UMALUSI

COUNCIL FOR QUALITY ASSURANCE IN GENERAL AND FURTHER EDUCATION AND TRAINING

Exemplar Book of Effective Questioning
Engineering Graphics & Design

Compiled by the Statistical Information and Research (SIR) Unit

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PREFACE

The National Senior Certificate (NSC) examinations are set and moderated in part using tools which specify the types of cognitive demand and the content deemed appropriate for Engineering Graphics and Design at Grade 12 level. Until recently, the level of cognitive demand made by a question was considered to be the main determinant of the overall level of cognitive challenge of an examination question.

However, during various examination evaluation projects conducted by Umalusi from 2008-2012, evaluators found the need to develop more complex tools to distinguish between questions which were categorised at the same cognitive demand level, but which were not of comparable degrees of difficulty. For many subjects, for each type of cognitive demand a three-level degree of difficulty designation, *easy, moderate and difficult* was developed. Evaluators first decided on the type of cognitive process required to answer a particular examination question, and then decided on the degree of difficulty, *as an attribute of the type of cognitive demand*, of that examination question.

Whilst this practice offered wider options in terms of *easy, moderate* and *difficult* levels of difficulty for each type of cognitive demand overcame some limitations of a one-dimensional cognitive demand taxonomy, other constraints emerged. Bloom's Taxonomy of Educational Objectives (BTEO) (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) and the Revised Bloom's Taxonomy are based on the assumption that a cumulative hierarchy exists between the different categories of cognitive demand (Bloom et al., 1956; Bloom, Hastings & Madaus, 1971). The practice of 'levels of difficulty' did not necessarily correspond to a hierarchical model of increasing complexity of cognitive demand. A key problem with using the level of difficulty as an attribute of the type of cognitive demand of examination questions is that, questions recognised at a higher level of cognitive demand are not necessarily categorised as more difficult than other questions categorised at lower levels of cognitive demand. For example, during analyses a basic recognition or

recall question could be considered more difficult than an easy evaluation question.

Research further revealed that evaluators often struggled to agree on the classification of questions at so many different levels. The finer categorization for each level of cognitive demand and the process of trying to match questions to pre-set definitions of levels of difficulty made the process of making judgments about cognitive challenge overly procedural. The complex two-dimensional multi-level model also made findings about the cognitive challenge of an examination very difficult for Umalusi Assessment Standards Committee (ASC) to interpret.

In an Umalusi Report, *Developing a Framework for Assessing and Comparing the Cognitive Challenge of Home Language Examinations* (Umalusi, 2012), it was recommended that the type and level of cognitive demand of a question and the level of a question's difficulty should be analysed separately. Further, it was argued that the ability to assess cognitive challenge lay in experts' abilities to recognise subtle interactions and make complicated connections that involved the use of multiple criteria simultaneously. However, the tacit nature of such judgments can make it difficult to generate a common understanding of what constitutes criteria for evaluating the cognitive challenge of examination questions, despite descriptions given in the policy documents of each subject.

The report also suggested that the Umalusi external moderators and evaluators be provided with a framework for thinking about question difficulty which would help them identify where the main sources of difficulty or ease in questions might reside. Such a framework should provide a common language for evaluators and moderators to discuss and justify decisions about question difficulty. It should also be used for building the capacity of novice or less experienced moderators and evaluators to exercise the necessary expert judgments by making them more aware of key aspects to consider in making such judgments.

The revised Umalusi examination moderation and evaluation instruments for each subject draw on research and literature reviews, together with the knowledge gained through the subject workshops. At these workshops, the proposed revisions were discussed with different subject specialists to attain a common understanding of the concepts, tools and framework used; and to test whether the framework developed for thinking about question difficulty 'works' for different content subjects. Using the same framework to think about question difficulty across subjects will allow for greater comparability of standards across subjects and projects.

An important change that has been made to the revised examination evaluation instrument is that the analysis of *the type of cognitive demand* of a question and analysis of *the level of difficulty* of each question are now treated as two separate judgments involving two different processes. Accordingly, the revised examination evaluation instrument now includes assessment of difficulty *as well as* cognitive demand.

LIST OF ABBREVIATIONS

Abbreviation	Full name
ASC	Assessment Standards Committee
BTEO	Bloom's Taxonomy of Educational Objectives
CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
FET	Further Education and Training
IEB	Independent Examinations Board
NSC	National Senior Certificate
NQF	National Qualifications Framework
QAA	Quality Assurance of Assessment
QCC	Qualifications, Curriculum and Certification
SIR	Statistical Information and Research

LIST OF TABLES

ACKNOWLEDGEMENTS

This Engineering Graphics and Design exemplar book is informed by Umalusi Research Reports of previous years, especially the report by Reeves (Umalusi, 2012) titled '*Developing a framework for assessing and comparing the cognitive challenge of Home Language examinations*'.

In addition, Engineering Graphics and Design subject experts and practitioners are acknowledged for their contribution to the content of this exemplar book. Included in this group are: Umalusi External Moderators and Maintaining Standards Subject Teams and Team Leaders; together with the South African Comprehensive Assessment Institute and the Independent Examinations Board (IEB) Examiners and Internal Moderators.

We also acknowledge the contributions of the members of the Umalusi Quality Assurance of Assessment (QAA); Qualifications, Curriculum and Certification (QCC) and Statistical Information and Research (SIR) Units. We specifically acknowledge the contribution made by the individuals listed below:

- Ms Agnes Mohale, who was responsible for the management and coordination of the Exemplar Books Project.
- Dr Cheryl Reeves, who was responsible for developing the framework that underpinned the design of the exemplar books.
- Mr Thapelo Rangongo, Ms Sisanda Loni and Ms Shannon Doolings for their assistance and support in the administration of the project.
- The review team included the following members: Mr Modiba Phosa, Mr Trevor Haas.

This exemplar book was prepared by Mr Merventheran Moodley.

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1. INTRODUCTION

The rules of assessment are essentially the same for all types of learning because, to learn is to acquire knowledge or skills, while to assess is to identify the level of knowledge or skill that has been acquired (Fiddler, Marienau & Whitaker, 2006). Nevertheless, the field of assessment in South Africa and elsewhere in the world is fraught with contestation. A review of the research literature on assessment indicates difficulties, misunderstanding and confusion in how terms describing educational measurement concepts, and the relationships between them, are used (Frisbie, 2005).

Umalusi believes that if all role players involved in examination processes can achieve a common understanding of key terms, concepts and processes involved in setting, moderating and evaluating examination papers, much unhappiness can be avoided. This exemplar book presents a particular set of guidelines for both novice and experienced Engineering Graphics and Design national examiners, internal and external moderators, and evaluators to use in the setting, moderation and evaluation of examinations at the National Senior Certificate (NSC) level.

The remainder of the exemplar book is organised as follows: First, the context in which the exemplar book was developed is described (Part 2), followed by a statement of its purpose (Part 3). Brief summaries of the roles of moderation and evaluation (Part 4) and cognitive demand (Part 5) an assessment. Examination questions selected from the NSC Engineering Graphics and Design examinations of assessment bodies, the Department of Basic Education (DBE), and/or the Independent Examinations Board (IEB) are used to illustrate how to identify different levels of cognitive demand as required by the Curriculum and Assessment Policy Statement (CAPS) Engineering Graphics and Design document (Part 6). Part 7 explains the protocols for identifying different levels of difficulty within a question paper. Application of the Umalusi

framework for determining difficulty described in Part 7 is illustrated, with reasons, by another set of questions from a range of Engineering Graphics and Design examinations (Part 8). Concluding remarks complete the exemplar book (Part 9).

2. CONTEXT

Umalusi has the responsibility to quality assure qualifications, curricula and assessments of National Qualification Framework (NQF) Levels 1 - 5. This is a legal mandate assigned by the *General and Further Education and Training Act (Act 58 of 2001)* and the *National Qualification Framework Act (Act 67 of 2008)*. To operationalize its mandate, Umalusi, amongst other things, conducts research and uses the findings of this research to enhance the quality and standards of curricula and assessments.

Since 2003, Umalusi has conducted several research studies that have investigated examination standards. For example, Umalusi conducted research on the NSC examinations, commonly known as 'Matriculation' or Grade 12, in order to gain an understanding of the standards of the new examinations (first introduced in 2008) relative to those of the previous NATED 550 Senior Certificate examinations (Umalusi, 2009a, 2009b). Research undertaken by Umalusi has assisted the organisation to arrive at a more informed understanding of what is meant by assessing the cognitive challenge of the examinations and of the processes necessary for determining whether the degree of cognitive challenge of examinations is comparable within a subject, across subjects and between years.

Research undertaken by Umalusi has revealed that different groups of examiners, moderators and evaluators do not always interpret cognitive demand in the same way, posing difficulties when comparisons of cognitive

challenge were required. The research across all subjects also showed that using the type and level of cognitive demand of a question *only* as measure for judging the cognitive challenge of a question is problematic because cognitive demand levels on their own do not necessarily distinguish between degrees of difficulty of questions.

The new Umalusi framework for thinking about question difficulty described in this exemplar book is intended to support all key role players in making complex decisions about what makes a particular question challenging for Grade 12 examination candidates.

3. THE PURPOSE OF THE EXEMPLAR BOOK

The overall goal of this exemplar book is to ensure the consistency of standards of examinations across the years in the Further Education and Training (FET) sub-sector and Grade 12, in particular. The specific purpose is to build a shared understanding among teachers, examiners, moderators, evaluators, and other stakeholders, of methods used for determining the type and level of cognitive demand as well as the level of difficulty of examination questions.

Ultimately, the common understanding that this exemplar book seeks to foster is based on the premise that the process of determining the type and level of cognitive demand of questions and that of determining the level of difficulty of examination questions are two separate judgements involving two different processes, both necessary for evaluating the cognitive challenge of examinations. This distinction between cognitive demand and difficulty posed by questions needs to be made in the setting, moderation, evaluation and comparison of Engineering Graphics and Design examination papers.

The exemplar book includes an explanation of the new Umalusi framework which is intended to provide all role-players in the setting of Engineering

Graphics and Design examinations with a common language for thinking and talking about question difficulty. The reader of the exemplar book is taken through the process of evaluating examination questions; first in relation to determining the type and level of cognitive demand made by a question, and then in terms of assessing the level of difficulty of a question. This is done by providing examples of a range of questions which make different types of cognitive demands on candidates, and examples of questions at different levels of difficulty.

Each question is accompanied by an explanation of the reasoning behind why it was judged as being of a particular level of cognitive demand or difficulty, and the reasoning behind the judgements made is explained. The examples of examination questions provided were sourced by Engineering Graphics and Design evaluators from previous DBE and the IEB Engineering Graphics and Design question papers, pre- and post- the implementation of CAPS during various Umalusi workshops.

This exemplar book is an official document. The process of revising the Umalusi examination evaluation instrument and of developing a framework for thinking about question difficulty for both moderation and evaluation purposes has been a consultative one, with the DBE and the IEB assessment bodies. The new framework for thinking about question difficulty is to be used by Umalusi in the moderation and evaluation of Grade 12 Engineering Graphics and Design examinations, and by all the assessment bodies in the setting of the question papers, in conjunction with the CAPS documents.

4. MODERATION AND EVALUATION OF ASSESSMENT

A fundamental requirement, ethically and legally, is that assessments are fair, reliable and valid (American Educational Research Association [AERA],

American Psychological Association [APA] and National Council on Measurement in Education [NCME], 1999). Moderation is one of several quality assurance assessment processes aimed at ensuring that an assessment is fair, reliable and valid (Downing & Haladyna, 2006). Ideally, moderation should be done at all levels of an education system, including the school, district, provincial and national level in all subjects.

The task of Umalusi examination **moderators** is to ensure that the quality and standards of a particular examination are maintained each year. Part of this task is for moderators to alert examiners to details of questions, material and/or any technical aspects in examination question papers that are deemed to be inadequate or problematic and that therefore, challenge the validity of that examination. In order to do this, moderators need to pay attention to a number of issues as they moderate a question paper – these are briefly described below.

Moderation of the technical aspects of examination papers includes checking correct question and/or section numbering, and ensuring that visual texts and/or resource material included in the papers are clear and legible. The clarity of instructions given to candidates, the wording of questions, the appropriateness of the level of language used, and the correct use of terminology need to be interrogated. Moderators are expected to detect question predictability, for example, when the same questions regularly appear in different examinations, and bias in examination papers. The adequacy and accuracy of the marking memorandum (marking guidelines) need to be checked to ensure that they reflect and correspond with the requirements of each question asked in the examination paper being moderated.

In addition, the task of moderators is to check that papers adhere to the overall examination requirements as set out by the relevant assessment body with regard to the format and structure (including the length, type of texts or reading selections prescribed) of the examination. This includes assessing

compliance with assessment requirements with regard to ensuring that the content is examined at an appropriate level and in the relative proportions (weightings) of content and/or skills areas required by the assessment body.

The role of Umalusi examination **evaluators** is to perform analysis of examination papers after they have been set and moderated and approved by the Umalusi moderators. This type of analysis entails applying additional expert judgments to evaluate the quality and standard of finalised examination papers before they are written by candidates in a specific year. However, the overall aim of this evaluation is to judge the comparability of an examination against the previous years' examination papers to ensure that consistent standards are being maintained over the years.

The results of the evaluators' analyses, and moderators' experiences provide the Umalusi Assessment Standards Committee (ASC) with valuable information which is used in the process of statistical moderation of each year's examination results. Therefore, this information forms an important component of essential qualitative data informing the ASC's final decisions in the standardisation of the examinations.

In order for the standardisation process to work effectively, efficiently and fairly, it is important that examiners, moderators and evaluators have a shared understanding of how the standard of an examination paper is assessed, and of the frameworks and main instruments that are used in this process.

5. COGNITIVE DEMANDS IN ASSESSMENT

The *Standards for educational and psychological testing* (AERA, APA, & NCME, 1999) require evidence to support interpretations of test scores with respect to cognitive processes. Therefore, valid, fair and reliable examinations require that the levels of cognitive demand required by examination questions are

appropriate and varied (Downing & Haladyna, 2006). Examination papers should not be dominated by questions that require reproduction of basic information, or replication of basic procedures, and under-represent questions invoking higher level cognitive demands.

Accordingly, the Grade 12 CAPS NSC subject examination specifications state that examination papers should be set in such a way that they reflect proportions of marks for questions at various level of cognitive demand. NSC examination papers are expected to comply with the specified cognitive demand levels and weightings. NSC examiners have to set and NSC internal moderators have to moderate examination papers as reflecting the proportions of marks for questions at different levels of cognitive demand as specified in the documents. Umalusi's external moderators and evaluators are similarly tasked with confirming compliance of the examinations with the CAPS cognitive demand levels and weightings, and Umalusi's revised examination evaluation instruments continue to reflect this requirement.

Despite that, subject experts, examiners, moderators and evaluators are familiar with the levels and explanations of the types of cognitive demand shown in the CAPS documents, Umalusi researchers have noted that individuals do not always interpret and classify the categories of cognitive demand provided in the CAPS the same way. In order to facilitate a common interpretation and classification of the cognitive demands made by questions, the next section of this exemplar book provides a clarification of each cognitive demand level for Engineering Graphics and Design followed by illustrative examples of examination questions that have been classified at that level of cognitive demand.

6. EXPLANATIONS AND EXAMPLES OF QUESTIONS ASSESSED AT THE DIFFERENT COGNITIVE DEMAND LEVELS IN THE ENGINEERING GRAPHICS AND DESIGN TAXONOMY ACCORDING TO CAPS

The taxonomies of cognitive demand for each school subject in the CAPS documents are mostly based on the Revised Bloom's Taxonomy (Anderson and Krathwohl, 2001) but resemble the original Bloom's taxonomy in that categories of cognitive demand are arranged along a single continuum. Bloom's Taxonomy of Educational Objectives (BTEO) (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) and the Revised Bloom's Taxonomy imply that each more advanced or successive category of cognitive demand subsumes all categories below it. The CAPS Taxonomies of Cognitive Demand make a similar assumption (Crowe, 2012).

Note:
In classifying the type and level of cognitive demand, each question is classified at the highest level of cognitive process involved. Thus, although a particular question involves recall of knowledge, as well as comprehension and application, the question is classified as an 'analysis' question if that is the highest level of cognitive process involved. If evaluating' is the highest level of cognitive process involved, the question as a whole should be classified as an 'evaluation' question. On the other hand, if one of more sub-sections of the question and the marks allocated for each sub-section can stand independently, then the level of cognitive demand for each sub-section of the question should be analysed separately.

The CAPS documents for many subjects also give examples of descriptive verbs that can be associated with each of the levels of cognitive demand. However, it is important to note that such 'action verbs' can be associated with more than one cognitive level depending on the context of a question.

The Engineering Graphics and Design CAPS document states that Grade 12 NSC Engineering Graphics and Design examination papers should examine three levels of cognitive demand (Table 1).

