National
Qualifications
2019

2019 Design and Manufacture

Higher

Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

General marking principles for Higher Design and Manufacture

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

(a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

(b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(c) The term 'or any other valid response' allows for possible variation in candidates' responses. Always award marks according to the accuracy and relevance of an answer.

(d) Where a question asks a candidate to **describe**, they must provide a statement or structure of characteristics and/or features. This should be more than an outline or a list. It may refer to, for example, a concept, process, experiment, situation, or facts, in the context of and appropriate to the question.

(e) Where a question asks candidates to **explain**, they must relate cause and effect and/or make relationships between things clear, in the context of the question or a specific area within the question.

(f) Where a question asks candidates to **discuss**, they must communicate ideas and information on a subject. It may be possible to debate two sides of the statement.

Marking instructions for each question

Section 1

Question			Expected response	Max mark	Additional guidance
1.	(a)		Candidates are expected to explain why the materials chosen are suitable for these products. Candidate explanations should relate to the materials chosen for the wheelchairs and or their component parts/features. It should include the properties or benefits of the materials.	**6**	**Six** valid explanations at **1 mark** each. **No marks** awarded for simply stating properties. **No marks** awarded for repetition of explanations. **Explanations may include the following properties** **ABS** • good impact resistance • good strength, able to hold the weight of the user • chemical resistance for ease of cleaning • suitable for production methods • scratch resistant • durable. **Stainless steel** • corrosion resistant • durable • tough • ease of cleaning • lightweight. **Tubular mild steel** • durable • corrosion resistant if coated • widely available • suitable for production methods • ease of cleaning • good strength, able to hold the weight of the user • strength to weight ratio • lightweight (tubular form) manoeuvring.

Question			Expected response	Max mark	Additional guidance
					Nylon • durable, resistant to wear • strong/safe • chemical resistance for cleaning • excellent abrasion resistance • recyclability • self-lubricating (paralympic wheelchair) • flexible. (seat of the collapsible only) **Carbon fibre** • high strength to weight ratio • increased durability • rigidity • chemical resistance for ease of cleaning • fatigue resistance • impact resistant • increased dimensional stability • design flexibility • comfortable to hold and easy to grip • aesthetic qualities • lightweight. (comparison or recognition of sport) **Aluminium** • lightweight (explained) • suitable for recycling • chemical resistance — easy to clean • corrosion resistant • good strength to weight ratio. Any other suitable explanation.

Question			Expected response	Max mark	Additional guidance
	(b)		Candidates are expected to name three appropriate manufacturing processes used in the production of these wheelchairs and explain why each one is suitable. Candidates will name and explain why these processes are appropriate to the production of the wheelchairs. It is likely that they will relate to the materials used.	**6**	Any **three** appropriate manufacturing processes and their suitability explained. Maximum of **3 marks** for naming of processes. (**1 mark** for each process.) Maximum of **3 marks** for explanations of suitability. **1 mark** for each explanation of suitability, where more than **one** explanation is given to a process, **a maximum of 2 marks** per process should be awarded. **NB** Marks can be awarded for correct explanation of an incorrect process. *The nylon wheels have been vacuum formed (**0 marks**, incorrect process) as it produces the intricate detail. (**1 mark**, correct justification for injection moulding)* **Processes could include** **Collapsible manual wheelchair** • extrusion of the mild steel frame/tyre • injection moulding of the foot rests/handles • bending of the mild steel frame • welding of the mild steel frame • piercing/CNC drilling of the holes • blanking of the stainless steel fittings • dip coating of the mild steel frame • die casting of the aluminium wheel • die casting of fixtures and fittings. **Paralympic sports wheelchair** • extrusion of the aluminium frame • press forming of the stainless steel bumper/wings • bending of the aluminium frame • welding of the aluminium frame • piercing/CNC drilling of the holes • blanking of the bumper/wings • injection moulding of the nylon wheel • die casting of fixtures and fittings.

Question			Expected response	Max mark	Additional guidance
					Explanations could include • repeatability of process • accuracy of process • intricate detail • uniform cross section (extrusion) • thin sheet • forms suitable for process • economies of scale (mass/batch/JIT) • quality of surface finish/no further finishing required • strength achieved through welding/press forming • speed of assembly. (bolts/screws) Any other suitable explanation.

