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Mark Scheme (Results)
Summer 2016

Pearson Edexcel GCSE
in Manufacturing & Engineering (5EM03_3E)

Electrical and Electronic, Process Control, Computers, Telecommunications (Paper 3E)

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General Marking Guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Learners must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the learner's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a learner's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the learner has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC,
  are being assessed. The strands are as follows:

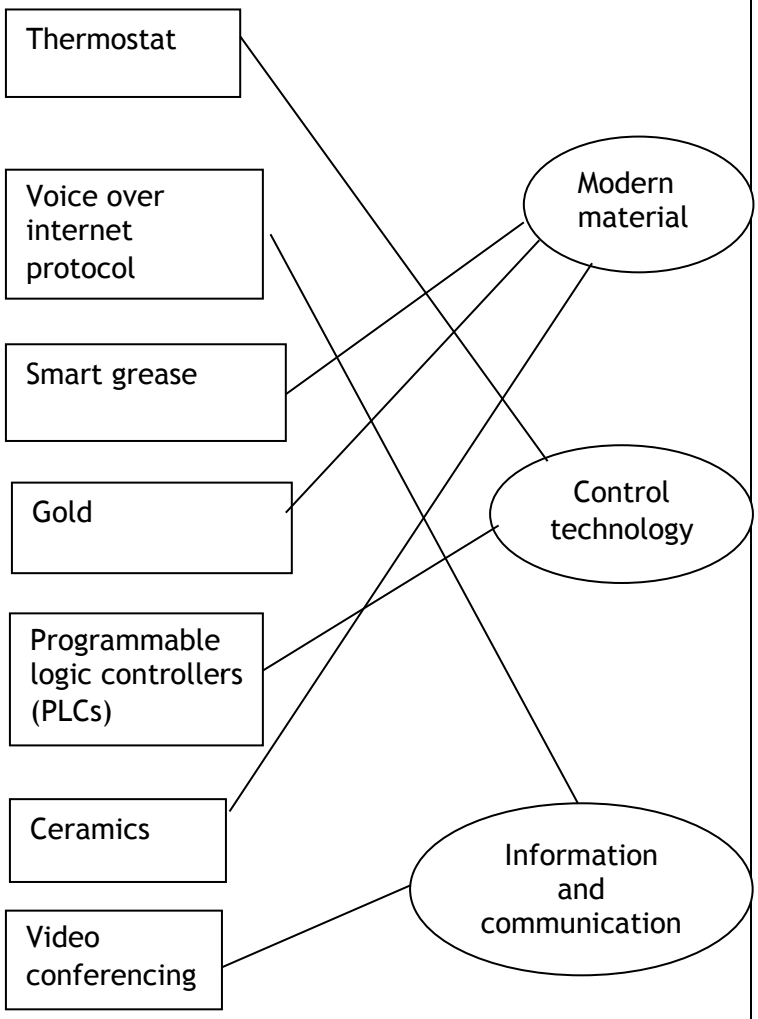
  i) Ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear

  ii) Select and use a form and style of writing appropriate to purpose and to complex subject matter

  iii) Organise information clearly and coherently, using specialist vocabulary when appropriate.

Question	Answer	Mark
1(a)	• Multi-meter • Hairdryer If 3 boxes or more crossed - no marks. (2 x 1)	**(2)**
1(b)	• Bluetooth speaker • Rate rise detector If 3 boxes or more crossed - no marks. (2 x 1)	**(2)**
		(Total 4 marks)

Question	Answer	Mark
2(a)(1)	• Electric screwdriver • Cordless screwdriver • Miniature electric screwdriver • Rechargeable screwdriver Do not accept power tool Do not accept screwdriver on its own Accept any recognisable spelling (phonetic) of the answer above (1 x 1)	
2(a)(2)	• Pipe bender • Tube bender • Plastic pipe bender • Copper pipe bender • Metal pipe bender • Tube former Do not accept bender on its own Accept any recognisable spelling (phonetic) of the answer above (1 x 1)	**(2)**
2(b) (1)	An answer that makes reference to two of the following points: • Acts as a preset/variable resistor (1) • Adjusting/Tuning/Calibrating a circuit (1) • Allows adjustment of current/voltage in a circuit (1) • Manually controlled component (1) Accept any other appropriate response e.g. acts as a variable resistor (1) used to tune a circuit (1) (1 x 2)	
2(b) (2)	An answer that makes reference to two of the following points: • Semiconductor device (1) • Absorbs light (1) • Detects different levels of light (1) • Produces current/electrical signal (1) • Converts energy/light (1) Accept any other appropriate response e.g. a semi conductive device (1) which detects light (1) (1 x 2)	**(4)**
		(Total 6 marks)

