OCR
Oxford Cambridge and RSA

Practice Paper December 2018
A Level in Design and Technology: Design Engineering
H404/02 Problem Solving in Design Engineering

Duration: 1 hour 45 minutes

MAXIMUM MARK 70

Last updated: 21/12/2018

(FOR OFFICE USE ONLY)

This document consists of 21 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING ON RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca.
3. Log-in to RM Assessor and mark the **required number** of practice responses ('scripts') and the **required number** of standardisation responses.
4. After the standardisation meeting: YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING INSTRIUCTIONS – FOR MARKING ON SCREEN

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed Out Responses**

   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions

   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

   Multiple Choice Question Responses

   When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
   When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the additional pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

   a. Where generic answer booklets are used, all pages must contain an annotation, or RM Assessor will not allow you to submit the script. Where no response is given by a candidate on a whole page the 'BP' annotation **must** be applied.
   b. Where additional objects are present, all pages must contain an annotation, or RM Assessor will not allow you to submit the script. Where no response is given by a candidate on a whole page the 'BP' annotation **must** be applied.
   c. Where structured answer booklets are used, the 'BP' annotation **must** be applied to all pages where no response is given by a candidate.

7. Where candidates have a choice of questions across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. (*The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.*)

8. Award No Response (NR) if:

- there is nothing written in the answer space.

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

9. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.** If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or e-mail.
10. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
11. These are the annotations, (including abbreviations), used in RM Assessor, which are used when marking:

Symbol	Description	Comment
	Tick	worthy of credit
	?	unclear
	S	error of spelling
	E	error of grammar, punctuation or expression

F	F	error of fact
^	^	omission
	H Line	to draw an attention to an error
	H Wavy Line	to draw attention to something
……	Highlight	as directed by PE
REL	REL	irrelevant point
REP	REP	conspicuous repetition
L	L	illegible word or phrase
BP	BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet and on each page of an additional object where there is no candidate response.

SUBJECT–SPECIFIC MARKING INSTRUCTIONS

Introduction

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. You should ensure that you have copies of these materials:

- the specification, especially the assessment objectives
- the question paper and its rubrics
- the mark scheme.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**. Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Information and instructions for examiners

The co-ordination scripts provide you with *examples* of the standard of each band. The marks awarded for these scripts will have been agreed by the Team Leaders and will be discussed fully at the Examiners' Co-ordination Meeting.

The specific task-related indicative content for each question will help you to understand how the band descriptors may be applied. However, this indicative content **does not** constitute the mark scheme: it is material that candidates **might** use, grouped according to each assessment objective tested by the question. It is hoped that candidates will respond to questions in a variety of ways. Rigid demands for 'what must be a good answer' would lead to a distorted assessment. Candidates' answers must be relevant to the question. Beware of prepared answers that do not show the candidate's thought and which have not been adapted to the thrust of the question. Beware also of answers where candidates attempt to reproduce interpretations and concepts that they have been taught but have only partially understood.

Using the Mark Scheme

Please study this Mark Scheme carefully. The Mark Scheme is an integral part of the process that begins with the setting of the question paper and ends with the awarding of grades. Question papers and Mark Schemes are developed in association with each other so that issues of differentiation and positive achievement can be addressed from the very start.

This Mark Scheme is a working document; it is not exhaustive; it does not provide 'correct' answers. The Mark Scheme can only provide 'best guesses' about how the question will work out, and it is subject to revision after we have looked at a wide range of scripts.

The Examiners' Standardisation Meeting will ensure that the Mark Scheme covers the range of candidates' responses to the questions, and that all Examiners understand and apply the Mark Scheme in the same way. The Mark Scheme will be discussed and amended at the meeting, and administrative procedures will be confirmed. Co-ordination scripts will be issued at the meeting to exemplify aspects of candidates' responses and achievements; the co-ordination scripts then become part of this Mark Scheme.

Before the Standardisation Meeting, you should read and mark in pencil a number of scripts, in order to gain an impression of the range of responses and achievement that may be expected.

