



**General Certificate of Secondary Education**

---

# **Technology and Design**

Unit 2  
Option B: Mechanical and Pneumatic  
Control Systems

**[GTY22]**

---

**Assessment**

**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.

Students must:

- recall, select and communicate their knowledge and understanding of technology and design in a range of contexts (AO1);
- apply skills, knowledge and understanding, in a variety of contexts and in designing and making products (AO2); and
- analyse and evaluate products, including their design and production (AO3).

### ***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.** You must not draw inferences or interpret what you think the candidate has meant. Teachers should carefully read and consider every response.

### ***Positive Marking***

Teachers 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. Teachers 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. Teachers are encouraged to use the full range of marks available.

### ***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.

### ***Bands of response***

Tasks and questions requiring candidates to respond in extended writing are marked in terms of bands of response. In deciding which mark to award, teachers 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 band to award to any response, teachers are expected to use their professional judgement. The following guidance is provided to assist teachers.

Basic, Limited, Satisfactory

- **Level 1:** Response which merits inclusion in the band and should be awarded the lower mark.
- **Level 2:** Response which satisfies the band description and should be awarded the highest mark.

Good, Excellent

- **Level 1:** Response which merits inclusion in the band should be awarded the lower mark.
- **Level 2:** Response which satisfies the band description and should be awarded the middle mark.
- **Level 3:** Response which satisfies the band description and should be awarded the highest mark.

### ***Marking calculations***

In marking answers involving calculations, teachers should apply the “error carried forward rule” so that candidates are not penalised more than once for a computational error.

Award full marks if a candidate gives the correct answer but does not show the working out.

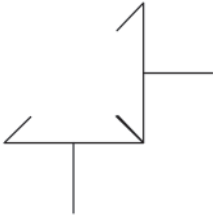
### ***Quality of written communication***

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 bands of response. The description for each band of response includes reference to the quality of written communication.

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

- Band 1: Quality of written communication is basic.
- Band 2: Quality of written communication is limited.
- Band 3: Quality of written communication is satisfactory.
- Band 4: Quality of written communication is good.
- Band 5: Quality of written communication is excellent.

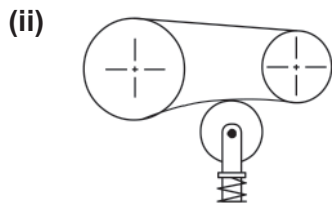
In interpreting these band descriptions, examiners should refer to the more detailed guidance provided in question 2 (f).

- 1 (a) Snail Cam [1]  
 Roller Follower [1]  
 Threaded Bar [1]  
 Lever [1]  
 Worm and Wormwheel [1]  
 (5 × [1]) [5]
- (b) (i) **Input:** Rotary [1]  
**Output:** Rotary [1]  
 (2 × [1]) [2]
- (ii) Bevel Gears [1] **or**  
 Meshed Bevel Gears [1]  
 (1 × [1]) [1]
- (iii)
- 
- (1 × [1]) [1]
- (iv) Handle is turned in a rotary motion [1]  
 Bevel Gears turn the drive through 90° in a rotary motion [1]  
 The bevel gear ratio increases the speed of rotation of the output [1]  
 (1 × [3]) [3]
- (v) Any **two** from the list below:  
 • Strength [1]  
 • Durability [1]  
 • Long lasting [1]  
 • Toughness [1]  
 (2 × [1]) [2]
- (vi) Hardening [1] and Tempering [1]  
 (1 × [2]) [2]

AVAILABLE  
 MARKS

- (c) (i) Any **one** from the list below:  
Slippage [1]  
**or** It will not drive the output pulley [1]  
**or** The belt will come off the pulley [1]  
(1 × [1])

[1]



- Wheel [1]  
Shaft [1]  
Spring [1]  
The belt drive moves across the jockey pulley [1] which is spring loaded to tighten the belt [1]  
(1 × [5])

[5]

(iii) 
$$VR = \frac{\text{Diameter of Driven Pulley}}{\text{Diameter of Driver Pulley}} = \frac{11}{33} = \frac{1}{3} = 1:3$$

[1] [1]

Award full marks if a candidate gives the correct answer but does not show the working out.

(1 × [2]) [2]

(iv) Speed of Driver = 
$$\frac{\text{Diameter of Driven Pulley}}{\text{Diameter of Driver Pulley}} \times 450$$

$$= \frac{11}{33} \times 450 = \frac{1}{3} \times 450 [1] = 150 \text{ rpm [1]}$$

Award full marks if a candidate gives the correct answer but does not show the working out.

