

New
Specification



Rewarding Learning

ADVANCED
General Certificate of Education
2018

Technology and Design

Assessment Unit A2 1

assessing

Systems and Control or Product Design

[ATE11]

FRIDAY 8 JUNE, MORNING

**MARK
SCHEME**

General Marking Instructions

Introduction

The main purpose of the mark scheme is to ensure that examinations are marked accurately, consistently and fairly. The mark scheme provides examiners with an indication of the nature and range of candidates' responses likely to be worthy of credit. It also sets out the criteria which they should apply in allocating marks to candidates' responses.

Assessment objectives

Below are the assessment objectives for GCE Technology and Design.

Candidates should be able to:

- AO1** Demonstrate specific knowledge and understanding, be able to apply that knowledge and understanding in combination with appropriate skills in their designing, communicate ideas and outcomes, and demonstrate strategies for evaluation.
- AO2** Apply skills, knowledge and understanding of relevant materials to produce suitable and appropriate outcomes; communicate ideas and outcomes, and demonstrate strategies for evaluation.

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of response reflecting the level of maturity which may reasonably be expected of a 17- or 18-year-old which is the age at which the majority of candidates sit their GCE examinations.

Flexibility in marking

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses 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.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do 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 of a 17- or 18-year-old GCE candidate.

Awarding zero marks

Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Marking Calculations

In marking answers involving calculations, examiners should apply the 'own figure rule' so that candidates are not penalised more than once for a computational error. To avoid a candidate being penalised, marks can be awarded where correct conclusions or inferences are made from their incorrect calculations.

Types of mark schemes

Mark schemes for tasks or questions which require 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.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Levels of response

In deciding which level of response to award, examiners should look for the 'best fit' bearing in mind that weakness in one area may be compensated for by strength in another. In deciding which mark within a particular level to award to any response, examiners are expected to use their professional judgement.

The following guidance is provided to assist examiners.

- **Threshold performance:** Response which just merits inclusion in the level and should be awarded a mark at or near the bottom of the range.
- **Intermediate performance:** Response which clearly merits inclusion in the level and should be awarded a mark at or near the middle of the range.
- **High performance:** Response which fully satisfies the level description and should be awarded a mark at or near the top of the range.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions that require them to respond in written form. These tasks and questions are marked on the basis of levels of response. The description for each level of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within levels of response as follows:

Level 1: Quality of written communication is basic.

Level 2: Quality of written communication is good.

Level 3: Quality of written communication is excellent.

In interpreting these level descriptions, examiners should refer to the more detailed guidance provided below:

Level 1 (Basic): The candidate makes only a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level 2 (Good): The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is some use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear.

Level 3 (Excellent): The candidate successfully selects and uses the most appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is widespread and accurate use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are of a sufficiently high standard to make meaning clear.

Section A

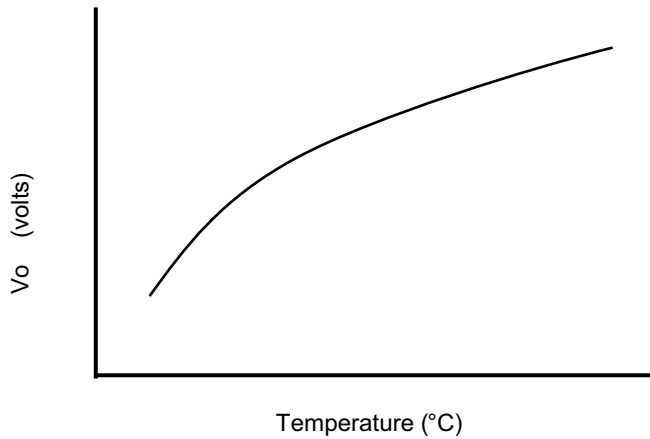
AVAILABLE MARKS

- 1 (a) (i) As the temperature of the thermistor increases its resistance decreases. Since the thermistor is positioned above the fixed resistor, V_o will increase as the temperature increases [2]

Award [2] for a full explanation and [1] for a limited explanation

Correct alternative responses will be given full credit

- (ii) Sketch curve [1] direction [1]



[2]

- (iii) At 2°C $V_o = 5 \times (10/20) = 2.5 \text{ V}$ [2]

- (iv) Allows for adjustment of V_o for a specific temperature. [1]

- (b) (i) $\frac{2}{5} \times 15 = 6$ [1]
Binary equivalent 0110 [1] [2]

- (ii) Diagram showing a PIC [2] with an associated program that provides an output at a frequency of 10 Hertz [2]
Correct alternative responses will be given full credit [4]

- (c) (i)

A	B	C	D	a	b	c	d	e	f	g
1	0	1	0	1	0	1	1	0	1	1

D [1] g [1] [2]

- (ii) Each LED anode in the 7 segment display has a separate connection but all of the cathodes are connected to one point [2]

Award [2] for a full explanation and [1] for a limited explanation

Correct alternative responses will be given full credit

- (iii) Protective resistor = $(5 - 2.3)/0.01$ [1]
= 270 ohms [1] [2]

- (iv) Power dissipated by 1 resistor = 2.7×0.01 [1]
= 27 mW [1] [2]

(d) Indicative content:

Any three issues from the following:

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Overheating/fire hazard issues:

1. The correct choice of components is important in ensuring the safe use of the system. Overheating components can lead to combustion. An example would be the incorrect choice of resistor for a particular application.
Procedure. The power dissipated in a resistor can be calculated using Ohm's law. Most components in an electrical circuit generate some heat but correctly calculated values should minimise the risk.
2. Another cause of problems may be the polarity of the component. Whilst resistors can be placed in a circuit either way round, the orientation of polarised components is critical. This is important not only to ensure that the circuit functions correctly but safely as components inserted with incorrect polarity may generate heat leading to a fire risk.
Procedure. Visual polarity check or use of a multimeter to verify polarity.
3. Exceeding rated values. Besides components overheating, it is possible for capacitors for example to 'pop' or explode if the voltage rating is exceeded.
Procedure. Visual check of ratings or if the circuit is required to supply particularly high currents, it may be possible to include fuses or thermal cut-outs.

Production hazard issues:

4. Poison/chemical burns and cuts. The two main methods used for PCB production currently are etch tanks and CNC routers. The chemicals used in etch tanks are hazardous and CNC routers have dangerous cutting tools that are usually behind safety guards.
Procedure. Chemical etching should be carried out by a suitably qualified person wearing appropriate protective clothing. The main safety precaution when using a CNC router would be to keep hands clear of the cutting tool when inserting or removing the PCB.
5. The final stage of PCB production is the soldering of components. Soldering presents a risk of burning due to the high temperature irons used. Solder 'spitting' can also present a risk to the eyes and some solders still contain lead which can cause poisoning.
Procedures include only soldering in a well ventilated room while wearing safety glasses and tying back long hair.

Testing hazard issues:

6. When initially testing circuits there is a risk that overheating components can cause burns.
Procedure. Connect the circuit board to a power supply before inserting any integrated circuits. If there is a short circuit at this stage, it is important to fix it before proceeding. Use a multimeter to check if the voltage levels correspond to those in the circuit diagram or on the computer screen.
7. When initially testing circuits there is a risk that poorly insulated components may cause electrical shock.
Procedure. Conduct a visual check for exposed conductors and do not touch any conductors until checked with a meter.

