Rewarding Learning

ADVANCED
General Certificate of Education
2017

Technology and Design

Assessment Unit A2 1

assessing

Systems and Control
and
Product Design

[AV211]

FRIDAY 9 JUNE, 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

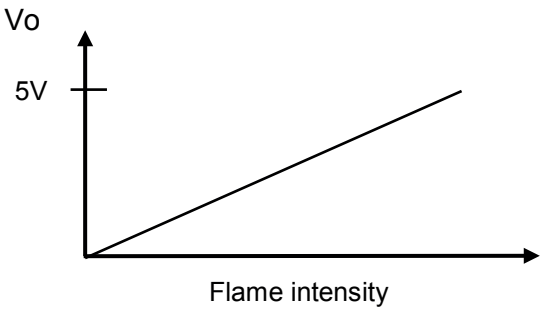
Section A

1 (a) (i) Any one for example,

The light emitted by a flame will cause the phototransistor to conduct making it a suitable detector for the flame.

The phototransistor does not have to be placed directly in the flame and can be positioned remotely. [1]

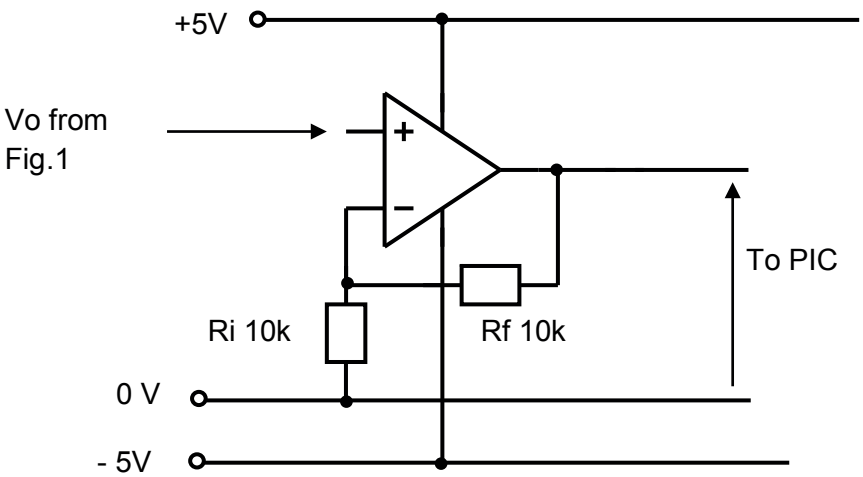
(ii) Sample graph



Labelled axes [1]
Graph [1] [2]

(b) (i) A dual power supply provides both a positive voltage and a negative voltage with respect to zero volts or ground potential. [1]

(ii)

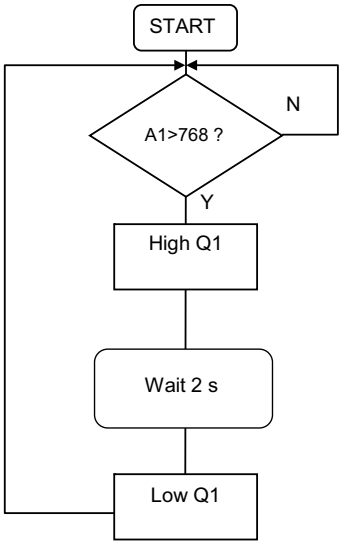


Drawing of non inverting amp [1]
Suitable values for Rf and Ri [1]
Labelling [1] [3]

(iii) $\frac{3.75}{5} \times 1024 = 768$ [2]

AVAILABLE MARKS

(iv)



Checking value and looping [1]

Output on and off [1]

Timing [1] [3]

(c) **(i)**

A	B	C	o/p3	o/p2	o/p1
0	0	0	0	0	1
1	0	0	0	1	0
0	1	0	0	1	0
1	1	0	1	0	0
0	0	1	0	1	0
1	0	1	1	0	0
0	1	1	1	0	0
1	1	1	1	0	0

A,B,C [1]
[1] each for o/p1, o/p2 and o/p3 [4]

(ii) o/p1 = $\overline{A}.\overline{B}.\overline{C}$

	$\overline{A}\overline{B}$	$\overline{A}B$	AB	$A\overline{B}$
$\overline{C}$	0	1	0	1
C	1	0	0	0

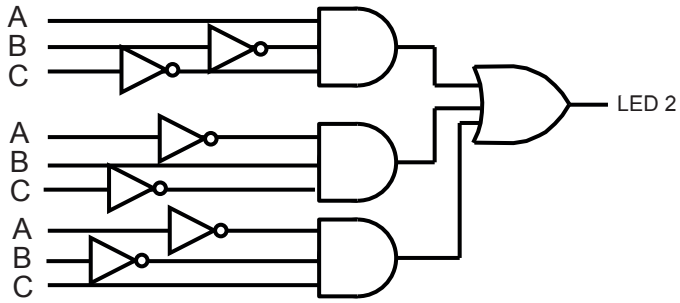
o/p2= $A.\overline{B}.\overline{C}+\overline{A}.B.\overline{C}+\overline{A}.\overline{B}.C$

	$\overline{A}\overline{B}$	$\overline{A}B$	AB	$A\overline{B}$
$\overline{C}$	0	0	1	0
C	0	1	1	1

o/p3 =A.B+B.C+A.C [3]

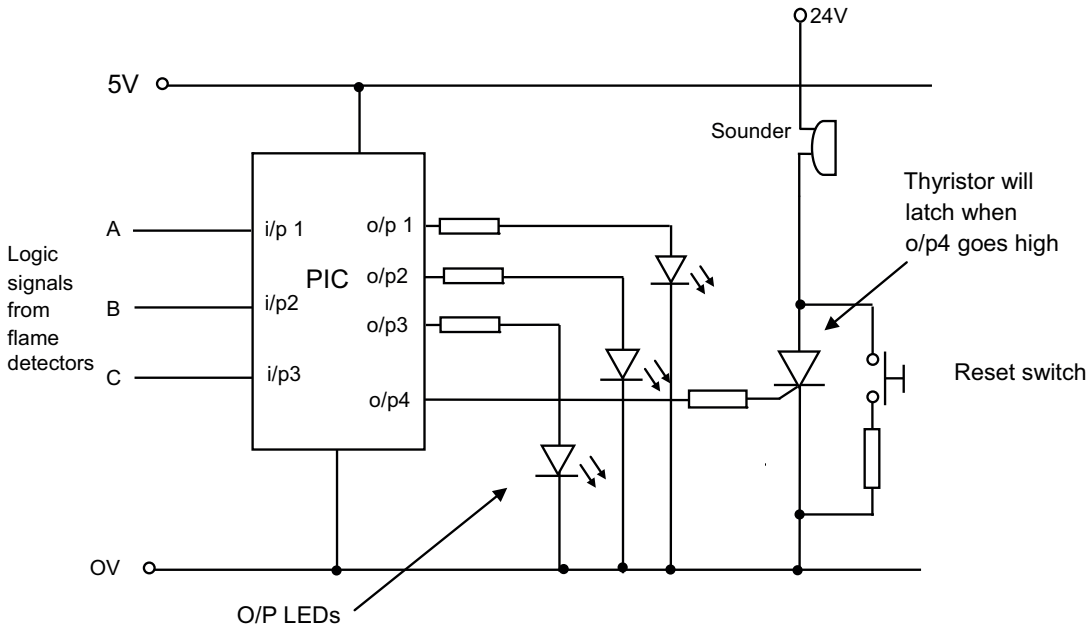
AVAILABLE MARKS

(iii)