Please read carefully all the scripts in your allocation and make every effort to look positively for achievement throughout the ability range. Always be prepared to use the full range of marks.

Information and instructions for examiners

The co-ordination scripts provide you with *examples* of the standard of each band. The marks awarded for these scripts will have been agreed by the Team Leaders and will be discussed fully at the Examiners' Co-ordination Meeting.

The specific task-related indicative content for each question will help you to understand how the band descriptors may be applied. However, this indicative content **does not** constitute the mark scheme: it is material that candidates **might** use, grouped according to each assessment objective tested by the question. It is hoped that candidates will respond to questions in a variety of ways. Rigid demands for 'what must be a good answer' would lead to a distorted assessment. Candidates' answers must be relevant to the question. Beware of prepared answers that do not show the candidate's thought and which have not been adapted to the thrust of the question. Beware also of answers where candidates attempt to reproduce interpretations and concepts that they have been taught but have only partially understood.

Marking Scripts

Answers must be marked using the level descriptors in the marking grids and a mark awarded for each Assessment Objective.
The points in the mark scheme are **indicative content only** and offer some question specific guidance. Credit should be given for other points and different views, if they seem possible and are well argued or supported by good evidence.

You must avoid negative marking - don't deduct marks for individual errors. All marks should be allocated by reference to the assessment grid.

Any queries on unexpected answers please consult your Principal Examiner.

Using annotations

- Take great care to place a tick (see below) against any valid points that lead you to think at all favourably of the answer.
- **Do not leave any page unmarked** (as a last resort tick the very bottom of a page to indicate that you have read it - otherwise Team Leaders/Principal Examiners cannot tell whether account has been taken of that page).
- Underline errors and place the appropriate symbol in the margin.
- Indicate that you have looked at every page of the answer booklet by placing the **BP** symbol at the top and bottom of any blank pages.

Ticks: these are the simplest, quickest and most efficient means for examiners to convey approval to Senior Examiners, and they should be inserted where they can be most effective. If the point you wish to highlight is in the middle of a paragraph, then put the tick in the middle of a line in the middle of a paragraph. Overuse of the tick tends to devalue its effectiveness.

Do use ticks to draw attention to anything worthy of credit [even single words].

Do not use ticks as a substitute for marking/assessment; marks for questions must be determined by reference to the assessment grid, **NOT** by mechanical addition of ticks.

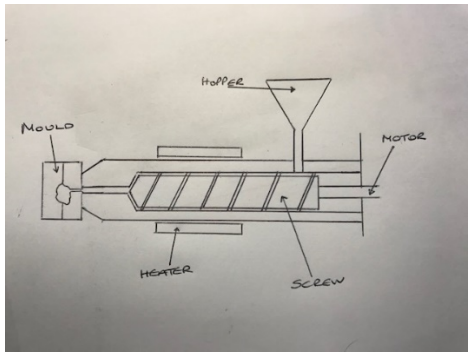
Highlighting: use highlighting as directed by your Principal Examiner.

Question			Answer	Mark	Guidance	
The indicative content in this mark scheme provides suitable exemplification of the key lines of enquiry that would be worthy of credit. In an examination series actual candidates responses will be reviewed to supplement this mark scheme with additional exemplification to ensure all key lines of enquiry are covered.						
					Content	**Levels of Response**
1*			**Indicative content:** Candidates are expected to produce a well-structured examination of social, moral and ethical implications. **Possible social, moral and ethical considerations may include:** **Social implications**: • Allows increased social interaction within the community. • Reference to the product having an effect on a group of people, either positive of negative. • Possibility of user being ostracised by the community. • Giving the individual a sense of belonging and allowing them to do jobs within the community. **Moral implications:** • Reference to helping individuals to lead as normal life as possible with use of the prosthetic. • Reference to the safety of the user being the responsibility of the designer. • How the product will affect the individual's life.	**14**	*All responses should be in relation to social, moral and ethical implications of developing countries being given access to the use of 3D printing for the production of prosthetic limbs.* *Any lifted information can be used in support of the critical examination but no marks should be awarded simply for duplicating text.* *Credit should be given for responses which identify issues evident in the supplied information and which are then critically analysed and evaluated in terms of their significance to the given scenario and relating to design and technical principles.*	**Level 4 (12-14 marks)** The candidate demonstrates a comprehensive understanding of the social, moral and ethical implications of developing countries being given access to the use of 3D printing for the production of prosthetic limbs. All three areas are considered with both positive and negative viewpoints put forward. The candidate effectively uses both the information in the Resource Booklet and applies their own design and technology understanding to build a well-constructed argument in relation to the question being asked with a clear and concise narrative. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 3 (9-11 marks)** The candidate demonstrates a good understanding of the social and/or moral and/or ethical implications of developing countries being given access to the use of 3D printing for the production of prosthetic limbs. At least two areas are considered with both positive and negative viewpoints put forward. The candidate for the most part uses the