Question	Answer	Mark
3	Key terms linked to a key area  No mark awarded where 2 or more lines are drawn from a term. Lines do not have to be straight but term and key area must be clearly linked. (7 x 1)	**(7)**
		(Total 7 marks)

Question	Answer	Mark
4(a)	Appropriate two **products** such as e.g. • Smartphone • I-pod • TV • Camera • Computer • Tablet • Mobile phone • Soldering Iron • Fuse box • Fire alarm • Smoke detector • Pen stick • A brand name of any other specific product is acceptable This list is not exhaustive, accept any product from the electrical and electronic, process control, computers, telecommunications sectors and that uses control technology in its manufacture (2 x 1)	**(2)**
4(b)(i)	Appropriate material removal suitable for the named product: • Turning • Drilling • Electrical discharge machining • Milling • Laser cutting • Presswork/Punching/Piercing/Blanking Accept answers naming specific types of appropriate processes Accept any appropriate response If no response or incorrect response to 4a, correct answer can still be awarded (1 x1)	**(1)**

Question	Answer	Mark
4(b)(ii)	An answer that makes reference to three of the following points for an etching process: Etching: • Uses photo resistant/etched board (1) • One side is copper clad which is photosensitive (1) • Peel back the plastic film to expose the photosensitive material (1) • PCB mask/transparency produced by hand or computer (1) • Mask placed under the photosensitive side of the board (1) • Photo etched board and mask transferred to UV light box (1) • Make sure mask is the correct way around (1) • Close lid of UV light box and switch on (1) • Leave for approx. 21/2 mins and remove (1) • Place in developer tank using plastic tongs (1) • Leave in developer for short period of time (10secs) (1) • Remove from developer solution and wash clean (1) • Place in the heated bubble etching tank (1) • This slows erodes/etches away the unwanted copper leaving the tracks (1) • Etching time can be between 15-45 mins approx. (1) • If left in the tank too long it could damage the circuit (1) • Remove from the etching solution and clean (1) • Clean the tracks with wire wool to create a good contact (1) Accept any appropriate response. If no answer or incorrect answer in 4b(1) then no access to marks for 4b(2) Low response (1) or two low responses (2) or 3 low responses (3) or detailed response (3) (1 x 3)	**(3)**

Question	Answer	Mark
4(c)	One mark for each identification of example, one mark for each extension: • Conveyor systems (1) transfer materials to manufacturing location (1) • Pick and place robots (1) assemble products continuously (1) • Labelling is applied continuously (1) at the packaging stage (1) • Product coding is applied (1) when products are sealed automatically (1) • Remotely operated vehicles (1) move products to specified locations (1) • Linked PLCs (1) used to control manufacturing processes (1) • Bowl feeders (1) used to align small parts for assembly processes (1) • CAM (1) used to produce consistent products (1) Accept any appropriate response. Low response (1) or two low responses (2) or detailed response (2), for each of the 2 examples If no response or incorrect response to 4a, correct answers can still be awarded 4 marks (2 x 2)	**(4)**
		(Total 10 marks)

Question	Answer	Mark
5(a)	Accept reference to any of the following two functions: • To create a design (1) • To modify a design (1) • To analyse a design (1) • To optimise a design (1) • To improve/check the quality of a design (1) • To improve/check the accuracy of a design (1) • To reduce the cost producing a design (1) • To render (1) • To convert 2D to 3D (1) • To produce nets (1) • To stress test (1) Accept any appropriate response. Do not accept quicker, faster, easier, cheaper, better without appropriate reference to CAD. Low response (1) or two low responses (2) (2x1)	**(2)**
5(b)	An answer that makes reference to two of the following disadvantages: • Set-up costs would be high (1) as hardware/software is required (1) • Cost of training staff will increase (1) due to new skills required (1) • Extra maintenance costs (1) due to specialist technicians required (1) • Ongoing updating costs (1) due to new technological developments (1) • Security issues (1) due to possible loss of data/theft of data (1) • Data can be corrupted (1) due to software malfunction (1) Accept any appropriate response. Low response (1) or two low responses (2) or detailed response (2) (1x2)	**(2)**

