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Examiners' report

DESIGN AND TECHNOLOGY: DESIGN ENGINEERING

H404

For first teaching in 2017

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

While it is clear that the standard of responses is improving over the years, there is still some room for improvement in the problem-solving areas.

This report is to offer a pragmatic review of the performance by the candidates.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• were able to use the correct symbols and understand the need for feedback in the system when appropriate. Students have greatly improved on recent years when drawing flow charts • used the examples in the RB to support their response, not just copy it out • where able to identify the wider issues that might affect the different questions • understood about the various different stakeholders involved in the products life • where able to apply their theoretical knowledge of systems into practical applications.	• struggled to problem solve the issues that are presented to them • were not able to communicate their thoughts through graphical means in the problem-solving question • did not use the RB enough in their responses • deviated away from the question in their response. Recommend that they read the question a few times while write their response.

Question 1

1 Since the 5th century BC there has been evidence of play equipment used for the enjoyment of children. Whilst the basic concept has remained the same the technologies and legislation behind this equipment have changed significantly.

A manufacturing company wishing to enter the play area market would need to explore relevant legislation and design standards.

Critically examine the benefits of exploring legislation and associated design standards when entering a new market such as the play area market.

In your answer you **must** consider the benefits to:

- a manufacturing company
- any other relevant stakeholders.

Refer to information on **pages 2 and 3** of the Resource Booklet. **[12]**

Some candidates struggled with this question giving responses that did not meet the question criteria. Many gave the negative points of legislations when the question asked for the benefits. Acknowledgment of these negative points would be an acceptable if the majority of the response was about the benefits of exploring legislation and design standards had been covered.

Candidates who achieved a Level 4 response were about to discuss these benefits in relation to the manufacturer and also the users of the equipment also taking into account the wider issues that may come about. They were also able to use the RB well, extracting the required information from it to support their response.

Where candidates scored in the lower levels, they either only spoke about the manufacturers, or in some cases went off away from the questions talking more about what they could do to prevent getting sued rather than the benefits to the different stakeholders. Many of the lower scoring candidates focused their response on the features of the play equipment which would make them safe, rather than the benefits to the manufacturer and stakeholders.

This was not an extended response question so candidates should be encouraged to use the given bullet points as subheadings to help structure their response.

Question 2*

2* **Page 4** in the Resource Booklet contains a case study for a series of play areas which were proposed for Cotton Mill Park.

When designing the play equipment for Cotton Mill Park, **designing for manufacture (DFM)** played a key role.

With specific reference to the Cotton Mill Park case study, discuss the considerations a Design Engineer would have to make in relation to DFM.

Refer to information on **page 4** of the Resource Booklet. **[14]**

This question on the whole was answered reasonably well by most candidates. Candidates were able to show an understanding of what DFM is and how it plays a key role in the design of the play area equipment.

Where candidates scored in the lower levels they had misconceptions of what DFM was about with some leading their response down the aesthetic/ergonomic design route with little to no reference as to how these could affect the manufacture of the equipment.

Candidates who achieved the high levels were able to clearly outline the key areas of DFM as outlined in the specification on page 14. Which states the 4 areas that are a focus: Planning, Scale of Production, Repair and Manufacture and Product Life. These candidates were able to refer to these points in line with the question context to show a clear understanding about how these pieces of equipment would be designed with manufacture in mind. Candidates would have also used the RB well retrieving any information that they would have needed, i.e. the fact it needed to be a modular unit and the scale of production.

This was an extended response question and candidates would have been expected to produce a well-constructed report showing a critical examination of the relevant issues. Bullet points were not acceptable for this response. Care should be taken by the candidates to make sure they are not simply listing points and are demonstrating that they can articulate the issues they are raising.

Exemplar 1

2* **Page 4** in the Resource Booklet contains a case study for a series of play areas which were proposed for Cotton Mill Park. maintenance.
Scale Standard Camp. regen
When designing the play equipment for Cotton Mill Park, **designing for manufacture (DFM)** played a key role.

