Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Technology and Design

Assessment Unit AS 1

assessing

Systems and Control or Product Design

[STE12]

MONDAY 22 MAY, 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.

Section A

Electronic and Microelectronic Control Systems

AVAILABLE MARKS

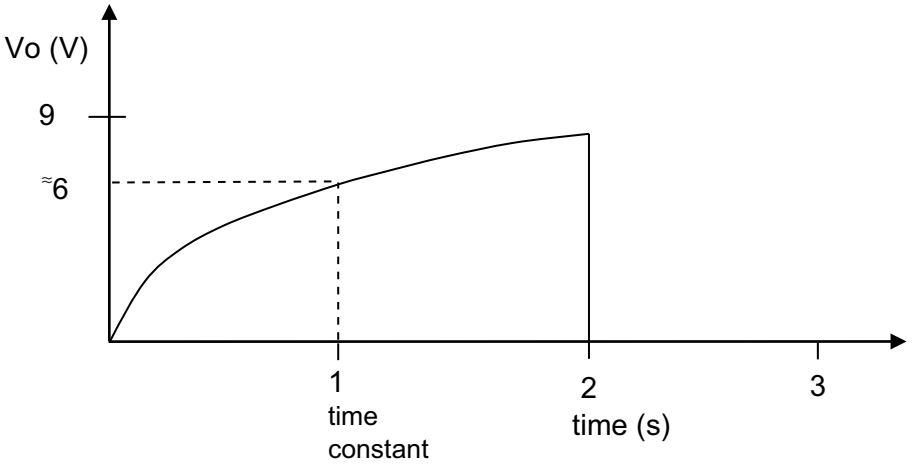
1 (a) (i) Rotary switch. [1]

(ii) Electrolytic capacitors have higher values of capacitance. [1]
They are polarized, i.e. to operate safely and efficiently the anode must be connected to a higher voltage than the cathode. [1] [2]

Correct alternative responses will be given full credit.

(iii) $47 \times 10^{-6} \times 22 \times 10^{3} = 1$ second [1] method and [1] correct calculation [2]

(iv)



Charge graph [1]
Discharge graph [1]
Time constant [1]

(b) (i) 9 V – 1.6 V = 7.4 V [1]
7.4 V ÷ (2 × 12 mA) = 308 Ohms [2]

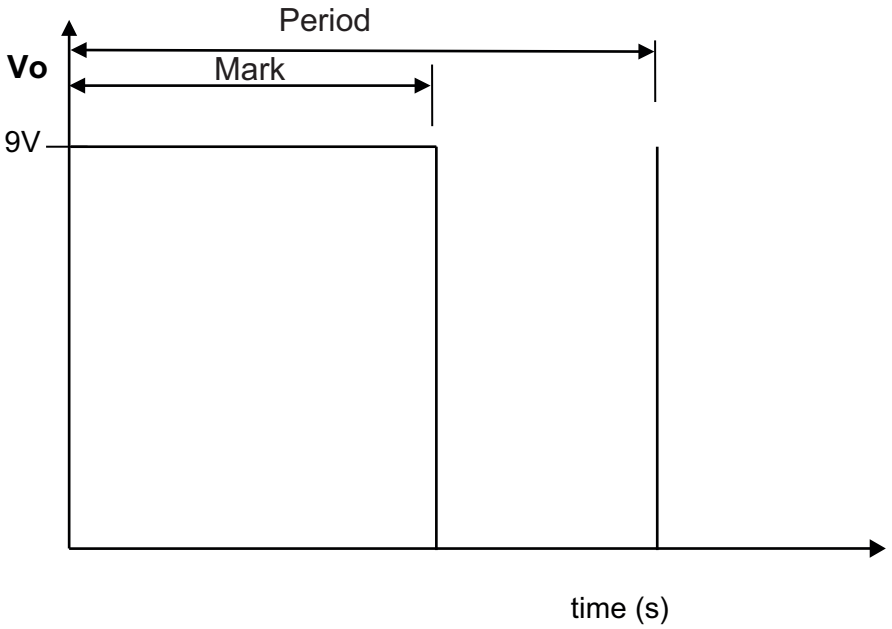
(ii) $4 = 1.44 \div (R1 + 2.4 \times 10^{3})\ 100 \times 10^{-6}$ [1]

therefore $(R1 + 2.4 \times 10^{3})\ 100 \times 10^{-6} = 0.36$ [1]

so R1 = 3600 – 2400 = 1200 or 1k2 Ohms [1]