TABLE 1 THE OF COGNITIVE DEMAND LEVELS FOR THE ENGINEERING GRAPHICS AND DESIGN NSC EXAMINATIONS

Levels	Cognitive type	Levels
Level 1:	**Lower order:** Understanding and remembering	**Level 1:**
Level 2:	**Middle order:** Analysing and applying	**Level 2:**
Level 3:	**Higher order:** Creating and evaluating	**Level 3:**

Source: CAPS (DBE, 2011a, p.34)

To facilitate reading of this section, each of the above cognitive demand levels in the Engineering graphics and design Taxonomy is explained, and the explanation is followed by at least **three** examples of questions from previous Engineering graphics and design NSC examinations classified at each of the levels of cognitive demand shown in Table 1 above. These examples were selected to represent the **best and clearest** examples of each level of cognitive demand that the Engineering graphics and design experts could find. The discussion below each example question explains the reasoning processes behind the classification of the question at that particular type of cognitive demand (Table 2 to Table 4).

Note:
Be mindful that analyses of *the level of cognitive process* of a question and *the level of difficulty* of each question are to be treated as two separate judgments involving two different processes. Therefore, whether the question is easy or difficult should not influence the categorisation of the question in terms of the type and level of cognitive demand. Questions should NOT be categorised as higher order evaluation/synthesis questions because they are difficult questions. Some questions involving the cognitive process of recall or recognition may be more difficult than other recall or recognition questions. Not all comprehension questions are easier than questions involving analysis or synthesis. Some comprehension questions may be very difficult, for example explanation of complex scientific processes. For these reasons, you need to categorise the level of difficulty of questions separately from identifying the type of cognitive process involved.

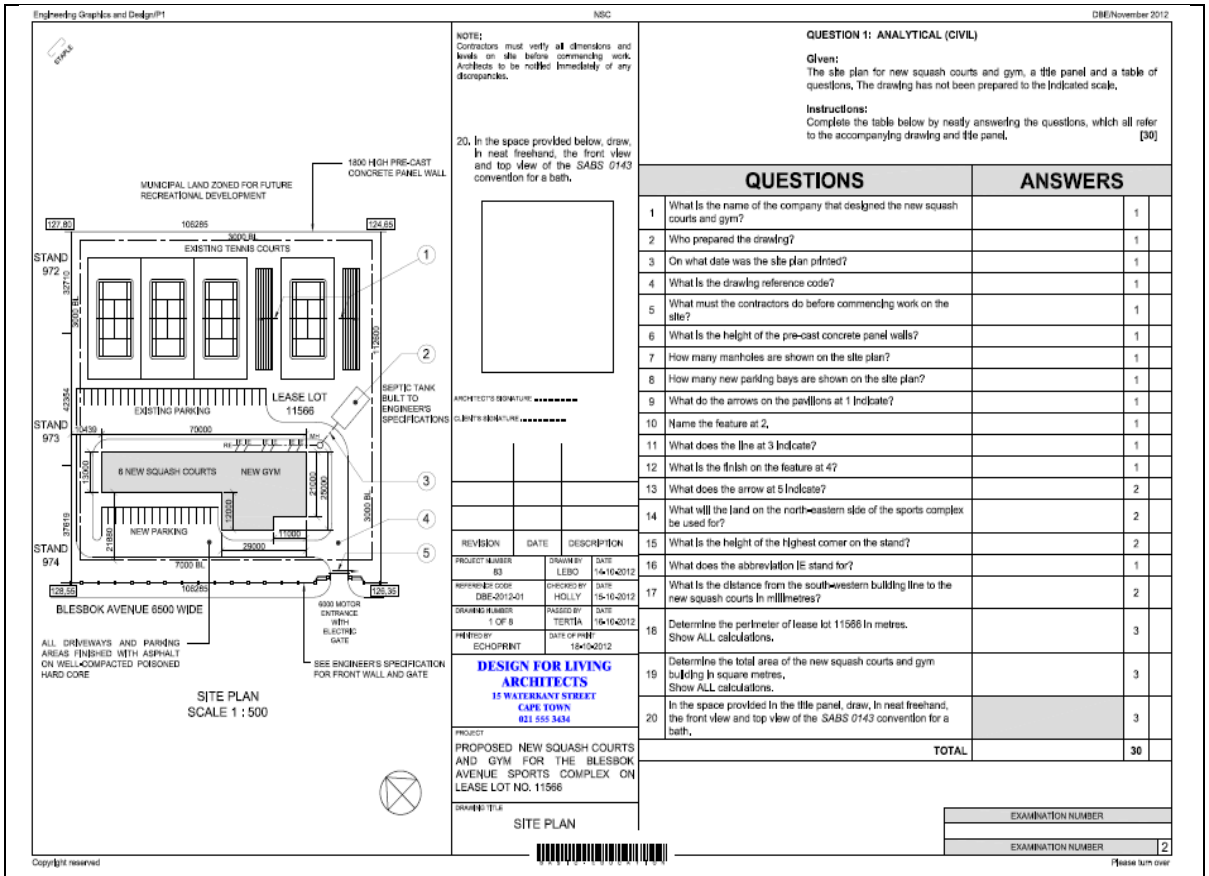
A noteworthy feature of the way this particular subject, Engineering Graphics and Design(EGD), is assessed is that, in answering many of the examination

questions, it requires the conversion of the written text and diagrams provided in the source material into some form of graphical representation. EGD uses graphical drawings as a primary means of communication in the technological world within the contexts of Mechanical, Civil and Electrical technologies. The application of the design process is integral to understanding the applications within these contexts.

Note: Due to the nature of EGD and the way it is assessed, there may be a number of different levels of cognitive demand residing within a single question.

TABLE 2: EXAMPLES OF QUESTIONS AT LEVEL 1: LOWER ORDER – UNDERSTANDING AND REMEMBERING

Remembering refers to the ability to retrieve information from long term memory. It includes the ability to **recall, recognise**, locate, identify, extract or retrieve **explicitly stated or readily observable** information, details, facts, formulas, terms, definitions, representations **from memory.** **Understanding** refers to the ability of learners to see the relationships between ideas, and the way in which concepts are organised or structured. The ideas and concepts may be contained in explanations, models or theories which they have learnt, or they may be in new material which is presented to them. They demonstrate understanding when they are able to: create a model or version, or re-organise information, data, ideas, facts or details that is explicitly stated or observable in material provided or which has been learnt in a different way or form from what was presented (e.g. summarise the main idea, restate the main ideas in their own words, paraphrase, categorise, draw, classify, explain or consolidate the information).
Example 1:
Question: Q1, November 2012, P1 Refer to the relevant sub-questions 11and13 11. What does the line at 3 indicate? 13. What does the arrow at 5 indicate?



Discussion:

In this question the site plan of new squash courts and gym is provided as source material. To answer the sub-questions candidates need to recall basic knowledge of the SANS 10143. They then simply have to recognise and extract the relevant information directly from the site plan provided, and copy down the answers in the space provided. They must also recall from memory the features required. The task of identifying and reading off information from source material such as those provided in this question would be very familiar to Grade 12 candidates who should have had a great deal of practice with similar tasks in the classroom environment. Although a drawing of the site plan is provided no analysis or interpretation is required for sub-questions 11and 13.

Memorandum/Marking guidelines

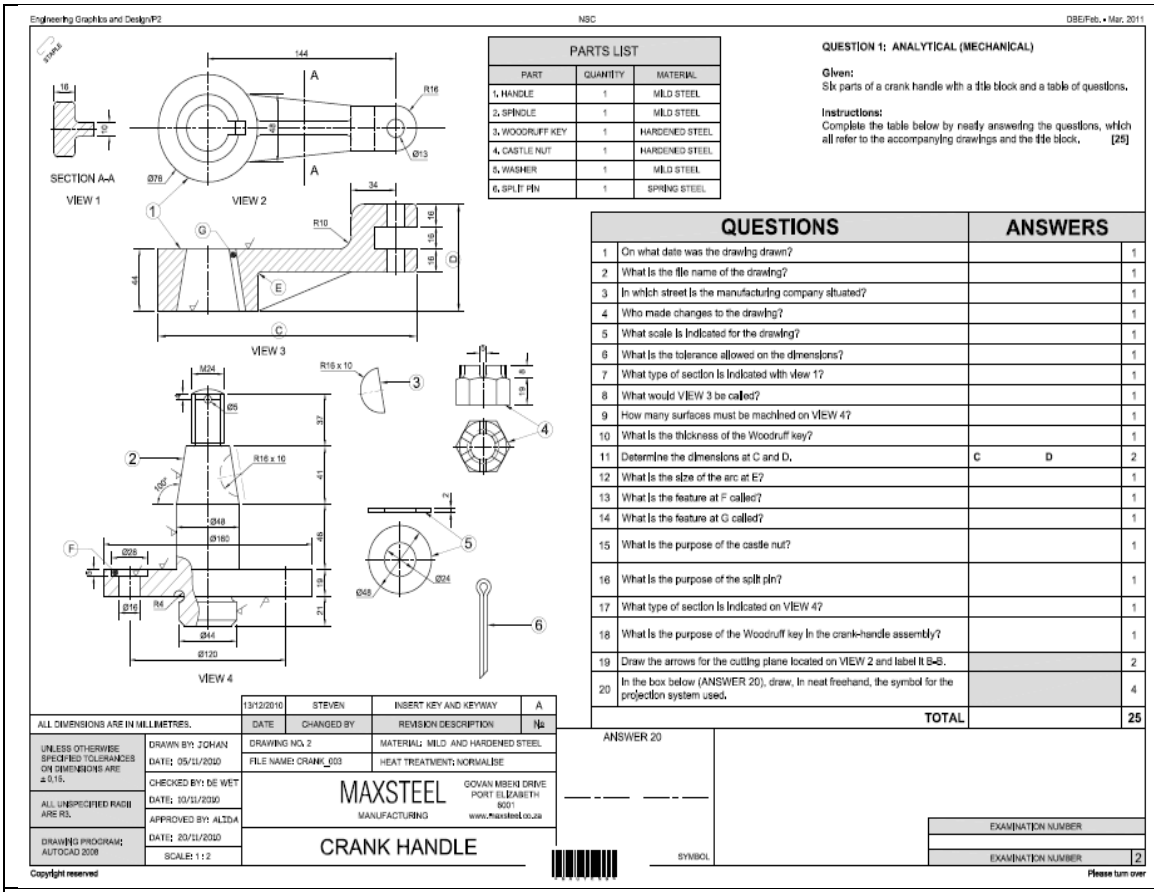
Answers:

11. Sewerage pipe/Line
13. Sliding gate/to the right

Example 2:

Question: Q1, February/March 2011, P2 (Sub-questions10)

10. What is the thickness of the woodruff key?



Engineering Graphics and Design/P2 NSC DBE/Feb. - Mar. 2011

PARTS LIST

PART	QUANTITY	MATERIAL
1. HANDLE	1	MILD STEEL
2. SPINDLE	1	MILD STEEL
3. WOODRUFF KEY	1	HARDENED STEEL
4. CASTLE NUT	1	HARDENED STEEL
5. WASHER	1	MILD STEEL
6. SPLIT PIN	1	SPRING STEEL

QUESTION 1: ANALYTICAL (MECHANICAL)

Given:
Six parts of a crank handle with a title block and a table of questions.

Instructions:
Complete the table below by neatly answering the questions, which all refer to the accompanying drawings and the title block. [25]

	QUESTIONS	ANSWERS	
1	On what date was the drawing drawn?		1
2	What is the file name of the drawing?		1
3	In which street is the manufacturing company situated?		1
4	Who made changes to the drawing?		1
5	What scale is indicated for the drawing?		1
6	What is the tolerance allowed on the dimensions?		1
7	What type of section is indicated with view 1?		1
8	What would VIEW 3 be called?		1
9	How many surfaces must be machined on VIEW 4?		1
10	What is the thickness of the Woodruff key?		1
11	Determine the dimensions at C and D.	C D	2
12	What is the size of the arc at E?		1
13	What is the feature at F called?		1
14	What is the feature at G called?		1
15	What is the purpose of the castle nut?		1
16	What is the purpose of the split pin?		1
17	What type of section is indicated on VIEW 4?		1
18	What is the purpose of the Woodruff key in the crank-handle assembly?		1
19	Draw the arrows for the cutting plane located on VIEW 2 and label it B-B.		2
20	In the box below (ANSWER 20), draw, in neat freehand, the symbol for the projection system used.		4
	TOTAL		25

ANSWER 20

SYMBOL

EXAMINATION NUMBER

EXAMINATION NUMBER 2

Please turn over

SECTION A-A
VIEW 1
VIEW 2
VIEW 3
VIEW 4

13/12/2010 STEVEN INSERT KEY AND KEYWAY A
DATE CHANGED BY REVISION DESCRIPTION №

ALL DIMENSIONS ARE IN MILLIMETRES.

UNLESS OTHERWISE SPECIFIED TOLERANCES ON DIMENSIONS ARE ± 0,10.
ALL UNSPECIFIED RADII ARE R3.
DRAWING PROGRAM: AUTOCAD 2008

DRAWN BY: JOHAN
DATE: 05/11/2010
CHECKED BY: DE WET
DATE: 10/11/2010
APPROVED BY: ALIDA
DATE: 20/11/2010
SCALE: 1 : 2

DRAWING NO. 2
FILE NAME: CRANK_003
MATERIAL: MILD AND HARDENED STEEL
HEAT TREATMENT: NORMALISE

MAXSTEEL
MANUFACTURING
GOVAN MBEKI DRIVE
PORT ELIZABETH
6001
www.maxsteel.co.za

CRANK HANDLE

Copyright reserved

Discussion:

To answer the question, candidates have to *recall* knowledge of the various views of the orthographic projection and the various components that make up the Crank Handle. They also need to have a clear *understanding* of orthographic projection, and in particular 3rd angle projection as outlined in the SANS 10111. They have to *recognise* the relevant information in the graphical representation provided. Once they have identified and selected the appropriate dimension from the drawings provided, they have to write this down in the space provided. All Grade 12 EGD candidates would have been exposed to similar types of 'understanding', 'remembering' and 'recognition' questions in the classroom.

Memorandum/Marking guidelines

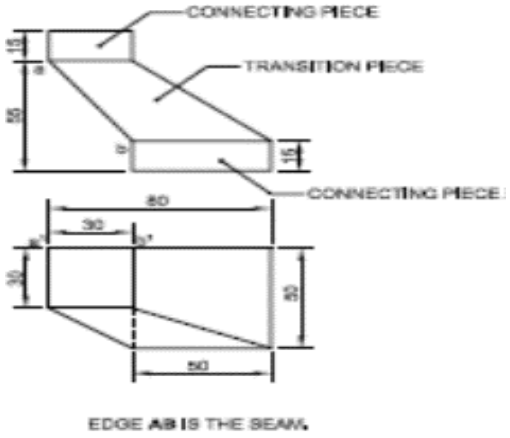
Answer: 10. 10mm

Example 3:

Question: Q2, November 2011, P1
Given

The front view and top view of a portion of a duct showing an offset square-to-square transition piece with two connecting pieces.

Instruction:
2.1 Draw, to scale 1: 1, the given front view and top view of the given portion of the duct.
2.2 Develop the surface of the transition piece ONLY. Make edge AB the seam. Show ALL construction and fold lines.



ASSESSMENT CRITERIA				
FRONT VIEW + TOP VIEW	10			
TRUE LENGTH + METHOD	10			
DEVELOPMENT	14			
TOTAL	34			

Discussion:
This question consists of two sub-sections of which Question 2.1 is a Level One question. This part of the question, requiring candidates to simply copy the given views, is an example of a 'remembering' and 'understanding' type of question. Copying the given front and top views of the duct as depicted in the source material in this aspect of the question involves *remembering* and *understanding* of concepts related to the development of transition pieces and 1st angle orthographic projection. To copy the given views, candidates need *understanding* of square ducting and scales, transition pieces, and connecting pieces. To answer this part of the question candidates have to use their knowledge to identify and select the appropriate information from the graphical representation. They also have to *recall* basic knowledge to produce this section of their answer.