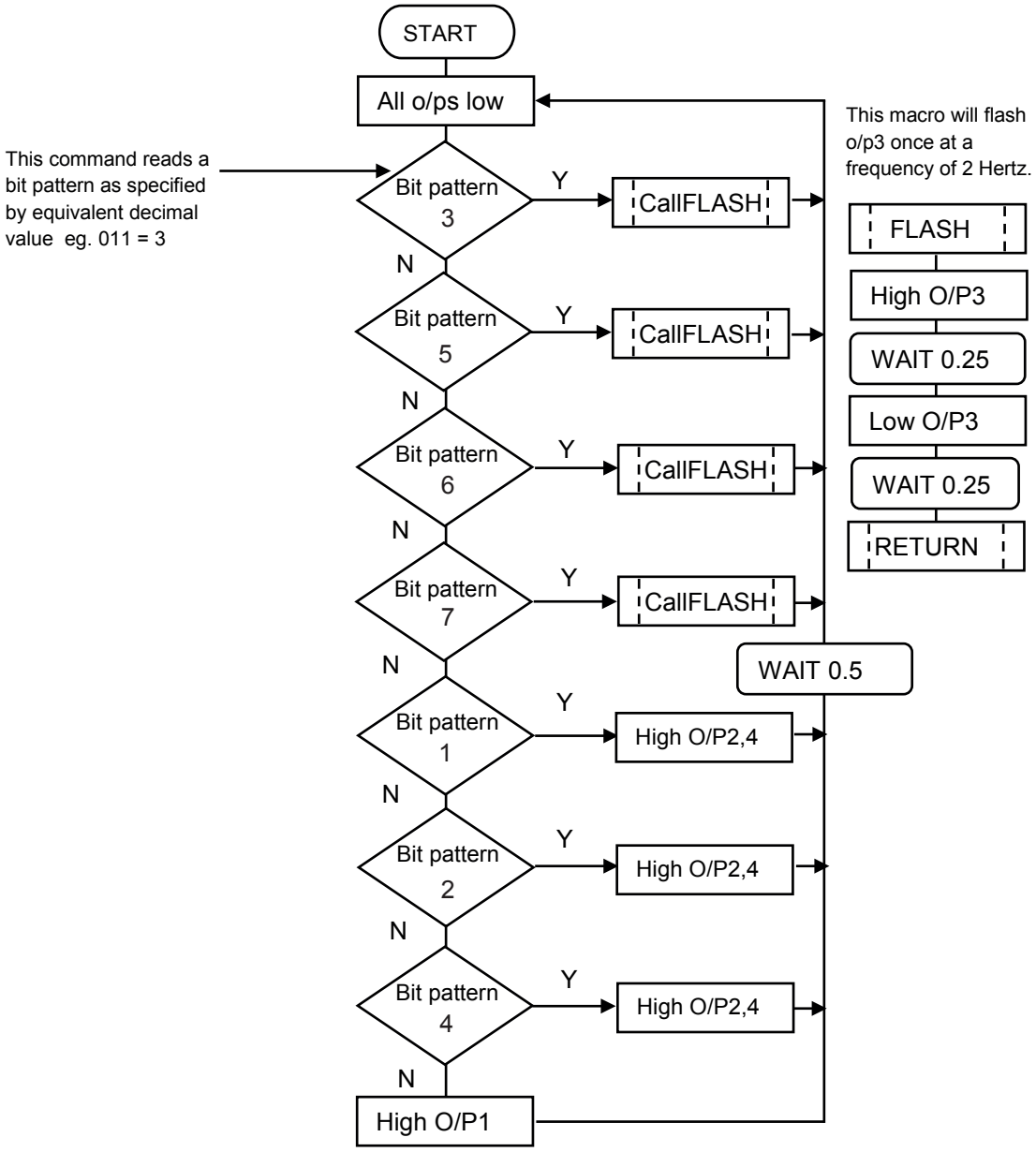


AND logic [1]
OR logic [1] [2]

(d) Sample answer



AVAILABLE MARKS



[10]

(e) Discussion likely to refer to any two of the following characteristics:

Gain. Op amps typically have a high open loop gain making them suitable for detecting small changes in analogue values. Additionally the gain can be tailored to suit specific sensor requirements by the addition of feedback and input resistors.

Stability. Op amps are designed to be stable in closed loop operation meaning there is less likelihood of errors due to drift.

Impedance. Op amps have a very high input impedance and a low output impedance. This means that they have negligible loading effect on sensor circuits.

Description of a differential op amp where the difference between two input (inverting and non inverting) voltages is amplified by a gain determined by two feedback resistors and two input resistors. [5]

AVAILABLE MARKS

Quality of written communication

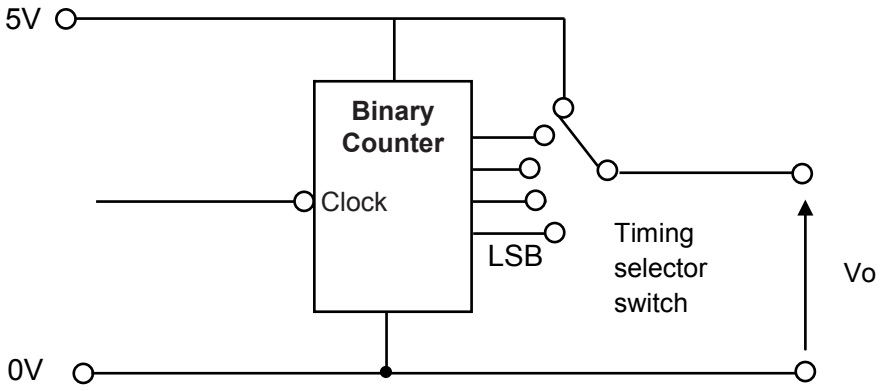
Level of response not worthy of credit.	[0]
Poor selection and use of a writing form and style appropriate to the content. The content is poorly organised and little use is made of appropriate technological vocabulary. The writing is barely legible and the spelling, grammar and punctuation are inaccurate.	[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 suitable.	[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]

[4]

2. **(a)** **(i)** Each time a pulse is applied to the **clock input** the binary counter increments or decrements the binary value presented at the outputs. The up down pin determines whether the counter will increment or decrement. [2]

(ii) In a counter with 4 binary outputs the sequence of output bits will range from 0000 to 1111 (decimal 0 to 15). In a BCD the sequence of output bits will range from 0000 to 1001 (decimal 0 to 9). [2]

(iii) sample answer

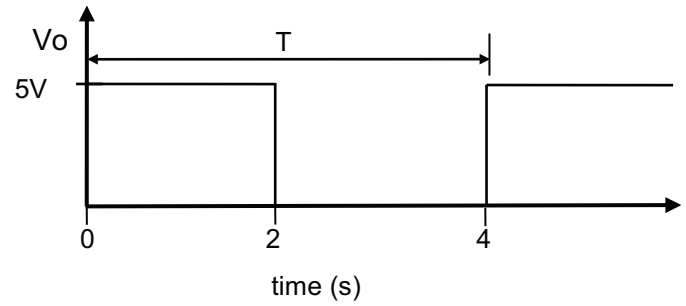


[2]

(iv) For a binary counter, the frequency of each output bit is half of the next LSB. And for the LSB, it is half of the clock frequency. Therefore the output of the MSB is 1/16 the clock frequency. [2]

AVAILABLE MARKS

(v)

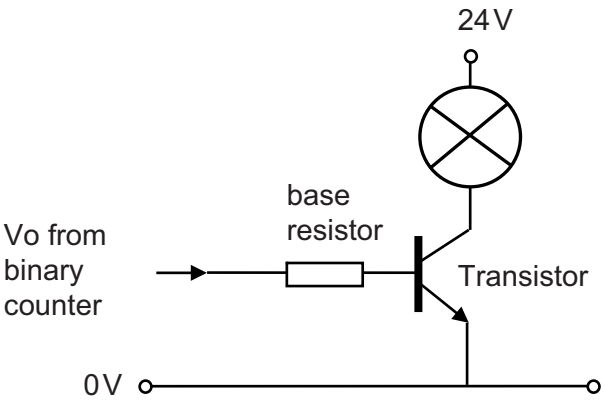


Labelled axes [1]
Waveform shape [1]
seconds stated/indicated [1]
Time period labelled [1] [4]

(vi) An annotated diagram showing a PIC with an associated program that provides an output at a frequency of 1 Hertz.