Correct formula [1]

(iii)



Graph with space drawn approximately $\frac{1}{2}$ the duration of the mark [1]
Mark correctly labelled [1]
Period correctly labelled [1]

(iv) Advantage – Fault finding restricted to hardware, i.e. no software to debug. [1]

Disadvantage – a higher number of additional components will be required to produce a flashing LED [1]

Correct alternative responses will be given full credit.

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2 (a) (i) R1 and R2 ensure the gate inputs receive a logic '0' when the switches are open. [1]

(ii)

A	B	Q
0	0	0
1	0	0
0	1	0
1	1	1

correct logic for Q [4]

(b) (i) Answer likely to refer to the following:
Current flows through an electromagnetic coil.
The resulting magnetic field pulls or pushes a mechanical valve.
The valve can be opened and closed by controlling the current.
Full explanation [2] limited explanation [1] [2]

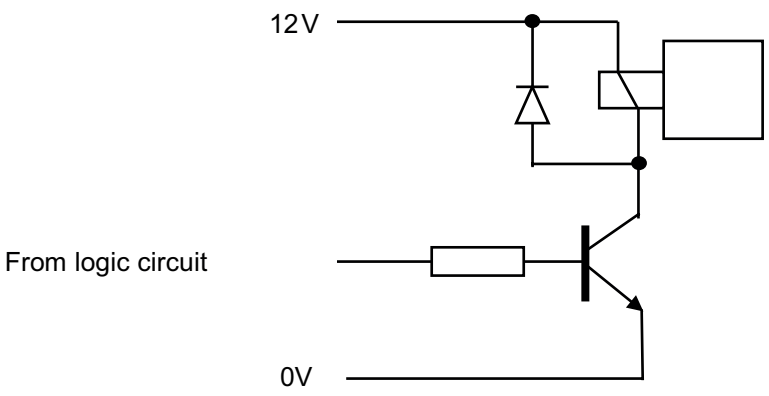
Correct alternative responses will be given full credit.

(ii) Ic = 12 ÷ 30 = 0.4 A [1]

If gain = 100 then Ib = 4 mA [1]

Rb = (5 V – 0.6 V) ÷ 4 mA = 1100 Ohms [2]

(iii)

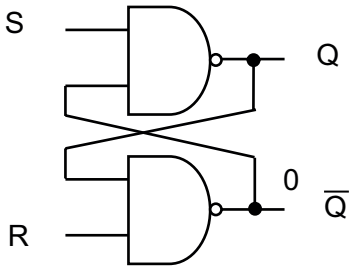


12V connection to solenoid [1]

Transistor connection to solenoid [1]

Addition of flywheel diode [1]

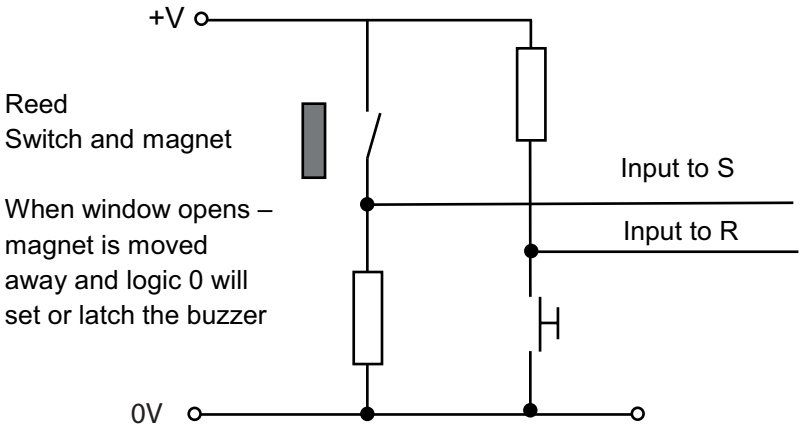
(c) **(i)**



two NAND gates [1]

correct cross coupled connections [1]