Memorandum/Marking guidelines

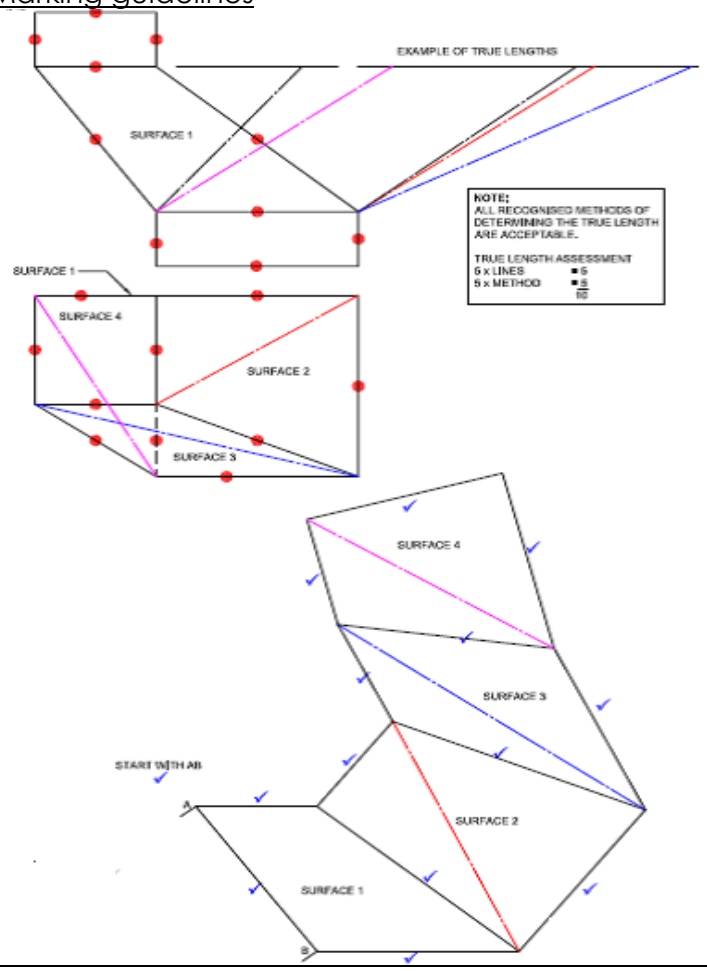


TABLE 3: EXAMPLES OF QUESTIONS AT LEVEL 2: ANALYSING AND APPLYING

Applying refers to the ability of learners to use their knowledge in a new situation or in a new way, or to transfer knowledge learned in one situation to another. They demonstrate this ability when they

- use, **perform** or follow **a procedure**/rule/method/ operation. These may be simple, or more complex, with several steps
- use understanding of geography concepts, facts, or processes as a basis for interpreting given details, relationships, patterns and results in unfamiliar contexts or material.

Analysing refers to the ability of learners to engage in **more abstract interpretation or reasoning,** or use conjecture, background knowledge and understanding, clues or **implicit** information, facts, details, ideas or concepts, in material provided, or from memory as a basis of forming hypotheses, predicting consequences, deducing reasons, suggesting a possible explanation, inferring causes, drawing conclusions, interpreting relationships, patterns, results, or ideas.

Example 1:

Question: Q2, November 2009, P2.

Given:

A mechanism consisting of a crank OP that is pin-joined to a slotted link AB slides over a fixed pin R That is located on the circumference of the wheel centre O.
FIGURE 1: A detailed drawing of a mechanism
FIGURE 2: A schematic drawing of the mechanism

Motion:

Crank OP rotates in an anti-clockwise direction while the wheel centre Q rotates at the same speed in a clockwise direction. The slotted link AB slides over the pin R during the rotation.

Instructions:

2.1 Draw to a scale 1:1 the given schematic drawing using point O as the reference point. Include all the labels.
2.2 Trace the locus generated by point A of the slotted link for one revolution.
2.3 Trace the locus generated by point B of the slotted link for one revolution.

Show all necessary construction. (33)

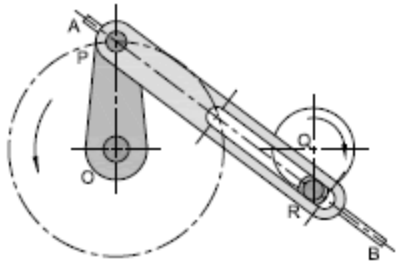


FIGURE 1

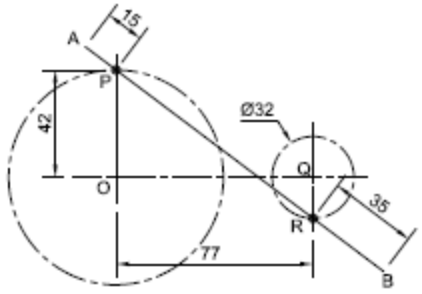


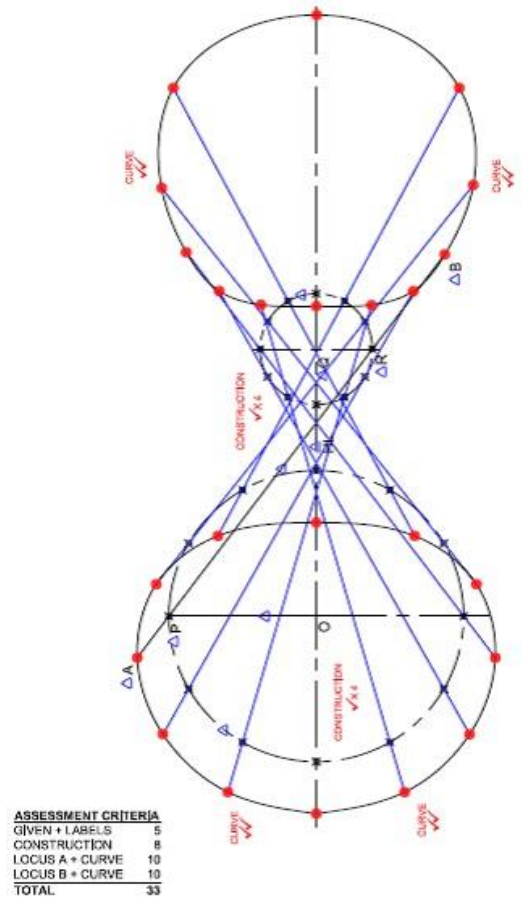
FIGURE 2

Discussion:

This question consists of a number of sub-sections, of which 2.2 and 2.3 are considered as middle order questions. The part of the question requiring candidates to draw the loci of a mechanism is an example of a 'analysing' and 'applying' type of question. To answer this question, candidates have to *understand* detailed drawings and schematic drawings as well as comprehend the concepts related to the loci of mechanisms. They also have to *recall* knowledge of the Loci of Mechanisms and **tracing the locus of a point** on a mechanism. They have to *analyse* the diagrams provided and *apply* the principles related to the functioning of mechanisms and their knowledge of the motion of mechanisms, to produce a locus of a point. They have to *apply* the theory, principles and methods to the new situation to trace the locus. In *applying* the theory, principles and methods,

candidates have to understand how to plot the points in relation to each other. The question also shows **the relationship of the components and the locus of the** points in relation to each other. The candidate has to apply a set of complex rules in order to obtain these points.

Memorandum/Marking guidelines



ASSESSMENT CRITERIA	
GIVEN + LABELS	5
CONSTRUCTION	8
LOCUS A + CURVE	10
LOCUS B + CURVE	10
TOTAL	33

Example 2:

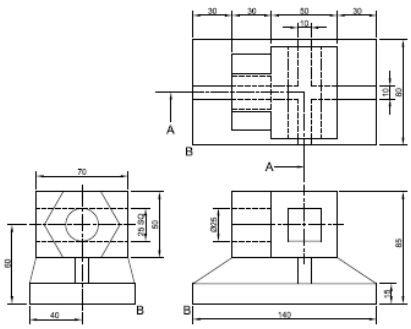
Question 3: Nov 2010, P2

Given:

- The front view, top view and left view of a channel drilling jig with cutting plane A-A
- The position of point B on the drawing sheet

Instructions:
Convert the orthographic views of the channel drilling jig into a scale 1:1 sectional isometric drawing on cutting plane A-A.

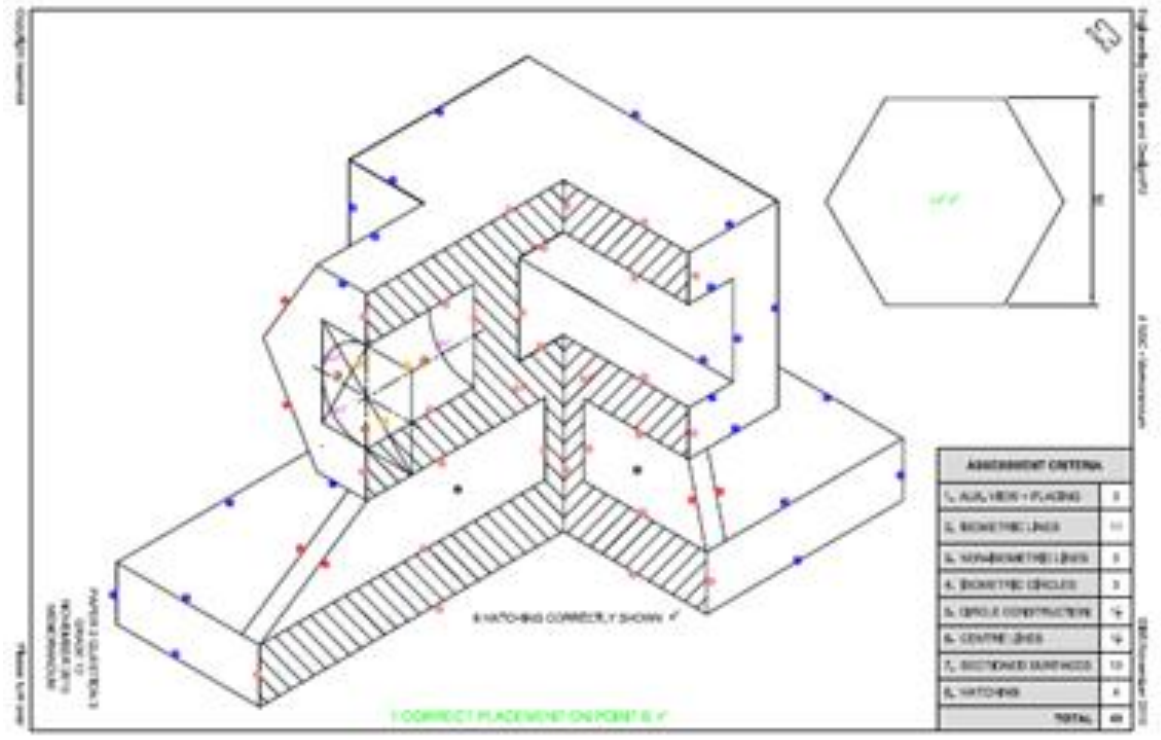
- Make corner B the lowest point of the drawing.
- Show ALL necessary circle and other construction.
- NO hidden detail is required. (40)



Discussion:

The question on the Drilling Jig calls for the conversion of the orthographic views (3rd angle) into a Sectioned Isometric view. Answering this question requires *recalling* knowledge of constructions and code from the SANS 10111 code of practice for Engineering drawing. Candidates then have to *apply* their background knowledge to *analyse* and interpret the information provided, and formulate their response graphically. *Applying* knowledge of cutting planes and position of the final view is essential if candidates are to provide the required answer. Answering this question also requires detailed *analysis* of the 3rd angle views in orthographic projection and the ability to visualise the required sectional view. Candidates are required to *apply* spatial perception, appropriate methods of abstraction and construction (middle order) to arrive at the expected answer.

Memorandum/Marking guidelines



Example 3:

Question 3: March 2011, P2

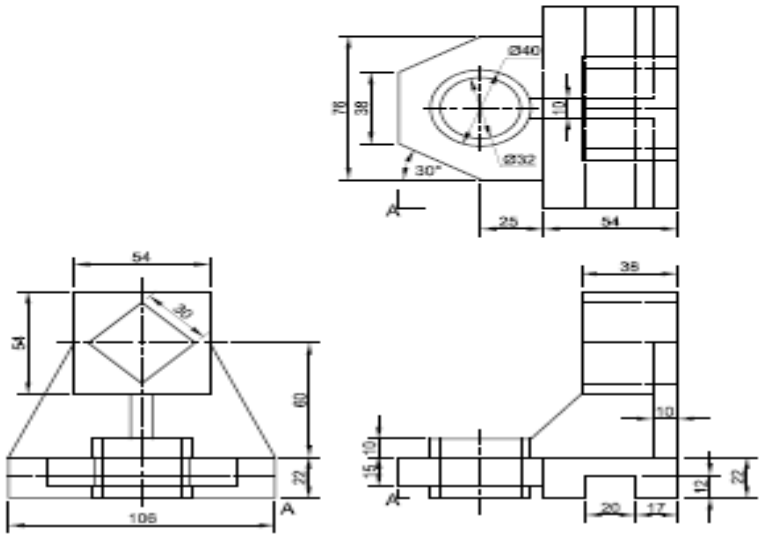
ISOMETRIC DRAWING

Given:

- The front view, top view and left view of a movable coupling
- The position of point A on the drawing sheet

Instructions:

- Convert the orthographic views of the movable coupling into a scale 1:1 Isometric drawing.
- Make corner A the lowest point of the drawing
- Show ALL necessary circle and other construction.
- NO hidden detail is required. (39)



Discussion:

Answering this question involves the conversion of 3rd angle orthographic views to an Isometric drawing. To complete this task, candidates have to *apply* knowledge of scales and methods of construction for the hexagonal and circle construction. Converting the given views from the 3rd angle orthographic views to an Isometric drawing involves the *analysis* and *application* of drawing principles. Such *analysis* and *application* requires candidates to have a sound *understanding* of auxiliary views and placement of such views. They also have to *understand* and *apply* construction techniques and skills, as they are not allowed to use stencils to obtain the arcs, circular features and the hexagonal details. They have to *apply* an appropriate abstraction (theory, principle, idea and method) to a new situation based on what is provided in the question. Answering the question requires *applying* spatial perception to know what the desired outcome of the isometric view will look like.

Memorandum/Marking guidelines

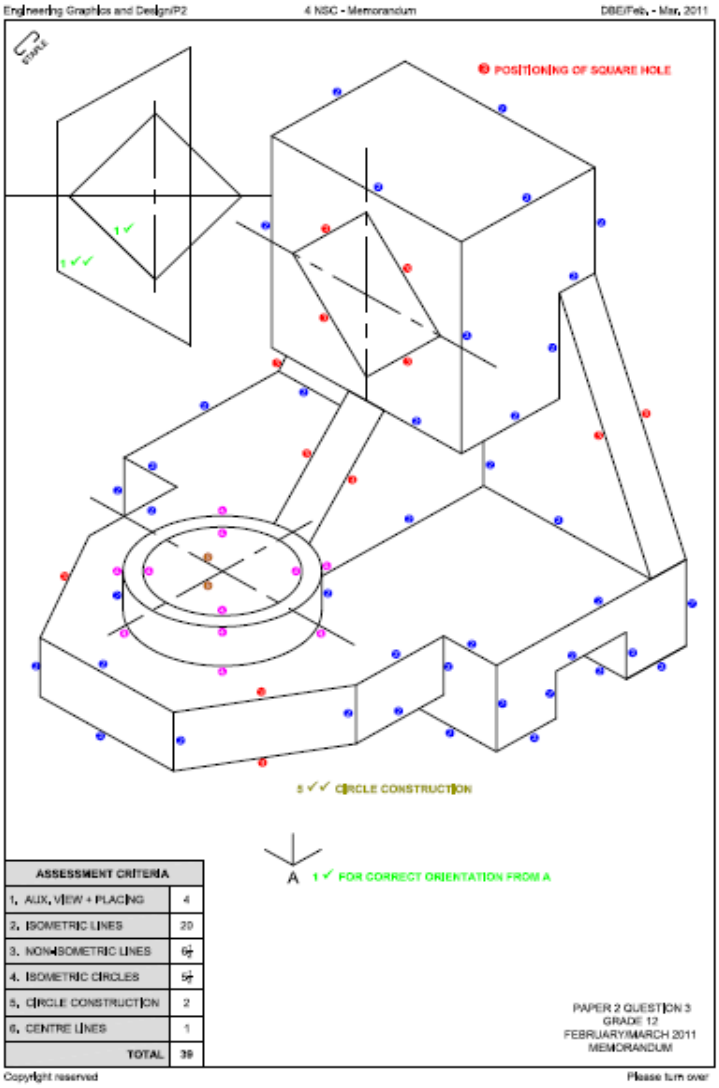


TABLE 4: EXAMPLES OF QUESTIONS AT LEVEL 3: HIGHER ORDER – CREATING AND EVALUATING

Evaluating refers to the ability of learners to make a critical **judgement,** for example, on qualities of accuracy, consistency, acceptability, desirability, worth, plausibility, or probability of a **given** argument, or proposed solution, outcome or strategy, using background knowledge of the subject and/or evidence/ information provided by sources to motivate the judgement.

Creating refers to the ability of learners to:

- adapt a variety of appropriate strategies to **solve** novel/ non-routine/complex/ open-ended **problems**.
- **integrate** EGD concepts, principles, ideas and information, make connections and relate **parts** of material, ideas, information or operations to one another and **to an overall structure** or purpose.

- engage in **original thought, generate and support own ideas/arguments** and put elements together to form a coherent whole.

Example 1:

Question: Q4, Nov 2008, P2.