Correct alternative responses will be given full credit

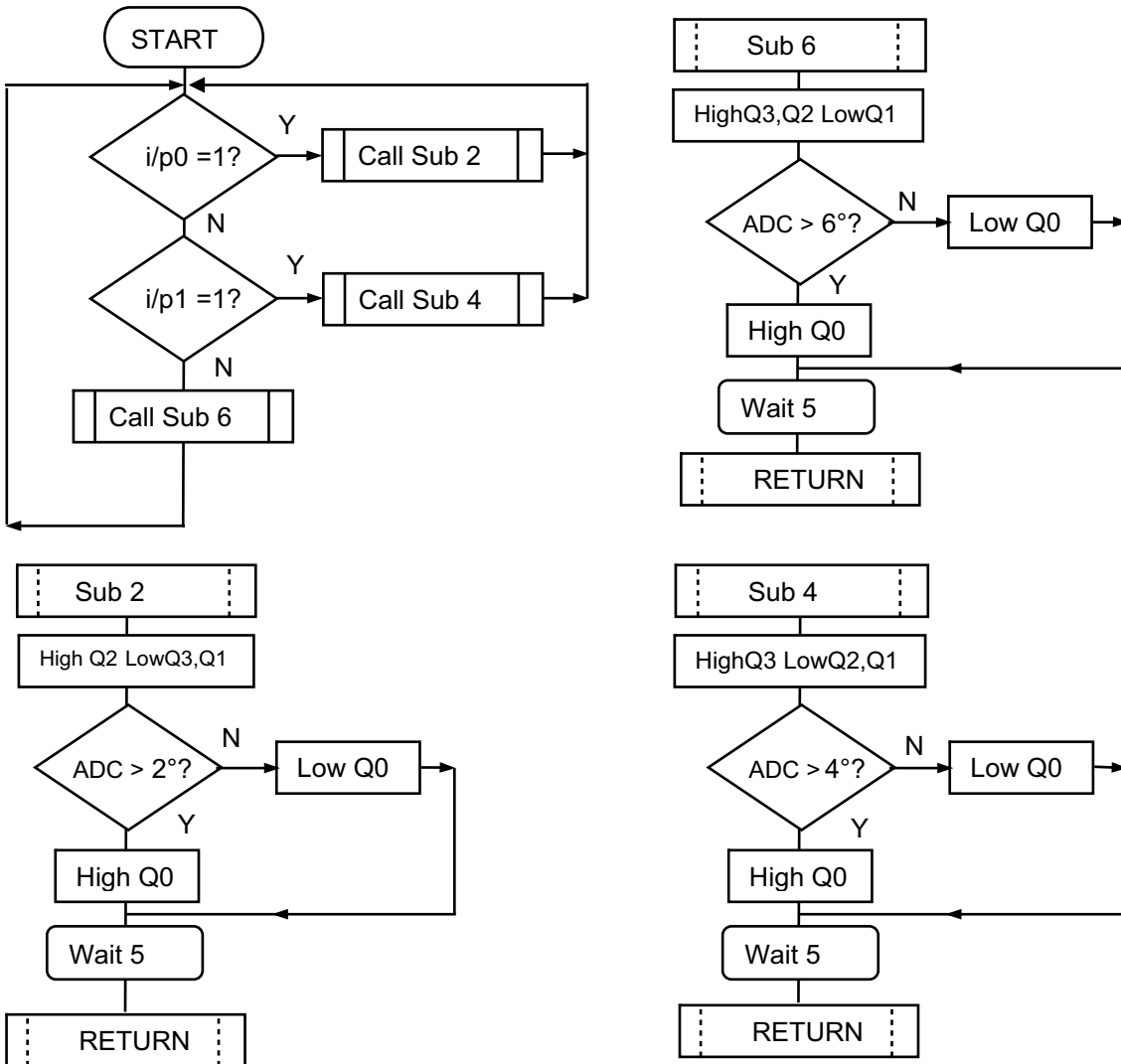
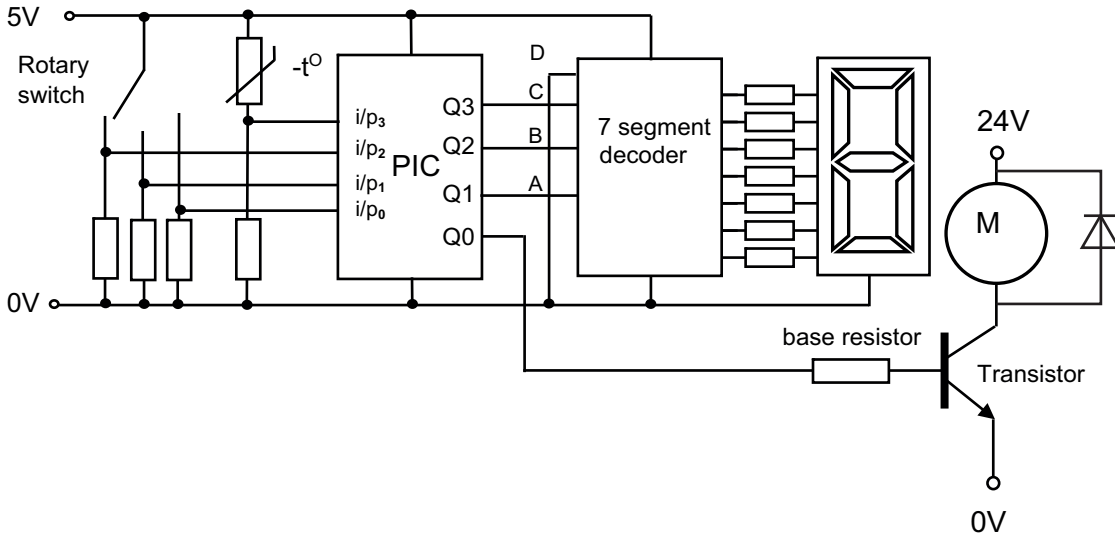
<p>Level 3 The candidate provides a detailed discussion of three fundamental safety issues associated with electronic system production and testing. The candidate then provides three detailed causes of these issues and associated hazards providing three practical examples of procedures that can be used to minimise risk. The written presentation is clear and precise and demonstrates very good knowledge of the subject to be considered. Excellent use of specialist terms and technological vocabulary used throughout. The candidate uses excellent spelling, punctuation and grammar, and the form and style are of a high standard.</p>	<p>[7]–[9]</p>
<p>Level 2 The candidate provides a good discussion of the safety issues associated with electronic system production and testing. The candidate then provides basic causes of how these issues arise and associated hazards, providing mainly practical examples of procedures that can be used to minimise risk. The written presentation is good and demonstrates an adequate knowledge of the subject to be considered. Some specialist terms and technological vocabulary used throughout. The candidate uses good spelling, punctuation and grammar, and the form and style are of a reasonable standard.</p>	<p>[4]–[6]</p>
<p>Level 1 The candidate provides a limited discussion of safety issues associated with electronic system production and testing. The candidate then provides limited causes of why these issues arise and limited reference to the associated hazards. The candidate provides limited examples of procedures that can be used to minimise risk. The written presentation is limited and demonstrates limited knowledge of the subject to be considered. Little use is made of specialist terms and technological vocabulary used throughout. The candidate uses limited spelling, punctuation and grammar with limited accuracy and the form and style are of a basic standard.</p>	<p>[1]–[3]</p>

<p>AVAILABLE MARKS</p>
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[9]

(e) Sample answer.

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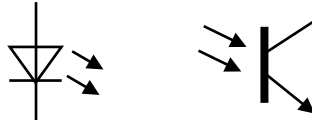


Correct alternative responses will be given full credit

[10]

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2 (a) (i)



(2 × [1])

[2]

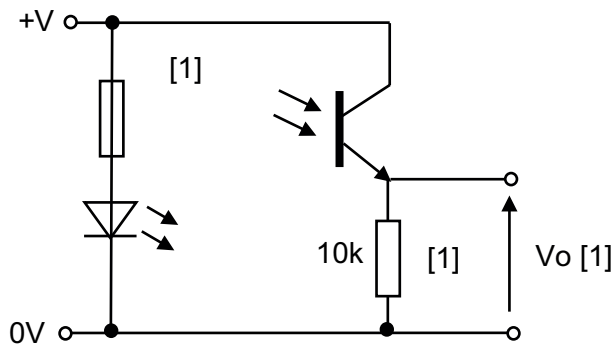
(ii) If the phototransistor responds only to infrared light then the potential for ambient light contamination is minimised. Ambient light could be reflected from light coloured surfaces.

