



**General Certificate of Secondary Education
2023**

Technology and Design

Unit 2

**Option B: Mechanical and Pneumatic
Control Systems**

[GTY22]

TUESDAY 20 JUNE, MORNING

**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) Worm and Wormwheel [1] D [1]
 Threaded Bar [1] C [1]
 Rack and Pinion [1] B [1]
 Pivoted Lever [1] E [1]
 Eccentric Cam [1] A [1] [10]
- (b) (i) Anticlockwise [1]
 (ii) The same size [1]
 (iii) High Speed Sprocket [1]
 (iv) Any **two** of the following:
 Direct Drive
 No Slippage
 Transmit rotary motion over a distance
 Increased efficiency
 Higher torque
 Smoother operation
 Less wear
 All relevant, valid responses will be given credit. [2]
 (v) Any **two** of the following:
 Noisy
 Needs Lubrication
 Slippage
 Can corrode or rust
 All relevant, valid responses will be given credit. [2]
 (vi) $VR = \frac{\text{Number of teeth on Driven}}{\text{Number of Teeth on Driver}} = \frac{20}{80} [1] = \frac{1}{4} [1]$
 $VR = 1:4 [1]$ Must be in ratio format for full marks. [3]
- (c) (i) $\frac{\text{Number of teeth on Driven Gear B}}{\text{Number of Teeth on Driver Gear A}} = \frac{20}{30} [1] = \frac{2}{3} [1]$
 $\frac{\text{Number of teeth on Driven Gear D}}{\text{Number of Teeth on Driver Gear C}} = \frac{20}{40} [1] = \frac{1}{2} [1]$
 $GR = \frac{2}{3} \times \frac{1}{2} = \frac{2}{6} = \frac{1}{3} [1] = 1:3 [1]$ Must be in ratio format for full marks [6]
 (ii) VR of A = $3 \times 1240 \text{ RPM} [1]$
 = $3720 [1] \text{ RPM} [1]$ RPM can only be awarded with correct answer. [3]
- (d) (i) Any **two** of the following:
 A screw jack
 A vice
 Nut and bolt
 G clamp
 All relevant, valid responses will be given credit. [2]

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(ii) Mechanical advantage = Load/Effort
 $50 = 8000/E$ [1]
 $E = 8000/50$ [1]
 $E = 160$ [1] N [1] N can only be awarded with correct answer. [4]

(iii) Velocity ratio = Effort Distance/Load Distance
 $= 2\pi \times 150/4$ [4]
 $= 236$
 235.5 [1]

or

πD (circumference of circle/distance move of effort)
 $= \pi 0.3$ [1] / 0.004 [1]
 $= 0.942$ [1] / 0.004 [1]
 $= 235.5$ [1] [5]

(iv) 1 Increase [1] the radius/distance to the effort handle [1]
 2 Decrease [1] the thread pitch [1] [4]

(v)

Response Type	Description	Mark Band
When a response is not worthy of credit, a [0] mark should be awarded		
Limited	Student produces sketch/sketches which do not convey a clear solution and show limited ideas. The construction lacks detail. The level of annotation conveys limited information and lacks technical vocabulary and specialist terms.	[1]–[2]
Satisfactory	Student produces satisfactory sketch/sketches which convey some ideas of the solution. The construction details are generally satisfactory. The level of annotation is satisfactory and contains some technical vocabulary and specialist terms.	[3]–[4]
Very Good	Student produces very good sketch/sketches which clearly convey most or all of the design solution. The construction details are very good. The level of annotation and technical vocabulary and specialist terms is generally very good.	[5]–[6]

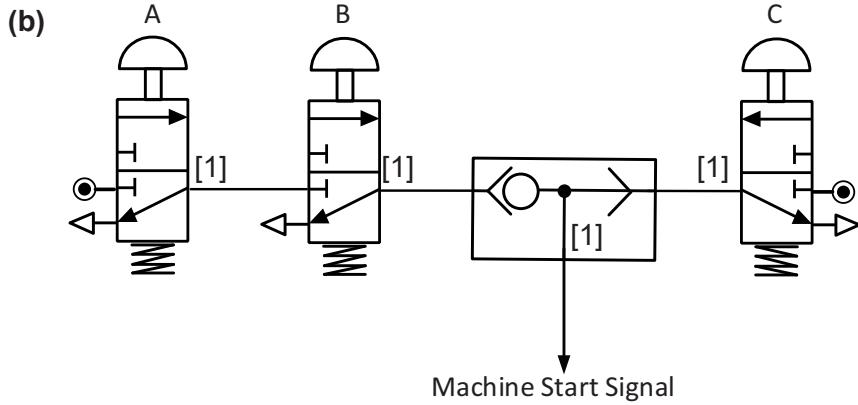
[6]

50

- 2 (a) Pipeline Junction
 Working Line, Return and Feed Line
 Pressure Source
 Unidirectional Flow Restrictor
 Roller Trip

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[5]



- AND connection for A and B [1]
 Shuttle valve fitted correctly [3]

[4]

- (c) (i) D: Reservoir [1]
 Pilot Operated 3 Port Valve [1]

[2]

- (ii) Air flows to create a Time delay [1]
 Pilot operated valve switches [1]
 Cylinder outstrokes [1]
 When the Start is released the Cylinder instrokes [1]

[4]

- (d) (i) Effective area on instroke = $500 - 100 = 400 \text{ mm}^2$ [1]
 Force = Pressure \times Area
 $F = 0.4 \times 400$ [1]
 $= 160$ [1] N [1] N can only be awarded with correct answer.