(ii) Sample answer



Appropriate arrangement of reed switch and resistor [1]

Appropriate arrangement of PTM switch and resistor [1]

Full description of how the position of the magnet relative to the reed switch determines the output state [2]. Limited description [1] [4]

Section A

AVAILABLE MARKS

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Section B

Mechanical and Pneumatic Control Systems

AVAILABLE MARKS

3 **(a)** Exhaust [1]

(b) • When the air bleed is activated air flows to the 3PV. [1]
• The 3PV provides a signal to the 12 side of the 5 PV. [1]
• Air flows through the 5PV via port 12 to instroke the DAC. [1]

Correct alternative responses will be given full credit.

(c) A sample answer could involve the use of a cam and follower system with a short stroke length of 2 cm. Positioning could be below the vibrating plate to provide the desired vertical reciprocating motion. Eccentric cam profiles would be suitable. The cam/s would have an overall rise and fall of 2 cm.

Description	Mark
Detailed annotated sketch of a mechanical system which moves the vibrating plate up and down by 2 cm in total.	[4]–[5]
Both the sketch and the annotation are good. The mechanical system moves the vibrating plate up and down by 2 cm in total.	[2]–[3]
Limited sketch lacking detail and appropriate annotation. The mechanical system moves the vibrating plate up and down.	[1]
The response is not worthy of any credit.	[0]

[5]

Correct alternative responses will be given full credit.

(d) Eff = MA/VR × 100 [1]
4.5/5 = 0.9
0.9 × 100 = 90% [1]

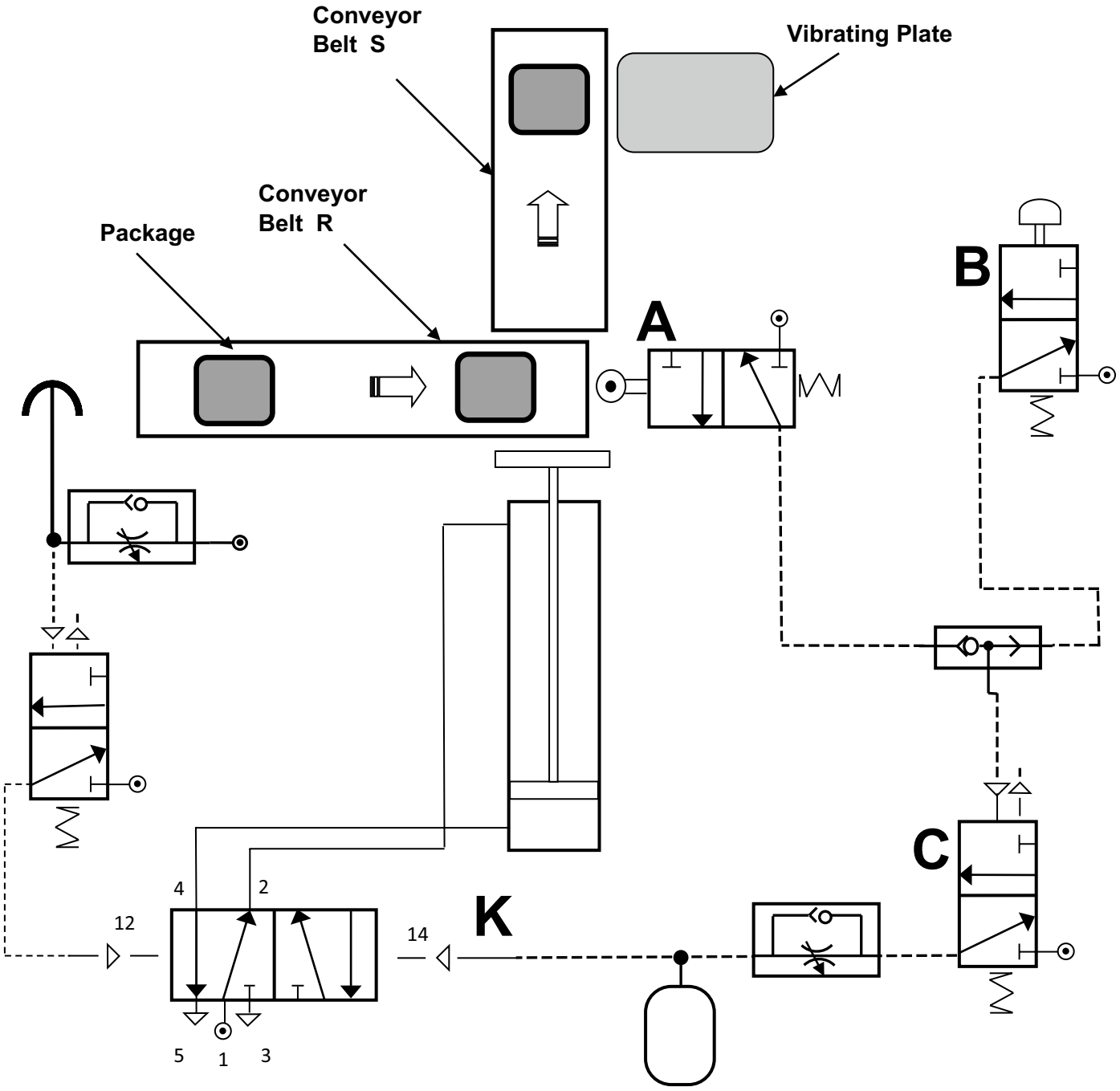
(e) 100 – 74.88 = 25.12 [1]
25.12/0.5 = 50.24 mm^2 [1]
50.24 mm^2/3.14 = 16
4 × 4 = 16 [1]
Radius = 4 mm [1]