Or an annotated diagram showing a hard wired alternative such as a 555 Astable [4]

(vii)



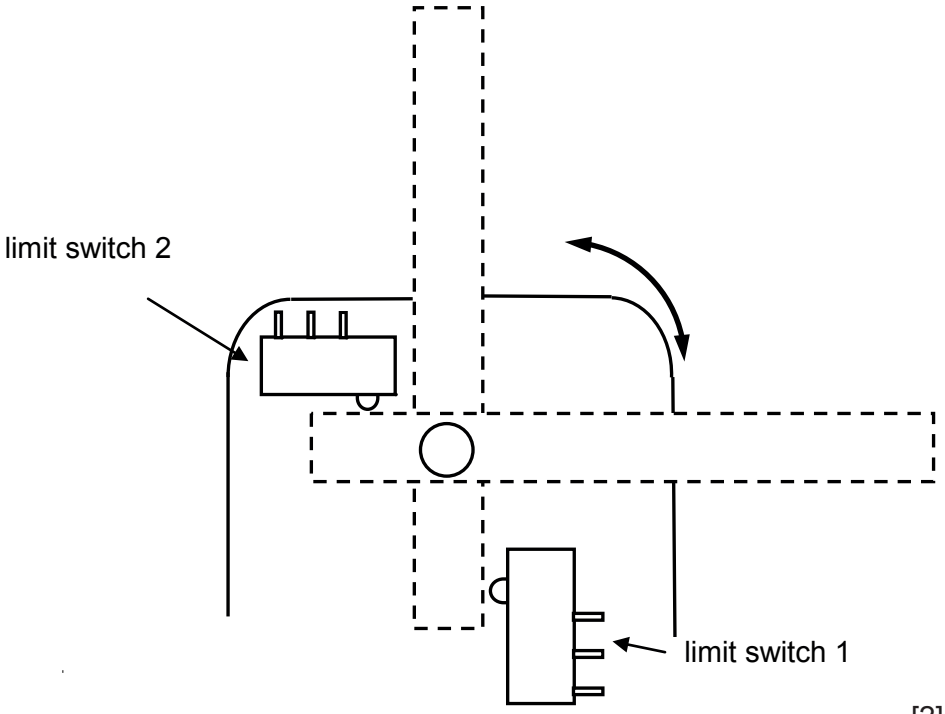
Base resistor [1]
Transistor [1]
Bulb and 24 volt supply [1] [3]

(b) **(i)** R = (24 – 4.2 × 2) / 3 × 0.025
= 208 ohms [2]

(ii) Total power dissipated 24 × 0.075 = 1.8 Watts [1]
Difference = 10 – 1.8 = 8.2 Watts [1] [2]

AVAILABLE MARKS

(c) (i)



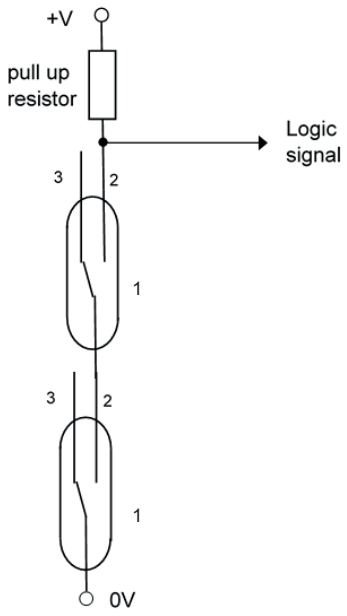
[2]

(ii) Any one of the following:
DC motors have a good torque characteristics when running at optimum RPM. In order to open and close the barrier it would be preferable to run the motor at optimum RPM at all times. Stepper motors have good torque characteristics at low RPM only which may not move the barrier at a suitable speed.

DC motors require only basic control circuits in order to run in forward and reverse directions. Stepper motors require either a dedicated driver circuit or a programmed coil switching circuit.

The barrier application does not require precise positional control i.e. the limit switches will determine the end of movement. A DC motor is best suited to this type of non precise motion. [2]

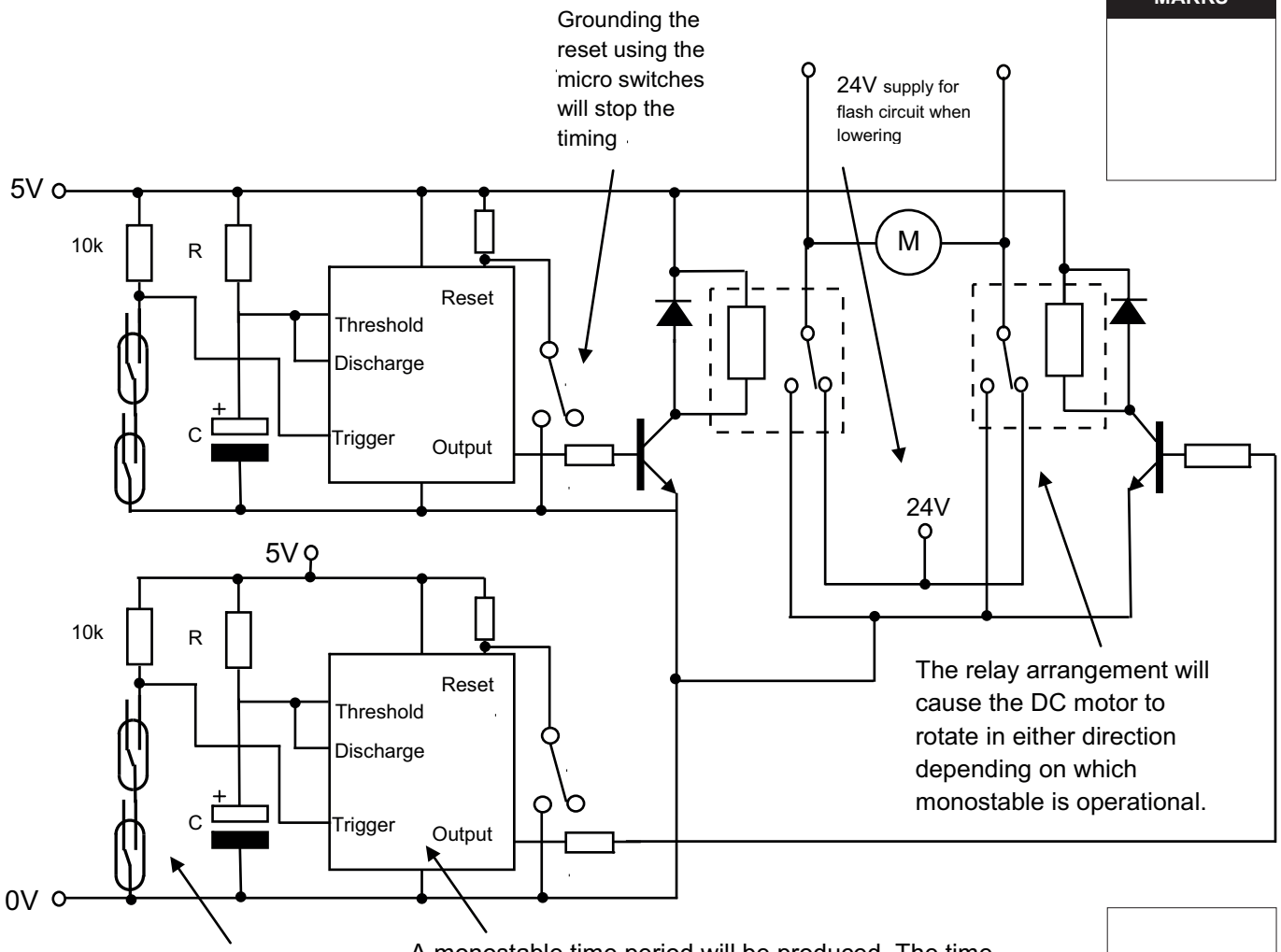
(d)