Award [2] for a full explanation and [1] for a limited explanation

Correct alternative responses will be given full credit

[2]

(iii)



[3]

(b) (i) Truth table

Dir.	A	B
W	1	1
S	0	1
E	1	0
N	0	0

(4 × [1])

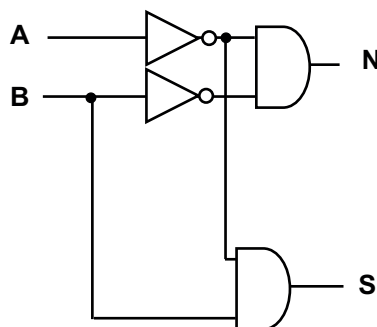
[4]

(ii) $N = \bar{A}. \bar{B}$ [1]

$S = \bar{A}.B$ [1]

[2]

(iii) Sample logic circuit –



[1] mark for each correct o/p

Correct alternative responses will be given full credit

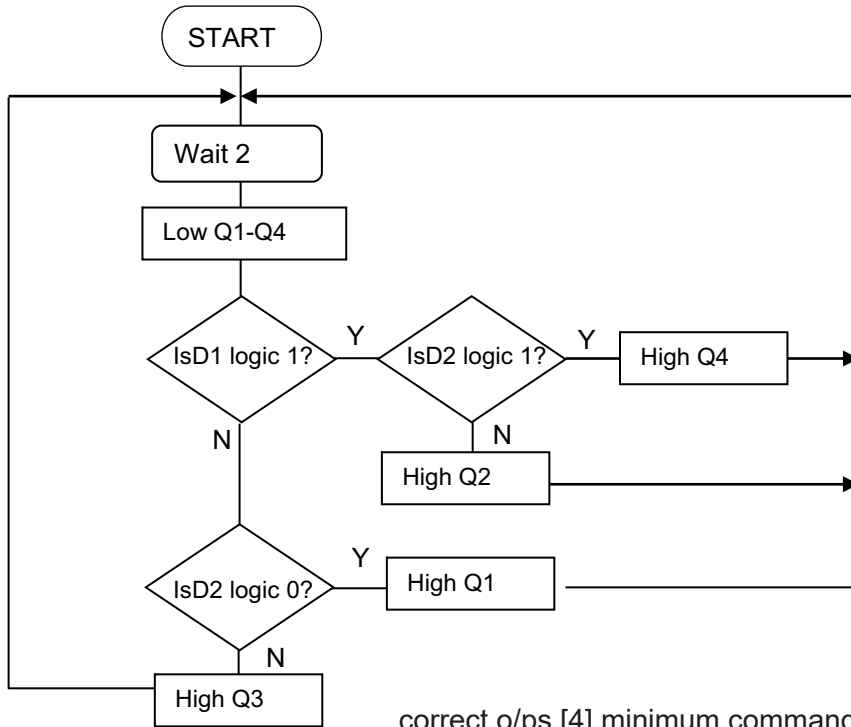
[2]

- (c) (i) A lower number of components are required with the PIC based circuit. As the logic circuit requires more than one type of gate at least 2 integrated circuits will be required as opposed to a single PIC. This will result in a physically smaller PCB.

Award [2] for a full explanation and [1] for a limited explanation

Correct alternative responses will be given full credit [2]

- (ii) Sample flowchart program –

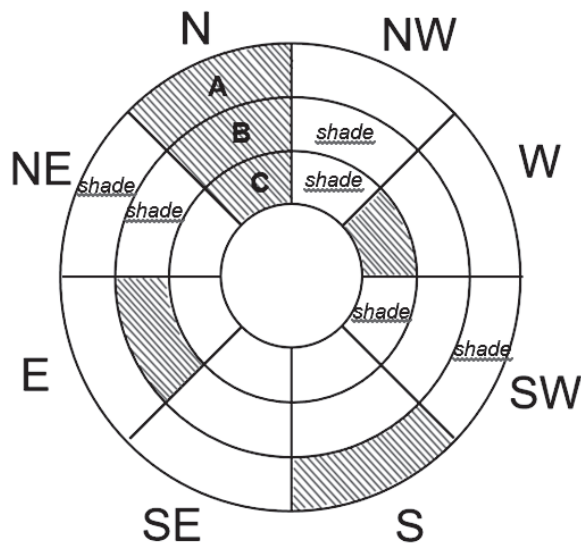


Correct alternative responses will be given full credit [5]

- (d) (i) Errors are minimised [1]

Correct alternative responses will be given full credit

- (ii) Each segment [1]



Source: CCEA

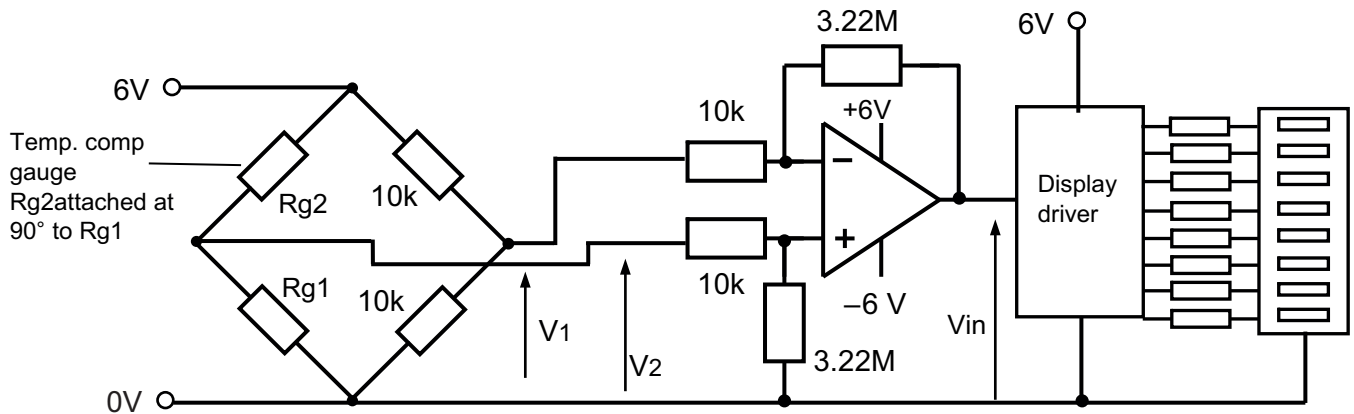
[4]

Correct alternative responses will be given full credit

(e) (i) Resistance of strain gauge = $120 + (120/100 \times 1.25)$ [2]
 = 121.5 ohms [1] [3]

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(ii) Sample answer.



When fully strained $R_{g1} = 121.5 \Omega$
 Therefore differential voltage = $(6 \times (121.5/241.5)) - 3 = 0.01863$
 To amplify to 6V will require a gain of 322

Display driver typically requires input voltage range 0–6V. All bars illuminated when $V_{in} = 6$ volts.

Suggested mark allocation Wheatstone bridge with temp compensation [2]
 Differential op-amp with correct inputs [2]
 Component values for Rf and Ri in k range [4]
 Driver and bar array [2]

Correct alternative responses will be given full credit [10]

Section A

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Section B

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Mechanical and Pneumatic

- 3 (a) (i) Any **two** of the following:
- Use appropriate guards on the machine
 - Operating pneumatic components at appropriate air pressure
 - Display safety signs
 - Complete proper maintenance of machines
- (2 × [1]) [2]

Correct alternative responses will be given full credit.

- (ii) Answer
= Gain in PE = mgh [1]
 $220950\text{J} = 2500 \times 9.82 \times ?$
 $2500 \times 9.82 = 24550$ [1]
 $220950/24550 = 9\text{m}$ [1] [3]

- (iii) Answer:
P = work/time
 $P = 33\text{N} \times 2\text{m}/30$
 $P = 2.2\text{W}$ [1]
 $P = 2.2 \times 100/75$ [1]
 $P = 2.93$ [1] [3]

- (iv) Answer $P = T\omega$
 $P = T = 130 \times \omega$
 $T = 130 \times (2\pi/60 \times 200\text{rpm})$ [1]
 $P = 130 \times 20.93$ [1]
 $P = 2720.9\text{ W}$
 $P = 2.72\text{ kW}$ [1] [3]

(b) (i)	For a response not worthy of credit	0
	Limited sketch of ball and socket joint with limited annotation.	1
	Good sketch of ball and socket joint with good annotation.	2
	Excellent sketch of ball and socket and excellent annotation.	3

[3]

Correct alternative responses will be given full credit

(ii)	For a response not worthy of credit	0
	Limited sketch of the garter seal with limited annotation.	1
	Good sketch of garter seal with good annotation.	2
	Excellent sketch of garter seal and excellent annotation.	3

[3]

Correct alternative responses will be given full credit.

Preference:

Garter would be preferred over the O-ring as it is more robust and has a coil to keep an extremely tight clamp on any shaft. Therefore, reducing the risk of an oil leak. O-rings are quite fragile and are for smaller based components. They would not provide a suitable clamping force on a gearbox drive shaft.

Award [2] for a full explanation of each term and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

(c) See A3 mark scheme [11]

Correct alternative responses will be given full credit.

(d) (i) See A3 mark scheme [5]

(ii) See A3 mark scheme [5]

Correct alternative responses will be given full credit.

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- 4 (a) (i) Force Comparison: Hydraulics – normally very powerful with pneumatics normally not having the same force outcome for a similar sized double acting cylinder.

