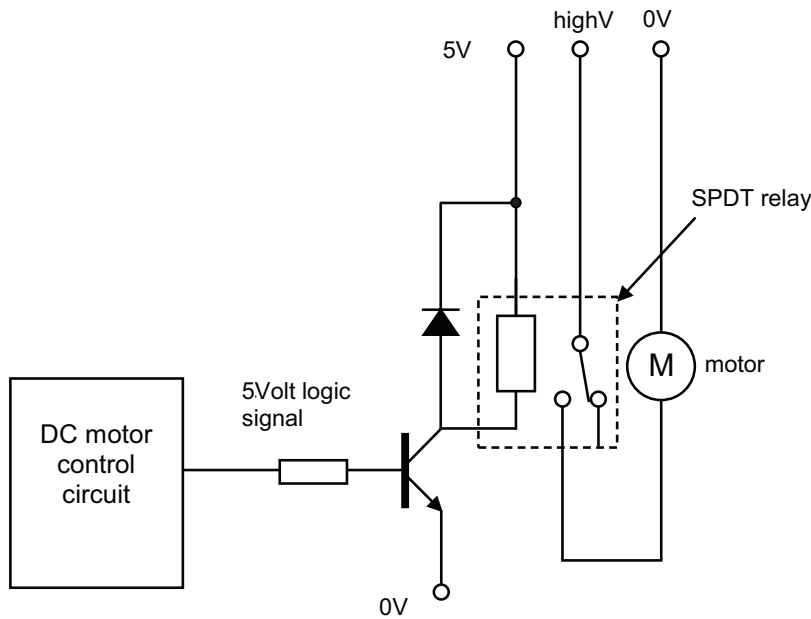


[2]

- (b) (i) No speed control necessary – DC only requires a simple on or off control system.
 No positional or directional control necessary therefore complex circuitry is not required. [2]

(ii) Sample answer

AVAILABLE MARKS



[3]

(c) (i) Common Cathode because each cathode has been connected together. [2]

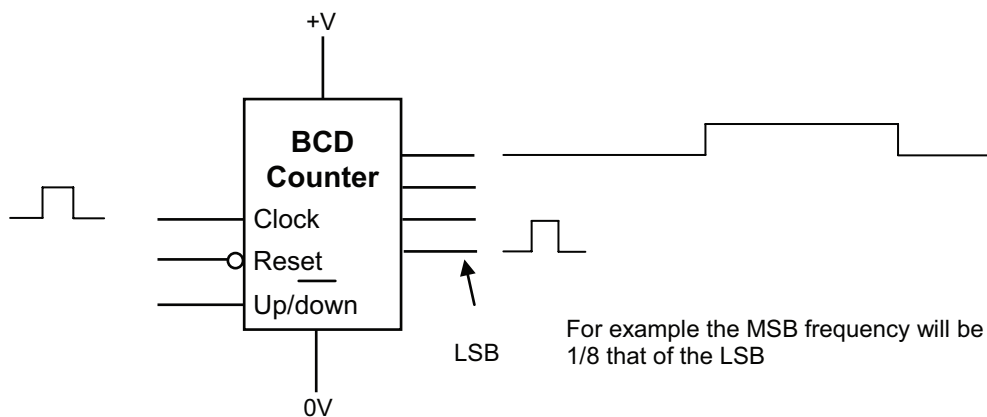
(ii) $12 - (2.2 \times 3)/0.01 = 540$ ohms [2]
 $5.4 \times 0.01 = 54\text{mW}$ therefore 0.125 watt suitable [2] [4]

(iii) $6.6 \times 0.01 \times 7 = 0.462$ watts [2]

(d) (i) Binary outputs refers to the only 2 possible logic states for each of the outputs on the up/down counter. [2]