[3]

(e) Sample answer

AVAILABLE MARKS



[10]	40
Section A	**80**

Section B

AVAILABLE MARKS

3 (a) (i) Torque is the tendency of a force to rotate an object about an axis, fulcrum or pivot. It is often referred to as the turning force. [2]

(ii) Answer:
Metric Module: Ratio used to work out the number of teeth on a gear. [2]
Pitch Circle Diameter through the actual point of contact where gears mesh. [2]

(b) (i) Gain in PE = mgh
Gain in PE = 2000 × 9.82 × 10
Gain in PE = 196400J [2]

(ii) Torque = Force × Distance from Turning Point

$$\text{Distance from Turning Point} = \frac{\text{Torque}}{\text{Force}}$$

$$= \frac{210\text{Nm}}{350\text{N}}$$

= 0.6m [2]

(c) Any **three** from:
Toggle Linkage
– Toggle linkages exert downwards force to clamp/lock an object in place.
– Normally consist of two links on a common pivot.
– They produce a high level of force and can be used to assist with air tight operations.
– Fast and effective method of clamping. [3]

Any **two** from:
Treadle Linkage
– Treadle linkages convert rotary motion to oscillating or oscillating to rotary.
– Can operate over a large distance.
– Provide accurate motion for oscillating motion [2]

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 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 suitable.	[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]

AVAILABLE MARKS

(d) **(i)** Answer (any one from two selected followers): [2]

Flat follower

Features any one:

– Very simplistic to manufacture.

– Not very accurate to follow a cam with an intrinsic design.

Roller follower

Features any one:

– Follows cam profile with ease.

– Cam design must accommodate the roller size.

Knife follower

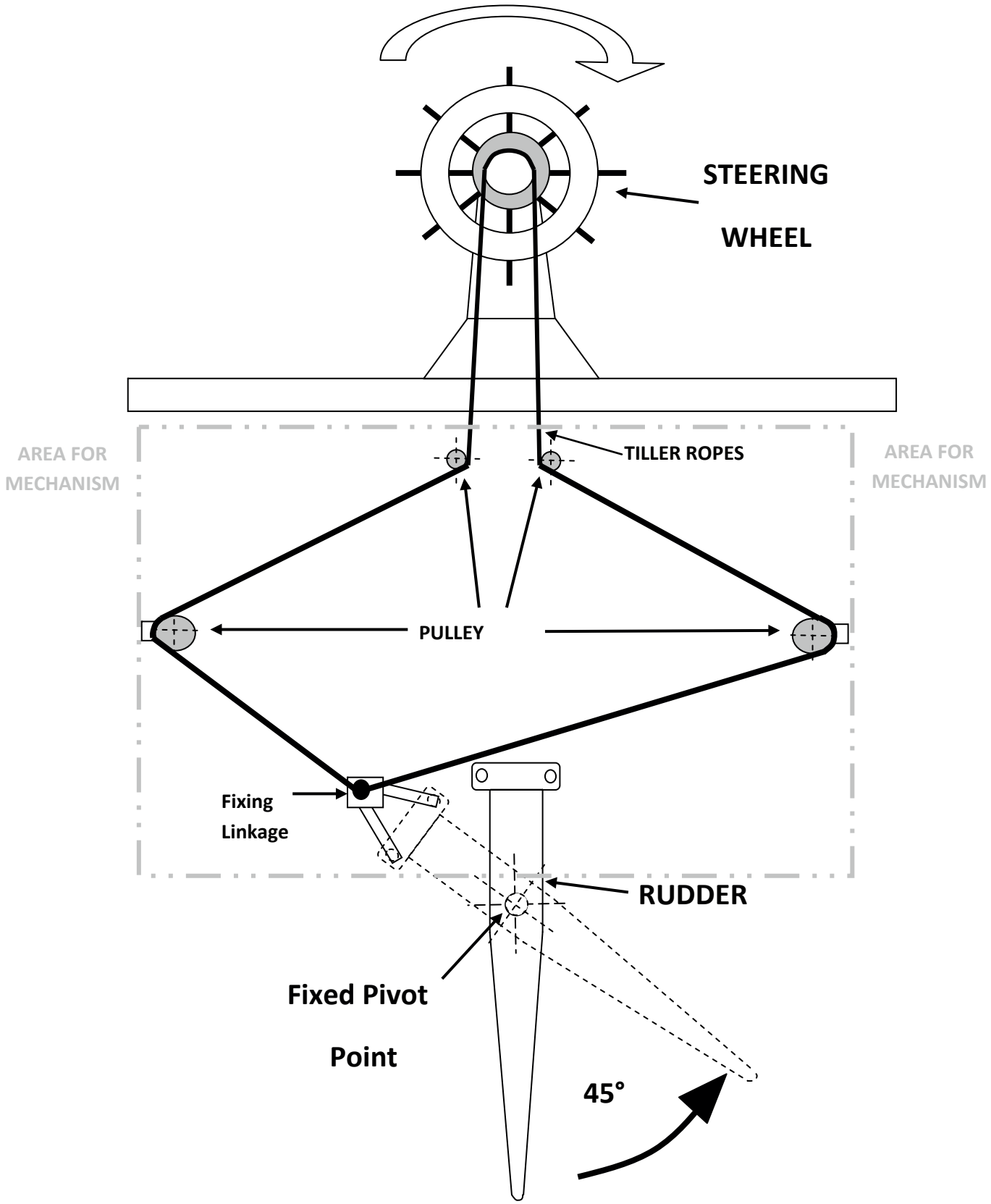
Features any one:

– Extremely accurate.

– Wears away very easily due to nature of tip.

(ii) See A3 Mark scheme. [9]

(e) **(i)** Sample Answer:

