



*Rewarding Learning*

**General Certificate of Secondary Education  
2024**

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## **Technology and Design**

Unit 2

Option B: Mechanical and Pneumatic  
Control Systems

**[GTY22]**

**WEDNESDAY 12 JUNE, MORNING**

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**MARK  
SCHEME**

## **General Marking Instructions**

### ***Introduction***

Mark schemes are intended to ensure that the GCSE examinations are marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses. The mark schemes should be read in conjunction with these general marking instructions.

### ***Assessment objectives***

Below are the assessment objectives for GCSE Technology and Design.

Candidates must:

- Recall, select and communicate their knowledge and understanding of Technology and Design in a range of contexts;
- Apply skills knowledge and understanding, including quality standards in a variety of design contexts. Plan and carry out investigations and making tasks involving an appropriate range of tools, equipment, materials and processes; and
- Analyse and evaluate evidence, design proposals and outcomes, make reasoned judgements and present conclusions and recommendations.

### ***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 16-year-old which is the age at which the majority of candidates sit their GCSE 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 an unanticipated answer, 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 16-year-old GCSE 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.

### **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**

Tasks and questions requiring candidates to respond in extended writing are marked in terms of 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.

### **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.

### **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 limited.

Level 2: Quality of written communication is satisfactory.

Level 3: Quality of written communication is very good.

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

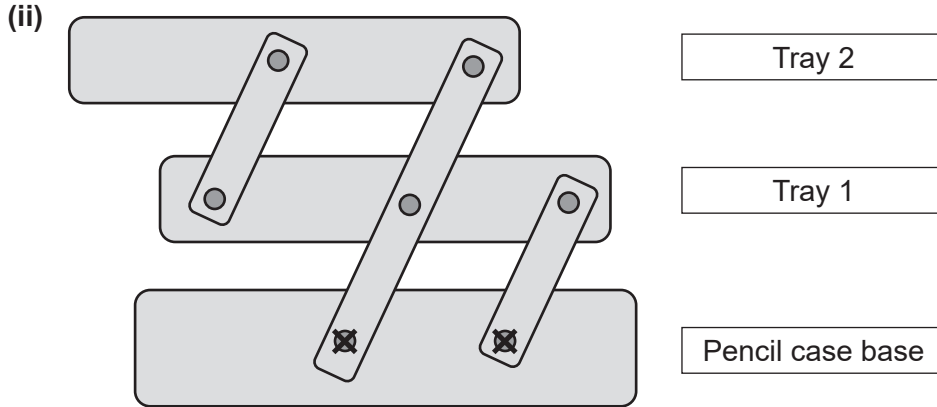
**Level 1 (Limited):** The level of accuracy of presentation, spelling, punctuation and grammar is limited. The candidate makes a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary.

**Level 2 (Satisfactory):** The level of accuracy of presentation, spelling, punctuation and grammar is satisfactory. The candidate makes a satisfactory selection and use of an appropriate form and style of writing supported with appropriate use of diagrams as required. Relevant material is organised with some clarity and coherence. There is some use of specialist vocabulary.

**Level 3 (Very Good):** The level of accuracy of presentation, spelling, punctuation and grammar is very good. The candidate successfully selects and uses the most appropriate form and style of writing, supported with precise and accurate use of diagrams where appropriate. Organisation of relevant material is very good. There is very good use of appropriate specialist vocabulary.

- 1 (a) Fixed Pivot [1] A [1]  
 Sprocket & Chain [1] D [1]  
 Snail Cam [1] B [1]  
 Bevel Gear [1] C [1]  
 Single pulley [1] E [1] [10]

- (b) (i) Parallel [1]