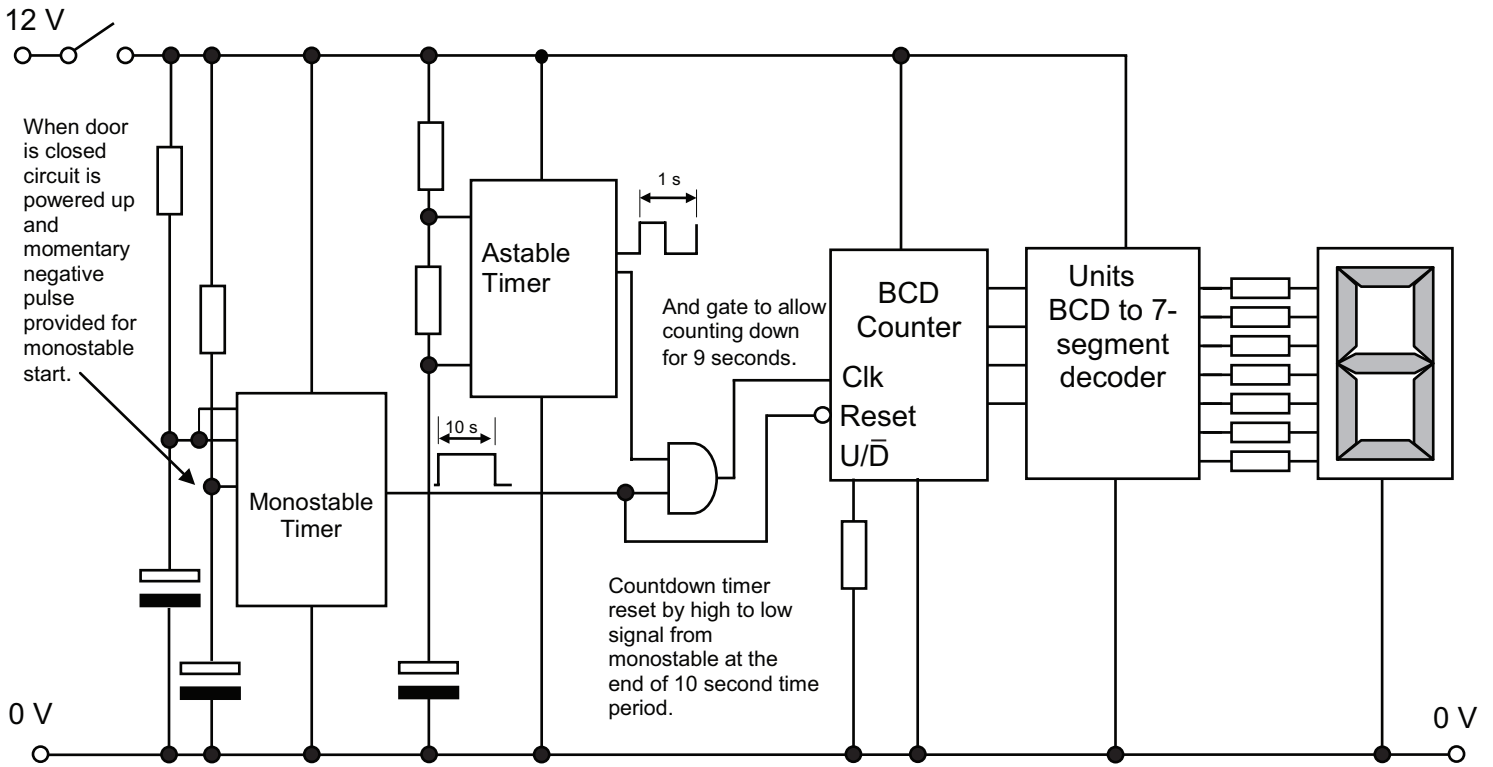
(ii) LSB refers to the least significant binary output i.e. the binary output that gives the 'units' value. [2]

(iii)



[4]

(e) Sample hard wired solution. (correct PIC based alternatives will be accepted)



[10]

Section A

AVAILABLE MARKS

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Section B

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MARKS**

- 3 (a) (i)** Any **two** from the following:
 – guards around moving parts.
 – zones.
 – signs. [2]
- (ii)** Answer:
 Gain in PE = mgh
 1981.5 kJ = 85 × 9.82 × ?
 85 × 9.82 = 834.7
 1981.5/834.7 = 2.37 m [3]
- (iii)** Answer:
 P = work/time
 P = 6000N × 6.2 m/30sec
 P = 1240W
 P = 1240 × $\frac{100}{80}$
 P = 1550 W [4]
- (b) (i)** A simple pulley system contains one pulley and is used on simple lifting systems. [1]
 A compound pulley system contains a range of fixed and moveable pulleys that provide greater mechanical advantage. [1] [2]
- (ii)** Ans = Use of a ratchet and pawl mechanism with suitable drawing showing incorporation with pulley. Pawl locks down onto ratchet and prevents the cable moving.
 ratchet [1]
 pawl [1]
 engage/disengage mechanism [1]
 incorporation with pulley [1]
 explanation [1] [5]
- (c) One advantage and disadvantage of disc brakes**
advantage – Any of the following:
 – Effective dissipation of heat.
 – Any slots on the disc area induce additional cooling.
 – Are more aerodynamic.
 – Disc brakes work better after exposure to rain and puddles, as the vertical disc is almost “self-dripping”. [1]
disadvantage – Any of the following:
 – Are more expensive.
 – Difficult to get an efficient parking brake using disc brakes. [1]
- One advantage and disadvantage of band brakes**
advantage – Any of the following:
 – Simple to manufacture.
 – Reasonably compact.
 – Can generate high force with a light input force. [1]
disadvantage – Any of the following:
 – Band brakes are prone to grabbing or chatter.
 – Lose brake force when hot.
 – Have limitations for their applications. [1]
 Justification of Disc Brake i.e. more efficient [1] [5]