Award [2] for a full explanation of each term and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

Speed Comparison: Hydraulics – can be quite slow with pneumatics normally the faster option for a similar sized double acting cylinder.

Award [2] for a full explanation of each term and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (ii) The purpose of the vacuum lifting cup is to transport a range of non-porous materials in a safe and secure manner. They are used in order not to have to damage the material as air is used as the contact method.

Award [2] for a full explanation of each term and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

Application: Lifting of glass [1]

Correct alternative responses will be given full credit.

(iii)	For a response not worthy of credit	0
	Limited sketch of the key features of the diaphragm clutch with limited annotation.	1
	Good sketch of the key features of the diaphragm clutch with good annotation.	2
	Excellent sketch of the key features of the diaphragm clutch and excellent annotation.	3

[3]

Correct alternative responses will be given full credit.

(iv)
$$\frac{S \times (D^2 - d^2) \times (3.5 + 1) \pi}{4}$$
 [1]

Volume = $60 \times (7^2 - 2^2) \times (3.5 + 1) \times \frac{3.14}{4}$ [1]
 Volume = 9537.75 cm^3 [1]

[3]

(v)
$$W = F \times L$$

$$= (220 - 30\%) \times 0.6$$

$$= 154 \times 0.6$$
 [1]

$$= 92.4 \text{ J}$$
 [1]

[2]

- (b) See A3 mark scheme. [6]

(c) Indicative content excluding cost and availability:

Drum Brakes:

Friction contact area is at the circumference of the brake therefore can provide a large braking force.

Use friction caused by a set of shoes or pads that press outward against a rotating cylinder.

Are often applied to the rear wheels as the heat generated is less and can be easily incorporated to facilitate a parking brake.

Are returned via a spring which gives a positive action and has less drag when released.

Disc Brakes:

Uses calipers to squeeze pairs of pads against a disc in order to create friction that stops the rotation of a shaft, such as a vehicle axle.

Rely on pliability of caliper seals and slight runout to release pads which can lead to drag.

Normally activated by hydraulics in vehicles and used on the front wheels.

Their braking force is always proportional to the pressure placed on the brake pad by the braking system via braking pedal, or lever. This tends to give the driver better “feel.”

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Level 3 The candidate discusses five relevant factors in excellent depth with reference to three specific characteristics of drum brakes and two specific characteristics of disc brakes. The written presentation is clear and precise and demonstrates very good knowledge of the issues to be considered. Appropriate specialist terms and technological vocabulary used throughout. The candidate uses excellent spelling, punctuation and grammar and the form and style are of a high standard.	[7]–[9]
Level 2 The candidate discusses a number of relevant factors in good depth with reference to specific characteristics of drum brakes and specific characteristics of disc brakes. The written presentation is reasonable and demonstrates an adequate knowledge of the issues to be considered. Some specialist terms and technological vocabulary are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of a reasonable standard.	[4]–[6]
Level 1 The candidate discusses few factors in limited depth with reference to specific characteristics of drum and disc brakes. The written presentation is limited and demonstrates a limited knowledge of the issues to be considered. Little use is made of specialist terms and technological vocabulary. The candidate uses spelling, punctuation and grammar with limited accuracy and the form and style are of a basic standard.	[1]–[3]
Response not worthy of credit	[0]

Correct alternative responses will be given full credit.

[9]

(d) (i) See A3 mark scheme [6]

(ii) See A3 mark scheme [4]

Fully functional mechanical system	[4]
Partially functional mechanical system	[2]–[3]
Limited functional mechanical system	[1]
Response not worthy of credit	[0]

Correct alternative responses will be given full credit.

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Section C

Product Design

- 5 (a) Incremental products are essentially part changes, improvements or additional features to an existing product. The iPhone series displays examples of additional features or improvements.

Award [2] for a full explanation of the term and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (b) A life-cycle assessment is a technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave (from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (c) (i) Any **two** main reasons why consideration should be given to responsible sourcing when selecting a metal for the trolley frame, for example:
- To ensure that the metals have been extracted and processed in an environmentally sensitive manner.
 - To ensure communities local to the extraction and manufacture have been given adequate consideration.
 - Applying a responsible sourcing strategy can help achieve sustainability objectives.

Correct alternative responses will be given full credit.
(2 × [1]) [2]

- (ii) Any **three** main reasons why we should consider recycled content when selecting a metal for a product, for example:

- Using a higher content of recycled metal will result in less energy being used (melt and remould is less than extraction).
- Cheaper to use recycled metals rather than mining for new ones.
- By producing components with a higher recycled content will reduce the environmental impact.
- Using a higher content of recycled metal will ultimately result in less material having to be extracted.

Correct alternative responses will be given full credit.
(3 × [1]) [3]

- (d) (i) How ICT is used to assist in the implementation of quality control.

ICT may be used in QC to ensure that components are the correct type, size and positioned correctly. ICT may also be used when testing the product (by sensors and computers) to ensure it is to the correct standard, before distribution.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (ii) Describe how ICT is used to assist in the implementation of quality assurance.

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. In addition ICT will be used to gain customer feedback to ensure customer satisfaction.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (e) (i) Any **two** benefits of 3D scanning which could be used to persuade the company to invest in the equipment, for example:

- 3D scanning can result in quick capture of all physical measurements of any product or component which can be used in development.
- 3D scanning saves the company time in design work which will ultimately save money.
- 3D scanning increases working effectiveness to the company when dealing with complex parts and shapes.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit.
(2 × [2]) [4]

- (ii) Any **two** benefits of QRM which could be used to persuade the company to adopt this approach, for example:

- Increase customer satisfaction – Using QRM may reduce waiting time and therefore ensure that you can supply customers quickly which can result in return business.
- Using QRM drives innovation and prevents a company from resting on its laurels while competitors innovate and take away customers.
- Using QRM can increase cash flow. Delivering products quicker, getting paid quicker improves cash flow giving the company more flexibility and a greater ability to respond to market changes.
- Reduced lead times.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit.
(2 × [2]) [4]

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- (f) Any **three** of the 6R's, using practical examples explain how they have been specifically incorporated into the design of the chosen example.

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Indicative content:

E.g. Reduce – The smart car reduces the material used to produce the overall vehicle. Not only has it reduced the number of components but it has reduced the number of manufacturing processes and assembly processes needed.

Reuse – The product can be reused after its initial function, for example the design of the reusable ink cartridge or in some cases the product may be reused for something entirely different.

Recycle – design for ease of disassembly and ensure that materials are clearly labelled for recycling purposes. The Dyson cleaner has a high percentage of high grade recyclable materials. In addition the electrical parts of the product have been designed to be fully recyclable.

Refuse – the customer has the right to refuse to purchase the product if they feel that the company with its design and manufacture has not done everything in its powers to address environmental issues. Take for example consumers choosing not to use as many plastic bags.

Repair – The desktop computer is a product that has been designed with repair in mind. All sub assemblies are able to be replaced/repared with parts supplied on a cost effective basis.

Rethink – The Ford company has rethought its design for the new F-150 truck using smart data to create a vehicle 700lbs lighter than its previous model. In addition, rethinking through the life cycle assessment helped Ford to see it was more sustainable to incorporate recycled materials from sources in industry rather than materials grown across the globe.

<p>Level 3 The candidate has selected three of the 6R's with suitable practical examples. They provide a detailed explanation of how three of the 6R's have been specifically incorporated into the design of their chosen examples. The written presentation is clear and precise and demonstrates very good knowledge of the subject to be considered. Appropriate specialist terms and technological vocabulary used throughout. The candidate uses excellent spelling, punctuation and grammar, and the form and style are of a high standard.</p>	<p>[7]–[9]</p>
<p>Level 2 The candidate has selected up to three of the 6R's with some suitable practical examples. They provide a good explanation of how up to three of the 6R's have been specifically incorporated into the design of their chosen examples. The written presentation is reasonable and demonstrates an adequate knowledge of the subject to be considered. Some specialist terms and technological vocabulary used throughout. The candidate uses good spelling, punctuation and grammar, and the form and style are of a reasonable standard.</p>	<p>[4]–[6]</p>
<p>Level 1 The candidate has selected up to three of the 6R's with limited practical examples. They provide a limited explanation of up to three of the 6R's have been specifically incorporated into the design of their chosen examples. The written presentation is basic and demonstrates limited knowledge of the subject to be considered. Little use is made of specialist terms and technological vocabulary used throughout. The candidate uses spelling, punctuation and grammar with limited accuracy and the form and style are of a basic standard.</p>	<p>[1]–[3]</p>

[9]

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- (g) A design could be based on a split hinged bracket which can be fitted onto the hand rail with the use of two recessed bolts. The scanner can be housed in a tapered threaded split slot. A threaded ring can be rotated by hand which will tighten to secure the scanner in position. A plastic threaded thumb screw could be used to position the scanner and bracket along the hand rail.