(1 × [2]) [2]

- (v) There are no teeth on the pulley wheels [1] therefore there is no drive [1].

**or**

Slippage may be required [1] for safety reasons [1]

**Correct alternative responses should be considered.**

(1 × [2]) [2]

- (vi) Any **two** from the list below:

Round [1]

Vee [1]

Flat [1]

(2 × [1])

[2]

- (vii) Any **two** from the list below:

Toothed Belt has teeth, the normal pulley has not [1] therefore a toothed belt will not slip [1].

Enables accurate positioning [1] because a toothed belt provides a

Positive Drive [1]

Enables accurate Timing to be achieved [1] between two shafts [1]

**Correct alternative responses should be considered.**

(2 × [2])

[4]

**AVAILABLE  
MARKS**

**(viii)** Any **two** from the list below:

Car Engine [1]

Reason: To provide accurate timing between the crankshaft and the camshaft [1]

Computer Printer [1]

Reason: Accurate position of the printer head / location of ink [1]

CNC Router / Laser Cutter [1]

Reason: For accurate positioning and movement of the tool head [1]

Computer Scanner [1]

Reason: Accurate positioning / precise movement of the scanning unit [1]

Sewing Machine [1]

Reason: Position of the sewing needle and width of the stitch [1]

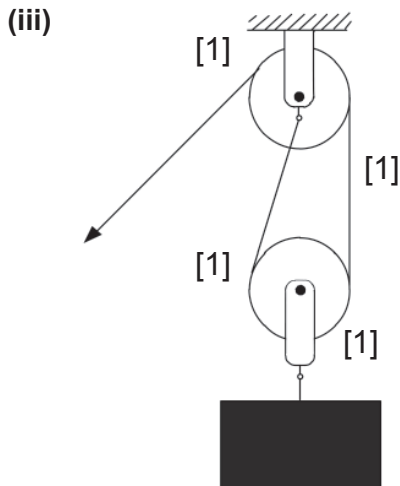
(2 × [2])

[4]

**Correct alternative answers should be considered**

(d) (i)  $1.5\text{ m} \times 3 [1] = 4.5\text{ m} [1]$   
Award full marks if a candidate gives the correct answer but does not show the working out.  
(1 × [2]) [2]

(ii) Any **two** from the list below:  
Friction in the axles [1]  
Friction in the rope [1]  
Rope may stretch [1]  
Person's hands could slip [1]  
**Correct alternative answers should be considered.**  
(2 × [1]) [2]



Fixed pulley [1]  
Moveable pulley [1]  
Rope correctly arranged [2]  
(1 × [4]) [4]

(iv) Any **two** from the list below:  
The velocity ratio [1] has decreased from 3 to 2 [1]  
More effort is required [1] but a shorter time is required to get the same lift [1]  
Less effort is required [1] to lift the load in **Fig. 3** compared to the two pulley system [1]  
The distance moved by the effort in **Fig. 3** is greater [1] than the two pulley system [1]  
The lower pulley will lift at a slower rate [1] in **Fig. 3** compared to the two pulley system [1]  
More friction in the three pulley system [1] compared to the two pulley system [1]  
Lift a greater load in **Fig. 3** with the same effort [1] compared to the two pulley system [1]  
**Correct alternative answers should be considered.**  
(2 × [2]) [4]

2 (a) Double Acting Cylinder [1]  
 Bidirectional Flow Restrictor [1]  
 Reservoir [1]  
 Five Port Valve [1] or 5PV [1]  
 (4 × [1]) [4]

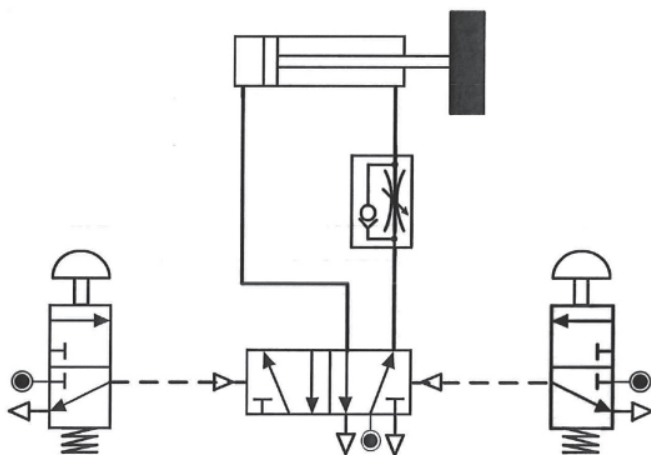
(b) (i) A: Push Button Three Port Valve [1] or Push button 3PV[1]  
 or Push button 3PV spring return [1]  
 B: Shuttle Valve [1]  
 C: Single Acting Cylinder [1] or SAC [1]  
 (3 × [1]) [3]