ASSEMBLY DRAWING

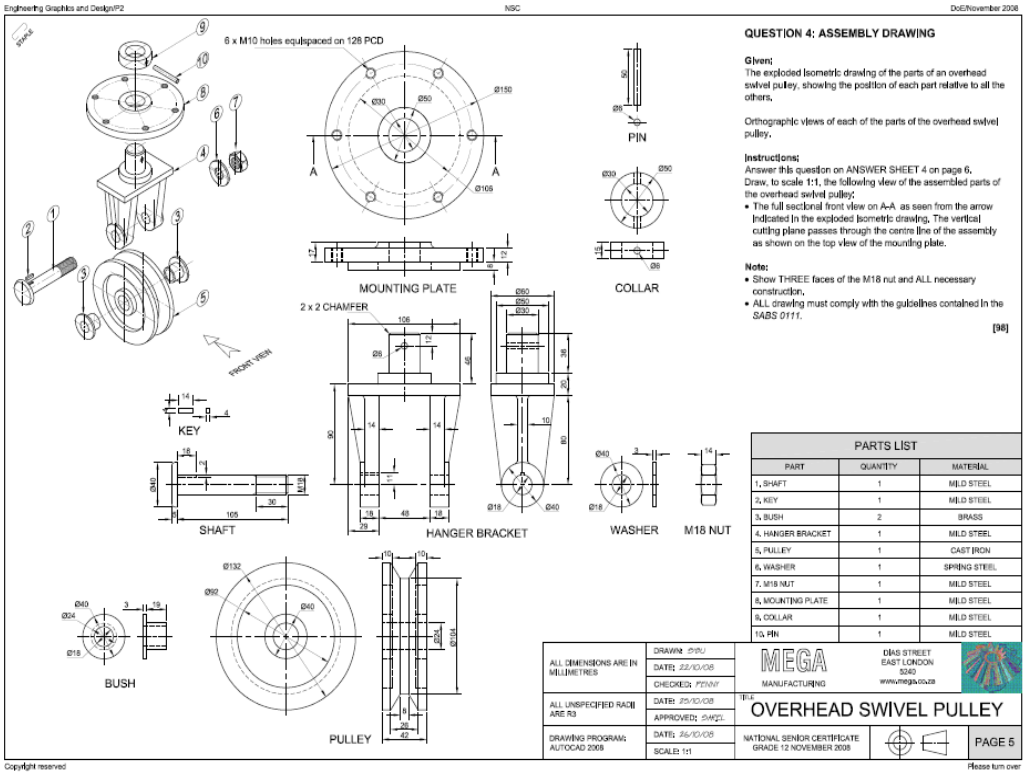
Given:
The exploded isometric drawing of the parts of an Overhead Swivel Pulley, showing the position of each part relative to all the others.
Orthographic views of each of the parts of the overhead swivel pulley.

Instructions:
Answer this question on ANSWER SHEET 4 on page 5.
Draw to a scale of 1:1, the following view of the assembled parts of the overhead swivel pulley

- The full sectional front view on A-A as seen from the arrow indicated on the exploded isometric drawing. The vertical cutting plane passes through the centre line of the assembly as shown on the top view of the mounting plate.

Note:

- Show three faces of the M18 nut and all the necessary construction.
- All drawings must comply with the guidelines contained in the SABS 0111. (98)

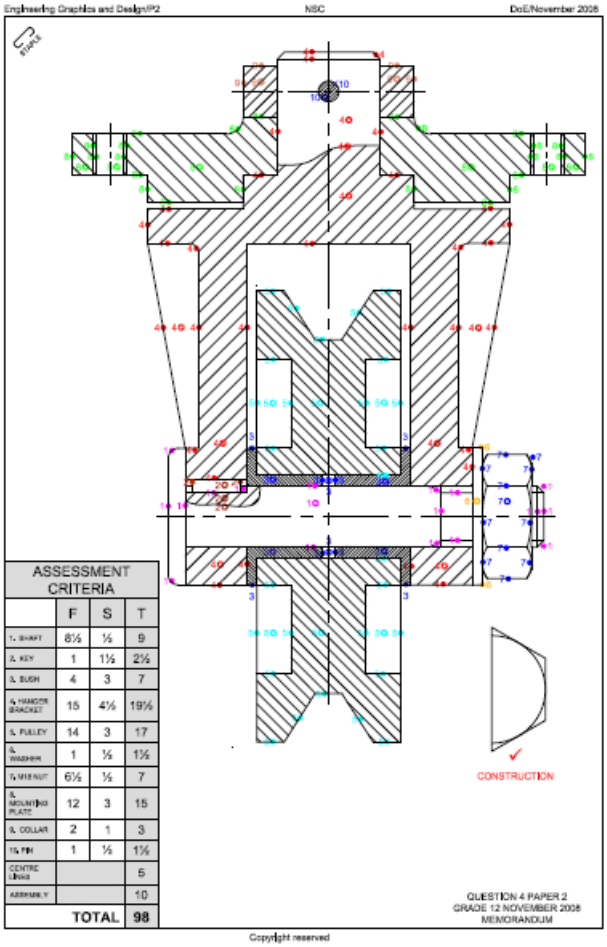


Discussion:

The question requires candidates to carry out a mechanical assembly of various components to *create* a sectional view. However, the whole of this task is not of a higher order. Although the question as a whole counts for 98 marks, only 15 marks are allocated for responses at Level 3 of the taxonomy. The rest of the question comprises components which are at Level 1 and Level 2 of the EGD taxonomy of

cognitive demand. Only aspects of the assembly of the Overhead Swivel Assembly, such as the positioning of the cutting plane, showing the required faces of the nut and the actual assembling of the components is at Level 3 of the EGD taxonomy. If candidates are unable to assemble the drawing after having been given the three-dimensional exploded view of the assembly, then they are not engaging in higher level cognitive processes. To answer this aspect of the question candidates have to *evaluate* the information contained in the written text, parts list, exploded view and 3rd angle orthographic views. They have to *integrate* and *synthesise* the written and graphical information provided to formulate a graphical representation. The design process involves integrating information and relating parts of material and information to one another and to an overall structure or purpose in a way that is relational and coherent. Candidates have to integrate parts and components to form a complete sectional drawing (Front view) of the assembled components. They are obliged to follow a set of given rules as set out in the SANS 10111 code for engineering drawing. They have to 'assemble' all the information provided into the required 'whole'. This *creative* process requires high levels of abstract visualization about the positioning of the cutting plane, showing the required faces of the nut and the actual assembling of the components. The production of the sectional view when assembled, hatched correctly and the application of knowledge needed to draw the nut in the correct rotated position. These aspects are deemed to be of a higher order.

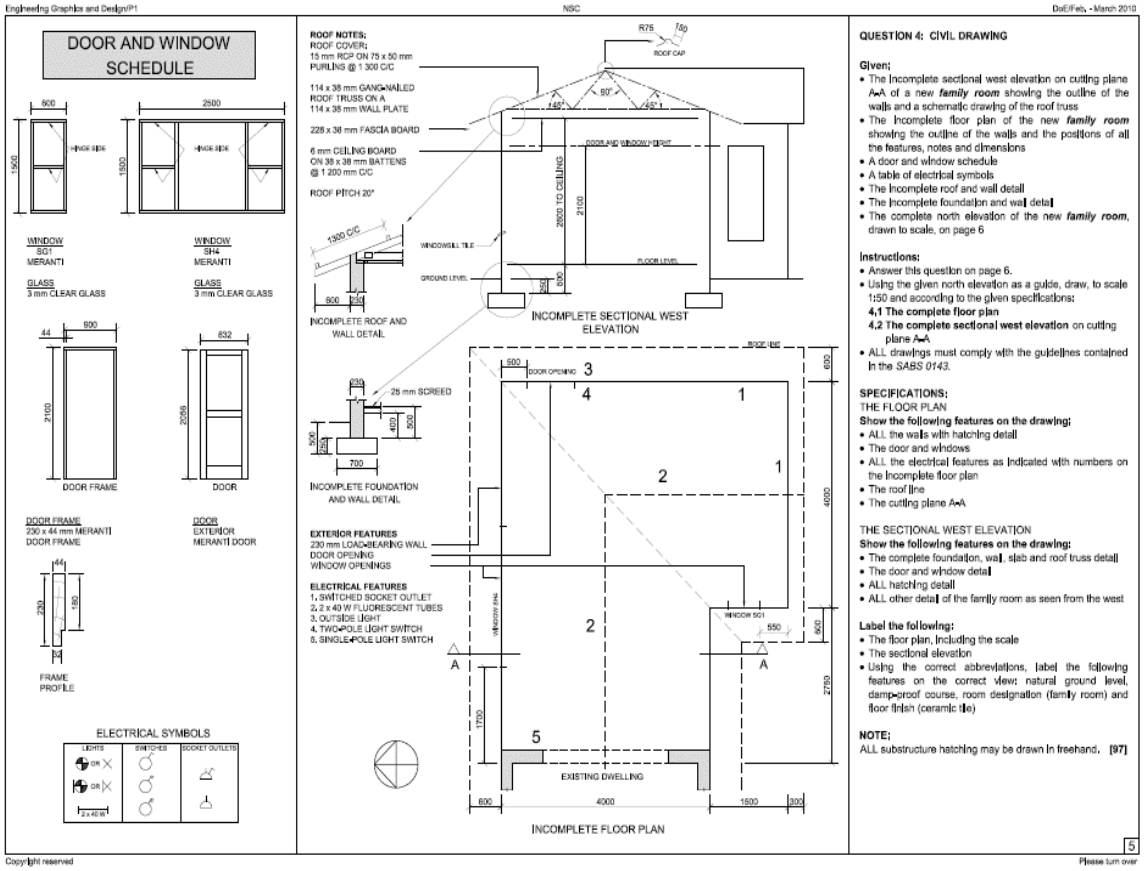
Memorandum/Marking guidelines



ASSESSMENT CRITERIA			
	F	S	T
1. SHAFT	8½	½	9
2. KEY	1	1½	2½
3. BUSH	4	3	7
4. HANGER BRACKET	15	4½	19½
5. PULLEY	14	3	17
6. WASHER	1	½	1½
7. M16 NUT	6½	½	7
8. MOUNTING PLATE	12	3	15
9. COLLAR	2	1	3
10. PIN	1	½	1½
CENTRE LINING			5
ASSEMBLY			10
TOTAL			98

Example 2:

Question 4, February-March 2010, P1

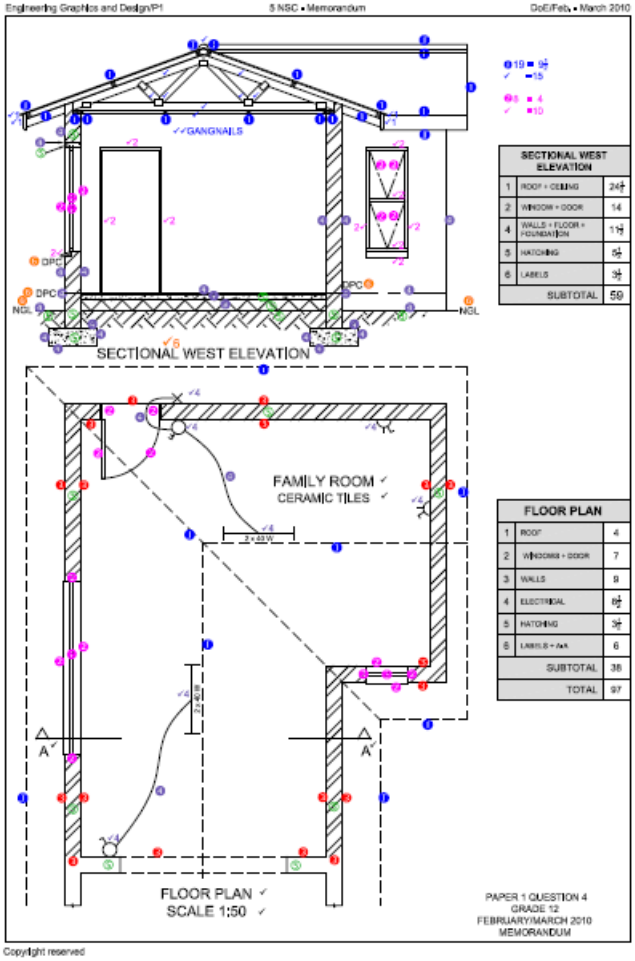


Discussion:

The Sectioned View i.e. Determining the Sectional West Elevation counts for more marks than the floor plan because the construction of the roof and the adjacent gable end roof is of a higher order. Obtaining the roof detail and heights is categorized as level 3 as this requires the candidate to **integrate** EGD concepts, principles, ideas and information, make connections and relate **parts** of material, ideas, information or operations to one another and **to an overall structure** or purpose.

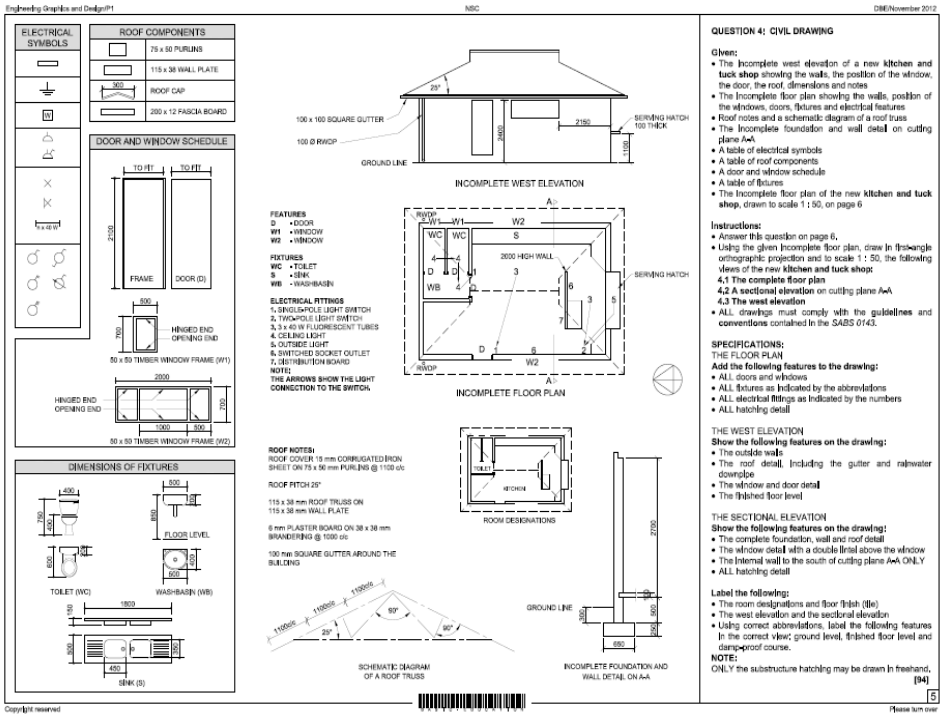
They engage in **original thought and generate** a coherent whole by putting together all the elements. Candidates have to convert the 1st angle orthographic views into a sectional view. This requires the candidate to integrate ideas and information and relate this information to one another in a way that is relational and coherent in the design process.

Memorandum/Marking guidelines



Example 3:

Question: November 2012, P1 Revisit MP Moodley

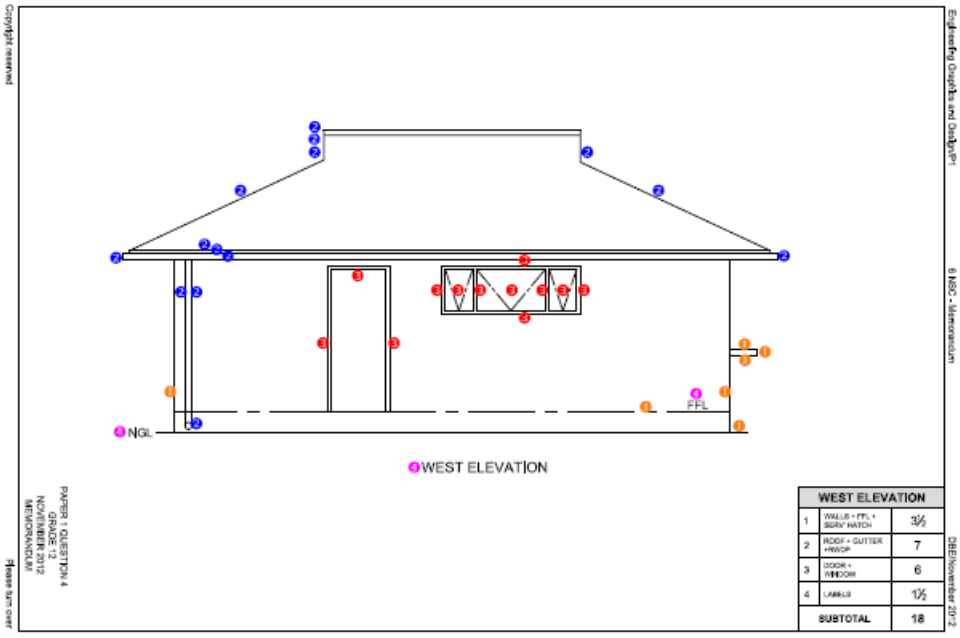


Discussion:

The question asks that the candidate assemble the various components to create a sectional view. The question requires that the candidate integrate ideas and information and relate parts and information to one another in a way that is relational and coherent.

Candidates engage in original creative thought and design and put elements together to form a coherent whole.

Memorandum/Marking guidelines



To accomplish the goal of discriminating between high achievers, those performing very poorly, and all candidates in between, examiners need to vary the challenge of examination questions. Until recently, the assumption has been that 'alignment' with the allocated percentage of marks for questions at the required cognitive demand levels meant that sufficient examination questions were relatively easy; moderately challenging; and difficult for candidates to answer.