With specific reference to the Cotton Mill Park case study, discuss the considerations a Design Engineer would have to make in relation to DFM.

Refer to information on **page 4** of the Resource Booklet. **[14]**

...Design for Manufacture (DFM) is a design philosophy in which decisions are always made with regard for the eventual manufacture. For example, designing with standardised components reduces overall complexity and thus DFM can be exceptionally useful to create a more holistic product which meets desired specs.

One consideration a design engineer must make in relation to the Park would involve standardised components. Firstly, standarder components are readily available due to mass production and moreover very cheap given scale of economies theory. This allows designers to reduce the complexity of the deligh and in addition, improve the ability to maintain the park. An unaffiliated groundsperson would be able to fix and resolve complications using standard components such as bolts bought from B&Q. This extends the longevity of a product and overall, the speed of manufacture is enhanced.

Secondly, the scale of manufacture must be considered by a design engineer. At best, the Parks will be ordered batch and thus creating a system to interconnect park components increases the range of...

products without increasing the complexity of manufacture. This is achieved through modular design such that one slide could be combined with a different tower. This allows local town planners in Cotton Mill to pick and choose components and rides which would best suit the needs and wants of the locals.

Finally, a design engineer must fully consider the pros and cons to each particular material. For example, the proposed ~~cotton Mill~~ Cotton Mill Park intends to utilise recycled polymers to provide a timber-esque aesthetic. Despite this being reasonable it can incur hardships for manufacturers. ~~For~~ This may be because recycled polymers are more challenging to work with and thus they may require unique manufacture processes. Designers considering manufacturing must ensure they consider the implications of material selection. It would always be optimal to select materials which are readily available and high in demand because there would have well-developed manufacturing processes.

To conclude, a designer who fails to consider their implications of choices on the manufacture should & prepare to create a less effective product which incurs additional costs and lead times. This would make stakeholders, such as Cotton Mill, less incentivised to utilise this particular company.

Exemplar 1 gives a Level 4 response to Question 1. In this response the candidate discusses the benefits to the manufacturer as well as identifying other stakeholders that it may directly or indirectly affect.

Misconception

Candidates seemed to have a misconception about Design for Manufacture. More emphasis of this design process should be a focus in both the theory and the production of the NEA.

Question 3 (a) (i)

3

(a) The designers of Cotton Mill Park have developed a design for a single swing. The design is shown on **Page 5** of the Resource Booklet.

The swing requires two ropes. The designers would like to use rope made from recycled polymer bottles.

A specification for the proposed rope is shown on **page 5** of the Resource Booklet.

(i) Calculate the cross-sectional area of the rope. Give your answer in m^2 to **3** significant figures. Show your working.

Use the formula: cross-sectional area = $\frac{\pi d^2}{4}$

Refer to information on **page 5** in the Resource Booklet, specifically **Fig. 6**. **[2]**

Cross-sectional area of the rope ..... m^2

In general, this question was answered well by the candidates. Most were able to retrieve the required information from the resource booklet and use the given equation correctly.

The most common error in this question related to the conversion of units from mm to m. This caused the response to be incorrect. Some candidates also were not able to give their response to 3 significant figures as required in the question.

Question 3 (a) (ii)

(ii) A child with a mass of 78 kg sits on the swing seat, without swinging.

Determine by calculation that the stress in **one** of the swing ropes is 3.39 MPa. Show your working.

You **must** use your answer from part **(a)(i)** and the following information:

$1\,MPa = 1 \times 10^6\,N/m^2$
Gravitational field strength = 9.81 N/kg
stress = force/cross-sectional area **[4]**

Many candidates did well in this question and across the series demonstrated multiple ways to prove the stress on one rope.

While the equation was given in the question, some candidates struggled to apply the given information to it.

It is worth reminding candidates that in these types of questions the presentation of clear workings is critical for marks to be given.