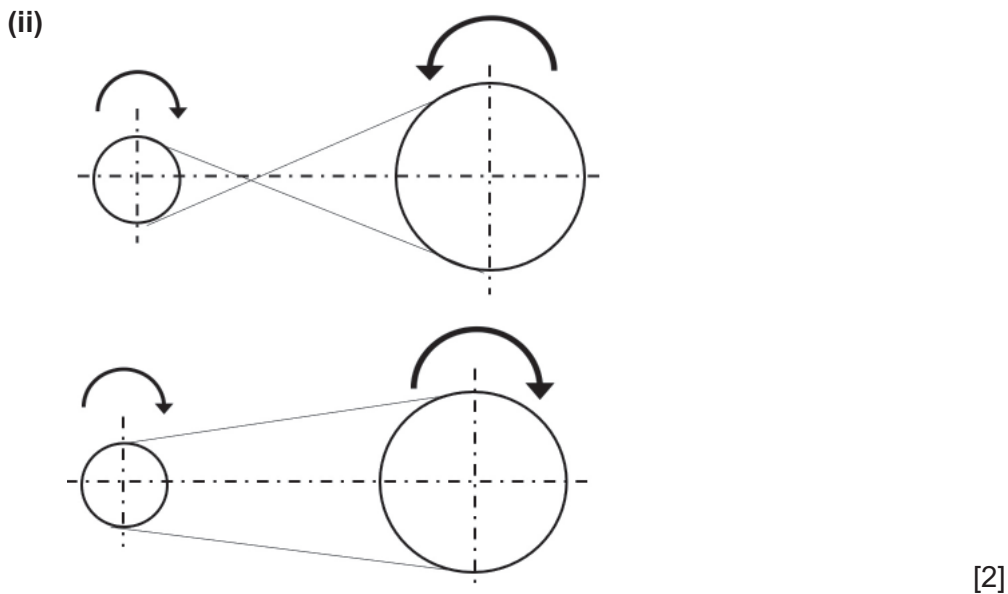


[1] for each correct marked fixed pivot  
 More than 2 marked [0] will be awarded [2]

- (iii) Any **two** of the following:  
 Can store items in various levels [1]  
 Allows easy access to base and trays [1]  
 Allows all 3 trays to be used at once [1]  
 Trays collapse when case closed to save space [1]  
 Compact storage [1]  
 Keeps trays separate when closed [1]  
 Trays lift up when pencil case opened [1]

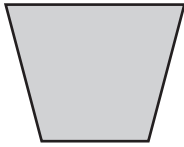
**All relevant, valid responses will be given credit.**  
 (2 × [1]) [2]

- (c) (i) Round belt [1]  
 Flat belt [1]  
 Toothed belt [1] [3]



(d) (i) V – Belt [1]

(ii) V – Belt profile



[1]

(iii)

Name of the Driver pulley	Diameter in mm	Name of the Driven pulley	Diameter in mm	Velocity Ratio	Output speed
A	270	D	45	1:6	<u>2160</u>
B	<u>120</u>	E	120	1:1	360
C	45	F	270	<u>6:1</u>	60

(3 × [1])

[3]

(iv)  $GR_T = GR_1 \times GR_2$

$$= \frac{180}{30} \times \frac{240}{30} [1]$$

$$= 6 \times 8 = 48 [1]$$

$$= 48:1 [1]$$

[3]

(v) Speed of driven = input speed/ $GR_T$

$$= \frac{3600}{48} [1]$$

$$= 75 [1] \text{ rpm}$$

[2]

(vi) Rack and pinion

[1]

(vii) 1 turn =  $13 \times 4 = 52 [1]$

$$\frac{117}{52} [1]$$

$$2.25 \text{ or } 2 \frac{1}{4} \text{ turns [1]}$$

[3]

(e) (i) Any **two** of the following:

Corrosion resistant [1]

High tensile strength [1]

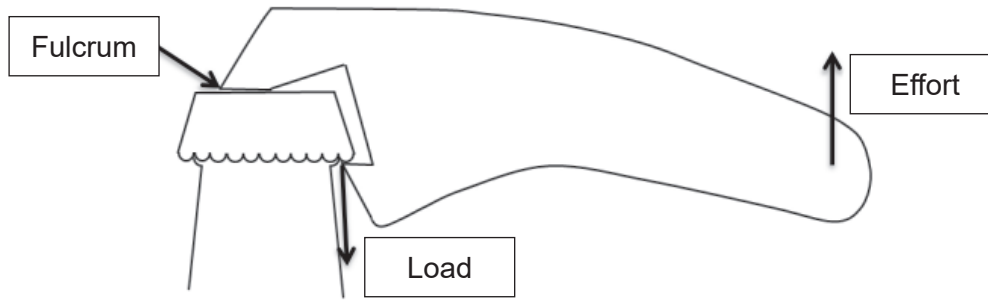
Hygienic [1]

**All relevant, valid responses will be given credit.**

[2]

AVAILABLE  
MARKS

(ii) Diagram as labelled: (3 × [1])



[3]

(iii) 2nd Class

[1]

(iv) Moment = Force × Distance

$$F \times 0.02 = 15 \times 0.08 \text{ [1]}$$

$$F = \frac{1.2}{0.02}$$

$$F = 60 \text{ [1] N}$$

[2]

(v) Mechanical advantage =  $\frac{\text{load}}{\text{effort}}$

$$MA = \frac{60}{15} \text{ [1]}$$

$$MA = 4 \text{ [1]}$$

[2]