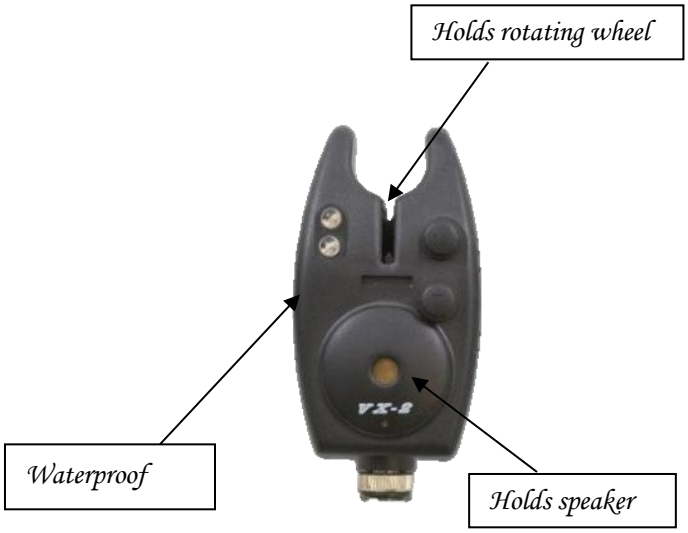
Question	Answer	Mark
5(c)	An answer that makes reference to two of the following functions: • To control the whole manufacturing/automated process (1) • To allow individual parts of the process to access database information (1) • To initiate necessary remedial actions (1) • To reduce manufacturing errors (1) • To allow inter-departmental communication (1) • To maintain quality levels (1) • To schedule maintenance (1) • To store and retrieve data and information (1) Accept any appropriate response. Do not accept quicker, faster, easier, cheaper, better without appropriate reference to CIM. Do not accept answers associated with Design and/or development (2x1)	**(2)**
5(d)	One mark for identification of benefit, one mark for explanation: • Improved efficiency (1) by combining design and manufacturing stages (1) • Lower operational costs (1) shorter periods between product design and manufacture (1) • Can reduce waste (1) through better communications between design and manufacturing teams (1) • More consistent products (1) reduced risk of 'out of specification' product being made (1) • Increased sales (1) through quick response to customer demands for new products (1) • Improve auditing (1) for traceability (1) Accept any appropriate response. Low response (1) or two low responses (2) or detailed response (2) (1x2)	**(2)**
		(Total 8 marks)

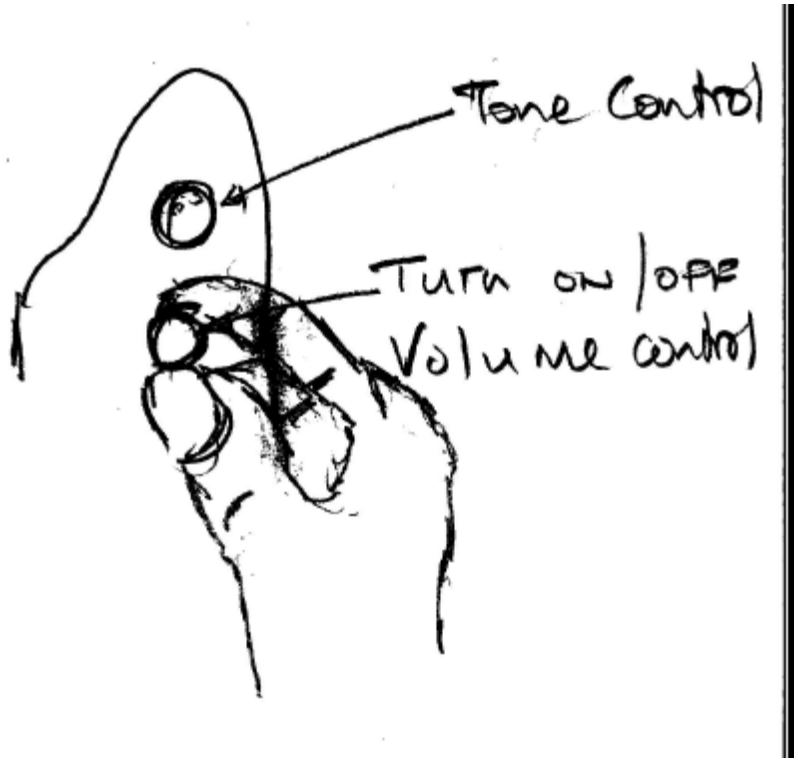
Question	Answer	Mark
6(a)(i)	Description that makes reference to three of the following points: • A collection of information/data • Information and data which is organised • Information and data presented in tabular formats • Handle information/data • Storage of information/data • Retrieve information/data • Interrogate data • Query data • Security of information/data Accept any appropriate response. e.g. a database is a stored collection (1) of information which is organised (1) and easily retrieved (1) Low response (1), two low responses (2),three low responses (3) or detailed response (3) (1 x 3)	**(3)**
6(a)(ii)	One mark for identification of disadvantage, one mark for extension: • Costly to install hardware and software (1) due to data collection/inputting (1) • Systems can breakdown/fail (1) leading to loss of data (1) • Connectivity can be lost (1) causing delays (1) • Trained staff required (1) which can be expensive/difficult to recruit (1) • Wrong data can be entered (1) therefore, errors can be transferred/continued (1) • Data can be hacked (1) leading to viruses being introduced (1) • IT skills replace research skills (1) therefore, some knowledge base lost (1) Accept any appropriate response. Low response (1) or two low responses (2) or detailed response (2). (1 x 2)	**(2)**