(f) Appropriate operation of A or B [1]
Shuttle valve [1]
Appropriate operation of C [1]
Flow control valve [1]
Reservoir [1]

AVAILABLE MARKS
20

See sample answer

Correct alternative responses will be given full credit.



Ans 3(f)

AVAILABLE MARKS

4 **(a)** **(i)** Clockwise direction [1]

(ii) Annotated sketch of a suitable system outlining:

A method which could link the motor shaft **P** and output shaft **Q** – for example a sketch of a bevel gearing system [1]

Velocity ratio maintained using the same sized gears to provide a VR of 1 [1]

Correct name of the system/component – Bevel gear/gearing system [1]

(iii) C–E 60/60 = 1 [1]

G/60 = 3 [1]

3 × 60 = 180 mm [1]

(iv) A–B 36/72 = 0.5 [1]

C–E 60/60 = 1 [1]

Tot VR 1 × 0.5 = 0.5 [1]

OS = 100/0.5 = 200 rev/min [1]

(b) Clothing or fingers could get caught or trapped in the moving parts. [1]

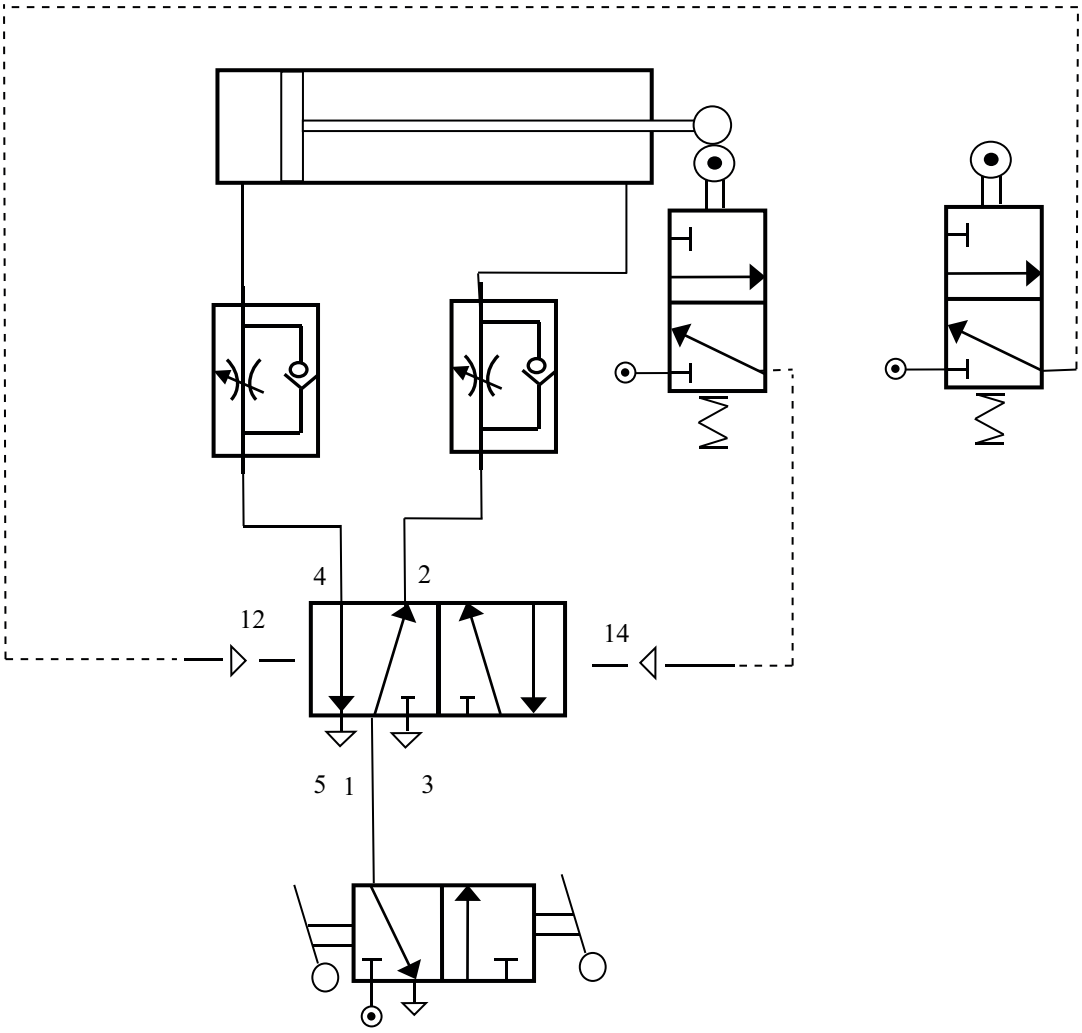
The moving parts are rotating at considerable rotational velocities and there is a danger of flying debris being released. [1]

As the components are easily accessible there is a danger of someone interfering. [1]

Correct alternative responses will be given full credit.

(c) See sample answer

AVAILABLE MARKS



Ans 4(c)

Slowly operation – outstroke	[1]	
Slowly operation – instroke	[1]	
Repeated outstroke and instroke	[2]	
Safety feature	[2]	20

Correct alternative responses will be given full credit.

Section B **40**

Section C

AVAILABLE MARKS

5 **(a)** SCAMPER –

Combine
Think about combining two or more parts of the radiator dryer to create a different product. [2]

Reverse
Change the direction (of the supports) or orientation by turning it upside-down, inside-out, or make it go backwards.

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

Correct alternative responses will be given full credit.

(b) Any **one** specific characteristic associated with a patent from the list below:

- Gives the owner the right to prevent others from making, using, importing or selling the invention without permission.
- Have an inventive step that is not obvious to someone with knowledge and experience in the subject.

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

Correct alternative responses will be given full credit

(c) Any **one** specific characteristic associated with the (COSHH) regulations from the list below:

- helps to protect employees in the workplace by informing them how chemicals and materials should be handled and stored safely
- COSHH considers chemicals, products containing chemicals, fumes, dusts, nanotechnology and gases as hazardous.

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

Correct alternative responses will be given full credit.

(d) **(i)** Any **two** main characteristics associated with JIT from the list below:

- Allows manufacturers to keep stock to a minimum whilst responding to demand quickly
- Allows manufacturers to increase their productivity with reduced costs
- The manufacturer does not need large warehouses of excess materials and finished products. [2]

(ii) Any **two** main ways that the company may benefit as a result of adopting 'right first time' from the list below:

- Be able to run a production process without needing to carry excessive inventory
- The company will be able to save time
- The company will be able to reduce the cost of production. [2]

Correct alternative responses will be given full credit.