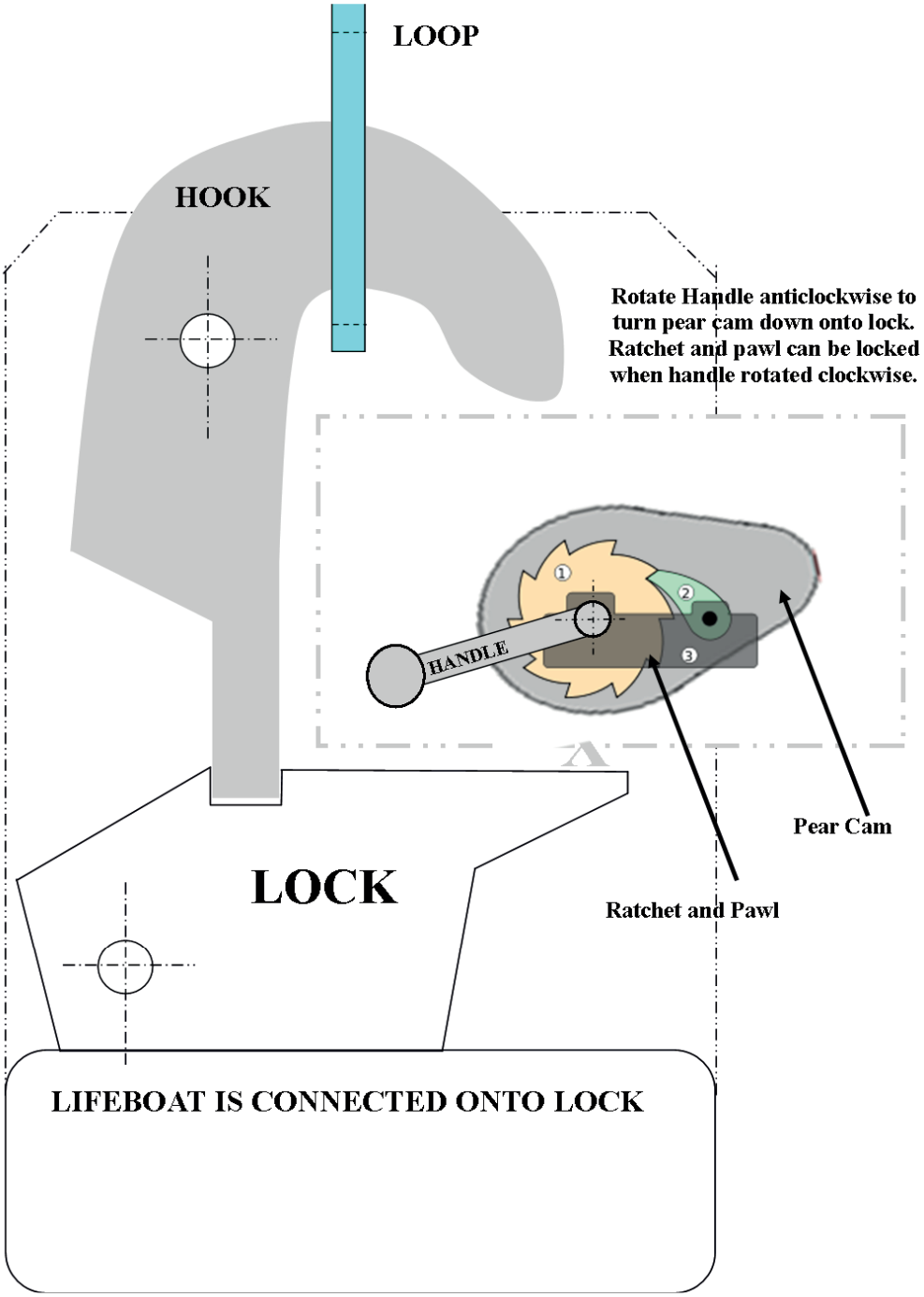


For a response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulty in deciding if the design would link the steering wheel to the rudder to achieve the desired rotations. Little or no consideration is provided for the attachment to the rudder.	[1]–[2]
Annotated sketches are limited. The design is limited in terms of how the steering wheel is linked to the rudder to achieve the desired rotations. Limited consideration is provided for the attachments to the rudder.	[3]
Detailed annotated sketches. The design provides a suitable mechanism to link the steering wheel to the rudder to achieve the desired rotations. Suitable attachments to the rudder are included.	[4]–[5]

[5]

AVAILABLE MARKS

(ii) Sample Answer:



Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulty in deciding if the design would enable the lock to be released using rotational movement and if it can be locked in place. Little or no consideration is provided for the attachments.	[1]–[2]
Annotated sketches are limited. The design is limited in how it would enable the lock to be released using rotational movement and how it can be locked in place. Limited consideration is provided for the attachments.	[3]
Detailed annotated sketches. The design provides a suitable mechanism which would enable the lock to be released using rotational movement and can be locked in place. Suitable consideration is provided for the attachments.	[4]–[5]

[5]

AVAILABLE MARKS

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4 **(a)** **(i)** Input – Microswitch or Solenoid [1]
Control – 3/2 Valves (A and B) or 5/2 Valve (C) [1]

(ii) Answer (any one of the following):
Issues:
Compressed air can enter the bloodstream.
Fingers can get injured from moving parts. [1]

Precautions:
– Have guards on moving parts.
– Cover all cuts/ exposed skin.
– Isolate air supply during adjustments. [1]

(iii) Answer:
Advantage (any one of the following):
– This will ensure the material does not get scratched or damaged.
– Held via compressed air which has a very strong force. [1]

Disadvantage (any one of the following):
– Specialist equipment and compressor required.
– Not suitable for many outdoor sites etc. [1]

(b) **(i)** Volume = $\frac{S \times (D^2 - d^2) \times (P+1)\ \pi}{4}$

Volume = $400 \times (60^2 - 30^2) \times (4+1) \times 3.14/4$ [3]
Volume = 16,956,000/4 = 4.239 litres [1]

(ii) Answer = WD = F × L
SAC WD = 300 × 0.2
WD = 60

TWO SAC = 120 [1]

NEW SAC WD = F × L
120 = 240 × L
$L = \frac{120}{240} = 0.5 = 500\,\text{mm}$ [2]

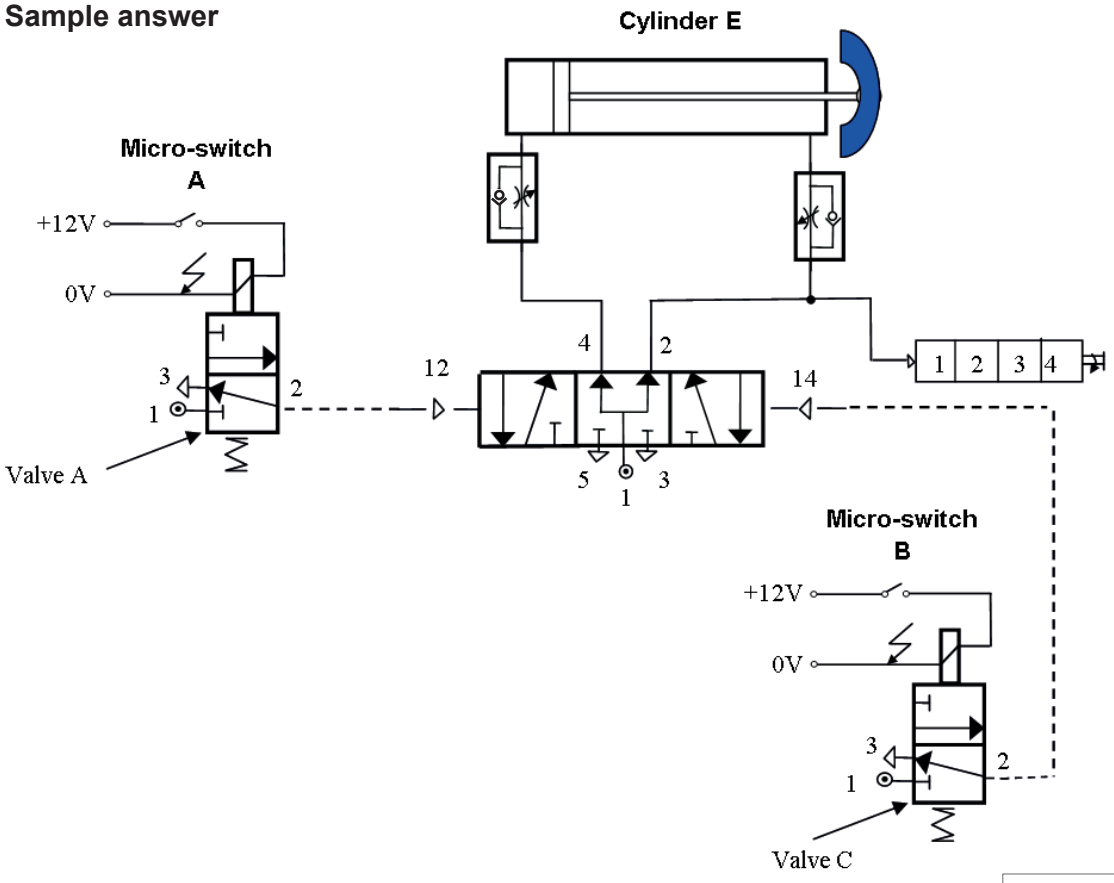
AVAILABLE MARKS

(c) See A3 Markscheme [17]