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Detailed annotated sketches of an appropriate design of a bracket which will ensure that the scanner is securely housed in an upright position and is firmly attached to the hand rail of the shopping trolley. In addition the design has an appropriate means of allowing the user to quickly move the bracket and scanner along the hand rail..	[7]–[10]
The sketches and annotation are good. The idea represents an improvement but there are some limitations on how the scanner is secured, how it is attached to the hand rail or how the bracket is moved along the hand rail.	[4]–[6]
Limited sketches lacking detail and appropriate annotation. Difficulties in determining if the design of the bracket will ensure that the scanner is securely housed in an upright position and is firmly attached to the hand rail of the shopping trolley. In addition it is difficult to determine if the design has an appropriate means of allowing the user to quickly move the bracket and scanner along the hand rail.	[1]–[3]
The response is not worthy of any credit.	[0]

Correct alternative responses will be given full credit.

[10]

40

6 (a) Any **two** main reasons why products are redesigned, for example:

- Changing customer demands
- New available technology
- New government legislation.

Correct alternative responses will be given full credit.

(2 × [1])

[2]

(b) (i) Any **two** main characteristics associated with market penetration, for example:

- Market penetration involves increasing sales to existing customers
- Finding new customers for existing products
- Taking customers from competitors.

Correct alternative responses will be given full credit.

(2 × [1])

[2]

(ii) Any **two** main characteristics associated with product development, for example:

- Changing or developing existing products further
- Developing new products from the basis of the old classic model
- Product development is used to differentiate products from competitors

Correct alternative responses will be given full credit.

(2 × [1])

[2]

(iii) Any **two** main characteristics associated with diversification, for example:

- Adding more markets to an existing business
- Adding more products to an existing business
- Diversification concentrates on product and market growth to enhance company sales and market share.

Correct alternative responses will be given full credit.

(2 × [1])

[2]

(c) Any **two** main differences between the main characteristics of introduction and the main characteristics of growth, for example:

- Marketing costs are extremely high at the introduction stage as people may not be aware of the product. The marketing costs reduce during the growth phase due to customer awareness.
- Very little profit at the introduction stage due to costs. Growth stage will have more profit due to reduction in costs and increase of sales.
- There are few or no competitors in the market at the introductory stage. This changes during the growth stage when competition increases with new companies entering the market.

Award [2] for a full explanation of each difference and [1] for a limited explanation for each difference.

Correct alternative responses will be given full credit.

(2 × [2])

[4]

(d) (i) Cost-plus

This involves estimating the average cost of producing and marketing the traffic cones (designing, manufacturing, packaging) and adding a mark-up for profit.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

(ii) Contribution pricing

This involves similar steps outlined in cost-plus but is a much more sophisticated version. This is because it takes account of the variation in costs of production of the traffic cones for different markets for different levels. Charts are used to show the break-even at various levels of sales.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

(iii) Perceived value

Perceived value is a pricing method based on market research. This research will establish what clients in the road safety industry think what a specific model of traffic cones are worth based on their experience and how they compare with other competitors in the market.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

(e) Example 1

Car – Hybrid technology and battery powered cars have reduced the environmental impact. In addition other aspects of car component design such as the catalytic convertor, start stop technology, material component selection and gearbox design has reduced the environmental impact.

Award [2] for a full explanation of the example and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

Example 2

Light bulbs – Light Emitting Diodes (LED) have revolutionised energy-efficient lighting. They last much longer, they are more durable, are mercury free, more efficient, inside the home save electricity, remain cool and save money on replacement costs.

Award [2] for a full explanation of the example and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (f) Any **two** specific examples of how the national government has influenced the design of products, for example:

Example 1

Plastic bag tax – This has reduced the use of plastic bags. It has influenced the design of longer life bags in the sense of material selection, size of bag, manufacturing processes and the opportunity for promotion.

Award [2] for a full explanation of the example and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

Example 2

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

Award [2] for a full explanation of the example and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (g) (i) One example of a product which incorporates moral factors in its design would be computers. This incorporates positive moral factors in its design as it provides the opportunity for the user to use software to filter on-line material.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (ii) One example of a product which incorporates social factors in its design would be the bicycle. Bicycles have been designed to cater for different lifestyles. Racing, off road, touring and mountain biking are just a few examples of how the designer has incorporated social factors in its design.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [2]

- (h) (i) A design could be based on a tapered ring with a diameter to secure position on the cone. A permanent bracket could be riveted to the sign. This bracket will have two protruding pins which will align with two holes in the ring and be secured in position by a pin.

AVAILABLE
MARKS

Detailed annotated sketches of an appropriate design that would allow the user to quickly and securely attach or detach the sign without rotation to the top of the cone without making any modifications. An appropriate means on how the design is attached to the back of the sign is provided.	[4]–[5]
The sketches and the annotation are good. The design represents an improvement but has limitations on how it would allow the user to quickly and securely attach or detach the sign without rotation to the top of the cone without making any modifications. How the design is attached to the back of the sign may also have some limitations.	[3]
Limited sketches lacking detail and appropriate annotation. Difficulties in determining if the design would allow the user to quickly and securely attach or detach the sign without rotation to the top of the cone without making any modifications. Difficulties in determining if an appropriate means to attach the design to the back of the sign is provided.	[1]–[2]
The response is not worthy of any credit.	[0]

Correct alternative responses will be given full credit. [5]

- (ii) A design could be based on an injection moulded ring to slip over the cone. A partially open hook will form part of the design on the ring and this will facilitate the chain link.

Detailed annotated sketches of an appropriate design that would allow the user to attach a closed chain link to the road cone at the position shown to increase the range of functions of the product.	[3]
The sketches and the annotation are good. The design represents an improvement but has limitations on how the user would attach a closed chain link to the road cone at the position shown to increase the range of functions of the product.	[2]
Limited sketches lacking detail and appropriate annotation. Difficulties in determining if the design would allow the user to attach a closed chain link to the road cone at the position shown to increase the range of functions of the product.	[1]
The response is not worthy of any credit.	[0]

Explain how your design takes account of the need for large scale production.

Explanation on how the design could take account of the need for large scale production may include a design suitable for a one piece injection moulding unit requiring minimal number of parts. The material selected will be based on injection moulding. The design will require minimal finishing processes and assembly.

Award [2] for a full explanation and [1] for a limited explanation.

Correct alternative responses will be given full credit. [5]