Question 3 (a) (iii)

(iii) Calculate the extension of a swing rope caused by a stress of 3.39 MPa. Give your answer in mm to **1** decimal place. Show your working.

Refer to the information on **page 5** of the Resource Booklet, specifically **Fig. 5** and **Fig. 6**. **[3]**

Extension of a swing rope ..... mm

This question relied on the candidates be able to recall Young's Modulus. Most candidates were able to do this to come success and the question was answered well on the whole.

Where candidates lost marks, they did not calculate the original rope length from the information in the resource booklet. With some candidates failing to answer the question to the required 1 decimal place.

Question 3 (b)

(b) The manufacturer wants to add decorative panels to one of the play areas.

The design of one of the decorative panels is shown on **page 6** of the Resource Booklet.

The panels will be cut from 12 mm thick aluminium using a MolsCat CNC plasma cutter.

The specification for the plasma cutter is given on **page 6** of the Resource Booklet.

Calculate the time it would take for the MolsCat CNC plasma cutter to cut out one of the decorative panels. In your calculation include the cutting of the perimeter of the panel and the cutting of the inlay section. Give your answer in minutes and show your working.

The inlay path length is 1260 mm.

Refer to information on **page 6** of the Resource Booklet, specifically **Fig. 7** and **Fig. 8**. **[3]**

Time ..... minutes

This question gave a range of responses. While the inlay path was given in the question, it was clear that some candidates struggled to calculate the outside path length which was required to work out the total cutting path. This led to incorrect responses.

Question 4

4 Most new play area developments are surrounded by a perimeter fence to keep children safe and to stop dogs from entering the area.

The county recreation department for the Cotton Mill Park development would also like the fence to function as a deterrent to people using the equipment during the hours of darkness. It is hoped this will minimise possible antisocial behaviour.

A decision has been made to use the MB400 play area gate, details of which are given on **page 7** of the Resource Booklet. Designers are asked to modify the MB400 play area gate so that it locks during the hours of darkness.

The design engineers have two issues that need to be overcome:

Issue 1

It is required that the MB400 play area gate locks when the light level falls to 10 lux and unlocks again the following morning when the light level rises to 100 lux. A decision has been made to use the NSL-19M51 light dependent resistor to sense the light level and a LA080Z linear solenoid to operate the lock mechanism. Data for both components is given on **page 7** of the Resource Booklet.

An electronic system is required that will activate the solenoid during the hours of darkness. The system should run off 12 volts.

Issue 2

The developers have discovered that the movement of the LA080Z linear solenoid is not enough to move the bolt to lock the play area gate. The bolt needs to move through a distance of 24 mm.

A mechanical system is required which will amplify the output motion of the linear solenoid to the required amount to lock the play area gate.

Use annotated sketches and/or notes to determine suitable technical solutions that overcome the **two** issues identified.

Refer to information on **page 7** of the Resource Booklet. **[16]**

Issue 1:

Issue 2:

This style of question allowed candidates to demonstrate their understanding of different systems and the application. While this question has been a staple part of the examination some candidates are still finding it challenging and not meeting the requirements of the question.

The question is broken down into two issues, these focus on different system-based problems that the candidates must solve.

Issue 1

This was an electronics-based system. Candidates should have shown their understanding of basic electronic systems and produced a circuit diagram which used a potential divider involving an LDR and a suitable resistor. A number of students were not able to draw a potential divider or the circuit symbol for an LDR and showed a disappointing level of understanding for output drivers.

Candidates who achieved a Level 4 response well were able to draw the potential divider with a suitable resistor from the information in the RB and the correct circuit symbol for an LDR and connect it to a micro-controller of their choice. They were also able to identify the need to amplify the output of the micro-controller to run the solenoid wit most candidates using either a transistor or a MOSFET. A few candidates were able to draw the system with a Relay, also considering the need for a protective diode for reverse EMF.

Candidates also needed to produce a flow chart for the micro-controller. These were greatly improved from previous years with most candidates using the correct symbols for the flow chart and understanding the need to have feedback in the system.