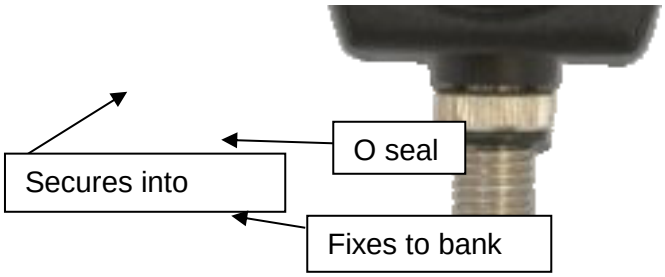
Question	Answer	Mark
6(b)	One mark for identifying each reason, one mark for each extension: • Formulas used to generate results (1) meaning less risk of calculation errors (1) • Easier/efficient way of recording data (1) easier to edit (1) • Quicker presentation of information (1) which can be imported into charts/tables (1) • Can store a large amount of data (1) that can be used in decision-making (1) • Ability to share information (1) as data can be transferred electronically (1) • Can support management reports (1) as data can be modelled into 'what if' scenarios (1) Accept any appropriate response. No repetition. Low response (1) or two low responses (2) or detailed response (2), for each of the 2 advantages (2 x 2)	**(4)**
		(Total 9 marks)

Question	Answer	Mark
7(a)	One mark for identifying benefit, up to two marks for extension: • Reduced use of paper (1) fewer trees would be needed (1) reducing global warming (1) • Reduced use of fossil fuels (1) to process paper materials (1) and carry out printing processes (1) • Lower carbon emissions (1) less fuel/energy needed manufacture printed materials (1) and transport them (1) • Reduced waste (1) less discarded paper (1) reducing need for recycling (1) • Less processing of raw materials (1) would reduce pollution (1) and improve health (1) • Reduces need to travel (1) to meet customers/clients (1) means less emissions from transport (1) Accept any appropriate response. Up to 3 marks for a detailed response. (1 x 3)	**(3)**

Question	Answer	Mark
7(b)	One mark for identifying advantage, up to two marks for extension: • Instant contact with potential customers (1) at low cost (1) to quickly obtain feedback (1) • Able to contact existing customers database (1) and target a wider audience (1) more efficiently (1) • Ability to change/modify marketing strategies quickly (1) to maximise potential sales (1) and achieve targets (1) • Can choose an appropriate communication system (1) to target potential customer sectors/groups (1) more quickly (1) • Allows for paperless marketing(1) reducing printing costs (1) and be updated easily (1) • Reduces time (1) to mail materials (1) which also reduces labour costs (1) • Reduces cash outlay producing printed materials (1) reduces storage space requirement (1) and potential waste of out of date materials (1) Accept any appropriate response. Do not accept references to specific types of communications technology e.g. email, internet, smart phone etc. without explanation of benefit. Up to 3 marks for a detailed response. (1 x 3)	**(3)**
		(Total 6 marks)
	Total Marks for Section A	**50**