For a response not worthy of credit.	[0]
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Quality of written communication [4]

(d) Bearing Selected: Roller Bearing

- Drawing of bearing – outer race/inner race roller and cage [2]
- Housing – recess for bearing [1]
- Secure the bearing – grub screw and flat [1]
- Provision for lubrication – drilled hole with dust cap [1] [5]

- (e) (i)** Suitable method of opening and closing the elevator doors attached from the top i.e. rack and pinion/screw thread with adequate attachments [5]

Sample Drawing: **Rack and Pinion Mechanism with double racks (top and bottom) Attachments clearly shown**

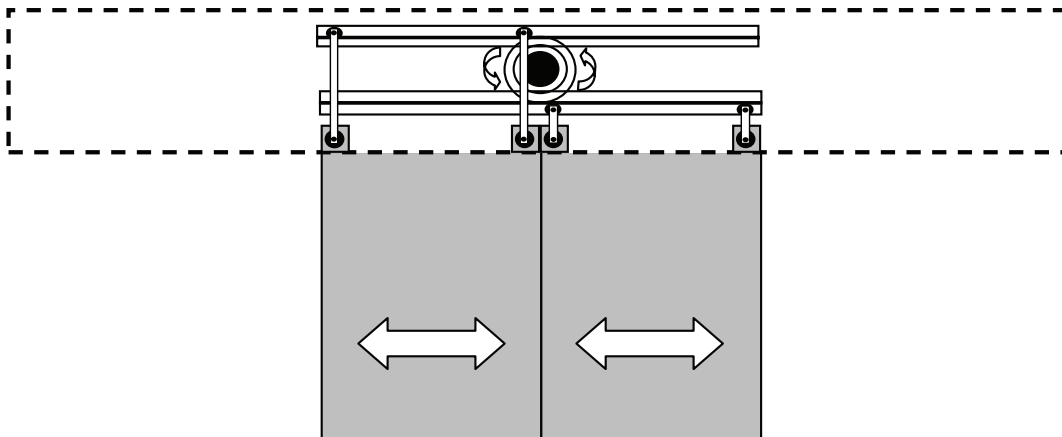


Fig 3(e)(i)

(ii) Suitable Pulley Ratio Answer

Example: 2.25 m in 30 seconds

$$2250/30 = 75 \text{ mm/s}$$

$$75 \times 60 = 4500 \text{ mm/min}$$

$$1 \text{ rpm of shaft} = 25 \text{ mm}$$

$$\frac{4500}{25} = 180 \text{ rpm}$$

Output speed = 180 rpm

5760	180
Input	Output

Velocity Ratio 1 : 32

Achieved by 1 : 4

1 : 4

1 : 2

Eg

Shaft A = 20 D

Shaft B = 80 D 20D

Shaft C 80D 20D

Shaft D 40D

[5]

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- 4 (a) (i) Ans = It is the design of circuits so that each operation is dependent on the completion of the previous. [2]
- (ii) Ans = The purpose of vacuum lifting cups is to lock itself onto a material to enable it to be moved with the application of an air vacuum. [1]
- Applications: (any one from the following)
Lifting glass/steel/stone/concrete [1] [2]
- (b) (i) $W = F \times L$ $1800 \text{ N} \times 0.4 = 720 \text{ J}$ [2]
- (ii) $F = P \times A$
- Taking max force by selecting (d) 14 mm (D) 60 mm at 8 bar [1]
- Max force for cylinder = $(3.14 \times 30^2) - (3.14 \times 7^2) \times 0.8 \text{ N/mm}^2$
 $(2826) - (153.86) \times 0.8$
2137.71 N [1]
- Taking min force by selecting (d) 22 mm (D) 36 mm at 2 bar [1]
- Min force for cylinder = $(3.14 \times 18^2) - (3.14 \times 11^2) \times 0.2 \text{ N/mm}^2$
 $(1017.36) - (379.94) \times 0.2 \text{ N/mm}^2$ [1] [4]
127.49 N
- (c) See A3 pro forma sample answer
Ans =
- Method of activating cylinder A+ B +** [2]
Method of activating Air Bleed [2]
Method of activating cylinder B- A- C+ [3]
Method of activating Air Bleed and Solenoid [2]
Method of activating cylinder C- D+ [2]
Method of activating cylinder D- [1]
Group changeover valves [6]
Connection to Shuttle Valve for or Logic [2] [20]
- (d) See A3 pro forma answer page [10]