Question			Expected response	Max mark	Additional guidance
	(c)		Candidates are expected to describe how function has influenced the design of these wheelchairs.	**5**	**Five** appropriate descriptions at **1 mark** each. **Descriptions may include** • easily folded for portability/storage (collapsible only) • simply designed for ease of use (collapsible only) • handles/wheel rims for pushing • use of brakes (collapsible only) • resistant to everyday knocks (collapsible only) • easy maintenance (collapsible only) • slip hazards (pattern on foot rest/raised edge — collapsible only) • easily steered/manoeuvred (very important for paralympic wheelchair) • can support the weight of the user group — or the particular user (paralympic) • resistant to severe knocks (paralympic only) • lightweight — with reference to how it will be used (paralympic only) • comfort for the user — everyday use (collapsible), performance use (paralympic) • stability (four wheels to provide balance) • secure grip (handles on collapsible/wheel rims on paralympic) • strength of construction (appropriate materials/assembly) — everyday use (collapsible), performance use. (paralympic) Any other suitable description.

Question			Expected response	Max mark	Additional guidance
	(d)		Candidates are expected to explain the benefits and drawbacks **for the manufacturer** of using standard components during the production of these wheelchairs.	**4**	**Four** benefits/drawbacks **for the manufacturer** at **1 mark** each. **Maximum of 3 marks** for each area (3+1). **Explanations are likely to include** **Benefits** • reduced costs (if explained) • ensures consistency/less waste/improved quality assurance • ease of ordering/multiple suppliers • sourcing reduces lead time • speeds up production process • allows JIT • reduces the number of manufacturing processes • standard sizes simplifies production process • greater flexibility in manufacture (can be used on other products) • simplifies assembly (not ease of assembly) • simplifies the use of a mass production line. **Drawbacks** • delivery issues • cost of outsourcing • dealing with third party, for example, contracts, relationships, stability of supplier • quality assurance • sustainability issues • restrictions in design. Any other suitable explanation.

Question			Expected response	Max mark	Additional guidance
	(e)		Candidates are expected to describe how **anthropometrics** and **physiology** have influenced the design of these wheelchairs.	**4**	**Four** appropriate descriptions at **1 mark** each. Candidates must make reference to **both** anthropometrics and physiology to achieve **full marks**. Maximum of **3 marks** for any single area (3+1). Candidate descriptions must relate to its appropriate area of ergonomics. **Descriptions are likely to include** **Anthropometrics** • diameter of handles • length of handles (collapsible only) • length of footrests • width of footrests • diameter of wheel rims • reach to wheel rims (moving the wheelchair) • width of the seat • height of the backrest • depth of the seat • height of the armrests (collapsible only) • adjustable height of the footrest (collapsible only) • support the weight of the user. **Candidates must relate anthropometrics to a part of the body.** (Ignore incorrect percentile range, if given.)

Question			Expected response	Max mark	Additional guidance
					Physiology • force required to push/pull wheels using wheel rims (strain) • force required to push/pull using handles (strain, collapsible only) • posture issues • comfort • strength required to lift the wheelchair • dexterity. Any other suitable explanation.