However, research and candidate performance both indicate that a range of factors other than type of cognitive demand contributes to the cognitive challenge of question. Such factors include the level of content knowledge required, the language used in the question, and the complexity or number of concepts tested. In other words, cognitive demand levels on their own do not necessarily distinguish between degrees of difficulty of questions.

This research helps, to some extent, explain why, despite that some NSC examination papers have complied with the specified cognitive demand weightings stipulated in the policy, they have not adequately distinguished between candidates with a range of academic abilities in particular between higher ability candidates. As a result, examiners, moderators and evaluators are now required to assess the difficulty of level of each examination question in addition to judging its cognitive demand.

Section 7 below explains the new protocol introduced by Umalusi for analysing examination question difficulty.

7. ANALYSING THE LEVEL OF DIFFICULTY OF EXAMINATION QUESTIONS

When analysing the level of difficulty of each examination question, there are six important protocols to note. These are:

1. Question difficulty is **assessed independently** of the type and level **of cognitive demand**.
2. Question difficulty is assessed against **four levels of difficulty**.
3. Question difficulty is determined against the assumed capabilities of the **ideal** '**envisaged**' Grade 12 Engineering Graphics and Design NSC examination **candidate**.
4. Question difficulty is determined using **a common framework** for thinking about question difficulty.
5. Question difficulty entails **distinguishing unintended sources of difficulty** or ease **from intended sources of difficulty** or ease.
6. Question difficulty entails identifying **differences** in levels of difficulty **within a single question**.

Each of the above protocols is individually explained and discussed below.

7.1 Question difficulty is assessed independently of the type and level of cognitive demand

As emphasised earlier in this exemplar book, the revised Umalusi NSC examination evaluation instruments separate the analysis of the type of cognitive demand of a question from the analysis of the level of difficulty of each examination question. Cognitive demand describes the *type of cognitive process* that is required to answer a question, and this does not necessarily equate or align with the *level of difficulty* of other aspects of a question, such as the difficulty of the content knowledge that is being assessed. For example, a recall question can ask a candidate to recall very complex and abstract scientific content. The question would be categorised as Level 1 in terms of the cognitive demand taxonomy but may be rated as 'difficult' (Level 3 Table 9 below).

Note:
Cognitive demand is just one of the features of a question that can influence your comparative judgments of question difficulty. The type and level of cognitive process involved in answering a question does not necessarily determine how difficult the question would be for candidates. Not all evaluation/synthesis /analysis questions are more difficult than questions involving lower-order processes such as comprehension or application.

7.2 Question difficulty is assessed at four levels of difficulty

The revised Umalusi NSC examination evaluation instruments require evaluators to exercise expert judgments about whether each examination question is 'Easy', 'Moderately challenging', 'Difficult' or 'Very difficult' for the envisaged Grade 12 learner to answer. Descriptions of these categories of difficulty are shown in Table 6.

TABLE 5 LEVELS OF DIFFICULTY OF EXAMINATION QUESTIONS

1	2	3	4
Easy for the envisaged Grade 12 student to answer.	**Moderately challenging** for the envisaged Grade 12 student to answer.	**Difficult** for the envisaged Grade 12 student to answer.	**Very difficult** for the envisaged Grade 12 student to answer. The skills and knowledge required to answer the question allow for the top students (*extremely* high-achieving/ability students) to be discriminated from other high achieving/ability students).

Note:
The forth level, 'very difficult' has been included in the levels of difficulty of examination questions to ensure that there are sufficient questions that discriminate well amongst higher ability candidates.

7.3 Question difficulty is determined against the assumed capabilities of the ideal 'envisaged' Grade 12 Engineering Graphics and Design studies NSC examination candidate

The revised Umalusi NSC examination evaluation instruments require evaluators to exercise expert judgments about whether each examination question is 'Easy', 'Moderately challenging', 'Difficult' or 'Very difficult' for the '**envisaged**' Grade 12 learner to answer (Table 8). In other words, assessment of question

difficulty is linked to a particular target student within the population of NSC candidates, that is, the Grade 12 candidate of average intelligence or ability.

The Grade 12 learners that you may have taught over the course of your career cannot be used as a benchmark of the 'envisaged' candidate as we cannot know whether their abilities fall too high, or too low on the entire spectrum of all Grade 12 Engineering Graphics and Design studies candidates in South Africa. The revised Umalusi NSC examination evaluation instruments thus emphasise that, when rating the level of difficulty of a particular question, your conception of the 'envisaged' candidate needs to be representative of the entire population of candidates for all schools in the country, in other words, of the overall Grade 12 population.

Most importantly, the conception of this 'envisaged' candidate is a learner who has been taught the whole curriculum adequately by a teacher who is qualified to teach the subject, in a functioning school. There are many disparities in the South African education system that can lead to very large differences in the implementation of the curriculum. Thus this 'envisaged' learner is not a typical South African Grade 12 learner – it is an intellectual construct (an imagined person) whom you need to imagine when judging the level of difficulty of a question. This ideal 'envisaged' Grade 12 learner is an aspirational ideal of where we would like all Engineering Graphics and Design studies learners in South Africa to be.

Note:
The concept of the ***ideal envisaged Grade 12 candidate is*** that of an imaginary learner who has the following features:

a. Is of average intelligence or ability
b. Has been taught by a competent teacher
c. Has been exposed to the entire examinable curriculum

This envisaged learner represents an imaginary person who occupies the middle ground of ability and approaches questions *having had all the necessary schooling.*

7.4 Question difficulty is determined using a common framework for thinking about question difficulty

Examiners, moderators and evaluators **in all subjects** are now provided with a common framework for thinking about question difficulty to use when identifying sources of difficulty or ease in each question, and to provide their reasons for the level of difficulty they select for each examination question.

The framework described in detail below provides the main sources of difficulty or 'ease' inherent in questions. The four sources of difficulty, which must be considered when thinking about the level of difficulty of examination questions in this framework, are as follows:

1. '**Content difficulty'** refers to the difficulty inherent in the subject matter and/or concept/s assessed.
2. '**Stimulus difficulty'** refers to the difficulty that candidates confront when they attempt to read and understand the question and its source material. The demands of the reading required to answer a question thus form an important element of 'stimulus difficulty'.
3. '**Task difficulty'** refers to the difficulty that candidates confront when they try to formulate or produce an answer. The level of cognitive demand of a question forms an element of 'Task difficulty', as does the demand of the written text or representations that learners are required to produce for their response.
4. **'Expected response difficulty'** refers to difficulty imposed by examiners in a marking guideline, scoring rubric or memorandum. For example, mark allocations affect the amount and level of answers students are expected to write.

This framework derived from Leong (2006) was chosen because it allows the person making judgments about question difficulty to grapple with nuances and with making connections. The underlying assumption is that judgment of question difficulty is influenced by the interaction and overlap of different aspects of the four main sources of difficulty. Whilst one of the above four sources of difficulty may be more pronounced in a specific question, the other three sources may also be evident. Furthermore, not all four sources of difficulty need to be present for a question to be rated as difficult.

The four-category conceptual framework is part of the required Umalusi examination evaluation instruments. Each category or source of difficulty in this framework is described and explained in detail below (Table 6). Please read the entire table very carefully.

TABLE 6: FRAMEWORK FOR THINKING ABOUT QUESTION DIFFICULTY

CONTENT/CONCEPT DIFFICULTY
Content/concept difficulty indexes the difficulty in the **subject matter, topic or conceptual knowledge** assessed or required. In this judgment of the item/question, difficulty exists in the **academic and conceptual demands** that questions make and/or the **grade level** boundaries of the various 'elements' of domain/subject knowledge (topics, facts, concepts, principles and procedures associated with the subject).
For example:
Questions that assess '**advanced content'**, that is, subject knowledge that is considered to be in advance of the grade level curriculum, are *likely* to be difficult or very difficult for most candidates. Questions that assess subject knowledge which forms part of the core curriculum for the grade are *likely* to be moderately difficult for most candidates. Questions that assess **'basic content'** or subject knowledge candidates would have learnt at lower grade levels, and which would be familiar to them are *unlikely* to pose too much of a challenge to most candidates. Questions that require general everyday knowledge or knowledge of 'real life' experiences are *often* easier than those that test more **specialized** school **knowledge**. Questions involving only concrete objects, phenomena, or processes are *usually* easier than those that involve more **abstract constructs, ideas, processes or modes.** Questions which test learners' understanding of theoretical or **de-contextualised issues or topics**, rather than their knowledge of specific examples or contextualised topics or issues *tend* to be more difficult. Questions involving familiar, contemporary/current contexts or events are *usually* easier than those that are more **abstract or** involve **'imagined' events** (e.g. past/future events) or **contexts** that are **distant from learners' experiences.** Content difficulty may also be varied by changing **the number of knowledge elements or operations assessed**. *Generally,* the difficulty of a question increases with the number of knowledge elements or operations assessed. Questions that assess learners on two or more knowledge elements or operations are *usually* (but not always) more difficult than those that assess a single knowledge element or operation. Assessing learners on **a combination of knowledge elements or operations that are seldom combined** *usually* increases the level of difficulty.

EXAMPLES OF INVALID OR UNINTENDED SOURCE OF CONTENT DIFFICULTY

- Testing obscure or unimportant concepts or facts that are not mentioned in the curriculum, or which are unimportant to the curriculum learning objectives.
- Testing very advanced concepts or operations that candidates are extremely unlikely to have had opportunities to learn.

STIMULUS DIFFICULTY

Stimulus difficulty refers to the difficulty of the linguistic **features of the question** (**linguistic** complexity) and the challenge that candidates face when they attempt to read, interpret and understand the words and phrases in the question AND when they attempt to read and understand the **information or 'text' or source material (diagrams, tables and graphs, pictures, cartoons, passages, etc.) that accompanies the question.**

For example:

Questions that contain words and phrases that require only simple and straightforward comprehension are *usually* easier than those that require the candidate to understand **subject specific phraseology and terminology** (e.g. idiomatic or grammatical language not usually encountered in everyday language), or that require more technical comprehension and specialised command of words and language (e.g. everyday words involving different meanings within the context of the subject).

Questions that contain information that is 'tailored' to an expected response, that is, questions that contain no irrelevant or distracting information, are *generally* easier than those that require candidates to select relevant and appropriate information or **unpack a large amount of information** for their response. A question **set in a very rich context** *can* increase question difficulty. For example, learners *may* find it difficult to select the correct operation when, for example, a mathematics or accountancy question is set in a context-rich context.

Although the level of difficulty in examinations is *usually* revealed most clearly through the questions, text complexity or the degree of **challenge or complexity in written or graphic texts** (such as a graph, table, picture, cartoon, etc.) that learners are required to read and interpret in order to respond *can* increase the level of difficulty. Questions that depend on reading and selecting content from a text *can* be more challenging than questions that do not **depend on actually reading the accompanying text** because they test reading comprehension skills as well as subject knowledge. Questions that require candidates to **read a lot** *can* be more challenging than those that require limited reading. Questions that tell learners where in the text to look for relevant information are *usually* easier than those where **learners are not told where to look**.

The level of difficulty *may* increase if texts set, and reading passages or other **source material** used are challenging for the grade level, and make **high reading demands** on learners at the grade level. Predictors of textual difficulty include

- **semantic content** – for example, if vocabulary and words used are typically outside the reading vocabulary of Grade 12 learners, 'texts' (passage,

cartoon, diagram, table, etc.) are *usually* more difficult. 'Texts' are *generally* easier if words or images are made accessible by using semantic/context, syntactic/structural or graphophonic/visual cues.

- **syntactic or organisational structure** – for example, sentence structure and length. For example, if learners are likely to be *familiar with the structure* of the 'text' or resource, for example, from reading newspapers or magazines, etc. 'texts' are *usually* easier than when the structure is unfamiliar.
- **literary techniques** – for example, abstractness of ideas and imagery – and **background knowledge required**, for example, to make sense of allusions.
- if the **context** is **unfamiliar** or remote, or if candidates do not have or are **not provided with access to the context** which informs a text (source material, passage, diagram, table, etc.) they are expected to read, and which informs the question they are supposed to answer and the answer they are expected to write, then constructing a response is *likely* to be more difficult than when the context is provided or familiar.

Questions which require learners to **cross-reference different sources** are *usually* more difficult than those which deal with one source at a time.

Another factor in stimulus difficulty is presentation and visual appearance. For example, type face and size, use of headings, and other types of textual organisers etc. can aid **'readability'** and make it easier for learners to interpret the meaning of a question.

EXAMPLES OF INVALID OR UNINTENDED SOURCES OF STIMULUS DIFFICULTY

- Meaning of words unclear or unknown.
- Difficult or impossible to work out what the question is asking.
- Questions which are ambiguous.
- Grammatical errors in the question that could cause misunderstanding.
- Inaccuracy or inconsistency of information or data given.
- Insufficient information provided.
- Unclear resource (badly drawn or printed diagram, inappropriate graph, unconventional table).
- Dense presentation (too many important points packed in a certain part of the stimulus).

TASK DIFFICULTY

Task difficulty refers to the **difficulty that candidates confront when they try to formulate or produce an answer**.

For example:

In most questions, to generate a response, candidates have to work through the steps of a solution. *Generally*, questions that **require more steps in a solution** are more difficult than those that require fewer steps. Questions involving only one or two steps in the solution are *generally* easier than those where several operations required for a solution**.**

Task difficulty may also be mediated by the **amount of guidance present in the question**. Although question format is not necessarily a factor and difficult questions

can have a short or simple format, questions that provide guided steps or cues (e.g. a clear and detailed framework for answering) are *generally* easier than those that are more open ended and require candidates to form or tailor their **own response strategy** or argument, work out the steps **and maintain the strategy for answering** the question by themselves. A high degree of prompting (a high degree of prompted recall, for example) *tends* to reduce difficulty level.

Questions that test specific knowledge are *usually* less difficult that **multi-step, multiple-concept or operation questions**.

A question that requires the candidate to **use** a **high level of** appropriate **subject specific, scientific or specialised terminology in** their **response** *tends* to be more difficult than one which does not.

A question requiring candidates to **create a complex abstract (symbolic or graphic) representation** is *usually* more challenging than a question requiring candidates to create a concrete representation.

A question requiring writing a one-word answer, a phrase, or a simple sentence is *often* easier to write than **responses that require more complex sentences, a paragraph or a full essay or composition**.

Narrative or descriptive writing, for example where the focus is on recounting or ordering a sequence of events chronologically, is *usually* easier than **writing discursively** (**argumentatively or analytically**) where ideas need to be developed and ordered logically. Some questions reflect task difficulty simply by **'creating the space' for A-grade candidates** to demonstrate genuine insight, original thought or good argumentation, and to write succinctly and coherently about their Knowledge.

Another element is the **complexity in structure of the required response**. When simple connections between ideas or operations are expected in a response, the question is *generally* easier to answer than a question in which the significance of the relations between the parts and the whole is expected to be discussed in a response. In other words, a question in which an unstructured response is expected is *generally* easier than a question in which **a relational response** is required. A response which involves **combining or linking a number of complex ideas or operations** is *usually* more difficult than a response where there is no need to combine or link ideas or operations.

On the other hand, questions which require continuous prose or extended writing *may* also be easier to answer correctly or to get marks for than questions that require no writing at all or single letter answer (such as multiple choice), or a brief response of one or two words or short phrase/s because they **test very specific Knowledge**.

The **cognitive demand** or **thinking processes** required form an aspect of task difficulty. Some questions test thinking ability, and learners' capacity to deal with ideas, etc. Questions that assess inferential comprehension or application of Knowledge, or that require learners to take ideas from one context and use it in another, for example, *tend* to be more difficult than questions that assess recognition or retrieval of basic information. On the other hand, questions requiring recall of Knowledge are *usually* more difficult than questions that require simple recognition processes.

When the **resources for answering** the question are included in the examination paper, then the task is *usually* easier than when candidates have to **use and select their own internal resources** (for example, their own Knowledge of the subject) or transform information to answer the question.

Questions that require learners to take or **transfer** ideas, **skills or Knowledge from one context/subject area and use them in another** *tend* to be more difficult.

EXAMPLES OF INVALID OR UNINTENDED SOURCES OF TASK DIFFICULTY

- Level of detail required in an answer is unclear.
- Context is unrelated to or uncharacteristic of the task than candidates have to do.
- Details of a context distract candidates from recalling or using the right bits of their Knowledge.
- Question is unanswerable.
- Illogical order or sequence of parts of the questions.
- Interference from a previous question.
- Insufficient space (or time) allocated for responding.
- Question predictability or task familiarity. If the same question regularly appears in examination papers or has been provided to schools as exemplars, learners are likely to have had prior exposure, and practised and rehearsed answers in class (for example, when the same language set works are prescribed each year).
- Questions which involve potential follow-on errors from answers to previous questions.

EXPECTED RESPONSE DIFFICULTY

Expected response difficulty refers to difficulty imposed by examiners in a **mark scheme and memorandum**. This location of difficulty is more applicable to 'constructed' response questions, as opposed to 'selected' response questions (such as multiple choice, matching/true-false).