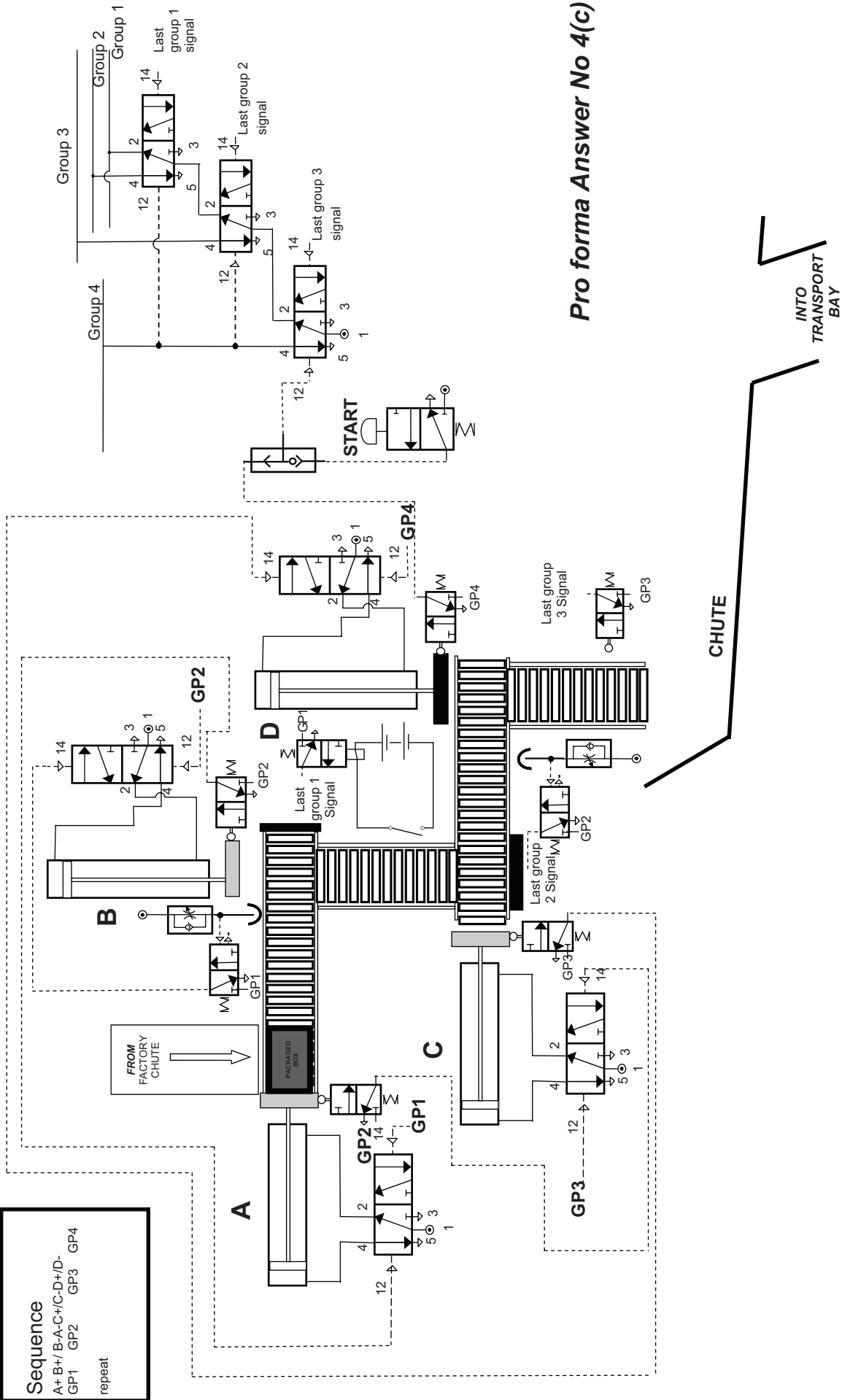
Section B

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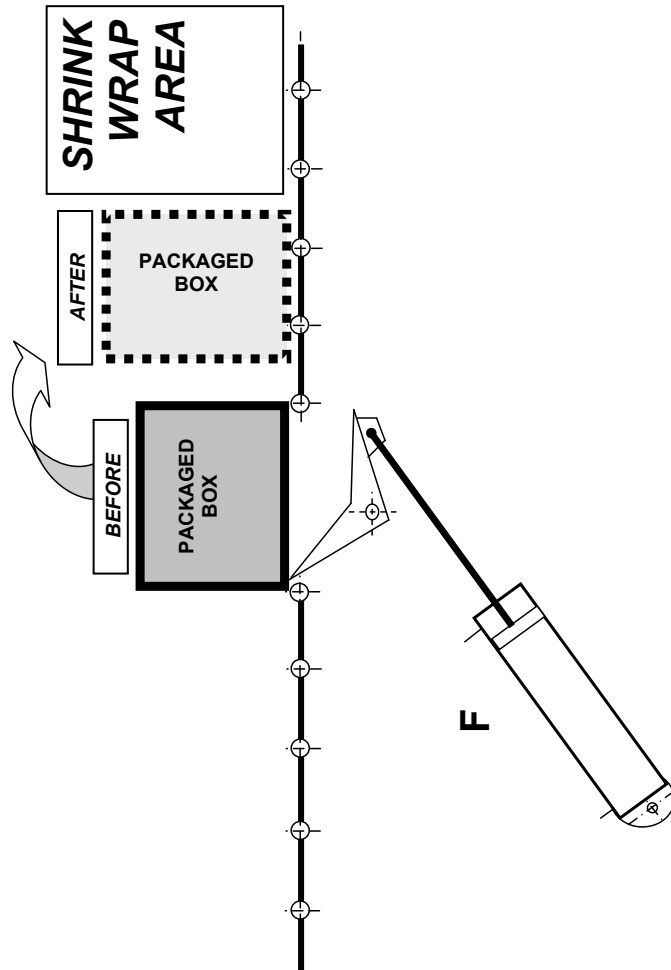
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Sequence
 A+ B+/ B-A-C+/C-D+/D-
 GP1 GP2 GP3 GP4
 repeat