Section 2

Question			Expected response	Max mark	Additional guidance
2.	(a)		Candidates are expected to explain why vacuum forming is a suitable process for the production of the food packaging.	**2**	**1 mark** for each valid explanation. **Explanations are likely to include** • sheet material can be used • low tooling cost • economies of scale • repeatability • appropriate to material/thermoplastics • patterns/textures transferred from the mould. Any other suitable answer.
	(b)		Candidates are expected to state a suitable thermoplastic and explain why this thermoplastic is appropriate for the manufacture of food packaging.	**3**	**Maximum 1 mark** for identification of material. **Material selection from** • high density polythene (polyethylene) (HDPE) • low density polythene (polyethylene) (LDPE) • polypropylene • polystyrene (HIPS) • polyvinyl chloride (PVC). **Responses are likely to include** • durable material (explained) • chemical resistance/easy to clean/hygienic • insulation of hot foods • suitable for vacuum forming • variety of colours/transparency • impact/scratch resistant (justified) • non-toxic • can be recycled (justified). Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
	(c)		Candidates are expected to outline two considerations which would influence the selection of a production system.	**2**	**1 mark** for each appropriate description. **Responses are likely to include** • demand for product • machinery available • certain components might need to be mass produced • how quickly parts are required • flexibility of design (shape/form etc) • economies of scale • standardisation (identical parts) • affordability • materials to be used. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
3.	(a)		Candidates are expected to outline the benefits of using CAD software in the design of these headphones.	**3**	**1 mark** awarded for each valid point. **Responses are likely to include** • accuracy (justified) • used with CAM production • use a library of existing parts • can quickly make changes to design • information sent through internet (collaboration with others) • can be used with rapid prototyping • customisation (can experiment with colours/textures/materials etc) • stress analysis/simulation • cost comparison to material use. Any other suitable answer.
	(b)		Candidates are expected to explain the benefits of a strong brand image.	**2**	**1 mark** for each appropriate benefit given or **2 marks** for a detailed explanation. **Responses are likely to include** • sets the product apart from competition • allows easy recognition of product • gives greater advertising opportunities • consumers might pay more for trusted brand • consumers may have brand loyalty • consumers more likely to purchase a brand that are familiar with • consumers might insist on buying a particular brand • the reputation of the brand is important to the consumer • the brand can command a higher selling price. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
	(c)		Candidates are expected to identify another method of protecting IPR and give an example of what it would be used to protect.	**2**	**1 mark** for identifying the method of protecting IPR. **1 mark** for giving a suitable example of what this would protect. **Responses are likely to include** **Method** • copyright • design-right/registering the design • trademark • confidentiality **Example** • copyright – printed or published materials for example book/movie/song • design-right/registering the design – the appearance for example shape/configuration of design • trademark – name or identity • confidentiality – trade secrets, recipes, formulas. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
	(d)		Candidates are expected to describe three of the stages of the product life cycle.	**3**	**Three** valid points at **1 mark** each. **1 mark** per stage. **No marks** for simply naming the stage of the product lifecycle. **No marks** for simply describing the graph. *For example In stage four the sales are declining (**0 marks**)* **Responses are likely to include** **Stage A — Introduction:** the company seeks to build product awareness and develop a market for the product. **Stage B — Growth:** the company seeks to build brand preference and increase market share. **Stage C — Maturity:** strong growth in sales diminishes. Competition may appear with similar products. The main objective at this point is to defend market share while maximising profit. **Stage D — Decline:** sales decline. The company can possibly rejuvenate the product adding new features and finding new uses. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
4.	(a)		Candidates are expected to discuss the aesthetics of the razors.	**4**	**Four** appropriate comments at **1 mark** each. Candidates must refer to **four different** aesthetic aspects. Reponses should be based on the aesthetic facts relating to the razors. **Aesthetics are likely to be examined in terms of** • shape • line • form • proportion • pattern • light • texture • colour • fashion • style/brand • contrast • harmony • balance/symmetry • market trends • suitability for target market • aesthetics for function. Any other suitable answer. *For example in the Gillette razor there is a contrast in colour between the silver of the body and orange of the logo (**1 mark**), there is also contrast of textures between the smooth body and rubbery grip (**1 mark**)this make the razor look more secure to hold when it's wet (**1 mark — aesthetics for function**).*

Question			Expected response	Max mark	Additional guidance
	(b)		Candidates are expected to identify two different types of model and describe how they could be used to advance the design of a product.	**6**	**Maximum of 2 marks** for the identification of the modelling technique. Marks can only be allocated to a maximum of **two** model types. A maximum of **5 marks** for any modelling type. **No marks** awarded for repetition of descriptions. **Responses are likely to include** **Sketch models** • produced quickly to visualise ideas • check products scale (anthropometrics) • check functional issues, for example, stability etc • check operational issues, for example, levers, linkages, fitting parts • check aesthetic factors • development of initial ideas. **Block models** • communicate and develop form • test ergonomics • presented to a client for advertising • analyse the aesthetics of the design • surface detail • position of buttons etc. **Scale model** • gather information on appropriate sizes • check the overall proportion • test ergonomics • check assembly methods.