Assessment for learning

Learning about simple electronic systems is important when developing the student's skills. This is especially important when designing systems with micro-controllers. A potential divider is a fundamental part of an electronic system and candidates should be able to draw a potential divider with a range of input transducers. This should be taught when teaching about input transducers as part of the specification.

Issue 2

Issue 2 involved the students demonstrating an understanding of a mechanical system needed to solve a problem. Most candidates used either a gear system involving rack and pinions or a class one lever system.

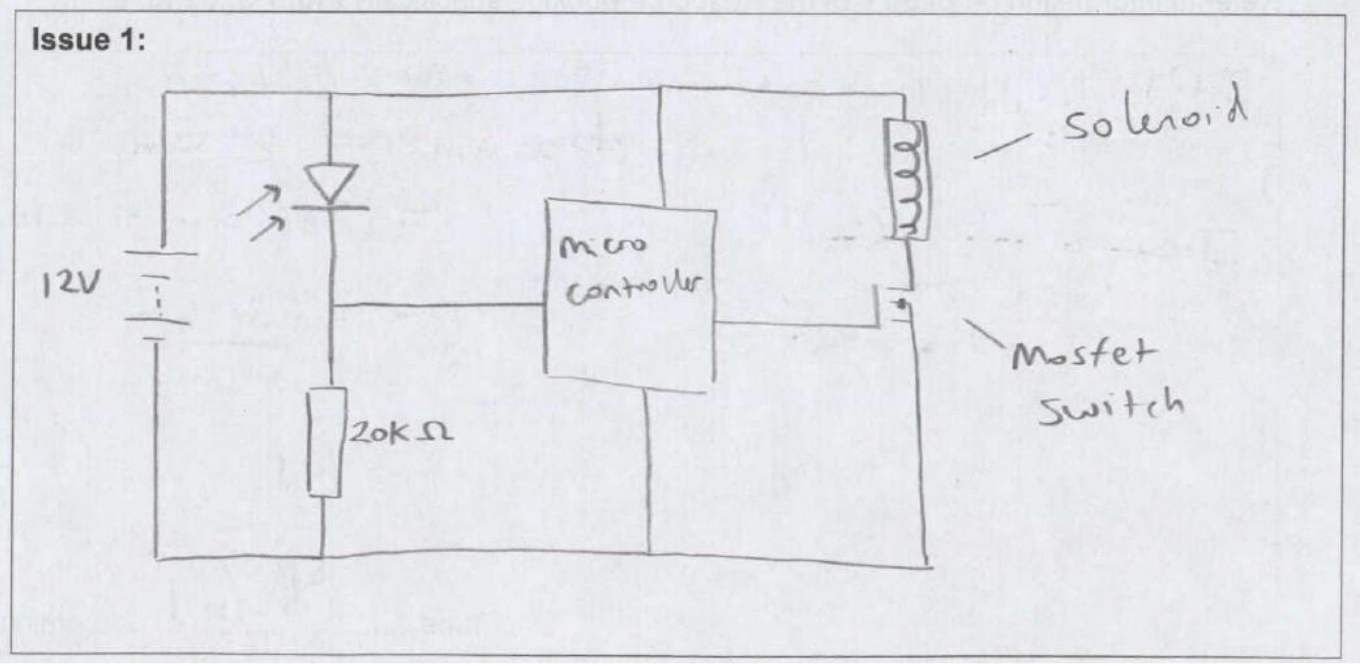
There were a number of students who mistook the linear solenoid for either a motor or a pneumatic solenoid. The information about the solenoid was available in the RB.

Candidates who were successful in this question were able to identify the velocity ratio of the system and then produce a system which could produce that output. Marks were given for labelling the number of teeth in a gear system, or the length of the levers. Candidates who gained a Level 4 response were able to clearly identify the different parts of the system and show how it would be able to amplify the input motion. Level 4 responses also showed how both the bolt and the solenoid would be attached to the system.