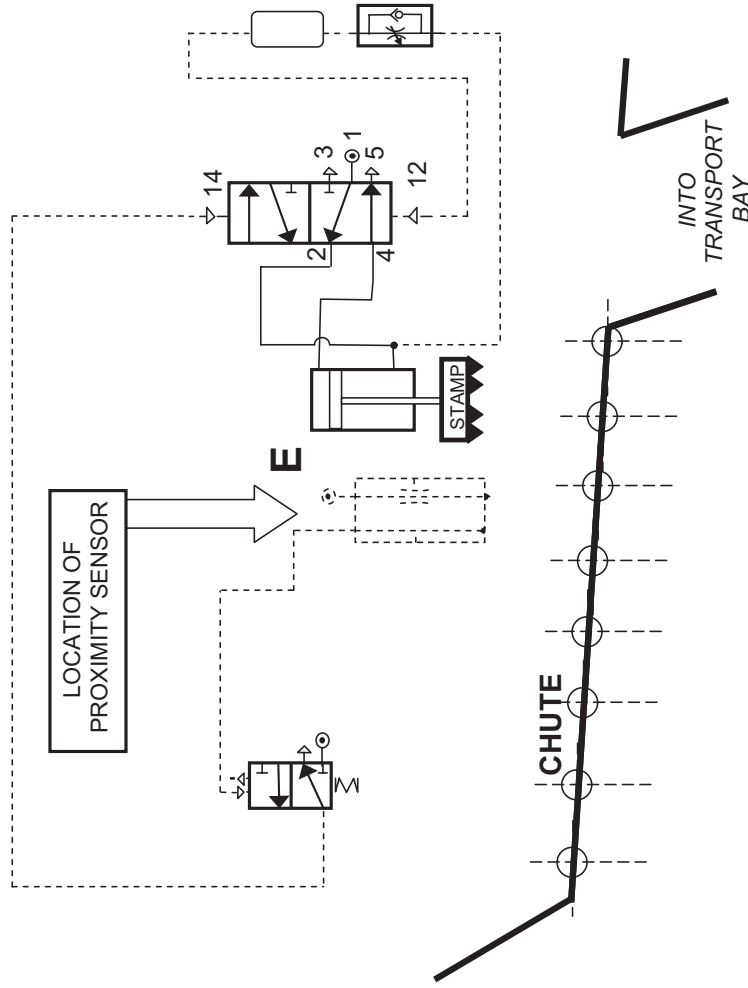


Pro forma Answer No 4(c)

Proforma Answer No 4(d)



- Suitable linkage i.e. bell crank linkage with appropriate attachment to the cylinder [2]
- Suitable connection to cylinder [1]
- Suitable pivot arrangement for cylinder [1]