			Ethical implications: • Who pays for the prosthetics and what should the cost be? • What is the product life span and who decides when it is changed? • Who decides who is given one? • At what age should they be given a prosthetic or it be taken away? • What physiotherapy training will they get when receiving a prosthetic? • Any other valid suggestion.			information in the Resource Booklet and applies their own design and technology understanding to build a well-constructed argument in relation to the question being asked although one or two opportunities are missed to develop the narrative. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 2 (5–8 marks)** The candidate demonstrates a sufficient understanding of the social and/or moral and/or ethical implications of developing countries being given access to the use of 3D printing for the production of prosthetic limbs. At least one area is considered with either positive or negative viewpoints put forward. The candidate adequately uses the information in the Resource Booklet and applies their own design and technology understanding to build a reasonable argument in relation to the question being asked although one or two inaccuracies exist in the narrative put forward. *The information has some relevance and is presented with limited structure. The information is supported by limited evidence.* **Level 1 (1–4 marks)** There is no analysis or evaluation of

						implications. The candidate demonstrates a limited knowledge of social, moral and ethical issues. The information in the Resource Booklet is used in a simplistic way and only limited knowledge is applied to the question being asked. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.

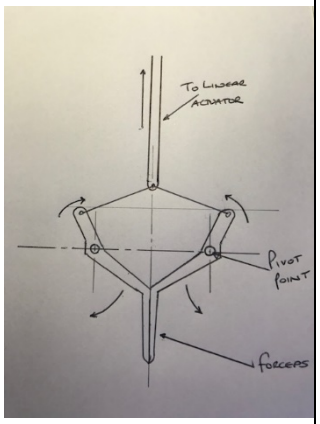
Question			Answer	Mark	Guidance	
					Content	Levels of Response
2			**The candidate is expected to demonstrate their understanding of the process involved through a series of annotated sketches and/or notes. There may be variations to the process as indicated but to get into L3 candidates must demonstrate a clear understanding of the end to end process.** **Indicative content:** **General exemplification in relation to bullet points:** • Suitability of the material, taking into account the materials properties and suitability for this application - i.e. PP, ABS, HIPS, PE, etc. • Details of a suitable manufacturing process for the socket. Reference to the unique design being custom built for individuals. • Processes like vacuum-forming or high temperature thermoforming pressing. These processes can produce one off products with minimal cost. • Reference to the process being suitable for one-off production should be made. • A suitable method of finishing the product should be mentioned, removal of sharp edges, coating in a	14	*Candidates can draw on practical experience of iterative designing and product analysis to support their response to this question.* *Candidates should reference the use of a thermoplastic material for manufacture. Failure to select a suitable material will mean that the candidate cannot achieve more than a L3 response.*	**Level 4 (11-14 marks)** The candidate has produced an excellent account of the manufacturing process needed to make the upper limb socket. All three bullet points in the question will have been covered. The candidate has named a suitable thermoplastic with material properties justifying their choice. The manufacturing process is suitable for the named material and the candidate will have explained how it takes into account the need for one-off production. Sketches if used will be clear and supported with relevant notes. The process will be end to end and clear in the way it is explained. **Level 3 (7-10 marks)** The candidate has produced a good account of the manufacturing process needed to make the upper limb socket. At least two of the three bullet points in the question will have been covered. The candidate has named a thermoplastic with material properties justifying the choice. The manufacturing process is suitable for the material and the candidate will have explained how it takes into account the need for one-off production. Sketches if used will for the most part be clear and supported with relevant notes although or one or two opportunities for clarity may be missed. The process will be end to end and for