(d) **(i)** Counter [1]
5/3 Valve with Piping [2]
Microswitches and 3/2 Piped [1]
Speed Control [1]

Sample answer

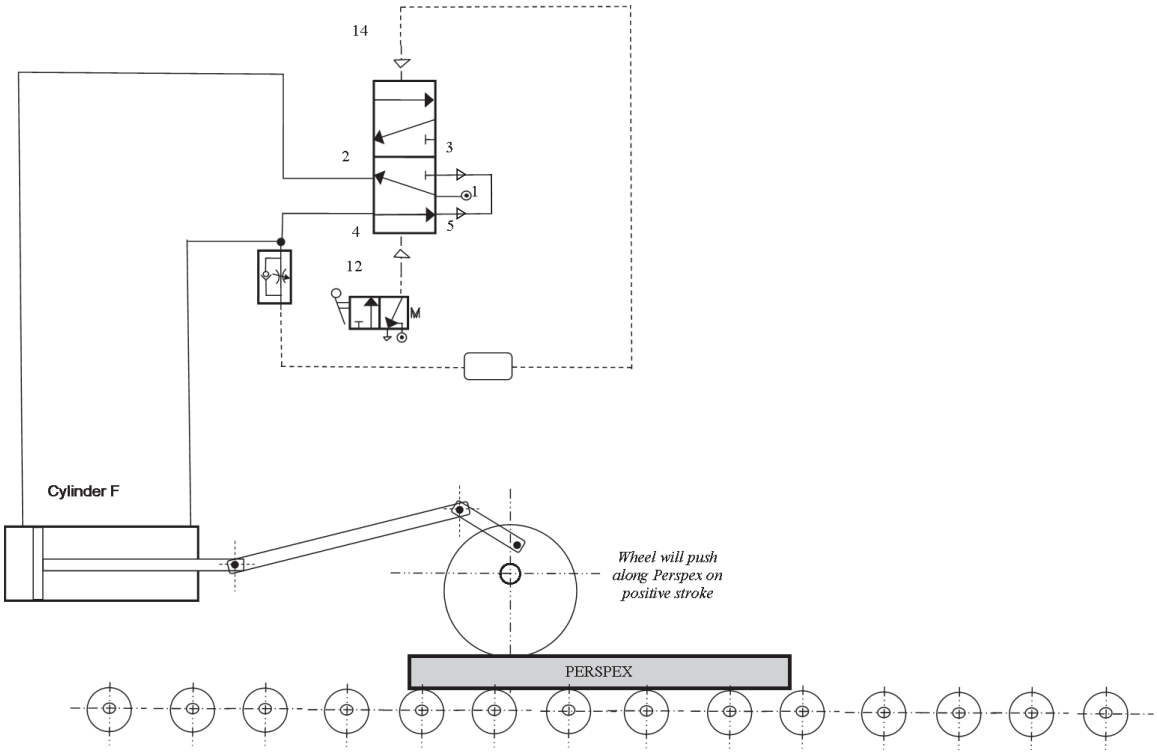
PERSPEX



Sample answer

AVAILABLE MARKS

(ii) Mechanism to move Perspex forward [3]
Automatic Return [2]



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80

Section B

Section C

AVAILABLE MARKS

5 **(a)** Introductory stage of the product life cycle is when a product is introduced into the market for the first time. [1]

(b) **(i)** Any **two** main factors associated with market pull for example:
- A new product comes from a need identified within a market.
- New products develop.
- Changing consumer attitudes change design priorities. [2]

(ii) Any **three** main factors associated with radical products for example:
- Are produced from new technologies.
- High level of uncertainty of the products' success.
- They are costly given the new technology.
- Require a high level of marketing. [3]

(c) **(i)** Any **two** main characteristics associated with market penetration for example:
- Increasing market share of an existing product.
- Finding new customers.
- Taking customers from competitors.
- Persuading existing customers to reinvest or increase usage. [2]

(ii) Diversification is about adding more markets and products to an existing business, [1] and this could benefit the company by increasing company sales and market share and profits. [1] [2]

(d) **(i)** Any **two** main characteristics associated with promotional research for example:
- Promotional research identifies the most effective way 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. [2]

(ii) Any **two** main characteristics associated with market testing for example:
- 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. [2]

(e) **(i)** Any **two** main characteristics associated with an opinion leader for example:
- 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]

AVAILABLE MARKS

(ii) Late adopters are individuals who tend to be suspicious of new technology or do not see the value of its new capabilities. [1] Laggards are traditionalists and are the very last group to adopt a new product. [1] [2]

(f) **(i)** Geothermal involves harnessing the heat in the earth's core to generate electricity. [1] Two connecting boreholes are drilled into the earth's core and water is fed down one of the holes where it is heated by the high temperatures in the core. [1] It returns up the other borehole as high pressure steam which may be used to create electricity. [1] [3]

(ii) Biomass is a collective term for all plant and animal material. [1] A number of different forms of biomass can be burned or digested to produce energy. E.g. wood, straw, poultry litter and willow. [1] 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. [1] [3]

(g) **(i)** Any **two** for example:

- To prevent valuable resources being used in the manufacture of televisions.
- To prevent pollution issues with leaching of harmful chemicals during manufacture. [2]

(ii) Any two for example:

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

(iii) A manufacturing process that may be considered to be environmentally friendly is the process used to manufacture polystyrene beads. The beads are expanded and moulded by product manufacturers using a toxic blowing agent. [1] Developments have produced a water-blown expandable polystyrene bead which is much more environmentally friendly. [1] [2]

(h) **(i)** Solution requires a simple and clearly graphical response that can be combined into one drawing or a combination.

- Two models Model 1 suitable for sizes between 32 inch and 50 inch. [1] Model 2 suitable for sizes between 55 inch and 75 inch. [1]
- Model 1 maximum of 400 mm. [1]
  Model 2 maximum of 650 mm. [1]
- Both Model 1 and Model 2 can rotate through 150 degrees when fully extended. [2] [6]

(ii) Solution (annotated sketch) could be based on a split polystyrene housing to protect the product during transit. This housing needs to be around 30 mm larger than the external dimensions of the product as well as providing suitable space for the lead and plug.

Suitable – Folded cardboard units which may be of a single or double fluted profile with a net size of approximately 1350 mm by 250 mm. The folded cardboard could be stabled together.

Level of response not worthy of credit.	[0]
Difficulties in deciding if the packaging is suitable for the television. Little consideration is given to sizes, protection for the product and minimising the amount of material used.	[1]–[2]
The packaging has aspects which are suitable for the television. Limited consideration is given to sizes, protection for the product and minimising the amount of material used.	[3]
The packaging is suitable for the television. Appropriate consideration is given to sizes, protection for the product and minimising the amount of material used.	[4]

[4]

AVAILABLE MARKS

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6 **(a)** New products arise for any one of the following reasons:

- New technology being introduced.
- A gap in the market identified by market research.
- Government/European legislation. [1]

(b) Any **two** different appropriate tests for example

Example 1

Select a sample of able bodied children, both male and female in age from 6 months, 1 year, 1½ years, 2 years, 2½ years and 3 years from a UK sample base. Test to see if the selected sample of children fit in the chair and can be safely secured in position.