- Correct drawing of Proximity Sensor [2]
- Correct piping [2]
- Time Delay [2]

Section C

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Product Design

5 (a) The word 'need' means something which we cannot do without for example food, clothing and shelter. The word 'demand' means something that we would like and arises directly from our needs. For example an awareness of the health dangers associated with vehicle exhaust emissions led to an environmental lobby which prompted changes in legislation and affected the design of new cars. [2]

(b) (i) Any **two** main factors associated with technology push from the following:

- New technologies make products that were previously impossible, possible e.g. mobile phones.
- New products developed long before the old ones wear out, e.g. computers.
- New ways of producing old products are developed
- New technologies are used as a way of achieving an advantage in the market. Hi-tech is attractive and often offers real improvements, e.g. digital tuning for radios.
- Continuous improvement in the design and manufacture of a product can lead to improved quality and/or reduced price.
- The quality of products is constantly improved as a result of new developments in materials and processing. [4]

(ii) Any **two** main factors associated with market pull from the following:

- Responding to changing lifestyles.
- Changing consumer attitudes change design priorities.
- New products closely mapped against customer attributes and profiles.
- New products developed from existing ones, e.g. CD Walkman.
- People like new things! [4]

(c) Any **two** main characteristics associated with Exploratory projects for each of the following:

- Exploratory projects tend to come early in the cycle.
- This may involve projects which examine areas for example market issues which have not been clearly defined.
- Exploratory projects tend to be very flexible and open-ended. [2]

Any **two** main characteristics associated with Explanatory projects for each of the following:

- Explanatory projects tend to explain behaviour in the market, address the question 'why' and come later in the decision cycle of projects.
- Explanatory projects look for causes and reasons.
- Explanatory projects could be carried out through questionnaires, group discussions, interviews and random sampling. [2]

Any **two** main characteristics associated with Predictive projects for each of the following:

- Predictive projects come at the late stage of the decision cycle of projects depending on information in order to forecast or predict the market.
- Predictive projects are widely used to predict the outcome of marketing decisions and therefore forecast the expected level of sales.
- Predictive projects use a wide range of sources from single or group interviews, questionnaires, surveys, statistics and mathematical techniques in order to forecast. [2] [6]

(d) (i) Any **two** different ways in which (ICT) is used to implement market research projects from the following:

- Online questionnaires, customer surveys in order to collect data.
- Computer based phone surveys or questionnaires.
- Virtual reality modelling to determine customer feedback. [2]

(ii) **Two** different ways in which (ICT) is used to analyse the outcome from the research from the following:

- For demographics, market share cost and profit analysis a simple database and spreadsheet would be suitable.
- For more complex and advanced statistical techniques and decision models more specific comparative software is required. [2]

(e) Any **two** main characteristics associated with Opinion leaders from the following:

- Opinion leaders (celebrities, magazines, early adopters) are the next most likely adopters of a fashion product after the fashion innovators.
- They copy the fashion innovators and change the product into a popular style.
- The opinion leaders influence the product and so it is produced by more companies and is sold at more retail outlets. [2]

Any **two** main characteristics associated with the late adopters from the following:

- The late adopters adopt when the product's popularity fades.
- The late adopters are very cautious before adopting.
- The late adopters often adopt when product is market for sale/clearance. [2] [4]

(f) (i) Any **two** main environmental reasons why it is so important for electronic companies to consider the management of waste.

- To prevent valuable resources being used up.
- To prevent pollution issues with leaching of harmful materials from landfills and incinerator ashes. [2]

(ii) Any **two** different ways in which electronic companies can start to address environmental issues through the disposal of products from the following:

- Using a scheme of return or take back of old products.
- Redesign of disassembly and recycling.
- End-of-life programmes designed to reuse or harvest materials back into the market where they are made into new products. [2]

- (iii) Any **two** from the following:
- Using cost effective cleaner technologies and processes.
 - Implementation of waste minimization techniques, appropriate pollution control measures and recycling.
 - Prevention of hazardous materials reaching waterways. [2]

(g) (i)

Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulties in deciding if the design is appropriate for the display.	[1]
Annotated sketches are limited. The design modifications are suitable but better use of minimising material could have been provided.	[2]
Detailed annotated sketches. The design is clearly suitable for the product and minimises material use whilst maintaining function.	[3]

- The thickness of the MDF could be considerably reduced.
- The size of the tiers are too big and could be reduced.
- A lot of wasted material within the tiers.
- Tubing much too thick for functional purposes.
- Over use of materials for the phone stand.
- Phone stand could be integrated into the tier to reduce materials. [3]