			cushioning material, etc. • Detailed understanding of the manufacturing process should be demonstrated with clear understanding of the stages involved. • Correct finishing techniques should be demonstrated. **Exemplar response:** Manufacturing method selected: **Injection moulding** • Injection moulding is a redistribution process where plastic granules are fed into a Hopper. These are then put into the injection moulding machine and heated until molten. Once the temperature has been reached the piston/screw thread forces the plastic into a mould under pressure. Once cooled this mould opens and releases the part (could include a diagram of the machine or process).  			the most part be clear in the way it is explained. **Level 2 (4-6 marks)** The candidate has produced a sufficient account of the manufacturing process needed to make the upper limb socket. At least two of the three bullet points in the question will have been covered. The candidate has named a thermoplastic with material properties although the justification may be limited. The manufacturing process is suitable for the material although the candidate will not necessarily have explained how it takes into account the need for one-off production. Sketches if used will be adequate and supported with notes some of which will be relevant. The process may not necessarily be end to end with some knowledge gaps evident. **Level 1 (1-3 marks)** The candidate has produced a basic account of the manufacturing process needed to make the upper limb socket. At least one of the three bullet points in the question will have been covered. The candidate may not name a suitable material for manufacture or account for the need for one-off production. Sketches, if used, will be unclear with only basic notes to accompany them. The end to end process may not exist and if anything is basic in nature. **0 marks** No response or no response worthy of

			• An appropriate material would be polyurethane. This can be injection moulded easily. It also is a softer plastic so will have a more comfortable fit for the end user. It is available in a variety of colours and whilst it cannot be recycled it can be repurposed by grinding down. • For correct finishing process reference to the removal of any runners and the sprue should be made. As well as finishing the edges to remove reference of the split line which cause rubbing on the user. The injection moulded product would not need a surface finishing but colour could be applied afterwards to give it more realism. Candidates can also discuss the manufacturing process through diagrams, showing each stage. An answer involving vacuum forming lends itself to this form of structure. For materials and finishing candidates may choose to draw a prosthetic and label the materials used in the process. • Any other valid suggestion.			credit.

Question			Answer	Marks	Guidance
3	(a)		$C = \tan^{-1}(\frac{Opp}{Adj})$ (1) $C = \tan^{-1}(\frac{120}{70})$ (1) $C = \tan^{-1} 1.71$ C = 59.68^o Accept rounded answers to 60^o (1).	3	Award three marks as follows: One mark for identifying the correct trigonometry formula. One mark for correct substitution of the Opposite and Adjacent lengths. One mark for calculating the angle C formed between the tie and the forearm If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks.
3	(b)		To find length of the support tie: y= length of support tie $\boldsymbol{y = \frac{Opp}{sin(C)}}$ (1) $\boldsymbol{y = \frac{120}{sin(*59.68)}}$ (1) $\boldsymbol{y = 139mm}$ (1)	3	Award three marks as follows: One mark for identifying the correct trigonometry formula. One mark for correct substitution of the numbers. One mark for calculating the length of the tie to the nearest mm. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Award marks for any other correct method, e.g. Pythagoras.