Question	Answer	Mark
8(a)	An answer that makes reference to any of the following points: • Provides waterproofing (1) • Houses the circuit (1) • Hold the LED's (1) • House the rotating wheel (1) • Provide access for stud (1) • Provide access for jack plug (1) • Hold the control switches (1) • Holds speaker (1)  Accept any other appropriate response. Answer must contain both notes and sketches. Max **two** marks if only notes or sketches used. (3 x 1)	**(3)**

Question	Answer	Mark
8(b)	An answer that makes reference to any of the following points: • Turn on/off (1) • Adjust volume (1) • Vary pitch/tone (1) • Preserve battery life (1) • Switch operates indicator circuit (1)  Accept any other appropriate response. Answer must contain both notes and sketches. Max **two** marks if only notes or sketches used. (3 x 1)	**(3)**

Question	Answer	Mark
8(c)	An answer that makes reference to any of the following points: • To be attached to the casing (1) • Position adjusted by screwed nut (1) • Provides water tight joint via O ring (1) • Provides fixing to bank stick (1) • Provides fixing to pod buzz bars (1)  Accept any other appropriate response. Answer must contain both notes and sketches. Max **two** marks if only notes or sketches used. (3 x 1)	**(3)**
		(Total 9 marks)

Question	Answer	Mark
9(a)(i)1	Design (1 x 1)	
9(a)(i)2	Assembly and finishing Assembly Finishing Finishing and assembly (1 x 1)	**(2)**
9(a)(ii)	Marketing Stage two/stage 2 Two/2 Second/second stage/2nd/2nd stage (1 x 1)	**(1)**
9(b)	An answer that makes reference to any three of the following activities: • Converting orders to production (1) • Calculating material requirements (1) • Estimating equipment requirements (1) • Establishing labour requirements (1) • Calculating packaging requirements (1) • Calculating energy requirements (1) • Scheduling production (1) • Calculating throughputs/outputs (1) • Establishing deadlines (1) • Scheduling quality checks (1) • Scheduling health and safety (1) Accept any other appropriate response. (3 x 1)	**(3)**

Question	Answer	Mark
9(c)	Appropriate descriptions including three of the following points (statements must be applicable to packs of bite alarms): • Ordering materials (1) • Receiving materials (1) • Goods inward inspection/testing (1) • Storing materials (1) • Stock checks/rotation (1) • Coding checks (1) • Quality checks (1) • Sourcing materials (1) • Purchasing materials(1) • Liaison with user departments (1) • Assembling 'internal' orders (1) • Delivery of 'internal' orders (1) • Completing documentation (1) • Liaison with administration departments (1) Accept any other appropriate response but must be related to the manufacture of bite alarms. e.g. at the materials supply and control stage stock levels of components to make the bite alarms would be checked (1) and coding inspections of all the parts would be carried out (1) before collating the internal parts orders for delivery to the production departments (1) 3x1 marks for 3 low responses or up to 3 marks for a detailed response. (1 x 3)	**(3)**
		(Total 9 marks)

Question	Answer	Mark
10(a)	• Brass (1) • Aluminium (1) • Aluminium Alloy (1) • Stainless steel (1) Accept any other appropriate response. Accept any recognisable spelling (phonetic) of the answers above. (1 x 1)	**(1)**
10(b)(i)	Any three of the following: • Laser cutting (1) • SMT (1) • Thermoforming (1) • Vacuum forming (1) • Twin sheet forming (1) • CNC machining (1) • Turning (1) • Knurling (1) • Thread cutting (1) • Soldering (1) • Shearing (1) • Drilling (1) Do not accept moulding. Accept any other appropriate response. Accept any recognisable spelling (phonetic) of the answers above. (3 x 1)	**(3)**