(ii) Allows the air from either A or D [1]  
 To move the ball and block the other pathway [1]  
 (1 × [2]) [2]

(c) (i) By pressing **A** outstrokes the cylinder to stamp the envelope [1]  
 By pressing **D** returns the cylinder [1]  
 (1 × [2]) [2]

(ii) Unidirectional Flow Restrictor [1] or Flow Restrictor [1]  
 (1 × [1]) [1]

(iii)



Drawn correctly [1] in the correct line [1] and correct orientation [1]  
 Drawn correctly in the correct line but inverted [1]  
 Drawn correctly but on wrong line [1]  
 (1 × [3]) [3]

(iv) So that it does not cause damage [1]  
 (1 × [1]) [1]

(v) The user could get injured [1] because there is no safety guard [1]  
 (1 × [2]) [2]

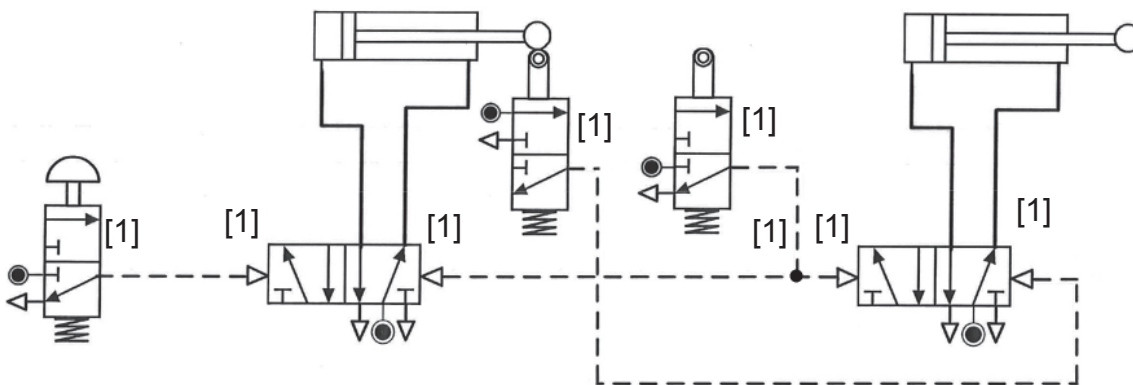
AVAILABLE MARKS

- (vi) Put a guard on machine [1]  
 Insert the 3/2 plunger valve between A and B [1]  
 (1 × [2]) [2]

- (d) (i)  $F = P \times CSA$   
 $210/0.6 = CSA$  [1]  $CSA = 350$  [1]  $mm^2$  [1]  
 Award full marks if a candidate gives the correct answer but does not show the working out.  
 (1 × [3]) [3]

- (ii) To hold the two parts in place [1]  
 so they do not move when component B is applied. [1]  
 (1 × [2]) [2]

- (e) (i)



- [1] for correct connections at each end of the piping.  
 (1 × [8]) [8]

- (ii) A+ [1], B+ and A- [1], B- [1]  
 (1 × [3]) [3]

- (iii) Include a Unidirectional Flow restrictor [1] and a Reservoir [1]  
 (1 × [2]) [2]

- (f) 1: Because of heat/combustible particles/gases it is unsafe for humans to work in such environments. It is dangerous to use electrical equipment because small sparks could start fires. Pneumatic equipment does not cause sparks.
- 2: Pneumatic spraying is used not only for cars and other vehicles, but also for cookers, washing machines, fridges, and many other industrial products. The inhalation of such fumes would be bad for the operative if manually spraying.
- 3: Pneumatic components are ideal for pushing, pulling, clamping, and positioning parts ready for further work to be done. These are mundane tasks for a normal operative and could lose concentration and therefore their personal safety could be compromised. The pneumatic machines can work 24/7 without the need for breaks/holidays/sick leave etc.

### Bands of response

Tasks and questions requiring candidates to respond in extended writing are marked in terms of bands of response. In deciding which mark to award, teachers 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 **band** to award to any response, teachers are expected to use their professional judgement. The following guidance is provided to assist teachers.