Example 2

Select a sample of able bodied children, both male and female from a weight of 5 kg up to a maximum weight of 15 kg (½ kg increments). The product could be tested on a test rig to simulate normal use and visual inspections could be recorded on a daily basis as to the performance of key components over time.

Example 3

Select a sample of adult female and male operators with a range of ages and experience. Instruct them on the operation and then time them and observe/record any difficulties the sample had on completing the task.

Example 4

Select a sample of adult female and male operators with a range of ages and experience together with a sample of able bodied children, both male and female from a weight of 5 kg up to a maximum weight of 15 kg (½ kg increments). Instruct them on the operation of the harness and then observe/record any difficulties in securing the child in the seat and on the ease of operation of the five point harness.

(2 × [2]) [4]

AVAILABLE MARKS

(c) **(i)** Any **two** main characteristics associated with exploratory projects for example:

- Exploratory projects tend to be more discovery coming early in the decision cycle of projects.
- 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]

(ii) Explanatory projects will focus on why certain events are happening like a decline in the sales of pushchairs in a certain time of the year [1] whereas descriptive projects will focus more on finding out certain aspects of the market such as determining what affects consumers attitudes on the pushchair. [1] [2]

(d) **(i)** Depending on the specific choice of product.

Quality Control may use ICT to ensure that components are positioned correctly, or that they are the correct type and size. [1] ICT may also be used as a final quality check to include testing the product (by sensors and computers) to ensure it is to the correct standard, before it is distributed to the retailer/customer. [1] [2]

(ii) Depending on the specific choice of product.

In a Quality Assurance system ICT will be used to ensure that staff training, administrative procedures and quality monitoring of the product at various stages of manufacture, is to the highest standard. [1] ICT will be used to gain customer feedback to ensure customer satisfaction. ICT will also be used in the administration process of the British Kite Mark and European CE Mark. [1] [2]

(e) The concept elasticity of demand is the measurement of changes in demand for a product in response to changes in its price. [1] If the price elasticity of demand is more than 1 it is sensitive to change and if it is less than 1 it is less sensitive to change. [1] [2]

A pricing strategy for a new mobile phone may be as follows:

Introductory stage –
Using penetration pricing will attempt to attract new customers to the product or in fact to attract customers away from rival mobile phone companies. This strategy may well work as the mobile phone business is a very competitive market. [1]

Growth stage –
Competitive Pricing may be suitable at the growth stage as the business is operating in a market where there is lots of competition, this type of pricing may be used during the growth stage of the product's life-cycle when competition for market share is high. [1]

Decline stage –
Using perceived value pricing will let the market determine the suitable price for the product considering what other similar type products are available on the market and potentially what new products are being introduced. This may help sustain sales figures and maintain market share. [1] [3]

AVAILABLE 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]

Quality of written communication [4]

(f) **(i)** Any **one** specific example how the National Government has influenced environmental issues through product design for example:

- The government influenced environmental issues by the development of specific recycling bins for a range of domestic and industrial waste. They encouraged home owners to recycle with a campaign of advertising and leaflet drops. The recycling has resulted in less waste going to landfill and reuse of existing materials.
- The government has been instrumental in encouraging the use of more electric cars and therefore reducing use of fossil fuels. Charging points around the country have been installed to assist the public. [2]

(ii) Any **one** specific example how the EU has influenced environmental issues through product design for example:

- The EU air quality directive has set maximum permissible levels for atmospheric concentrations of pollutants. Emissions of these air quality pollutants from road vehicles are being reduced by improving the quality of fuels and better engine design. All new cars are required to meet the Euro 5 standard.
- Eco-Labelling – The EU developed a labelling system which rated the energy efficiency of domestic products such as fridges, washing machines and tumble dryers etc. This label indicated to customers the level of efficiency of the product which may influence sales. [2]

(g) Any **four** main features which characterise the influence of Trevor Baylis for example:

- 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 radio was designed to help stop the spread of Aids in Africa through a program of better education using radio broadcasts.
- With publicity on Tomorrows 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.

AVAILABLE MARKS

- 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 precedecessor 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'. [4]

(h) (i) Solution based on an injection moulded rectangular shaped holder (to fulfil the size requirements) with a corner pocket removed to prevent water remaining in the unit. An angled tubular bracket could press fit over the tubular section aluminium alloy. Polythene can be injection moulded and is suitable for the functional requirements of the product.

Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulties in deciding if the design is low cost, suitable to house the wipes and can be attached to and quickly removed from the side of the pushchair. Little or no justification is provided regarding the selection of material.	[1]
Annotated sketches are limited. The design is limited in terms of being low cost, suitable to house the wipes and how it can be attached to and quickly removed from the side. Limited justification is provided regarding the selection of material.	[2]–[3]
Detailed annotated sketches. The design is low cost, suitable to house the wipes and can be attached to and quickly removed from the side of the pushchair. Suitable justification is provided regarding the selection of material	[4]

[4]

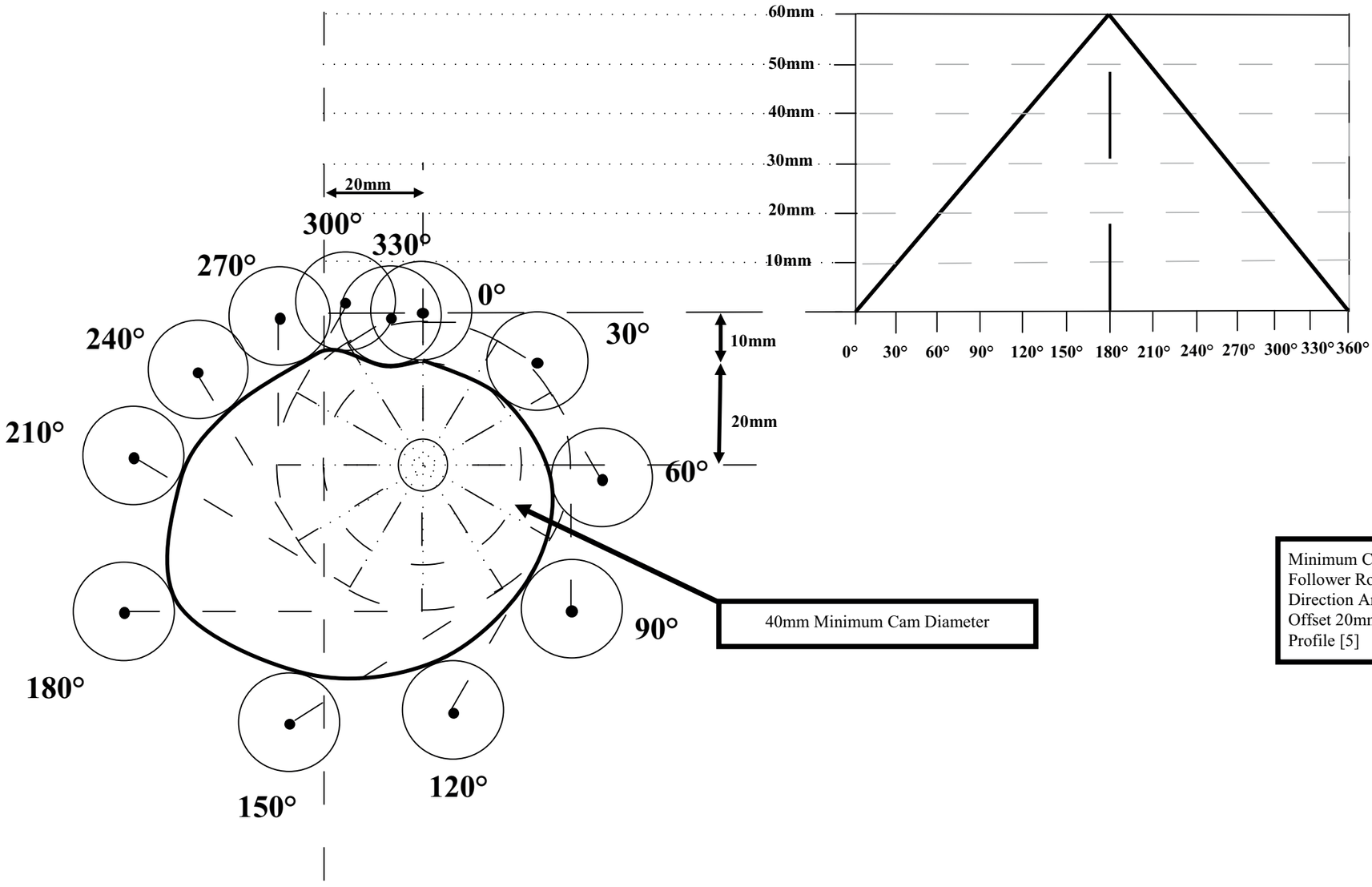
(ii) Solution based on a three section front support bar with an ergonomically shaped handle. The ends could be secured to the front supports with plastic injection moulded brackets which could be riveted in place. The support bar is manufactured in three sections with two knuckle joints used to assist inward folding and outward locking for lifting.