Section C

Total

**AVAILABLE
MARKS**

40

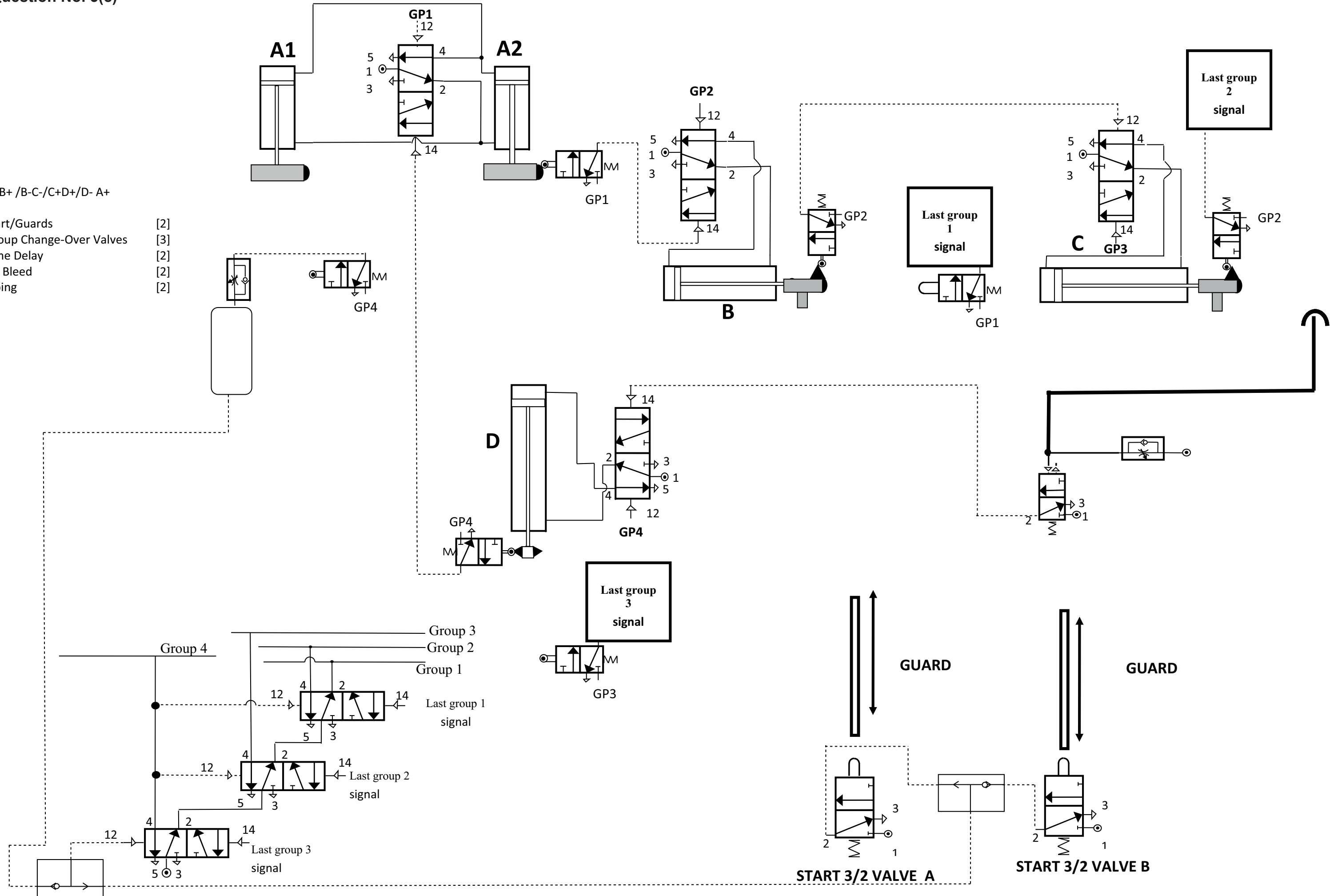
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80

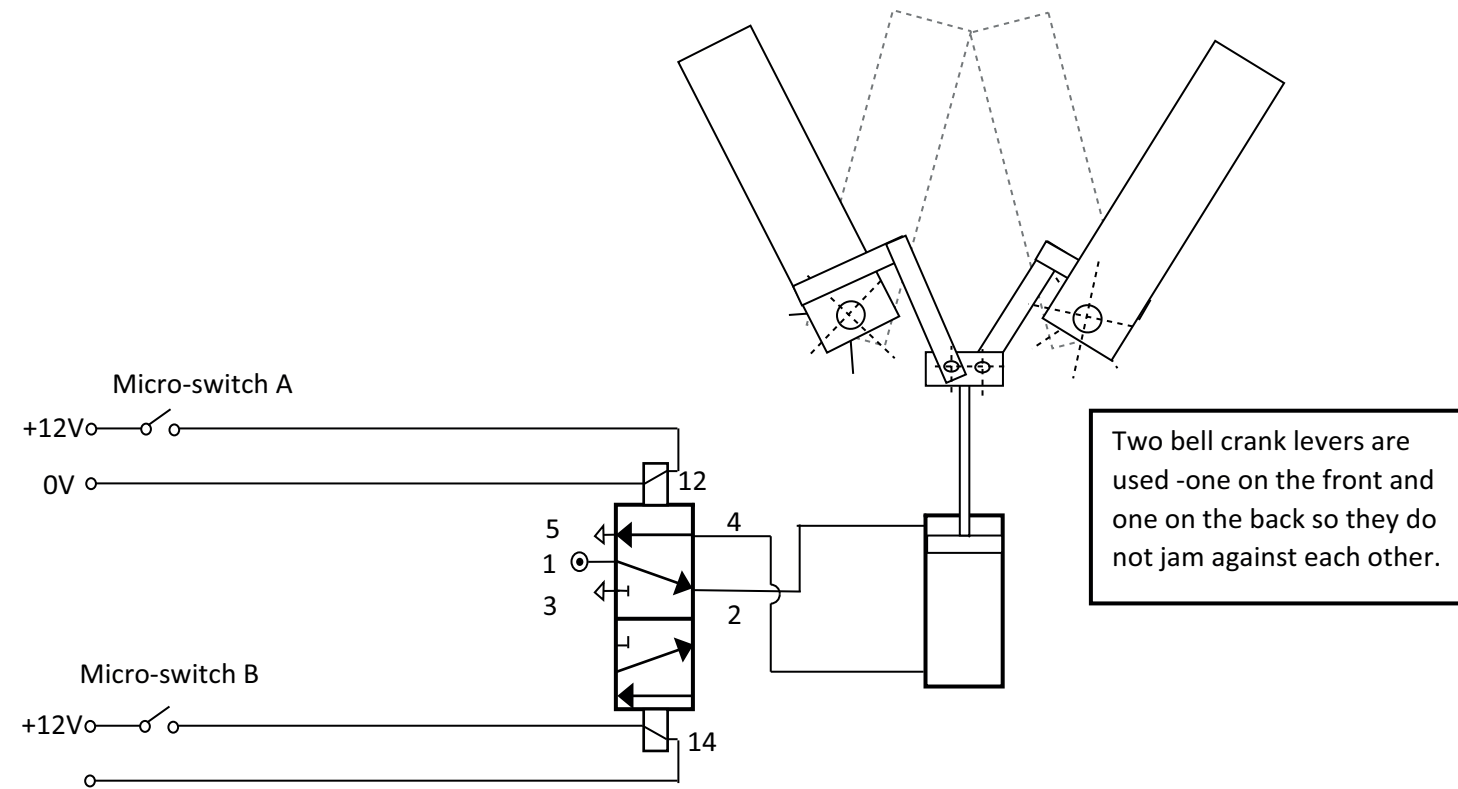
Question No. 3(c)

A- B+ /B-C-/C+D+/D- A+

- Start/Guards [2]
- Group Change-Over Valves [3]
- Time Delay [2]
- Air Bleed [2]
- Piping [2]



Question No. 3(d)(i)