Assessment for learning

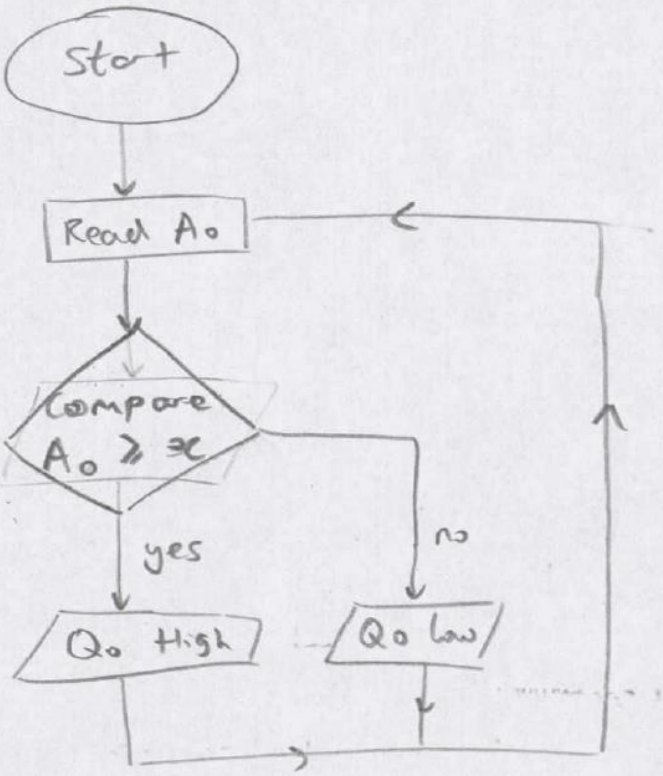
When teaching how to prepare for a problem-solving based question, it is worth reminding the candidates that systems must be attached to their input and output components. Giving them a wider understanding of how the system fits in will help them to develop their designs further.

Exemplar 2



LDR → Microcontroller → MOSFET

Explanation:
When light is at 10 lux or below, the input voltage to the microcontroller is less than 6V. This will allow the microcontroller to control a MOSFET which allows the solenoid to activate / deactivate accordingly. LDR is mounted on top of gate for most sun exposure.



Ao is the pin which reads input voltage

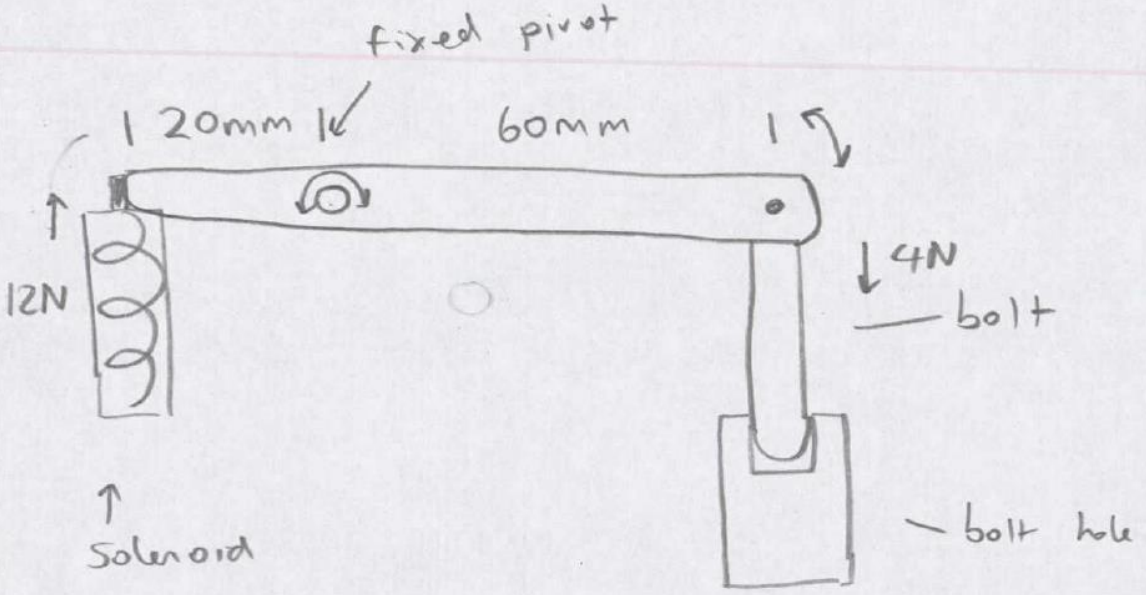
x is the value which voltage is at 6V, (Resistance = 20KΩ)