Level of response not worthy of credit.	[0]
Poor information on how modifications minimise the use of manufacturing processes. Difficulties in deciding if the processes are appropriate for the display.	[1]
Limited information on how modifications minimise the use of manufacturing processes. The modifications are suitable but better use of minimising manufacturing processes could have been provided.	[2]
Detailed information on how modifications minimise the use of manufacturing processes. The modifications are clearly suitable and would result in minimising the number of manufacturing processes.	[3]

- Plastic ties could reduce the number of processes.
- Phone holder designed to be part of the tier could reduce the material needed and the processes required.
- Tiers with support bracket could be manufactured in one process which would reduce the need for the separate support and hence additional processes. [3]

		AVAILABLE MARKS
	<p>(ii) Reduce the products environmental impact.</p> <ul style="list-style-type: none"> Using standard materials and process. Using locally sourced materials. Ensuring build quality to last longer. Ensuring product is easily dismantled for recycling. <p style="text-align: right;">[2]</p>	
	<p>Be suitable for batch production, e.g.</p> <ul style="list-style-type: none"> Support plate – suitable for batch production as it can be injection moulded. Top/middle/Bottom tier – suitable for batch production as it can be CNC milled. <p style="text-align: right;">[2]</p>	40
6	<p>(a) (i) The main purpose associated with market research is to Identify customer needs, look at whether a market for a product exists and examine possible areas for new product development.</p> <p style="text-align: right;">[1]</p>	
	<p>(ii) Two main characteristics associated with Price research from the following:</p> <ul style="list-style-type: none"> Price research will determine competitors' prices. Price research will determine what price the market will bear. Price research will assess the price which will generate the optimum volume of sales and profit. <p style="text-align: right;">[2]</p>	
	<p>Two main characteristics associated with Promotional research from the following:</p> <ul style="list-style-type: none"> Promotion research identifies the most effective ways of communicating with potential customers. Testing customer reactions to advertising ideas and existing advertisements. Promotional research can determine the most effective form of promotion during each stage of the life cycle of a specific product. <p style="text-align: right;">[2]</p>	
	<p>Two main characteristics associated with Market testing from the following:</p> <ul style="list-style-type: none"> Market testing assesses trial marketing of new products. Market testing looks at customer behaviour and sales performance. Market testing is normally conducted through focus groups, questionnaires or prototyping. <p style="text-align: right;">[2] [6]</p>	
	<p>(b) (i) The basic principles of wind. A wind turbine uses the wind's energy to generate electricity turbines catch the wind's energy with the aerodynamically optimised blades to generate rotational energy. The blades are connected to a generator sometimes via a gearbox, sometimes directly. In both cases the generator converts the mechanical energy into electrical energy.</p> <p style="text-align: right;">[3]</p>	
	<p>(ii) The basic principles of biomass. Biomass is a collective term for all plant and animal material. A number of different forms of biomass can be burned or digested to produce energy, e.g. wood, straw, poultry litter and willow. Biomass is a very versatile material and can be used to produce heat (space and water heating), electricity and a combination of heat and power.</p> <p style="text-align: right;">[3]</p>	

- (c) (i) The life cycle for a fashion product of your choice.
Fashion product life cycles, e.g. clothes and house decor last a shorter time than basic product life cycles. By definition, fashion is a style of the time. A large number of people adopt a style at a particular time. When it is no longer adopted by many, a fashion product life cycle ends. Fashion products have a steep decline once they reach their highest sales. [2]
- (ii) The life cycle for a basic product of your choice.
Basic products such as cars, refrigerators, and cookers are sold for years with few style changes. Businesses selling basic products can count on a long product life cycle with the same customers buying multiple units of the same product. Basic products have a relatively slow introduction, growth, maturity and decline making their life cycles generally the longest. [2]
- (d) Describe and fully justify with reference to five main discussion points the impact that Trevor Baylis has had on product design. Main points:
- Rather than using batteries or an electric source Baylis powered a radio by winding a crank up for several seconds (using stored energy in a spring).
 - The technology has influenced developments in other electronic consumer products.
 - With publicity on Tomorrow's world (BBC 1994) and the formation of a company Freeplay Energy in 1996 his work was to change the lives of many in the developing world as it provided education and communication.
 - Freeplay then signed a world-wide exclusive co-branding and distribution agreement with Motorola Inc's Companion products and accessories division to market and distribute a cellphone accessory charger incorporating the Freeplay self-sufficient energy technology.
 - In August 1999 Freeplay's technology leaps ahead with the launch of the freeplay S360 Radio. This concept solar/self-powered radio is several times smaller than its predecessor and offers up to 15 hours of playtime.
 - Baylis set up the Trevor Baylis foundation to 'promote the activity of invention by encouraging and supporting inventors and Engineers'. [5]