Question			Expected response	Max mark	Additional guidance
					Test model • functional suitability/efficiency/performance • structural suitability • material performance • health and safety regulations • allow for alterations to be made pre-manufacture. **Prototype** • test a fully working product/component • assist with marketing • provides clients with a fully working product (testing or promotion) • check for any flaws before actual production. **Computer generated model** • can be fully integrated with CAD/CAM for testing of different factors • check aesthetics (fully rendered models) • used for marketing/promotion • check dimensions and assembly methods. Any other suitable answer. *For example a miniature model (**0 marks — incorrect model type**) allows you to check the proportions using an ergonome. (**1 mark — correct reason for scale model**)*

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	Candidates are expected to describe the **purpose** of the following types of specifications and give an **example** of the type of information found in each one. **Product design specification**	**2**	**1 mark** for correct description of the purpose. **1 mark** for the example of type of information given. **Responses are likely to include** **Purpose** • defines specific parameters • provides direction to the design process • used to evaluate changes in decisions. **Example** • number to be produced • target market • cost • impact on environment • dimensions • information relating to design factors • environment it will be used in. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
		(ii)	Candidates are expected to describe the **purpose** of the following types of specifications and give an **example** of the type of information found in each one. **Technical specification**	**2**	**1 mark** for correct description of the purpose. **1 mark** for the example of type of information given. **Responses are likely to include** **Purpose** • provides specific technical detail required to manufacture product • produced after the product is designed and tested to provide specific technical information. **Example** • materials • processes to be used • assembly methods • production costs • dimensions • weight • maintenance cycles • performance • power supply • comply with safety standards. Any other suitable answer. *For example how you make the product (**1 mark**) for example tubular frame would be extruded. (**1 mark**)*

Question			Expected response	Max mark	Additional guidance
	(b)		Candidates are expected to describe appropriate methods of carrying out research into the needs of the target market.	**2**	**Two** valid points at **1 mark** each. **No marks** for simply naming the research technique. **Responses are likely to include the type of information that could be gathered from** • questionnaires/surveys • analysis of market trends • analysis of **existing** products • analysis of ergonomic data • focus groups. Any other suitable answer. *For example a questionnaire or a survey to find out the needs of the target market, what they like and want in a product (**0 marks**). You could research products already on the market to find out what sort of price they are selling for (**1 mark**).*

Question			Expected response	Max mark	Additional guidance
	(c)		Candidates are expected to describe how manufacturers could reduce the negative environmental impact of their products.	4	**1 mark** for each valid point. **Responses are likely to include** • using **recyclable** materials • materials from sustainable sources • labelling of plastic components to assist recycling • use of **recycled** materials in the manufacture of the product • use of processes that do not cause harm to the environment • manufacture of the product close to the market to minimize transport • using efficient machinery • easily dismantled products • easily transported (lightweight/stackable) • reduced volume of material used in each product • reduce number of materials used • reduce number of manufacturing processes used • minimise waste (during production) • reuse components • reduced or no packaging • efficient in use ('A' rated products) • use of 'green' materials as an alternative • use of renewable energy for production • use of durable materials to increase lifespan of product. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
6.	(a)		Candidates are expected to describe a range of methods that could be used to identify materials.	**4**	**1 mark** for each valid point or up to **3 marks** for a detailed explanation of one method. **No marks** for simply identifying a method. **Responses are likely to include** • testing – flame test – float test – scratch test – cut test – magnetic • identification symbols • comparisons to other materials • aesthetic aspects. Any other suitable answer. *For example you could find out what the material is by burning it. (**0 marks**) You could look at the aesthetics of the material that is colour, texture. (**1 mark**) You could tell the difference between aluminium and stainless steel because the aluminium will be lighter. (**1 mark**)*