(vi) Efficiency (%) =  $\frac{MA}{VR} \times 100$

$$VR = \frac{\text{Effort distance}}{\text{Load distance}} = \frac{44.8}{2.8} = 16 \text{ [1]}$$

$$\text{Efficiency} = \frac{4}{16} \times 100 \text{ [1]}$$

$$\text{Efficiency} = 25\% \text{ or } 0.25 \text{ [1]}$$

[3]

AVAILABLE  
MARKS

(vii)

<b>Response Type</b>	<b>Description</b>	<b>Mark Band</b>
When a response is not worthy of credit, a <b>[0]</b> mark should be awarded		
<b>Limited</b>	Candidate produces sketch/sketches which do not convey a clear solution and show limited ideas. The solution lacks detail. The level of annotation conveys limited information and lacks technical vocabulary and specialist terms.	<b>[1]</b>
<b>Satisfactory</b>	Candidate produces satisfactory sketch/sketches which convey some ideas for the solution. The level of annotation is satisfactory and contains some technical vocabulary and specialist terms.	<b>[2]</b>
<b>Very Good</b>	Candidate produces very good sketch/sketches which clearly convey most or all of the design solution. The level of annotation, technical vocabulary and specialist terms is generally very good.	<b>[3]</b>

[3]

**Total**

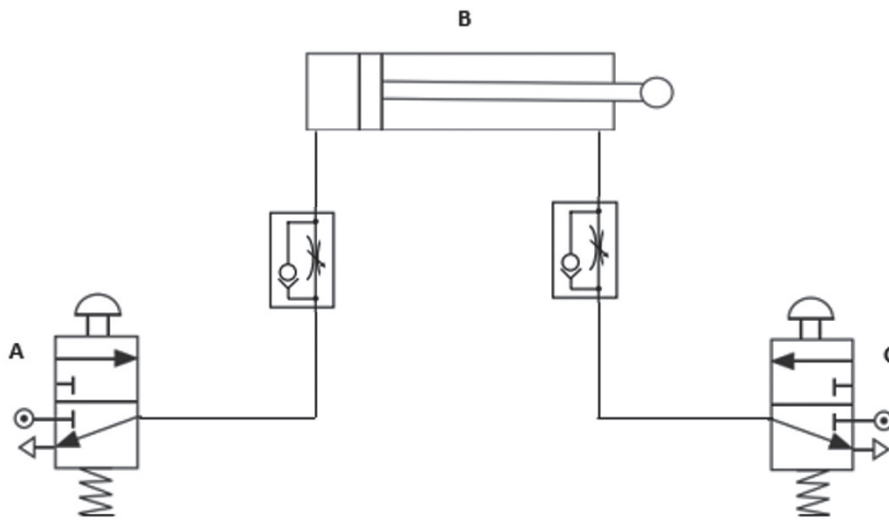
**AVAILABLE MARKS**

50

**50**

- 2 (a) Roller trip [1]  
Pilot pressure [1]  
Lever [1]  
Plunger [1] [4]
- (b) (i) Double acting cylinder [1]
- (ii) **Any one:**  
Has 2 ports [1]  
No spring return [1] [1]
- (c) (i) 3/2 Valve/3PV/3 port valve [1] [1]
- (ii) Push button [1]  
Spring return [1] [2]

(iii)



- Correct symbol for Unidirectional flow restrictor on line A or C [1]  
Correct orientation of Unidirectional flow restrictor on line A [1]  
Correct orientation of Unidirectional flow restrictor on line C [1] [3]

**All relevant, valid responses will be given credit.**

- (iv) A [1]  
C [1] [2]

- (v) **Area** =  $\pi r^2$   
 $\pi \times 25^2$   
= 1963.4954 or 1963.50 [1] Note: If
- P = F/A**  
= 500/1963.4954 or = 500/1963.50 [1]  
= 0.25 [1] Nmm<sup>2</sup> [3]

(vi) Area of rod

$$A = \pi r^2$$

$$\pi \times 5^2$$

$$= 78.5398 [1]$$

Area of cylinder – rod

$$= 1963.4954 - 78.5398$$

$$= 1884.9556 [1]$$

$F = P \times A$

$$= 0.25 \times 1884.9556 [1]$$

$$= 471.24 \text{ N} [1]$$

[4]

(d) (i) 3/4/1/6/2/5 (5 × [1])

[5]

(ii) Pipeline Junction/T Junction/T Connector

[1]

(e) (i) AND

[1]

(ii) Any one:

It is safer [1]

It ensures a guard is in position before operation occurs [1]

[1]