[4]

- (ii) F switches and the cylinder extends slowly [1]
 E is actuated and F is reset [1]
 Cylinder retracts slowly activating D [1]
 This continues until the start valve is reset [1]

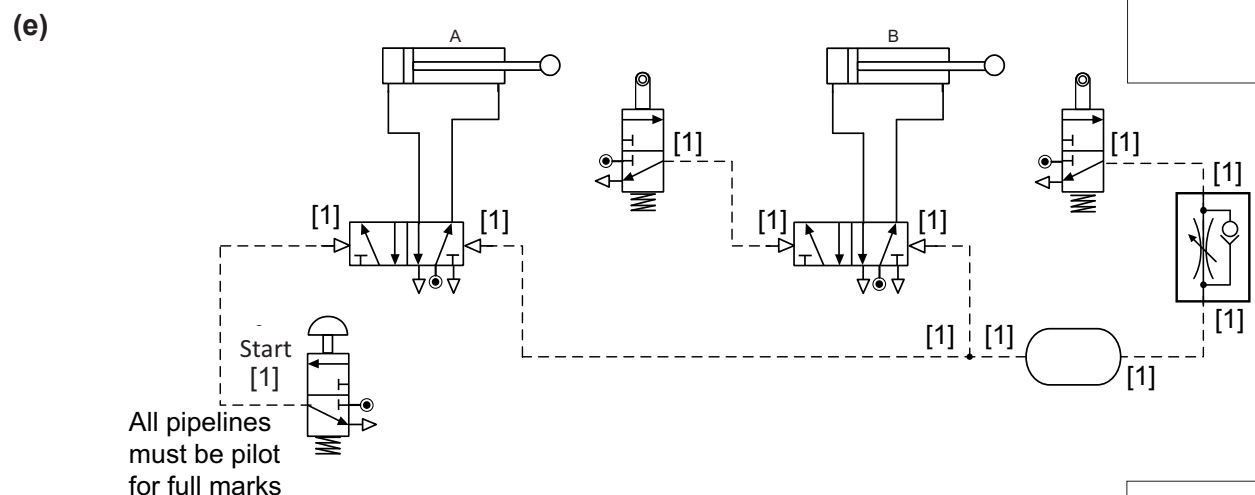
[4]

- (iii) Valve B [1]

[1]

- (iv) By changing the positions of Valve D [1] and/or Valve E [1]

[2]



All pipelines must be pilot for full marks

[1] Correct connections at each end $6 \times [2]$

[12]

(f) Any **three** of the following:

1: **Dentist's Drills:** This is a hygienic method to spin the drill bit with no mess of oil or any other contaminants and no danger because they do not use electricity and are easily cleaned.

2: **Working in Dangerous Environments:** 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 is ideal in these areas because it does not cause sparks.

3: **Paint Spraying:** Pneumatic spraying is used not only for cars and other vehicles, but also for cookers, washing machines, fridges, and many other products. The inhalation of such fumes would be bad for the operative if manually spraying.

4: **Moving Components:** 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 they 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.

5: **Automatic Doors:** The doors on tube trains and many buses are pneumatic as there is a pneumatic system already on board for the brakes, they use the pneumatic air supply to open and close the doors safely as well.

6: **Wheel and tyre changing:** Pneumatic tools are used in the tyre fitting bays to undo and tighten wheel nuts as well as to remove old tyres from wheels causing less exertion by the operative and creating a better working environment.

7: **Road Drills:** The pneumatic drill is the name of the tool to dig up roads powered by a portable compressor. Remote usage of the pneumatic road drill is important because there is no electrical supply out on the road network.

All relevant, valid responses will be given credit.

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Response Type	Description	Mark Band
When a response is not worthy of credit, a [0] mark should be awarded		
Limited	Student outlines at least one everyday application where pneumatic products are used. The level of accuracy of spelling, punctuation and grammar is limited in most cases. Form and style are generally inappropriate as is the use of technical vocabulary and specialist terms.	[1]–[4]
Satisfactory	Student outlines at least two everyday applications where pneumatic products are used. The level of accuracy of spelling, punctuation and grammar is satisfactory in most cases. Form and style are generally appropriate as is the use of technical vocabulary and specialist terms.	[5]–[8]
Very Good	Student outlines three everyday applications where pneumatic products are used. The level of 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.	[9]–[12]

[12]

Total

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50

100