Level of response not worthy of credit.	[0]
Poor sketches with little or no annotation. Difficulties in deciding if the design will allow the user to comfortably grip and lift the front of the pushchair. Little or no information is provided on how the design is permanently attached to the front supports of the chair and how it is made more compact for folding.	[1]–[2]
Annotated sketches are limited. The design is limited in terms of allowing the user to comfortably grip and lift the front of the pushchair. The design is limited in terms of the attachment to the front supports of the chair and how it can be made more compact for folding.	[3]–[4]
Detailed annotated sketches. The design is appropriate and allows the user to comfortably grip and lift the front of the pushchair. The design is permanently attached to the front supports of the chair and can be made more compact for folding.	[5]–[6]

[6] 40

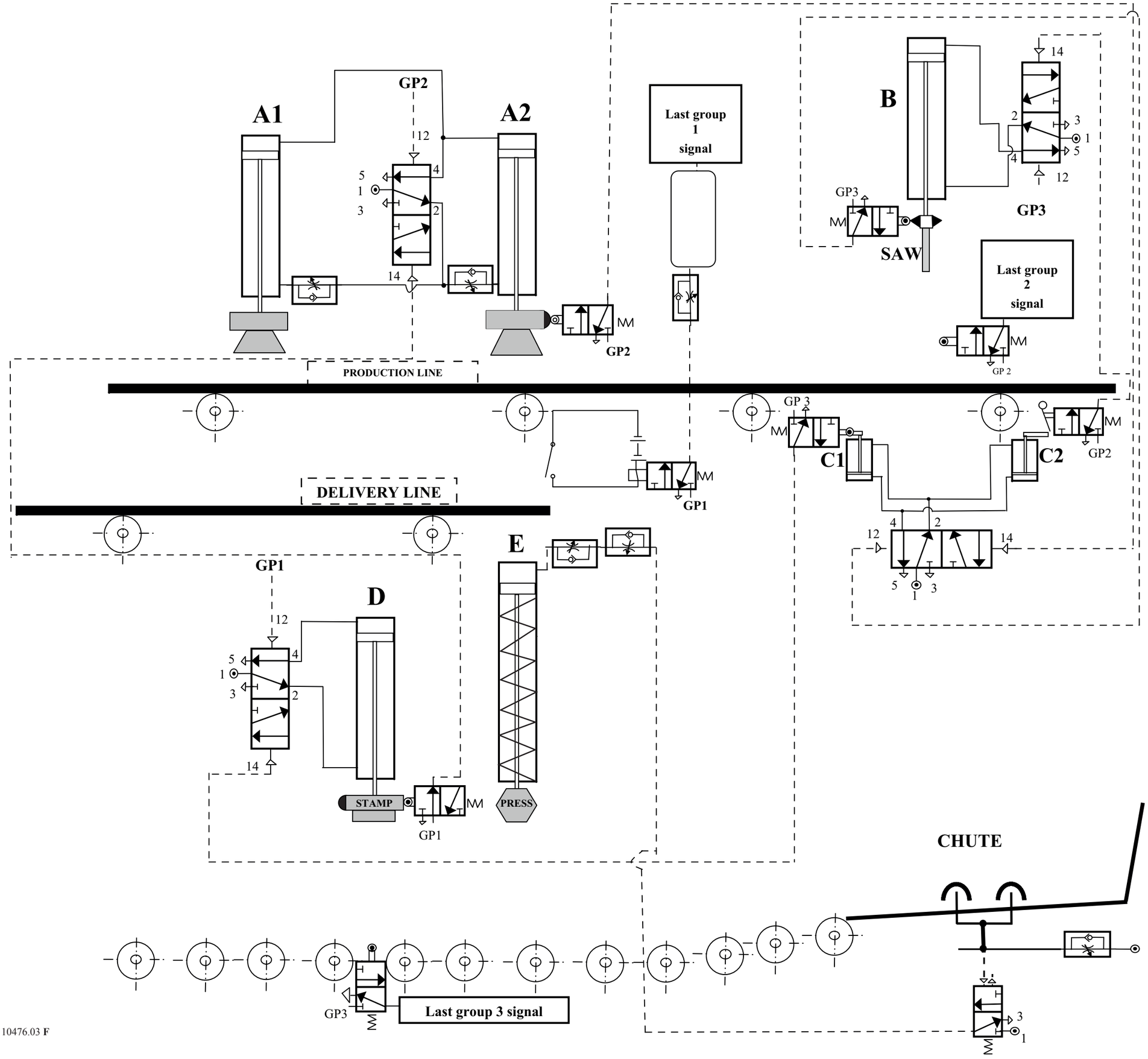
Section C **80**

AVAILABLE MARKS



Minimum Cam Diameter =40mm [1]
Follower Roller =20mm [1]
Direction Anticlockwise [1]
Offset 20mm [1]
Profile [5]

Pro forma answer 3(d)(ii)



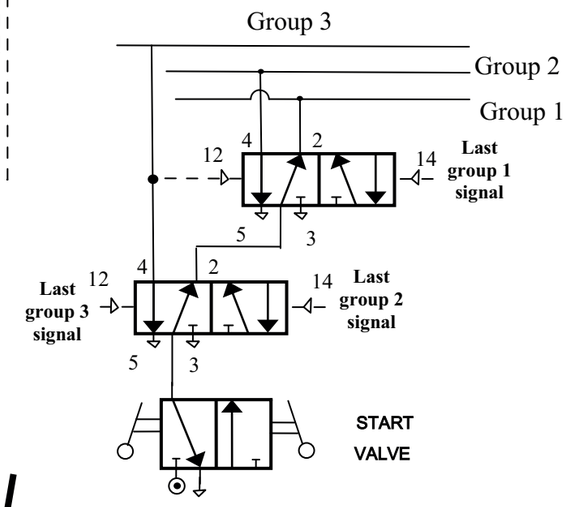
D- / A1 and 2+ Time delay (GP1)

A1 and 2–/ C+/ B+ (GP2)

B-/ C– / D+ (GP2) E+ E- (GP3)

SAMPLE ANSWER: 3 GROUPS

D- A+/ A- C+ B+/ B- C- D+	[6]
START VALVE	[1]
A_1, A_2^+, E+ SPEED CONTROL	[2]
MICRO	[1]
TIME DELAY	[2]
AIR BLEED	[2]
PIPING	[3]



Pro forma answer 4(c)