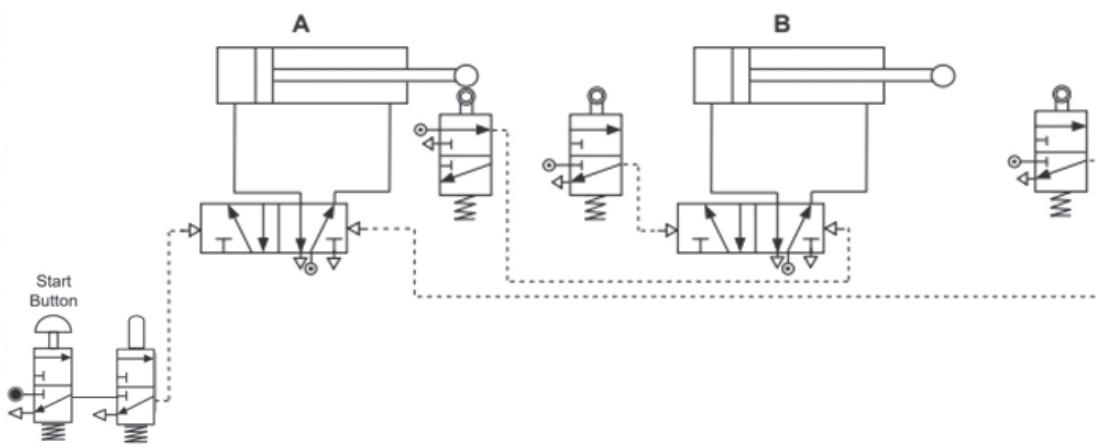
(iii) A+, B+, A-, B-

[1]

(iv) correct use of pilot/signal lines [1]

correct connection at each end (8 × [1])

[9]



(v) addition of unidirectional flow restrictor [1]

linked to a reservoir [1]

On the line between A+ and the 5/2 valve [1]

[3]

**(f) Indicative Content:**

**AVAILABLE  
MARKS**

**Negatives: Any 2 discussed**

- Expensive to install
- Expensive to maintain
- Workers need training on a regular basis which is also expensive
- Concerns over machine operating safety and possible workplace accidents
- Concerns over litigation/fines for workplace accidents
- A caring employer may be concerned about the unemployment of current workforce
- Cannot make decisions on their own and so appropriate software needed to communicate with them
- Robots cannot easily adapt to unusual conditions as a human can and so quality control issues may occur on a line
- Other companies that they trade with may not have the same software systems to transfer files etc
- Loss of human workforce may lead to decrease in emotional well-being of other workforce members/community moral
- Mundane tasks such as robotics supervision may lead to a higher turnover of staff due to lack of job satisfaction
- Reliance on the system – if breakdown occurs downtime and lead time may increase
- Reliance on automated stock control may lead to shortages during high demand (seasonal items)
- Increase cost of products to offset initial set up costs
- Deskilling of a workforce

**Positives: Any 2 discussed**

- Faster production speeds
- Decreased lead time
- Positive company brand name/increase of brand loyalty due to reliability
- Tolerances exact/less human error
- Quality control increased (can track batches/recall batched)
- Increased product safety
- Can perform mundane tasks without getting bored/getting RSI/needng a break
- Can work 24/7
- Can work in dangerous environments
- Product reliable repeatability
- Files can be stored and repeated
- Files can be sent across the world
- Can increase the skill set of workers/high pay available to trained staff

**All relevant, valid responses will be given credit.**

Response Type	Description	Mark Band
When a response is not worthy of credit, a <b>[0]</b> mark should be awarded		
<b>Limited</b>	Candidate discusses one to two aspects that manufacturers may be concerned about. There is limited discussion on the points given. Spelling, punctuation, and grammar have limited accuracy in most cases. Form and style are generally inappropriate as is the use of technical vocabulary and specialist terms.	<b>[1]–[2]</b>
<b>Satisfactory</b>	Candidate discusses two to three negative/positive aspects that manufacturers may be concerned about. There is satisfactory discussion on the points given. Spelling, punctuation, and grammar have satisfactory accuracy in most cases. Form and style are generally appropriate as is the use of technical vocabulary and specialist terms.	<b>[3]–[5]</b>
<b>Very Good</b>	Candidate discusses two negative and two positive aspects that manufacturers may consider. There is very good discussion on the points given. Accuracy of spelling, punctuation, and grammar is very good. Form and style are very good as is the use of technical vocabulary and specialist terms.	<b>[6]–[8]</b>

[8]

**Total**

**AVAILABLE MARKS**

50

**100**