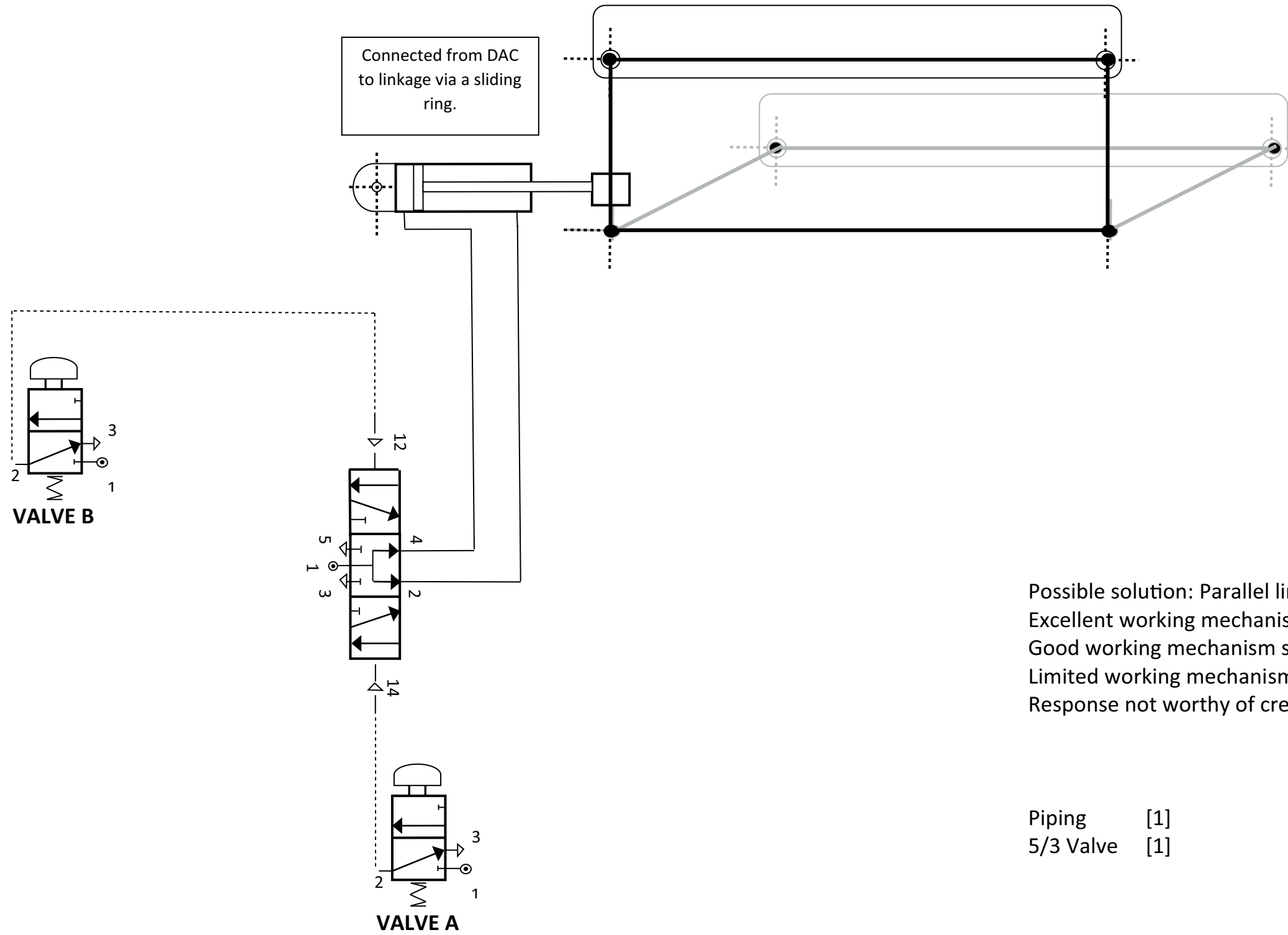


Possible solution: Solenoid operated 5/2 valve with two bell crank levers

- Excellent working mechanism [3]
- Good working mechanism [2]
- Limited working mechanism [1]
- Response not worthy of credit [0]

- 5/2 Valve with solenoids [1]
- Wiring for switches [1]

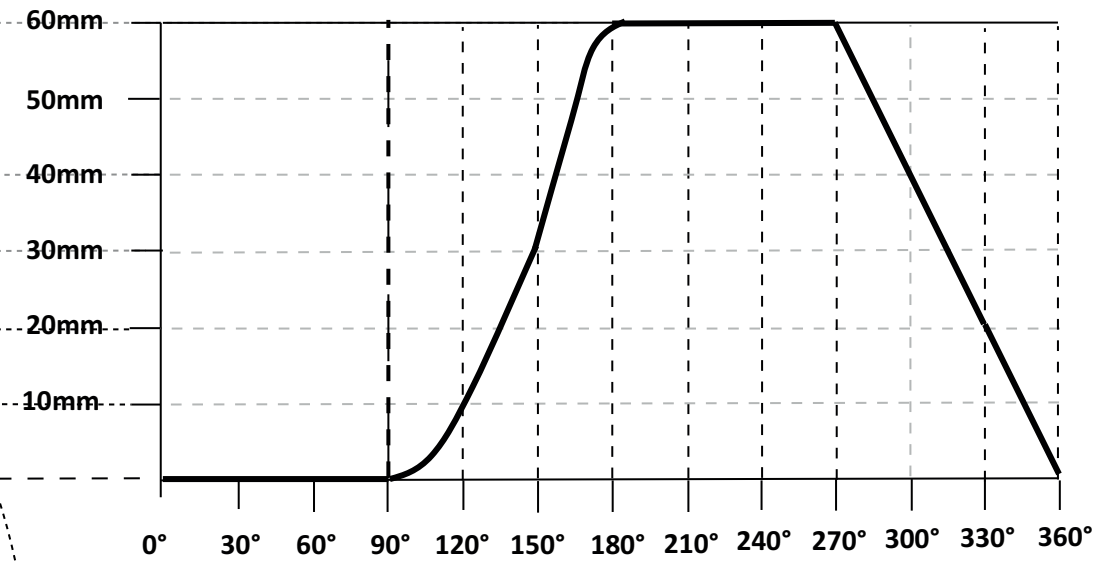
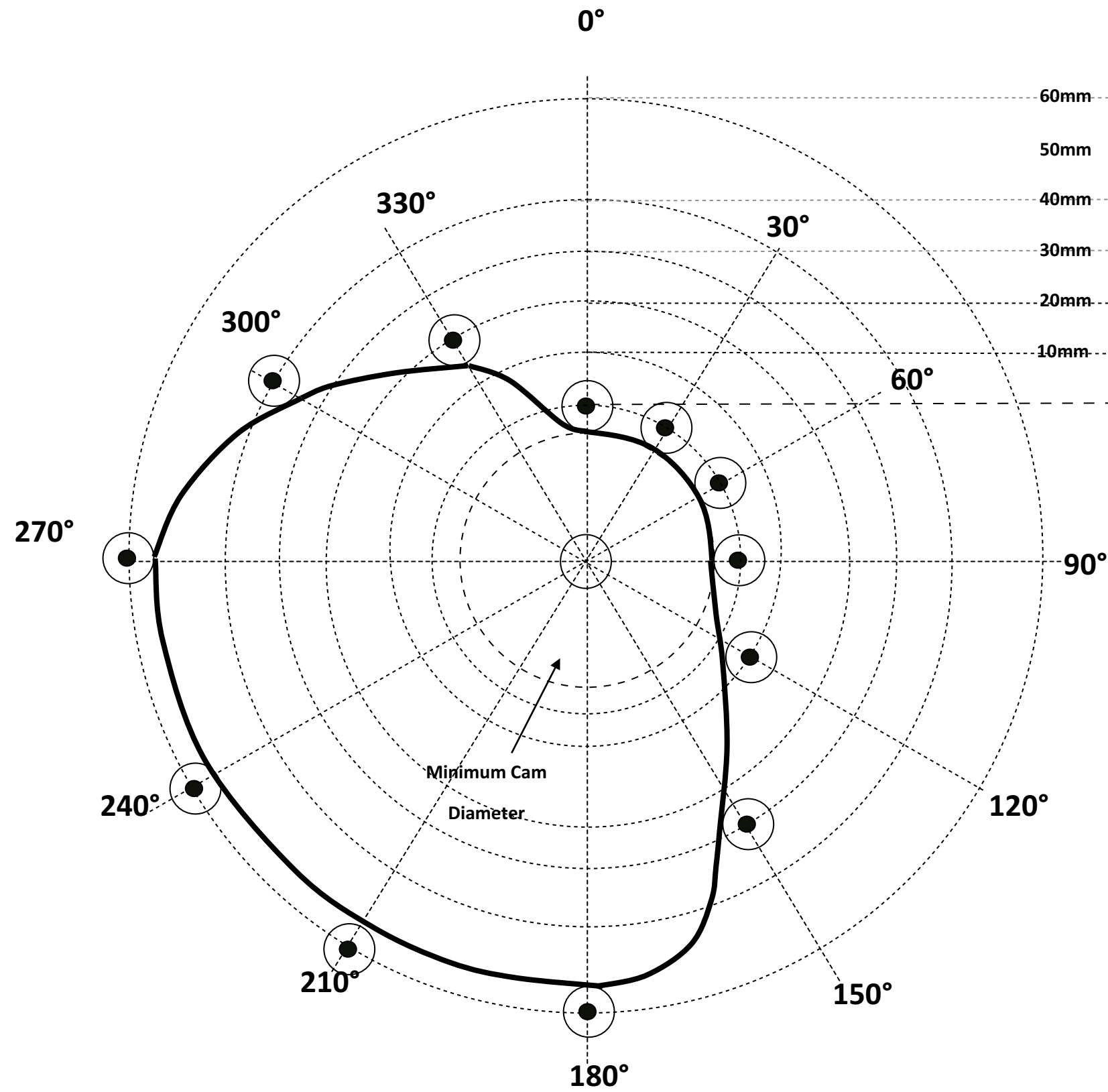
Question No. 3(d)(ii)



Possible solution: Parallel linkage with 5/3 Valve for accuracy
 Excellent working mechanism showing suitable connections [3]
 Good working mechanism showing some connections [2]
 Limited working mechanism with no connections [1]
 Response not worthy of credit [0]