(e) (i) An appropriate design could be based on two threaded lugs (this would be part of the injection moulded support bracket) protruding from the bracket and two support rods with left and right hand threaded ends. These would be supplied in the packaging for the user to assemble.

AVAILABLE MARKS

Description	Marks Awarded
Detailed annotated sketches representing an appropriate improvement to the rigidity of the product. The design is easily assembled.	[3]–[4]
Both the sketches and annotation are good. The ideas represent some improvement to the rigidity of the product. The design has potential in terms of ease of assembly.	[2]
Limited sketches lacking detail and appropriate annotation. Difficulties in determining if any improvement has been made to the rigidity of the product and ease of assembly.	[1]
Level of response not worthy of credit.	[0]

[4]

Correct alternative responses will be given full credit.

(ii) An appropriate design may involve extending the support brackets to include two press clips (one for the laundry frame another for a tray). The tray would be shallow, injection moulded and press clipped into position by the user quickly and easily. By extending the brackets this could minimise the use of materials over other design ideas.

Description	Marks Awarded
Detailed annotated sketches of a design of a tray that can be quickly and easily attached to catch water droplets. The design minimises the use of materials.	[3]–[4]
Both the sketches and annotation are good. The design has potential with some consideration given to minimising the use of materials.	[2]
Limited sketches lacking detail and appropriate annotation. Difficulties in determining if the design is appropriate and if consideration is given to minimising the use of materials.	[1]
Level of response not worthy of credit.	[0]

[4]

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Correct alternative responses will be given full credit.

AVAILABLE MARKS

6 (a) (i) Any **two** main sources associated with secondary research from the list below:

- Articles from books
- Items from catalogues
- Printed material from companies. [2]

(ii) Any **one** of the main sources, e.g. books and magazines. The type of information that might have been obtained could be ergonomic/ anthropometric data, information on the properties of specific plastics and their manufacturing restrictions.
Award [2] for a full explanation and [1] for a limited explanation. [2]

Correct alternative responses will be given full credit.

(b) Explanation of 3D printing process;

Drawing File

- A component or part is created and saved as a stl file.
- The software 'slices' the final model into hundreds or thousands of horizontal layers.

3D product

- When the sliced file is uploaded the printer reads every slice to create the object with hardly any visible sign of the layers of the commonly used ABS or PLA.
- The layers will depend on the settings (quality and shelling) selected by the operator before printing.

Award [2] for a full explanation for the drawing file and [2] for a full explanation on the 3D product. Award [1] for a limited explanation for the drawing file and [1] for a limited explanation on the 3D product. [4]

Correct alternative responses will be given full credit.

(c) Any **two** main characteristics associated with batch production from the list below:

- Involves shorter runs than mass production, around 100 to 1000 products.
- It requires skilled labour on the factory floor.
- Can produce variations of the same item.
- Batch production may require processes to be stopped before making changes which can be expensive and time consuming. (2 × [1]) [2]

Correct alternative responses will be given full credit.

(d) Any **two** main characteristics associated with a Gantt chart from the list below:

- Gantt charts enable processes to be carried out on schedule
- They can help map out all aspects of manufacture against time
- The chart will help companies to draw up an order of priority. (2 × [1]) [2]

Correct alternative responses will be given full credit.

(e) Statistical testing method refers to the use of statistics to generate the selection of finished products for testing.

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

Correct alternative responses will be given full credit.

(f) The ISO 9001 standard is a quality management system which will help monitor and manage quality across all operations. It outlines ways to achieve, as well as benchmark consistent performance.

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

Correct alternative responses will be given full credit.

(g) A solution based on an ergonomically shaped strap with a sliding clip to accommodate different wrist sizes. One end of the strap could be inserted through a hole on the end of the handle and closed to allow freedom of movement.

Description	Marks
Detailed annotated sketch representing an appropriate improvement to the overall design.	[3]–[4]
Both the sketch and the annotation are good. The idea represents an improvement but lacks the finesse appropriate for the product.	[2]
Limited sketch lacking detail and appropriate annotation. Difficulties in determining if the idea is appropriate and represents an improvement.	[1]
The response is not worthy of any credit.	[0]

[4] 20

Correct alternative responses will be given full credit.

Section C **40**

Total **40**

AVAILABLE MARKS