3	**(c)**		Load L = 9 x 9.81 = 88.29N (1) Weight W = 2 x 9.81 = 19.62N (1) Anticlockwise moments about elbow joint = (L x 230) + (W x 115) = (88.29* x 230) + (19.62* x 115) = 20306.7 + 2256.3 = 22563 (Nmm) (1) Clockwise moment about elbow joint = F sin(C) x 70 (1) ACW moments = CW moments 22563 = F sin (*59.68) x 70 (1) **F =** $\frac{22563*}{\sin(*59.68) \times 70} = \boldsymbol{373.4N}$ (1) Allow for a range in the answer between 373 and 374 N	**6**	Award six marks as follows: One mark for using W=mg to calculate L. One mark for using W=mg to calculate W. One mark for calculating the anticlockwise moments. One mark for resolving force F. One mark for equating ACW moment = CW moment. One mark for calculating the tensile force (F) in the tie when the maximum recommended load is being held in the hand. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown. Award marks for any other correct method.

Question			Answer	Mark	Content	Guidance
4			**Indicative content:** **Problem 1:** • Reference to the conversion of linear to oscillating motion. • Suitable mechanism to aid this process. • Suitable mechanism to produce the correct movement (the amplification of 5mm linear motion to 15mm of oscillating motion). • Reference to a pivot point to reverse the direction. • Reference to the increase in force created by the linkage. • Reference to linkage methods should be made. Plain bearings to increase efficiency but reduce the chance of contamination should be recognised. • Sketches could be used to show the mechanism in detail. Sketches should have the lengths of each piece to give the required amplification. • Sketches could also show how the movement of the linear actuator produces the required movement.  	14	*Candidates should have produced a drawing using the dimensions in the Resource Booklet.* *Reference to the amplification of the movement needing to be 3:1 should have been made and appropriate calculations shown. This should also be clear on the diagrams provided by the candidate.* *Scale drawings are not required but dimensions should be labelled.* *For L4 to be awarded both problems must have been solved.* *This question assesses applied knowledge of technical principles to the existing design, so responses that focus on redesigning the existing solution should not be rewarded.* *Candidates can draw on practical experience of iterative designing and product analysis to support their response to this question.*	**Level 4 (11-14 Marks)** The candidate has designed a suitable system to produce the required motion at the output. All three bullet points in the question will have been covered and both problems will have been solved. The candidate will have an excellent understanding of the application of the part. All dimensions have been referenced and a clear understanding of the amplification of the movement has been demonstrated. Sketches if used will be clear and supported with relevant notes. **Level 3 (7-10 Marks)** The candidate has designed a suitable system to produce the required motion at the output. At least two bullet points in the question will have been covered and both problems will have been solved, albeit one or both of the solutions may lack some detail. The candidate will for the most part have a good understanding of the application of the part. All dimensions have been referenced and a clear understanding of the amplification of the movement for the most part has been demonstrated. Sketches if used will for the most part be clear and supported with relevant notes although or one or two opportunities for clarity may be missed. **Level 2 (4-6 Marks)** The candidate has designed a suitable system to produce the required motion at the output but has not considered the amplification. At least two bullet points in

			• Candidates should not be penalised for a mechanism which is too complex as long as it performs the required task. • Reference to the materials being used should include comments about suitability i.e. stainless steel as can be sterilised before use or polymers as they are inert and will not react with the fluids it may encounter. • Any other valid suggestion. **Problem 2:** • Reference to the transducer used to create the rotational motion; servo, geared motor, stepper motor etc. • Details should be given of the method of controlling the transducer mentions. • For servo reference to PWM or controlling via a microcontroller. • For a geared motor, reference to a motor driver should be made and appropriate control device. • For stepper motor, relevant control method should be shown for both clockwise and anti-clockwise motion. • Candidate should make reference to controlling speed and direction in their answer. • Any other valid suggestion.			the question will have been covered but only one of the problems may have been solved. The candidate will have a sufficient understanding of the application of the part. The basic dimensions have been referenced. Sketches if used will be adequate and supported with notes some of which will be relevant. **Level 1 (1-3 Marks)** Candidate has produced a very basic system but has little understanding of the conversion of linear to oscillating motion. At least one of the three bullet points in the question will have been covered. The candidate will have a basic understanding of the application of the part. Dimensions may be missing or if listed may contain errors. Sketches, if used, will be unclear with only basic notes to accompany them.