Question	Answer	Mark
10(b)(ii)	An explanation that makes reference to three of the following points: • Quick method/fast production rate (1) • Excellent surface finish (1) • No further processing needed (1) • Any excess material can be re–used (1) • Unit costs are low for medium to high volume injection runs (1) • Highly automated process (1) • Reliable process (1) • Minimal waste (1) • Not labour intensive (1) • Can be mass produced easily (1) • Complex shapes can be produced (1) • Multiple components on each mould (1) Accept any other appropriate response. e.g. a highly automated process (1) allowing casings to be mass produced easily (1) with consistent quality (1) 3 x 1 marks for 3 low responses or up to 3 marks for a detailed response (3 x 1)	**(3)**
10(c)	An explanation that makes reference to three of the following points: • Improved product properties (1) • ~~Fewer distribution constraints (1)~~ • Improved product consistency (1) • Fewer reject products (1) • Less rework (1) • Less energy required (1) • Less processing in manufacture (1) • Smaller volume of materials used (1) • Materials can be recycled (1) Accept any other appropriate response e.g. Less processing during manufacture (1) meaning they do not use as much energy when manufacturing them (1) and they are easy to recycle at the end of their useful life (1) 3x1 marks for 3 low responses or up to 3 marks for a detailed response (1x3)	**(3)**
		(Total 10 marks)

Question	Answer	Mark
11(a)	Any two of the following reasons: • To improve efficiency (1) • To improve throughput/output (1) • To reduce manufacturing costs (1) • To improve control of manufacturing costs (1) • To reduce labour costs (1) • To improve consistency/accuracy (1) • To improve process control (1) • To reduce wastage (1) • To reduce health and safety risks (1) Accept any other appropriate response Do not accept 'quicker ', 'faster', 'cheaper' without clarification. No repetition (2 x 1)	**(2)**
11(b)	One mark for identifying each procedure, one mark for each extension: • Checking packaging seals (1) through visual inspection (1) • Checking codes (1) using barcode scanners (1) • Checking for packaging misprints (1) using registration (1) • Checking pack/carton weights (1) using in-line weighing equipment/manually (1) • Checks for identifying damaged/non conforming product (1) using optical sensors (1) • Checking for box contents (1) using x-ray equipment (1) • Checking shipment details (1) with links to databases (1) • Machinery checks (1) through the use of maintenance activities (1) Accept any other appropriate response. Must be a description of the quality control check rather than a reason for its use Low response (1) or two low responses (2) or detailed response (2), for each of the three reasons (3 x 2)	**(6)**

Question	Answer	Mark
11(c)	One mark for identifying each benefit, one mark for each extension: • Early identification of non-conforming product (1) fewer customer complaints (1) • Avoids faulty products being dispatched (1) less returns (1) • Fewer product recalls (1) avoids dealing with customer complaints (1) • Improved product safety (1) less risk to customer (1) • More consistent/reliable product (1) increased customer confidence (1) • Increased sales/profit/turnover (1) improved manufacturers status (1) • Less waste (1) improved efficiency (1) Accept any other appropriate response. Low response (1) or two low responses (2) or detailed response (2) for each of the two benefits. (2 x 2)	**(4)**
		(Total 12 marks)

Question	Answer	Mark
12(a)(i)	One mark for any of the following changes: • Reduced employment opportunities (1) • Increased competition for jobs (1) • Higher skill levels required (1) • Increased emotional stress (1) • Changes to work patterns (1) • Alterations to life style (1) • Changes to work requirements (1) • More training required (1) • Reduced physical demands (1) Accept any other appropriate response. Low response (1) or two low responses (2) or detailed response (2) (2 x 1)	**(2)**
12(a)(ii)	One mark for identifying effect, one mark for explanation: • Reduced noise pollution (1) – better designed equipment(1) • Better dust/fume extraction(1)- dedicated extraction/conditioning systems (1) • Improved temperature control (1) regulated air conditioning (1). • Cleaner/healthier (1) improved equipment design (1) • Improved lighting (1) better designed illumination (1) • Improved safety (1) equipment fitted with safety sensors. • Fewer injuries (1) more space in workplace (1) Accept any other appropriate response. Low response (1) or two low responses (2) or detailed response (2) for each of the two effects (2 x 2)	**(4)**