For example:

When examiners expect few or no details in a response, the question is *generally* easier than one where the mark scheme implies that **a lot of details are expected**.

A further aspect of expected response difficulty is the clarity of the **allocation of marks**. Questions are *generally* easier when the allocation of marks is explicit, straight-forward or logical (i.e. 3 marks for listing 3 points) than when the **mark allocation is indeterminate or implicit** (e.g. when candidates need all 3 points for one full mark or 20 marks for a discussion of a concept, without any indication of how much and what to write in a response). This aspect affects difficulty because candidates who are unclear about the mark expectations in a response may not produce sufficient amount of answers in their response that will earn the marks that befit their ability.

Some questions are more difficult/easy to mark accurately than others. Questions that are **harder to mark and score objectively** are *generally* more difficult for

candidates than questions that require simple marking or scoring strategies on the part of markers. For example, recognition and recall questions are *usually* easier to test and mark objectively because they usually require the use of matching and/or simple scanning strategies on the part of markers. More complex questions requiring analysis (breaking down a passage or material into its component parts), evaluation (making judgments, for example, about the worth of material or text, or about solutions to a problem), synthesis (bringing together parts or elements to form a whole), and creativity (presenting own ideas or original thoughts) are *generally* harder to mark/score objectively. The best way to test for analysis, evaluation, synthesis and creativity is usually through extended writing. Such extended writing *generally* requires the use of more cognitively demanding *marking* strategies such as interpreting and evaluating the logic of what the candidate has written.

Questions where **a wide range of alternative answers or response/s** is possible or where the correct answer may be arrived at through different strategies *tend* to be more difficult. On the other hand, questions may be so open-ended that learners will get marks even if they engage with the task very superficially.

EXAMPLES OF INVALID OR UNINTENDED SOURCES OF EXPECTED RESPONSE DIFFICULTY

- Mark allocation is unclear or illogical. The weighting of marks is important in questions that comprise more than one component when components vary in levels of difficulty. Learners may be able to get the same marks for answering easy component/s of the item as other learners are awarded for answering the more difficult components.
- Mark scheme and questions are incongruent. For example, there is no clear correlation between the mark indicated on the question paper and the mark allocation of the memorandum.
- Question asked is not the one that examiners want candidates to answer. Memorandum spells out expectation to a slightly different question, not the actual question.
- Impossible for candidate to work out from the question what the answer to the question is (answer is indeterminable).
- Wrong answer provided in memorandum.
- Alternative correct answers from those provided or spelt out in the memorandum are also plausible.
- The question is 'open' but the memo has a closed response. Memo allows no leeway for markers to interpret answers and give credit where due.

The framework described above does not provide you with explicit links between the different sources of difficulty, or show relationships and overlaps between the different categories and concepts in the framework. This is because it is impossible to set prescribed rules or pre-determined combinations of categories and concepts used for making judgments about the source of difficulty in a particular examination question.

The intention behind the framework is to allow you to exercise your sense of judgment as an expert. The complexity of your judgment lies in your ability as an expert to recognise subtle interactions and identify links between different categories of a question's difficulty or ease. For example, a question that tests specific Knowledge of your subject can actually be more difficult that a multi-step question because it requires candidates to explain a highly abstract concept, or very complex content. In other words, although questions that test specific Knowledge are *usually* less difficult than multiple-concept or operation questions, the level of difficulty of the content Knowledge required to answer a question can make the question more difficult than a multi-step or multi-operation question.

Not all one-word response questions can automatically be assumed to be easy. For example, multiple-choice questions are not automatically easy because a choice of responses is provided – some can be difficult. As an expert in your subject, you need to make these types of judgments about each question.

Note:
It is very important that you become extremely familiar with the framework explained in Table 6, and with each category or source of difficulty provided (i.e. content difficulty, task difficulty, stimulus difficulty, and expected response difficulty). You need to understand the examples of questions which illustrate each of the four levels (Table 7 to Table 10). This framework is intended to assist you in discussing and justifying your decisions regarding the difficulty level ratings of questions. You are expected to **refer to all four categories or sources of difficulty** in justifying your decisions.

When considering question difficulty ask:

- How difficult is the **knowledge** (content, concepts or procedures) that is being assessed for the envisaged Grade 12 candidate? (*Content difficulty*)
- How difficult is it for the envisaged I Grade 12 candidate to formulate the answer to the question? In considering this source of difficulty, you should **take into account the type of cognitive demand** made by the task. (*Task difficulty*)
- How difficult is it for the envisaged Grade 12 candidate to **understand the question and the source material** that need to be read to answer the particular question? (*Stimulus difficulty*)
- What does the **marking memorandum and mark scheme** show about the difficulty of the question? (*Expected response difficulty*)

7.5 Question difficulty entails distinguishing unintended sources of difficulty or ease from intended sources of difficulty or ease

Close inspection of the framework for thinking about question difficulty (Section 7.4, Table 6) above, shows that, for each general category or source of difficulty, the framework makes a distinction between 'valid' or intended, and 'invalid' or unintended sources of question difficulty or ease. Therefore, defining question difficulty entails identifying whether sources of difficulty or ease in a question were intended or unintended by examiners. Included in Table 6 are examples of unintended sources of difficulty or ease for each of the four categories.

Valid difficulty or 'easiness' in a question has its source in the requirements of the question, and is ***intended*** by the examiner (Ahmed and Pollit, 1999). Invalid sources of difficulty or 'easiness' refer to those features of question difficulty or 'easiness' that were ***not intended*** by the examiner. Such unintended 'mistakes' or omissions in questions can prevent the question from assessing what the examiner intended, and are likely to prevent candidates from demonstrating their true ability or competence, and can result in a question being easier or more difficult than the examiner intended.

For example, grammatical errors in a question that could cause misunderstanding for candidates are unintended sources of question difficulty because the difficulty in answering the question could lie in the faulty formulation of the question, rather than in the intrinsic difficulty of the question itself (for example, because of stimulus difficulty). Candidates "may misunderstand the question and therefore not be able to demonstrate what they know" (Ahmed and Pollit, 1999, p.2). Another example is question predictability (when the same questions regularly appear in examination papers or textbooks) because familiarity can make a question which was intended to be difficult, less challenging for examination candidates.

Detecting unintended sources of difficulty or ease in examinations is largely the task of moderators. Nevertheless, evaluators also need to be vigilant about detecting sources which could influence or alter the intended level of question difficulty that moderators may have overlooked.

Note:

When judging question difficulty, you should distinguish **unintended sources of question difficulty or ease** from those sources that are intended, thus ensuring that examinations have a range of levels of difficulty. The framework for thinking about question difficulty allows you to systematically identify technical and other problems in each question. Examples of problems might be: unclear instructions, poor phrasing of questions, the provision of inaccurate and insufficient information, unclear or confusing visual sources or illustrations, incorrect use of terminology, inaccurate or inadequate answers in the marking memorandum, and question predictability. You should **not** rate a question as difficult/easy if the source of difficulty/ease lies in the 'faultiness' of the question or memorandum. Instead, as moderators and evaluators, you need to alert examiners to unintended sources of difficulty/ease so that they can improve questions and remedy errors or sources of confusion before candidates write the examination.

7.6 Question difficulty entails identifying differences in levels of difficulty within a single question

An examination question can incorporate more than one level of difficulty if it has subsections. It is important that the components of such questions are 'broken down' into to their individual levels of difficulty.

Note:

Each subsection of a question should be analysed separately so that the percentage of marks allocated at each level of difficulty and the weighting for each level of difficulty can be ascertained as accurately as possible for that question.

8. EXAMPLES OF QUESTIONS AT DIFFERENT LEVELS OF DIFFICULTY

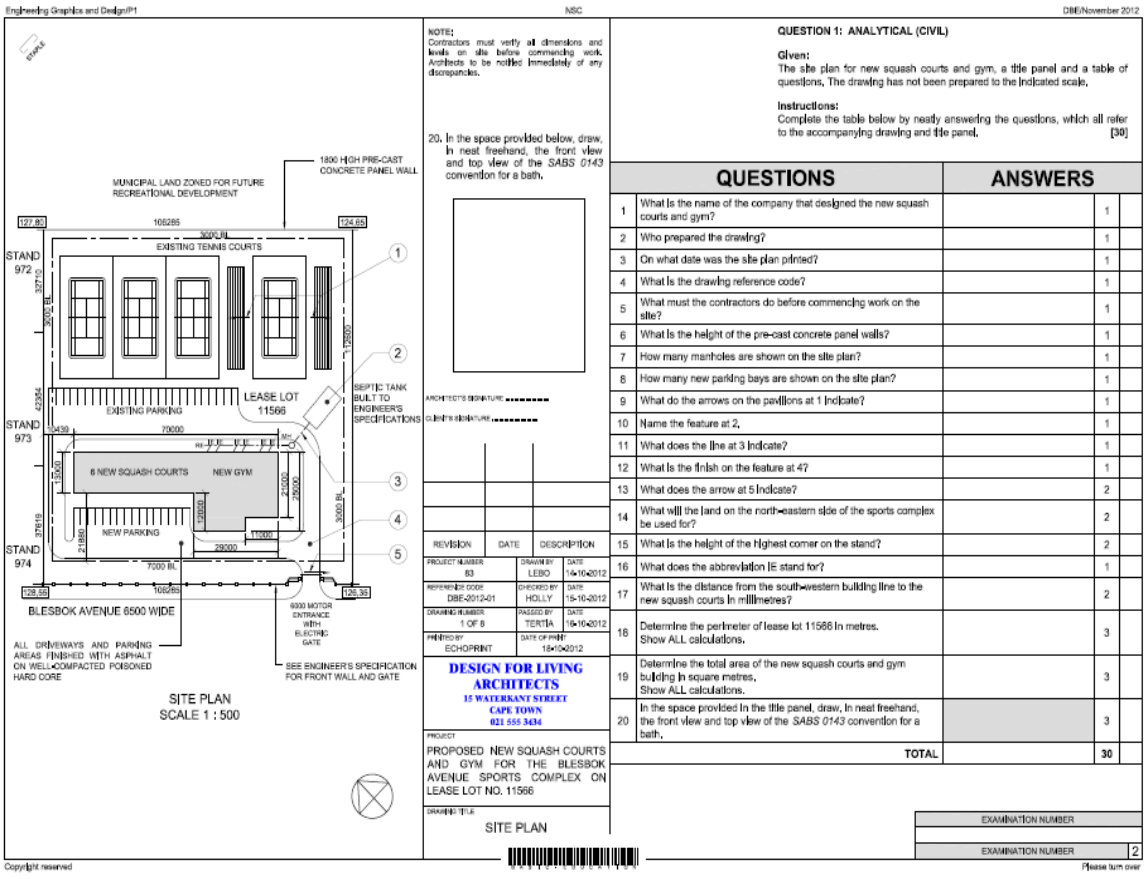
This section provides at least **three** examples of questions from previous Engineering graphics and design NSC examinations (Table 7 to Table 10) categorised at each of the four levels of difficulty described in Section 7 (Table 5) above. These examples were selected to represent the **best and clearest** examples of each level of difficulty that the Engineering graphics and design experts could find. The discussion below each example question tries to explain

the reasoning behind the judgments made about the categorisation of the question at that particular level of difficulty.

TABLE 7: EXAMPLES OF QUESTIONS AT DIFFICULTY LEVEL 1 – EASY

Example 1

Question: 1.1-1.5, November 2012, P1



1. What is the name of the company that designed the squash courts and the gym? (1)
2. Who prepared the drawing? (1)
3. On what date was the site plan printed? (1)
4. What is the drawing reference code? (1)
5. What must the contractors do before commencing work on the site? (1)

Discussion:

This question is classified as easy because:

Easy for the envisaged Grade 12 student to answer

- The drawing is clearly showing the features and information required to answer the sub-questions. The questions are short and easy to read and understand. Appropriate subject terminology is used **(stimulus)**.

- To answer this question, candidates do not have to have in-depth knowledge of the concepts. It requires knowledge of basic content taught in the curriculum and refers to the SANS 10143 code of practice for drawing with regards to representation of lines and symbols. Extracting the answers and features should be easy because they have specifically learnt this and this information is easily identifiable on the drawing **(content)**.
- The task entails candidates to identify the information as shown on the drawing. The answers to the question simply need to be read directly from the site plan and written on the question paper. All Grade 12 candidates should have performed similar tasks in the classroom **(task)**.
- The answers to these questions are rather simple single worded answers and easy to write down in the space provided on the question paper. Not much writing is required for each answer and answers are easy to formulate and mark. Each of the answers carry a max of 1 mark **(expected response)**.
- These sub-questions are therefore easy with regards to all four sources of difficulty in the framework.

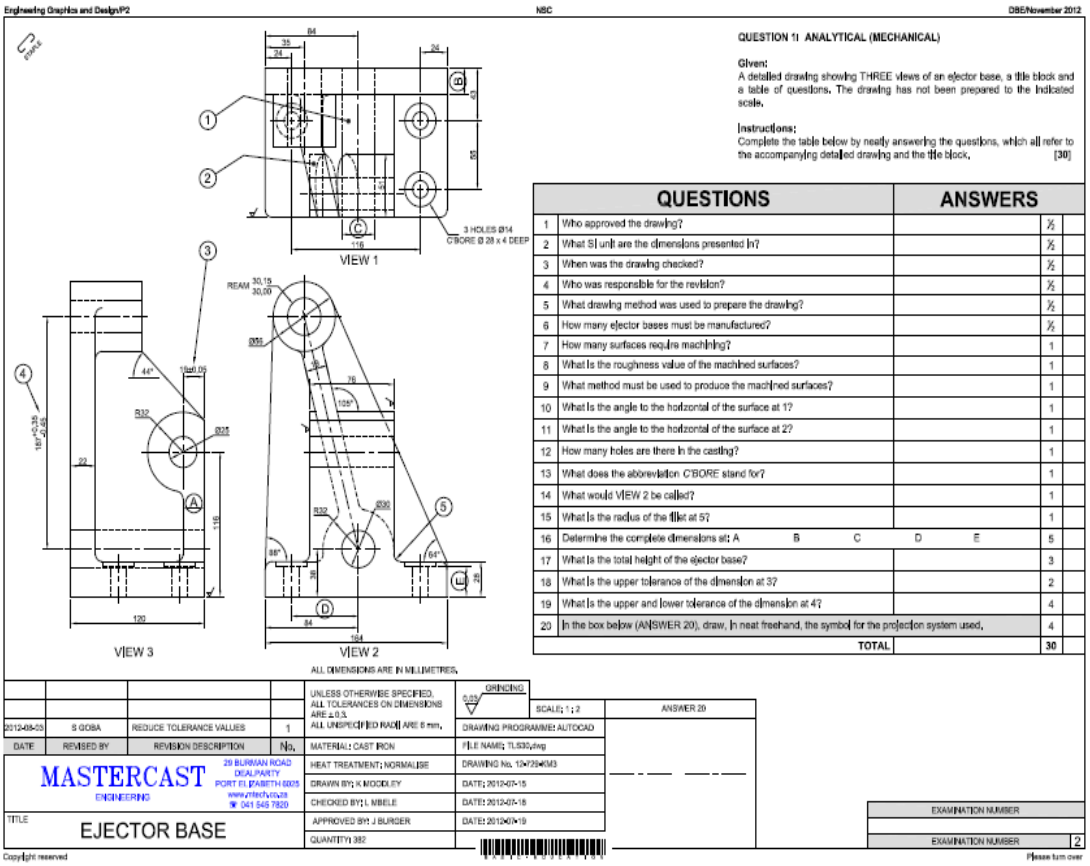
Memorandum/Marking guidelines

Answers:

1. Design for Living Architects
2. Lebo
3. 18/10/2012
4. DBE-2012-01
5. Verify dimensions and check levels

Example 2:

Question 1: November 2012, P2



Engineering Graphics and Design/P2 NSC DBE/November 2012

QUESTION 1: ANALYTICAL (MECHANICAL)

Given:
A detailed drawing showing THREE views of an ejector base, a title block and a table of questions. The drawing has not been prepared to the indicated scale.

Instructions:
Complete the table below by neatly answering the questions, which all refer to the accompanying detailed drawing and the title block. [30]

	QUESTIONS	ANSWERS	
1	Who approved the drawing?		½
2	What SI unit are the dimensions presented in?		½
3	When was the drawing checked?		½
4	Who was responsible for the revision?		½
5	What drawing method was used to prepare the drawing?		½
6	How many ejector bases must be manufactured?		½
7	How many surfaces require machining?		1
8	What is the roughness value of the machined surfaces?		1
9	What method must be used to produce the machined surfaces?		1
10	What is the angle to the horizontal of the surface at 1?		1
11	What is the angle to the horizontal of the surface at 2?		1
12	How many holes are there in the casting?		1
13	What does the abbreviation C'BORE stand for?		1
14	What would VIEW 2 be called?		1
15	What is the radius of the fillet at 5?		1
16	Determine the complete dimensions at: A B C D E		5
17	What is the total height of the ejector base?		3
18	What is the upper tolerance of the dimension at 3?		2
19	What is the upper and lower tolerance of the dimension at 4?		4
20	In the box below (ANSWER 20), draw, in neat freehand, the symbol for the projection system used.		4
	TOTAL		30

VIEW 1 VIEW 2 VIEW 3

3 HOLES Ø14 C'BORE Ø 28 x 4 DEEP

ALL DIMENSIONS ARE IN MILLIMETRES.