5*			**Indicative content:**
			
			Candidates would be expected to demonstrate a wide range of understanding for the use and applications of technological advancements in the design process.
			
			Possible areas could be and are not limited to:
			
			• Market research – using internet surveys, etc.
			• Product research.
			• Graphical purposes, either rendering or technical drawings.
			• Communicating ideas between companies/countries via the internet.
			• Prototyping with specific reference to:
			  • time saving;
			  • cost saving;
			  • creating parts with high levels of detail.
			• Creating a machine code for use with CNC machines.
			• Medical testing using 3D simulators (augmented reality, etc.).
			
			Reference to specific techniques should be recognised throughout the question. Possible rapid prototyping techniques could be and are not limited to:
			
			• 3D Printing
			• Stereolithography (SLA)
			• Selective Laser Sintering (SLS)
				16	*All responses should cover how technological advancements have assisted designer engineers in the design and development of products to progress medical science.*
					
					Candidates may extract information from any part of the Resource Booklet. Any such lifted information can be used in support of the critical evaluation but no marks should be awarded simply for duplicating text.
					
					Credit should be given for responses which identify issues evident in the supplied information and which are then critically analysed and evaluated in terms of their significance to the given scenario and relating to design and technical principles.
						Level 4 (13-16 marks)
						The candidate demonstrates a comprehensive understanding of how technological advancements have assisted design engineers in the design and development of products to progress medical science. The candidate effectively uses both the information in the Resource Booklet and applies their own product knowledge to build a well-constructed argument in relation to the question being asked with a clear and concise narrative.
						
						There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
						
						Level 3 (9-12 marks)
						The candidate demonstrates a good understanding of how technological advancements have assisted design engineers in the design and development of products to progress medical science. The candidate for the most part uses the information in the Resource Booklet and applies their own product knowledge to build a well-constructed argument in relation to the question being asked although one or two opportunities are missed to develop the narrative.
						
						There is a line of reasoning presented with some structure. The information

			• Fused Deposition Modelling (FDM) • Selective Laser Melting (SLM) • Laminated Object Manufacturing (LOM) • Multi Jet Modelling (MJM) • Digital Light Processing (DLP). Reference to the use of these techniques should be made in relation to a product either taken from the Resource Booklet or through their personal experience. Candidate could make reference to the advancements in technologies to enable these developments. Reference should be taken from the Resource Booklet using specific examples. Credit should be given to examples used which are not evident in the Resource Book, e.g.: • development of small actuators to enable accurate control of equipment such as the Endo-wrist; • the development of wireless technology to enable fast and stable transference of data throughout a procedure. Candidates can make reference to the design and development process from the use of CAD in the design phase through to testing the product in simulations or augmented reality.			*presented is in the most-part relevant and supported by some evidence.* **Level 2 (5–8 marks)** The candidate demonstrates a sufficient understanding of how technological advancements have assisted design engineers in the design and development of products to progress medical science. The candidate adequately uses either the information in the Resource Booklet or applies their own product knowledge to build a reasonable argument in relation to the question being asked although one or two inaccuracies exist in the narrative put forward. *The information has some relevance and is presented with limited structure. The information is supported by limited evidence.* **Level 1 (1–4 marks)** There is no analysis or evaluation of how technological advancements have assisted design engineers. The candidate demonstrates a limited knowledge of any impacts. The information in the Resource Booklet is used in a simplistic way and only limited product knowledge is applied to the question being asked. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the*

			Candidates may also have made reference to the development of materials for use in the systems. Answers could include but are not limited to: • the development of new polymers for use when there is an electro-magnetic presence in the procedure (MRI scanning); • development of alloys for the production of the equipment tools used in the procedures. When referring to materials candidates should make reference to the specific properties that make them suitable for that application. Where appropriate candidates can use annotated sketches to help explain their answer. Candidates should not be awarded marks if they have discussed other issues away from the technological advancements, i.e. financing of the projects etc. • Any other valid suggestion.			*evidence may not be clear.* **0 marks** No response or no response worthy of credit.