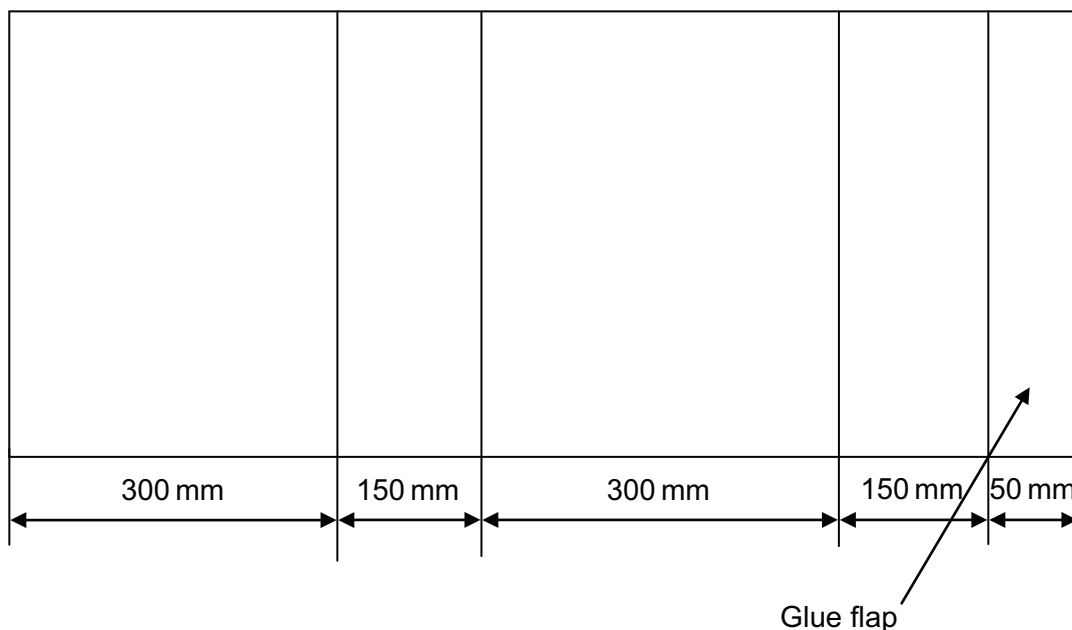
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Poor selection and use of a writing form and style appropriate to the content. The content is poorly organised and little use is made of appropriate Technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation are 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 are 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 are very accurate.	[4]

Quality of written communication [4]

(e) Any **two** main quality control processes that may be used for the housing of the electric heater from the following:

- 1 Measuring the housing for shrinkage and warpage using digitizing systems during specified stages of volume production.
- 2 Material thickness checks – using micrometer to ensure consistency of the profile for the housing.
- 3 Visual inspection – Visual inspection used to check the quality of surface finish and edge profile after removal from mould
- 4 Assembly checks – checking acceptable tolerances for the two halves joining together.
- 5 Operational tolerances – checking that the operational tolerances for switches and fittings fall within recommended limits. [4]

(f) (i) Solution (annotated sketch) could be based on a split polystyrene housing to protect the product during transit. This housing needs to be around 20 mm larger than the external dimensions of the product as well as providing suitable space for the lead and plug. A sleeve of cardboard would then slide over the two part mould. Suitable – solid white board. 400–600 microns with a net size of approximately 950 mm by 250 mm. [5]



Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation or information. Difficult in deciding if the packaging design is appropriate.	[1]–[2]
Annotated sketches are limited. The design of the packaging provides protection for the product. Limited information is provided on the type, size and thicknesses of materials.	[3]
Detailed sketches. The design for the packaging gives adequate protection for the product. Suitable information is provided on the type, size and thicknesses of materials.	[4]–[5]

- (ii) Solution could be based on a set of legs folding out from the base but design to be integrated into the body of the injected moulded base. The designer needs to indicate how the feet would be shaped, manufactured to be low cost (injection moulded) and secured (clip or press fit) in position when not in use (clip or press fit). [5]

Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulty in deciding if the design is appropriate for the heater.	[1]–[2]
Annotated sketches are limited. The design for the elevation of the front of the heater is suitable. Limited information provided on cost, on how it is fixed, and to suitability for batch production.	[3]
Detailed annotated sketches. The design for the elevation of the front of the heater is clearly suitable, low cost, permanently fixed and suitable for batch production.	[4]–[5]

Section C

Total

AVAILABLE MARKS

40

40

80