Question	Answer	Mark
12(b)	One mark for identifying benefit. One mark for explanation: • Better functionality (1) improved performance will help with repeat sales (1) • Longer lasting product (1) will reduce customer complaints and encourage re-purchase/returning customers (1) • Lighter materials/better strength to weight ratio (1) suggests a quality product which will lead to more sales (1) • Smaller product size/miniaturisation (1) easier to use bite alarm means better value and increase sales (1) • Improved appearance (1) as a range of finishes/colours can lead to increased sales (1) • More sustainable (1) as easier to recycle which will lead to more sales (1) • Increase availability (1) as lower costs/quicker to market/larger product range will help with repeat sales (1) Accept any other appropriate response. Do not accept 'cheaper' Low response (1) or two low responses (2) or detailed response (2) for each of the two benefits (2 x 2)	**(4)**
		(Total 10 marks)

Question	Answer	Mark
13	An answer that makes reference to the following points with explanation: • Guards/sensors on machinery (1) • Machinery can shut down/stop automatically (1) • Machinery can operate in hazardous environments (1) • Less human input at the production stage (1) • Reduced number of accidents (1) • Fewer fatigue related accidents (1) • Enables continuous processing with less risk of accidents (1) • Better process control less risk of injury (1) Or any other appropriate response e.g. control technology can shut down machinery automatically (1) which lowers the risk of injury (1) and better process control can reduce the number of accidents (1) as less human input is required at the production stage (1) Up to 4 low responses (4) or detailed response up to (4) (4 x 1)	**(4)**
		(Total 4 marks)

Question	Answer	Mark
14 **QWC i, ii, iii**	**Indicative content** Discussion may address the following issues: **Impact** <u>Production efficiency</u> Development • Improved throughputs achieved • Increased productivity • Can operate continuously • Does not tire • Can be modified/upgraded to increase efficiency • Able to operate in extreme/hazardous conditions • Lower levels of waste Or any other appropriate response **Impact** <u>Product quality</u> Development • Produces consistent/uniform products • Operates within closer tolerances • Adjustment of the level of precision • Produces products to specification • Reduced risk of error • Ability to extract non conforming product Or any other appropriate response **Impact** <u>Manufacturing costs</u> Development - 'Positive' • No wage costs • No holiday pay to 'factor in' • No national insurance, income tax, pension to 'factor in' • No sick pay/compensation costs • No redundancy costs • Lower energy costs i.e. can work in dark/cold/heat • Less non conforming product • Reduced waste • Lower raw materials costs Or any other appropriate response.	**(6)**

Question	Answer	Mark
	Development - 'Negative' • Expensive to maintain/service • Initial capital costs high • Replacement costs high • Updating/refurbishing costs high • Can breakdown increasing 'down time' • Can be inflexible • Malfunctions can be very disruptive/costly Or any other appropriate response. Example learner answer (level 3); Robots are able operate continuously without getting tired or needing to take breaks this enables output to be increased which improves efficiency. There are no wages or other costs linked to employing people such as holiday pay, national insurance, pensions etc to pay which lowers manufacturing costs. Workplace lighting, heating / cooling is often not needed, so expenditure on energy is reduced. The reductions in manufacturing expenditure makes competitive pricing possible as these costs do not need to be 'factored in' when costing products. However, the initial purchase costs of robotics costs can be high and can also be expensive to maintain and repair if they breakdown. Robots are able to produce consistent products to precise specifications so waste is reduced and quality is maintained.	
		(Total 6 marks)

Level	Mark	Descriptor
	0	No material deserving of reward
1	**1-2**	The learner identifies at least two impact related points linked to efficiency/product quality/manufacturing costs or gives a brief description of one inter-related impact, and shows some understanding of the topic. The learner uses everyday language and the response lacks clarity and organisation. Spelling, punctuation and the rules of grammar are used with limited accuracy.
2	**3-4**	The learner gives a brief description of at least two impact related points linked to efficiency/product quality/manufacturing costs or one inter-related detailed description. The learner uses some manufacturing/technological terms and shows some focus and organisation. Spelling, punctuation and the rules of grammar are used with some accuracy. Some spelling errors may still be found.
3	**5-6**	The learner gives a detailed explanation of at least three impact related points linked to efficiency/product quality/manufacturing costs or two inter-related detailed descriptions. The learner uses a range of appropriate manufacturing/technological terms and shows good focus and organisation. Spelling, punctuation and the rules of grammar are used with considerable accuracy.
		(Total 6 marks)
	Total Marks for Section B	**60**
	Total Marks for the whole paper for Section A & B	**110**