Qo is output pin which activates MOSFET

Issue 2:

Mechanical advantage required = $\frac{8}{24} = \frac{1}{3}$

∴ length to be amplified x 3



Solenoid pin pushes up which rotates arm about fixed point. Length ratio is 1:3 as shown. This causes the bolt to move 3x further than solenoid pin does. 8mm x 3 = 24mm which is the value needed for the bolt to lock the gate.

Exemplar 2 shows a Level 4 response, where the candidate has clearly understood the different elements of DFM and how these points would affect the design of a piece of play equipment. They have considered the scale of production and different elements of the RB well in their response.

Question 5*

5* Developers and local residents are keen for new children's outdoor public play areas to be built from sustainable materials.

Discuss the sustainability issues relating to materials choice when developing new children's outdoor public play areas.

In your answer you **must** consider:

- recycling considerations
- up-cycling possibilities
- material availability
- cost implications.

Refer to information on **page 8** of the Resource Booklet and also information from your own studies or experience. **[16]**

Candidates on the whole answered Question 5 well. They were able to produce an extended response which discussed the issues. It is clear that the topic of sustainable design is well taught and important to the students as the level of detail in most of the response showed a good understanding of the issues.

Where candidates achieved the lower levels, they did not cover the four bullet points outlined in the question.

The high levels were achieved by demonstrating a comprehensive understanding on the four issues outlined. They were also able to use the information in the RB along with examples from their studies to support their responses.

This was an extended response question and candidates would have been expected to produce a well-constructed report showing a critical examination of the points to be considered. Bullet points were not acceptable for this response. Care should be taken by the candidates to make sure they are not simply listing points and are demonstrating that they can articulate the points for consideration through clear analysis.

Exemplar 3

A product's sustainability is its impact on the environment and the waste it produces after use. Key considerations include recycling, up-cycling, availability of material and cost.

One consideration is the use of easily recycled materials, especially in larger parts. This includes the use of thermo forming rather than thermo setting plastics in slides, as well as metal alloys in crossbars. These materials can be melted down and reused relatively cheaply at the end of the play area's lifetime, although the use of thermo-forming polymers may affect the durability of the play area in hotter climates. Recycled materials could also be used during manufacturing to reduce materials footprint during production.

Another consideration is the upcycling of materials, both when building and demolishing the play area. Depleted resources such as car tyres can be used to create parts such as swings and climbing

crates, [illegible] and other upcycled objects could be repurposed as decorative parts. Similarly, when considering the waste produced by the play set at its end of life, standardized bolts could be used in the assembly to enable upcycling of such parts once the play set is disassembled. However, use of standard-sized parts may limit the design of the play area, compromising functionality.

Using recycled materials will impact the cost of the manufacturing of the play area. One such factor is that recycled materials are not as readily available, as their supply is dictated by the rate at which waste is produced. This could affect cost and lead times as certain recycled materials may be in short supply. Furthermore, recycled materials are often more expensive as the separation of materials from complete products consumes large amounts of energy and manpower. All this means the playset's cost of manufacturing outside of materials will have to be optimized, and testing of materials in development will be limited.

Exemplar 3 shows a Level 4 response to this question. It shows the level of detail and understanding that the candidate had in the different areas and also enables the candidate to demonstrate their knowledge and ability to apply this knowledge in these areas.

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