Piping [1]
 5/3 Valve [1]

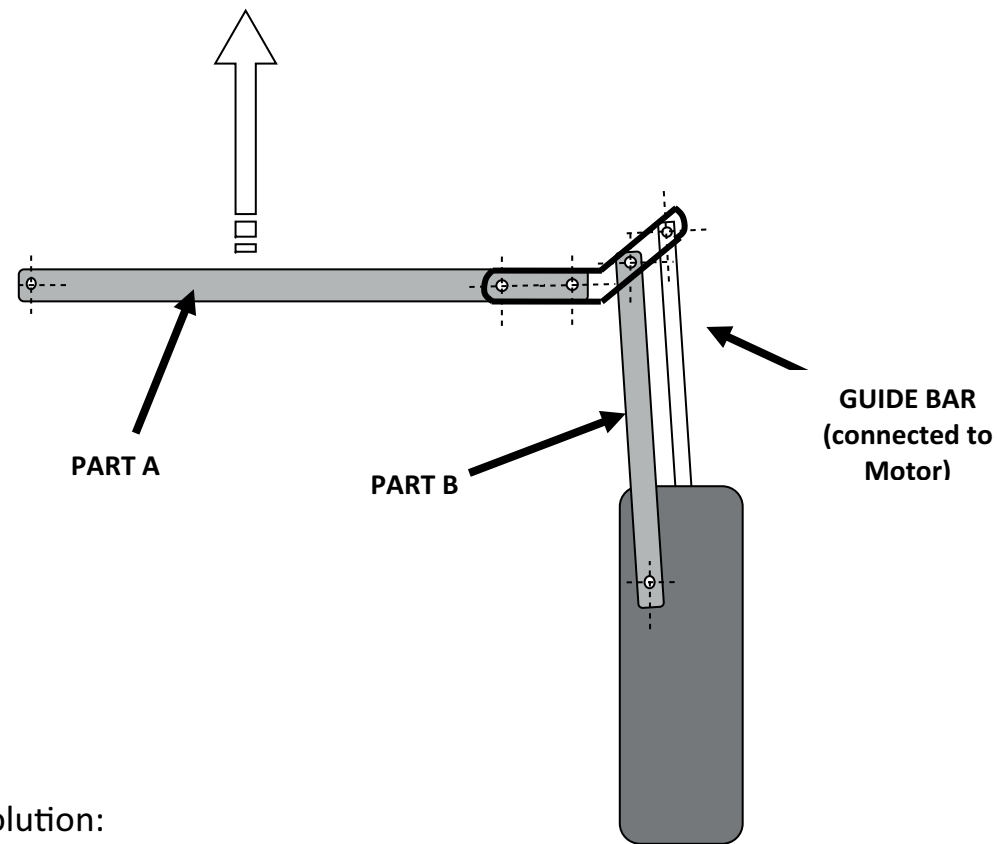
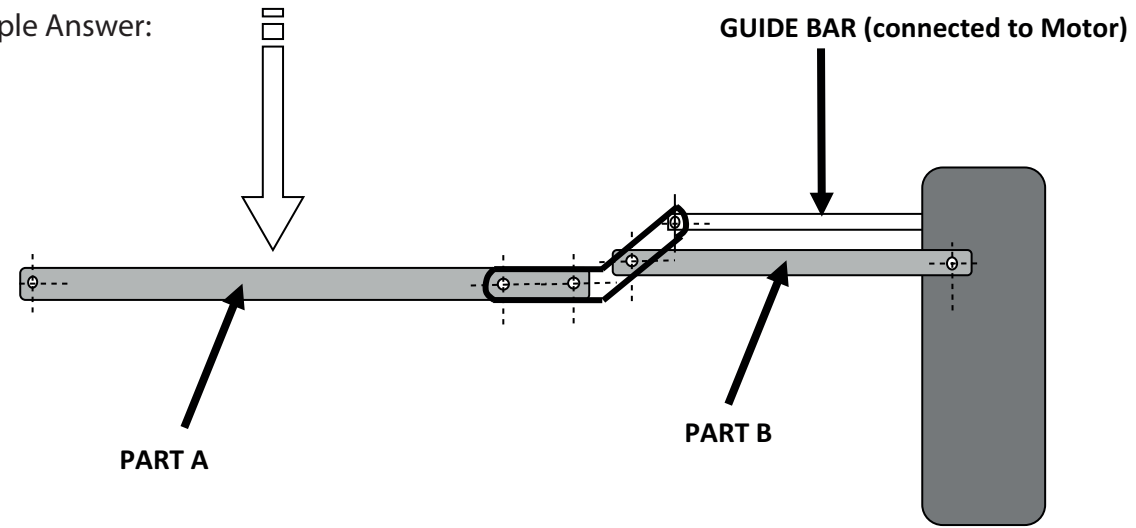
Question No. 4(b)



0-90° / 270-360° Dwell	[1]
Rise and Fall	[2]
Profile	[1]
Transfer of points to degree segments	[1]
Roller follower indication	[1]

Question No. 4(d)(i) and (ii)

Sample Answer:



Possible solution:

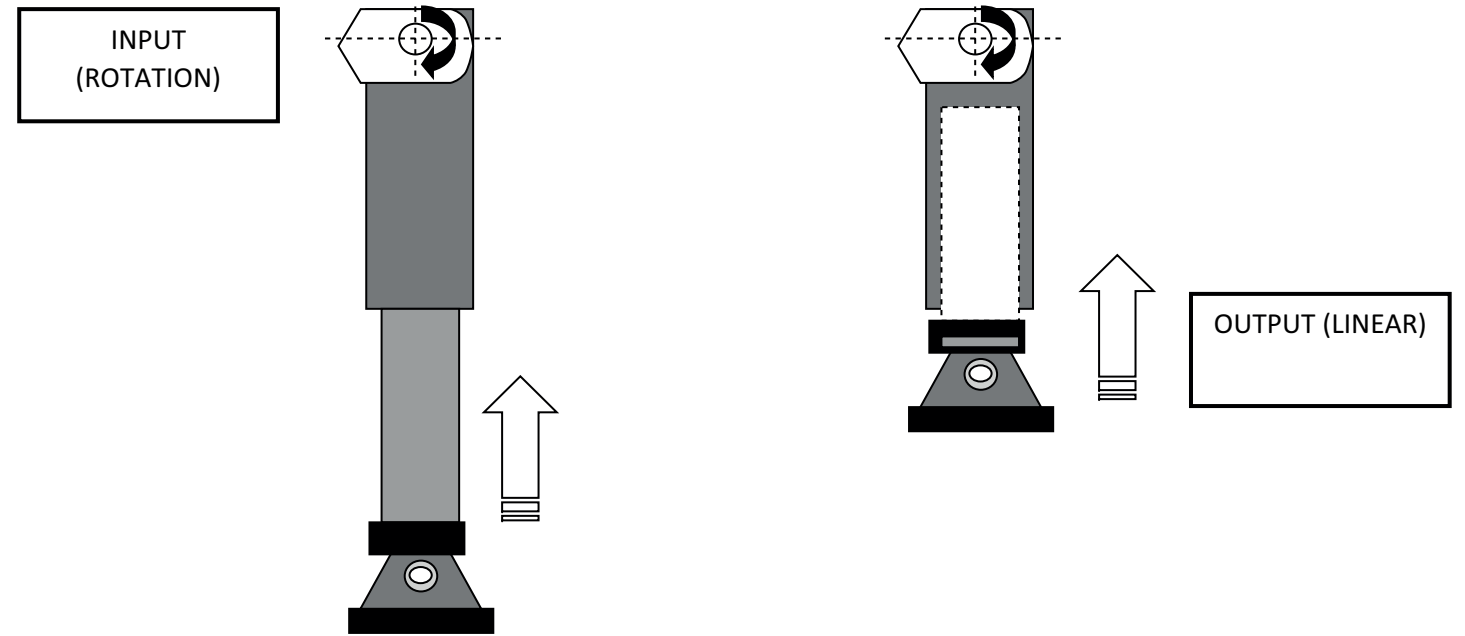
Linkage to connect together Parts A and B.

Roller bearing to connect guiding bar to linkage.

Fully functional mechanical system	[4]
Partially functional mechanical system	[2]–[3]
Limited functional mechanical system	[1]
Response not worthy of credit	[0]

Suitable bearing [1]
 Suitable connections [1]

Sample Answer:



Possible solution: Rack and Pinion with lockable handle