UNLESS OTHERWISE SPECIFIED, ALL TOLERANCES ON DIMENSIONS ARE ±0,3. ALL UNSPECIFIED RADII ARE 6 mm.

GRINDING

SCALE: 1 : 2

ANSWER 20

2012-08-03 S GOBA REDUCE TOLERANCE VALUES 1

DATE REVISED BY REVISION DESCRIPTION No.

MASTERCAST ENGINEERING 29 BURMAN ROAD DEALPARTY PORT ELIZABETH 6025 www.mastercast.co.za 041 545 7820

MATERIAL: CAST IRON

HEAT TREATMENT: NORMALISE

DRAWN BY: K MOODLEY

CHECKED BY: L MBELE

APPROVED BY: J BURGER

QUANTITY: 382

DRAWING PROGRAMME: AUTOCAD

FILE NAME: TL530.dwg

DRAWING No. 12/729/M3

DATE: 2012-07-15

DATE: 2012-07-18

DATE: 2012-07-19

TITLE

EJECTOR BASE

EXAMINATION NUMBER

EXAMINATION NUMBER 2

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Refer to sub-questions 1-4

1. Who approved the drawing? (½)
2. What SI unit are the drawings presented in? (½)
3. When was the drawing checked? (½)
4. Who was responsible for the revision? (½)

Discussion:

- Features of these questions contains simple words and phrases and minimal comprehension is required. Here the envisaged Grade 12 candidate is not challenged to any degree. Candidates will know where to look for the required information. Very little reading demands are made on the candidate **(stimulus)**.
- These questions aim to assess basic content of the SANS code of practice 10111 and engineering drawing subject knowledge. Information is easily extracted from the given drawing **(content)**.
- Formulation of these answers is relatively easy. Candidates are not required to engage in much debate when answering. Answers are easily obtainable from the drawing and these single word answers needs to be written down in the space provided **(task)**.
- The answers to these questions are easy as no detailed responses are required. The mark allocation shows that these questions are straightforward. Candidates are clear on the mark allocation and expectation. Marking these

questions is very objective without any alternative responses. Each answer carries a maximum of ½ mark **(expected response)**.

Memorandum/Marking Guidelines

Answers:

1.J. Burger

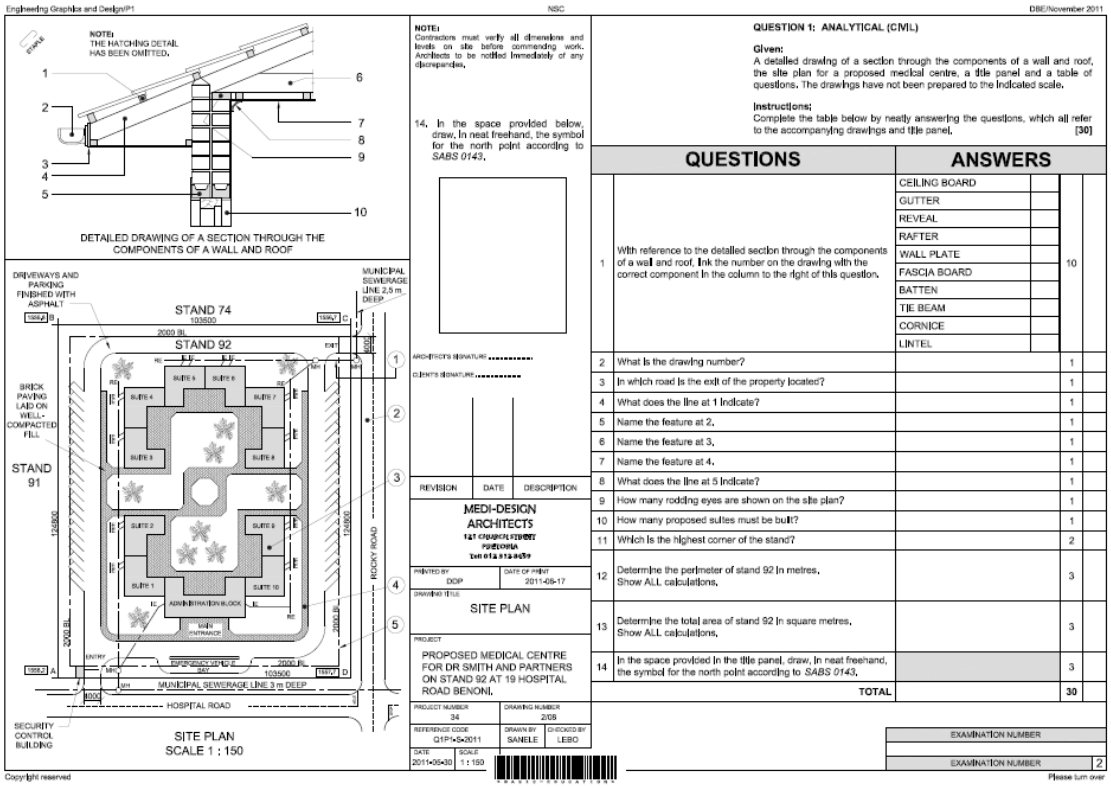
2. mm

3. 2012-07-18

4. S. Goba

Example 3:

Question 1: November 2011, P1



Refer to sub-question 2-8
2. What is the drawing number?
3. In which road is the exit of the property located?
4. What does the line at 1 indicate?
5. Name the feature at 2.
6. Name the feature at 3.
7. Name the feature at 4.
8. What does the line at 5 indicate?

Discussion:

Easy for the envisaged Grade 12 student to answer because:

- The drawing of the Site Plan of the medical centre shows clearly the features and information required to answer the sub-questions. The questions are short

and easy to read and understand. Appropriate subject terminology is used **(stimulus)**.

- To answer this question, candidates do not have to have in-depth knowledge of the concepts. It requires knowledge of basic content taught in the curriculum and refers to the SANS 10143 code of practice for drawing with regards to representation of lines and symbols. Extracting the answers and features should be easy because they have specifically learnt this and this information is easily identifiable in the drawing **(content)**.
- The task entails candidates to identify the information as shown on the drawing. The answers to the question simply need to be read directly from the site plan. All Grade 12 candidates should have performed similar tasks in the classroom **(task)**.
- The answers to these questions are rather simple single worded answers and easy to write down in the space provided on the question paper. Not much writing is required for each answer and answers are easy to formulate and mark. Each expected answer is one mark **(expected response)**.
- These sub-questions are therefore easy with regards to all four sources of difficulty in the framework.

Memorandum/Marking guidelines
Answers:
2. 2/08
3. Rocky Road
4. Sewer Line
5. Road
6. Unit/Building/Suite/Consulting Room 9
7. Brick Paving/Walkway
8. Building Line

TABLE 8: EXAMPLES OF QUESTIONS AT DIFFICULTY LEVEL 2 – MODERATE

Example 1:

Question 2: November 2012 P1

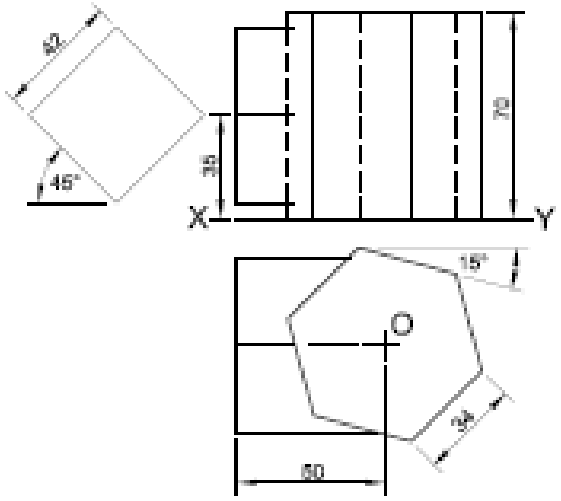
Interpenetration and Development

GIVEN:

- The incomplete front view and top view of a regular square prism that has been shaped to fit around a right regular hexagonal prism. The axes of both prisms lie in a common vertical plane.
- The auxiliary view of the square prism.
- The position of O on the drawing sheet.

Instructions:
Draw to a scale of 1:1 the following views of the TWO prisms:
2.1 The given top view.
2.2 The left view.
2.3 The complete front view, clearly showing the curves of interpenetration.
2.4 Develop the surfaces of the square prism.

Show ALL hidden detail and fold lines.



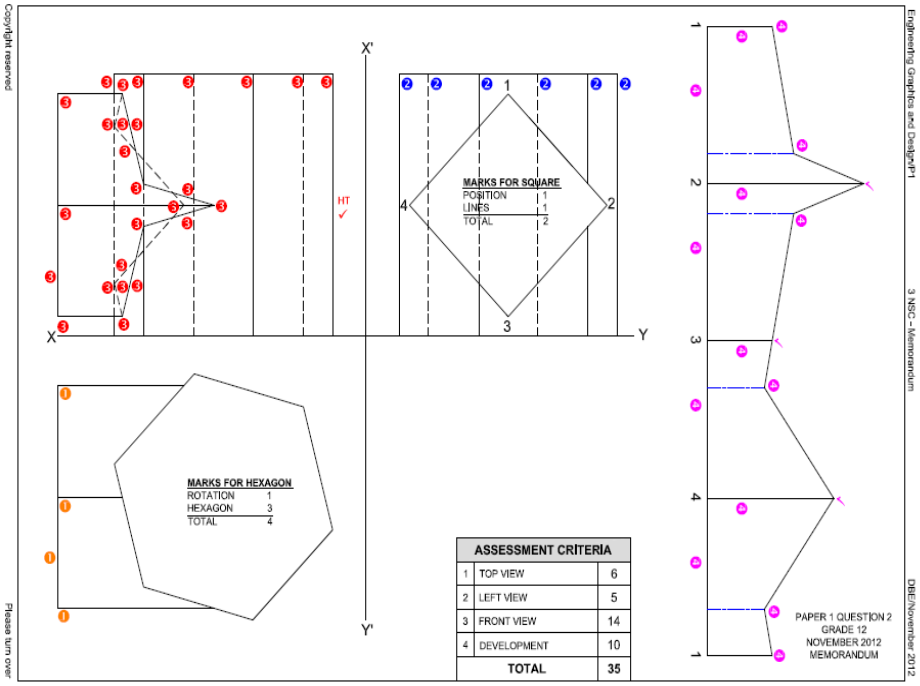
Discussion:

Moderately challenging for the ideal Grade 12 student to answer

- In this case the stimulus material is moderately challenging for the ideal Grade 12 candidate. Copying the given graphics should be relatively easy for the candidate. (Task) The questions are designed so that the candidate knows exactly what is required. The question is moderately difficult because the candidate has to read the question and relate this to the graphical representation shown **(stimulus)**.
- To answer this question, candidates need to have specialized skills and knowledge of prisms to complete the question and the necessary views. The concept of rotating the prisms makes this moderately difficult when finding the lines of penetration and requires a greater degree of skill and knowledge than if these were not rotated to any degree. Furthermore, there are a number of processes that the candidate must understand from the EGD content in order to draw what is required **(content)**.
- To answer this question candidates have to manipulate their instruments to obtain the required rotation of 15°.The rotation of 15° of the hexagonal prism makes this question moderately difficult for candidates. Many candidates find it moderately challenging to apply the two set- square method to obtain the 15° rotation and to obtain the lines of penetration of the two prisms**(task)**.
- The allocation of the marks in this question makes it moderately difficult. The marks are spread across the different aspects of the question. See the assessment criteria on the memorandum **(expected response)**.

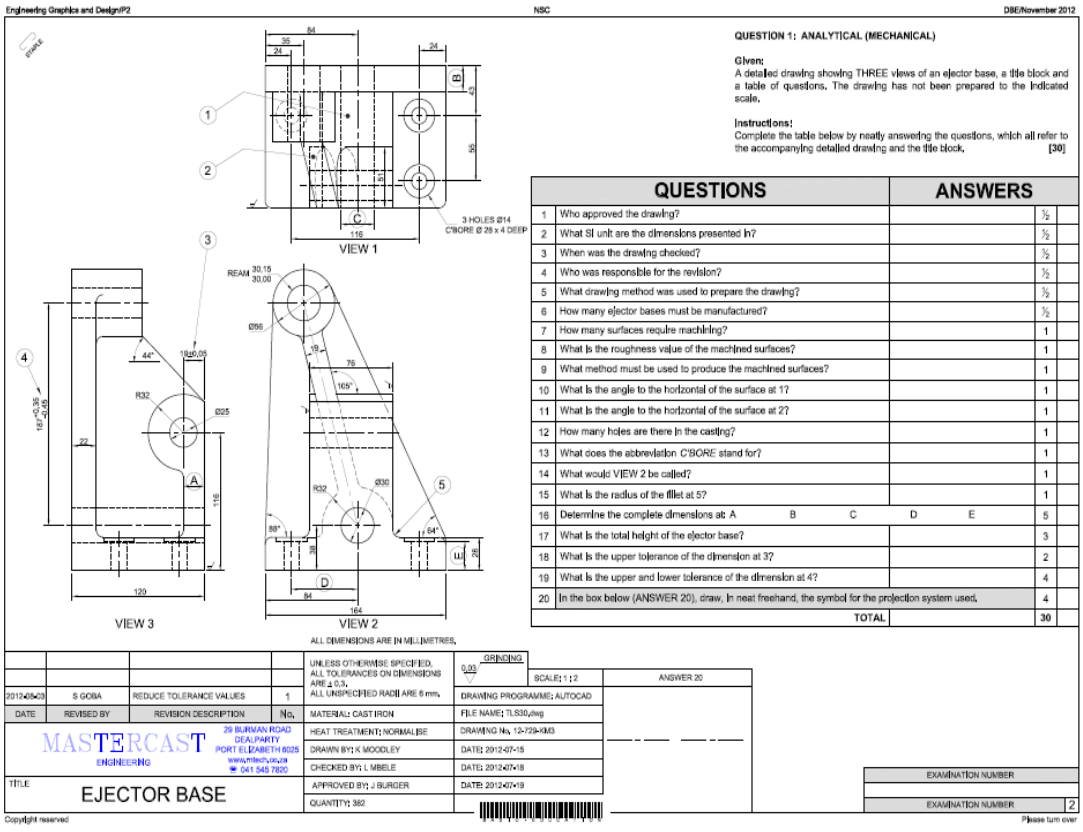
In the memorandum below the front view showing the lines of intersection and the development of the square prism carries more weighting of the marks. The candidates who are unclear on the mark expectation in the response may not produce appropriate answers in their responses. The ideal Grade 12 candidate would however, be relatively familiar with the allocation of these marks. Therefore, this question is moderately difficult.

Memorandum/Marking guidelines



Example 2:

Question 1: Nov 2012, P2



Refer to sub-question 16

16. Determine the complete dimensions at: A. B. C. D. E. (5 marks)

Discussion:

Moderately challenging for the ideal Grade 12 student to answer because:

- Here the candidate has to unpack a relatively large amount of information by evaluating the written word and the graphical representation. Although the ideal Grade 12 candidate should be familiar with these types of questions, the amount of graphical information contributes to this question being moderately difficult **(stimulus)**.
- The question assesses specialized content knowledge concerning the SANS 10111, 3rd Angle orthographic projection and machine assemblies within an abstract format, therefore it is moderately difficult in terms of content. A combination of skills is also assessed. This increases the level of difficulty **(content)**.
- The task is to determine the dimensions of castings. The candidate has to work through a number of steps in order to arrive at the answer. No guidance is provided to the candidate on how they should arrive at the solution. The candidate has to interpret the information provided to do the task **(task)**.
- Markers in this case will need to examine the answer carefully to determine whether candidates have included the symbols for some answers to award the half mark. Here there are FIVE answers and 5 marks. Candidates may be unsure of whether to include the unit of measurements for each dimension **(expected response)**.