Question			Expected response	Max mark	Additional guidance
	(b)		Candidates are expected to explain the purpose of location pins, bosses and ribs/webs.	**4**	**1 mark** for each valid point. Candidates must make reference to **all** manufacturing features to achieve full marks. **No marks** awarded for repetition of explanations. **Responses are likely to include** **Location pins** • used to ensure the accurate positioning of a work piece • adds product strength, less likelihood of movement of each part. **Bosses** • incorporate a space for a thread/bolt/screw for assembly • adds component strength for the thread/bolt. **Ribs/webs** • add strength and rigidity to the finished component • allow the material to flow evenly into all areas of the mould • allow location of internal components. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
	(c)		Candidates are expected to describe two benefits of these symbols and labels for the consumer.	**2**	**1 mark** for each valid point. **Responses are likely to include** • recyclable material • made from recycled material • identify base material • information on breaking down product into recyclable parts • identify food grade plastics • non-toxic • dishwasher safe • microwave compatible • meets BS and CE safety standards • explanation of function (direction for opening) • branding. Any other suitable answer.

Question			Expected response	Max mark	Additional guidance
7.			This question is set to test the candidate's ability to present a reasoned discussion about a variety of graphics that can be used effectively at different stages in the design process. Although there is an underlying body of knowledge required to answer it, there is a very wide range of possible answers. Therefore, the question is marked holistically. The features which are looked for are: knowledge of the subject matter, and ability to comprehend the question and construct an answer, which uses clear examples to support the points made. The table below should be used to award **appropriate marks**.	**8**	**Descriptions are likely to make reference to some of the aspects below** • variety of graphics available. (2D/3D sketch, orthographic, oblique, one-point perspective, isometric, two-point perspective, exploded/assembly, sectional, scale drawing, working drawing, rendered — **all can be manual or CAD**.) **Idea generation** Graphics used at this stage are mainly exploratory. Simple, quick sketches outlining the basic idea. No need for too much detail or rendering. • freehand and carried out at a fast pace • range of 2D/3D sketches • oblique • isometric • perspective. **Development — exploration/refinement** Graphics used at this stage are initially exploratory and will become progressively more detailed. • designer will still be problem solving, graphics may still be produced quickly • some explanatory graphics may begin to appear to help visualise emerging details • range of 2D/3D sketches • pictorial drawings • scale drawings • orthographic/dimensioned drawings of emerging details • exploded sketches of emerging details • sectional sketches of emerging details rendered views. (manual/CAD)

Question			Expected response	Max mark	Additional guidance
					Production Graphics used at this stage are to aid production. These will be rich in information containing sufficient detail to allow prototypes to be made and final manufacture to take place. These graphics require a high degree of accuracy. • dimensioned orthographic drawings/working drawings — produced on CAD or with drawing equipment • sectioned orthographic • exploded. **Presentation** Graphics used at this stage are mainly presentation/promotional. These graphics would be used to communicate the design to the client and for advertising purposes. These must not be too technical as the client may not understand them. • must provide a very clear image that is visually appealing • graphics should look as realistic as possible • manual rendered illustration • render CAD illustration/animations. Whilst the response can include these types of graphics, it should be noted that the candidate may include others.

0–2 marks	3–4 marks	5–6 marks	7–8 marks
An answer which falls into this category may do so for a number of reasons. • **limited** knowledge or understanding of the use of graphics in the design process • there is little or no reference to types of graphics • very few points are made • much of the response does not answer the question • the answer is simply too thin.	An answer which falls into this category may do so for a number of reasons. • **adequate** knowledge or understanding of the use of graphics in the design process • the answer will be relevant to the question • reference is made to different types of graphics • although examples are used, points made are unclear.	An answer which falls into this category may do so for a number of reasons. • **secure** knowledge or understanding of the use of graphics in the design process • the answer will be relevant to the question and demonstrate a good level of comprehension • clear reference is made to types of graphics • several clear points are made and examples are used to support them.	An answer which falls into this category may do so for a number of reasons. • **extensive** knowledge or understanding of the use of graphics in the design process • the answer will be relevant to the question, demonstrating a high level of comprehension • detailed information is given about different types of graphics and how they are used to support designing • all points made are clear and examples are used to support them.

[END OF MARKING INSTRUCTIONS]