Basic, Limited Satisfactory

**Level 1:** Response which merits inclusion in the band and should be awarded the lower mark.

**Level 2:** Response which satisfies the band description and should be awarded the highest mark.

Good, Excellent

**Level 1:** Response which merits inclusion in the band and should be awarded the lower mark.

**Level 2:** Response which satisfies the band description and should be awarded the middle mark.

**Level 3:** Response which satisfies the band description and should be awarded the highest mark.

Response Band	Description	Mark
When response is not worthy of credit [0] should be awarded.		
<b>Basic</b> <b>[1]–[2]</b>	Student responds by completely missing the focus of the question. This response may or may not be well written.	<b>[1]</b>
	Student response contains little content. It may name some applications and uses of pneumatics in dangerous working environments. The response lacks clarity and coherence and is poorly organised. The level of written communication is basic.	<b>[2]</b>

<b>Limited</b> <b>[3]–[4]</b>	Student may provide a very poor description with limited or no discussion of some of the uses of pneumatics in dangerous working environments. Some uses of pneumatics are given but tend to be very general rather than being specific to a dangerous working environment. Some or all the applications may be inaccurate/irrelevant. The level of written communication is limited but conveys some information. It is limited in technical vocabulary and specialist terms. Spelling, punctuation and grammar lack accuracy.	<b>[3]</b>
	Student may provide a limited description and engages in a limited discussion of the uses of pneumatics in dangerous working environments. Some limited uses of pneumatics specific to the dangerous working environments are given. Some of the applications may be inaccurate/irrelevant. The level of written communication conveys some information but lacks technical vocabulary and specialist terms. Spelling, punctuation and grammar lack accuracy.	<b>[4]</b>
<b>Satisfactory</b> <b>[5]–[6]</b>	Student describes some of the applications of pneumatics and engages in some discussion of the uses of pneumatics in dangerous working environments. Some general uses of pneumatics in dangerous environments have been discussed. There may be some inaccuracies. The level of written communication is satisfactory and contains some technical vocabulary and specialist terms. The accuracy of spelling, punctuation and grammar is satisfactory.	<b>[5]</b>
	Student describes some of the applications of pneumatics and engages in some discussion of the uses of pneumatics in dangerous working environments. Some appropriate uses of pneumatics in dangerous environments are discussed and/or described at relevant stages throughout the answer. There may be some inaccuracies. The level of written communication is satisfactory and contains some technical vocabulary and specialist terms. The accuracy of spelling, punctuation and grammar is satisfactory.	<b>[6]</b>
<b>Good</b> <b>[7]–[9]</b>	Student makes a good response at describing most or all their chosen applications of pneumatics and engages in a good discussion of the uses of pneumatics in dangerous working environments. The level of written communication and technical vocabulary and specialist terms is generally good. The accuracy of spelling, punctuation and grammar is good.	<b>[7]</b>

**AVAILABLE  
MARKS**

	<p>Student makes a good response at describing most or all their chosen applications of pneumatics and engages in a good discussion of the uses of pneumatics in dangerous working environments. The response is well organised, clear and coherent. The level of written communication and technical vocabulary and specialist terms is good throughout. The accuracy of spelling, punctuation and grammar is good.</p>	[8]	<b>AVAILABLE MARKS</b>
	<p>Student makes a very good response at describing most or all their chosen applications of pneumatics and engages in a very good discussion of the uses of pneumatics in dangerous working environments. The response is very well organised, clear and coherent. The level of written communication and technical vocabulary and specialist terms is very good throughout. The accuracy of spelling, punctuation and grammar is very good.</p>	[9]	
<b>Excellent</b> <b>[10]–[12]</b>	<p>Student provides a very full description and discussion of most or all their chosen applications required and makes full reference to their uses in dangerous working environments. Most applications and uses of pneumatics are referred to throughout the answer. The level of written communication and technical vocabulary and specialist terms is excellent. The accuracy of spelling, punctuation and grammar is excellent.</p>	[10]	
	<p>Student provides a full description and discussion of all their chosen applications required and makes full reference to their uses in dangerous working environments. All relevant applications and uses of pneumatics associated with dangerous working environments have been discussed at appropriate points throughout the answer. The level of written communication and technical vocabulary and specialist terms is excellent. The accuracy of spelling, punctuation and grammar is excellent.</p>	[11]	
	<p>Student provides a very full description and discussion of all their chosen applications required and makes excellent reference to their uses in dangerous working environments. All relevant applications and uses of pneumatics associated with dangerous working environments have been fully discussed at appropriate points throughout the answer. The level of written communication and technical vocabulary and specialist terms is excellent. The accuracy of spelling, punctuation and grammar is excellent.</p>	[12]	
(1 × [12])		[12]	50
		<b>Total</b>	<b>100</b>