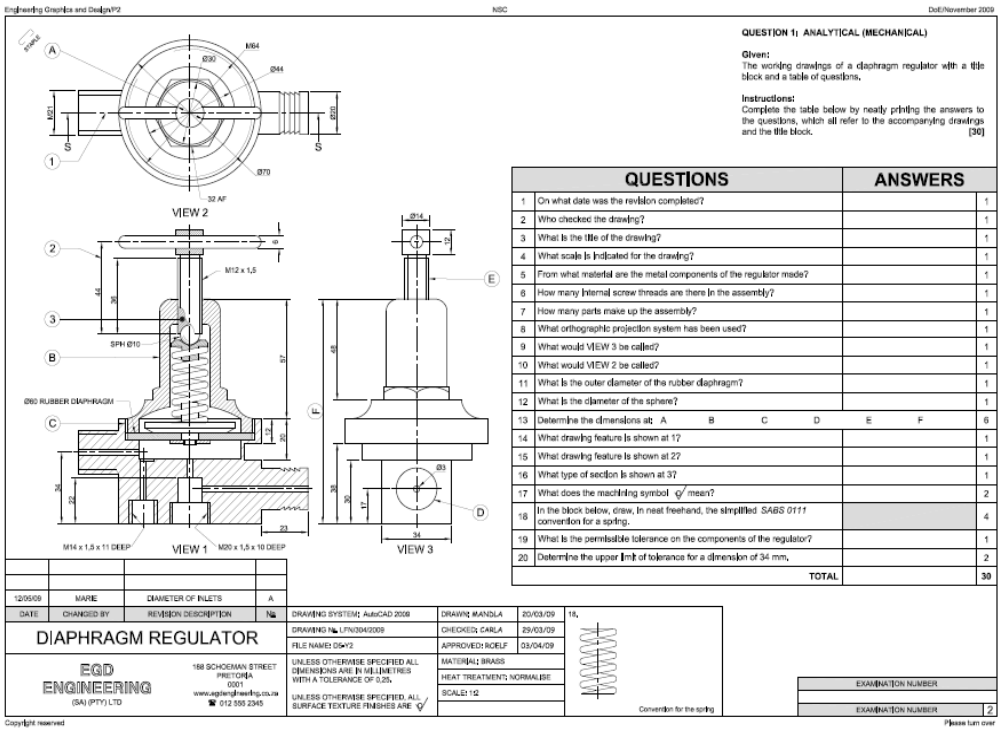
Memorandum/Marking guidelines

Answer 16:

A. 19 ± 0.05 B. 22 C. Ø 30 D. 60 E. 24 (5 marks)

Example 3:

Question1: November 2009, P2



Engineering Graphics and Design/P2 NSC DoE/November 2009

QUESTION 1: ANALYTICAL (MECHANICAL)

Given:
The working drawings of a diaphragm regulator with a title block and a table of questions.

Instructions:
Complete the table below by neatly printing the answers to the questions, which all refer to the accompanying drawings and the title block. **[30]**

	QUESTIONS	ANSWERS	
1	On what date was the revision completed?		1
2	Who checked the drawing?		1
3	What is the title of the drawing?		1
4	What scale is indicated for the drawing?		1
5	From what material are the metal components of the regulator made?		1
6	How many internal screw threads are there in the assembly?		1
7	How many parts make up the assembly?		1
8	What orthographic projection system has been used?		1
9	What would VIEW 3 be called?		1
10	What would VIEW 2 be called?		1
11	What is the outer diameter of the rubber diaphragm?		1
12	What is the diameter of the sphere?		1
13	Determine the dimensions at: A B C D E F		6
14	What drawing feature is shown at 1?		1
15	What drawing feature is shown at 2?		1
16	What type of section is shown at 3?		1
17	What does the machining symbol $\sqrt{}$ mean?		2
18	In the block below, draw, in neat freehand, the simplified *SABS 0111* convention for a spring.		4
19	What is the permissible tolerance on the components of the regulator?		1
20	Determine the upper limit of tolerance for a dimension of 34 mm.		2
	TOTAL		30

VIEW 1 VIEW 2 VIEW 3

Ø60 RUBBER DIAPHRAGM

M12 x 1,5

SPH Ø10

M14 x 1,5 x 11 DEEP M20 x 1,5 x 10 DEEP

DATE	CHANGED BY	REVISION DESCRIPTION	№
12/05/09	MARIE	DIAMETER OF INLETS	A

DIAPHRAGM REGULATOR

EGD ENGINEERING (SA) (PTY) LTD

168 SCHOEMAN STREET PRETORIA 0001 www.egdengineering.co.za ☎ 012 555 2345

DRAWING SYSTEM: AutoCAD 2008 | DRAWN: MANDLA | 20/03/09

DRAWING №: LFN/304/2009 | CHECKED: CARLA | 29/03/09

FILE NAME: D5eY2 | APPROVED: ROELF | 03/04/09

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETRES WITH A TOLERANCE OF 0,25.

MATERIAL: BRASS

HEAT TREATMENT: NORMALISE

SCALE: 1:2

UNLESS OTHERWISE SPECIFIED, ALL SURFACE TEXTURE FINISHES ARE $\sqrt{}$

Convention for the spring

EXAMINATION NUMBER

EXAMINATION NUMBER 2

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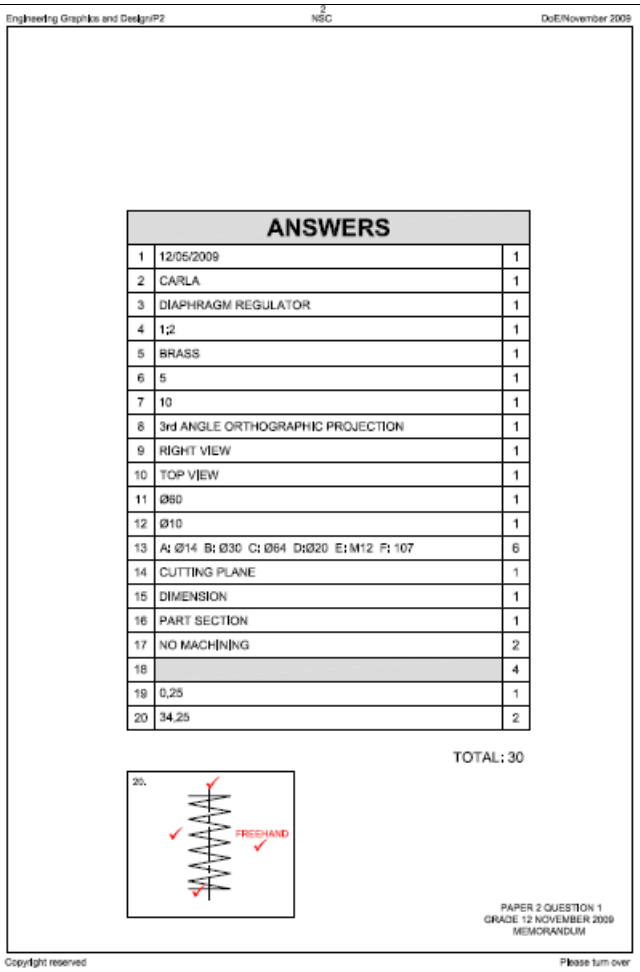

Engineering Graphics and Design/P2 2 NSC DoE/November 2009

ANSWERS		
1	12/05/2009	1
2	CARLA	1
3	DIAPHRAGM REGULATOR	1
4	1:2	1
5	BRASS	1
6	5	1
7	10	1
8	3rd ANGLE ORTHOGRAPHIC PROJECTION	1
9	RIGHT VIEW	1
10	TOP VIEW	1
11	Ø80	1
12	Ø10	1
13	A: Ø14 B: Ø30 C: Ø64 D:Ø20 E: M12 F: 107	6
14	CUTTING PLANE	1
15	DIMENSION	1
16	PART SECTION	1
17	NO MACHINING	2
18		4
19	0,25	1
20	34,25	2

TOTAL: 30

20. FREEHAND

PAPER 2 QUESTION 1
GRADE 12 NOVEMBER 2009
MEMORANDUM

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Refer to sub-question 13

13. Determine the dimensions at: A. B. C. D. E. F. (6 marks)

Discussion:

This question is classified as moderately difficult for reasons related to all four sources of difficulty

- The stimulus material is abstract and complex. Candidates are provided with a third angle drawing of the Diaphragm Regulator, but are not told which information to use to obtain the dimensions. The drawing provided is unfamiliar to candidates even though they would have been exposed to these types of questions before **(stimulus)**.
- They need to recall prior complex knowledge of dimensioning as specified in the SANS 10111 in order to obtain the dimensions and relate dimensions in third angle orthographic projection to obtain the required answer. This application makes it moderately difficult **(content)**.
- The task is to determine the total dimensions of castings. The task requires application and analysis, although not at a very high order. Candidates are required to assimilate information before writing down the answer in the space provided, therefore contributing to task difficulty **(task)**.
- Markers will need to examine the answer carefully to determine whether candidates have included the symbols for some answers to award the half mark. Here there are 6 marks. However, candidates may obtain half marks for

some answers. Candidates may be unsure of whether to include the unit of measurements for each dimension **(expected response)**.
Memorandum/Marking guidelines Answer: 13. A. Ø14 B. Ø30 C. Ø64 D. Ø20 E.M12 F. 107 (6 marks)

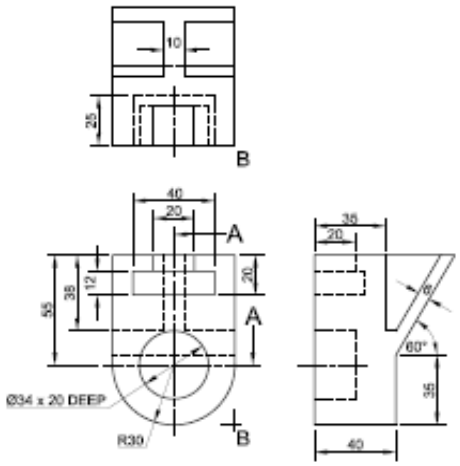
TABLE 9: EXAMPLES OF QUESTIONS AT DIFFICULTY LEVEL 3 – DIFFICULT

Example 1:

Question: 3 November 2009, P2

Isometric Drawing
Given The front view, top view and right view of a jig bracket with a cutting plane A-A.
The position of point B on the drawing sheet.
Instructions: Convert the orthographic views of the Jig Bracket into a sectional isometric drawing on the cutting plane A-A

- Make corner B the lowest point on the drawing.
- Show ALL necessary constructions.
- NO hidden detail is required. (44 marks)



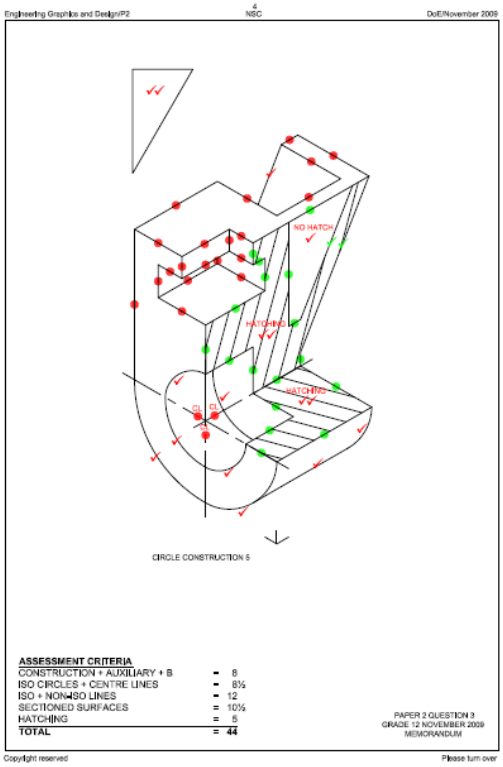
Discussion:

- The degree of challenge resides in the complexity of the graphics provided, which the candidate must interpret in order to respond. No hints are provided to guide the candidate in any way **(stimulus)**.
- The content difficulty is varied by changing the number of knowledge operations that are assessed such as 3rd angle orthographic projection, conversion from orthographic to isometric projection, isometric circle construction, sectioning of solids using SANS 10111 and inclined planes drawn

in isometric. These operations are abstract and the candidate has to visually imagine the completed sectional isometric view **(content)**.

- This question requires the candidate to use a high level of subject specific and specialized skills in their response. It also requires of them to create a complex graphical representation (sectional isometric view) from equally complex given 3rd angle orthographic views **(task)**.
- The ideal Grade 12 candidate must have the necessary knowledge in the specific subject area of EGD in general and isometric sectioning in particular otherwise, they will have difficulty synthesizing, analysing or evaluating what is required in the answer. The circles, semi- circle, slots and rib plus the half-sectional view all contributed to the level of difficulty. The assessment criteria block provides an indication of how the marks are allocated to the question. This will provide the ideal Grade 12 candidate with clear information of how the marks are distributed throughout the answer **(expected response)**.

Memorandum/Marking guidelines



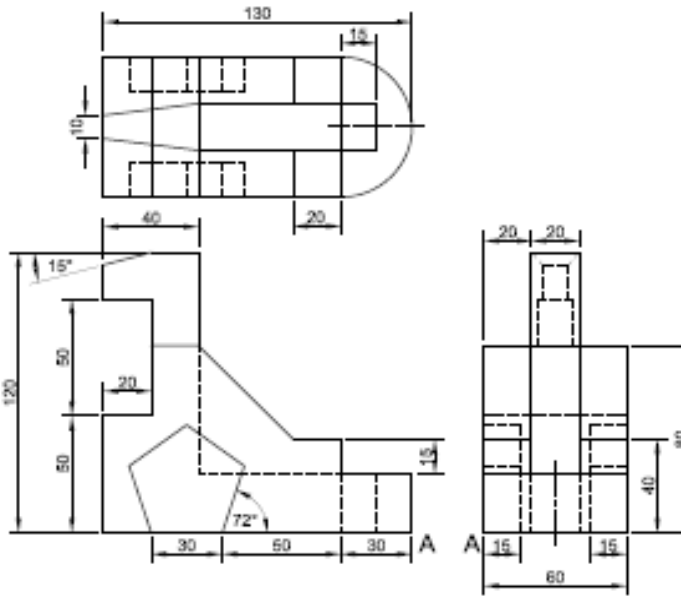
Example 2:

Question 3: November 2011, P2

Isometric Drawing
Given: The front view, top view and right view of a safety clip with TWO regular pentagonal slot holes.
The position of point A on the drawing sheet.
Instructions: Using a scale of 1:1, convert the orthographic views of the safety clip into an isometric drawing.

- Make A the lowest point of the drawing.
- Show ALL necessary construction.
- NO stencils may be used.

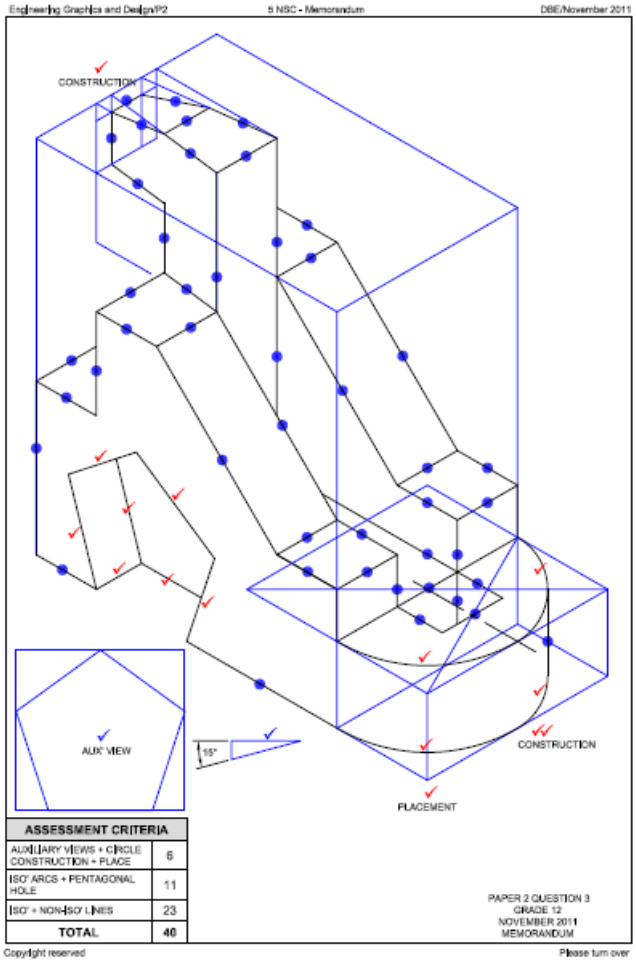
NO hidden detail is required. (40 marks)



Discussion:

- The degree of challenge resides in the complexity of the graphics provided, which the ideal Grade 12 candidate must interpret in order to respond. No hints are provided to guide the candidate in any way **(stimulus)**.
- In this instance, the content difficulty is varied by changing the number of knowledge operations such as 3rd angle orthographic projection, conversion from orthographic to isometric projection, isometric circle construction, auxiliary views, SANS 10111 and inclined planes drawn in isometric that are assessed. These operations are abstract and the candidate has to visually imagine the completed isometric view **(content)**.
- This question requires the ideal Grade 12 candidate to use a high level of subject specific and specialized skills in their response. It also requires of them to create a complex graphical representation from equally complex given 3rd angle orthographic views through analysis and interpretation **(task)**.
- The ideal Grade 12 candidate must have the necessary knowledge in the specific subject area of EGD in general, they will have difficulty synthesizing, analysing or evaluating what is required in the answer. The pentagonal slot, semi- circle, slots and taper all contributed to the level of difficulty. The assessment criteria block provides an indication of how the marks are allocated to the question. This will provide the student with clear information of how the marks are distributed throughout the answer **(expected response)**.

Memorandum/Marking guidelines



Example 3:

Question 3: November 2012, P2

ISOMETRIC DRAWING

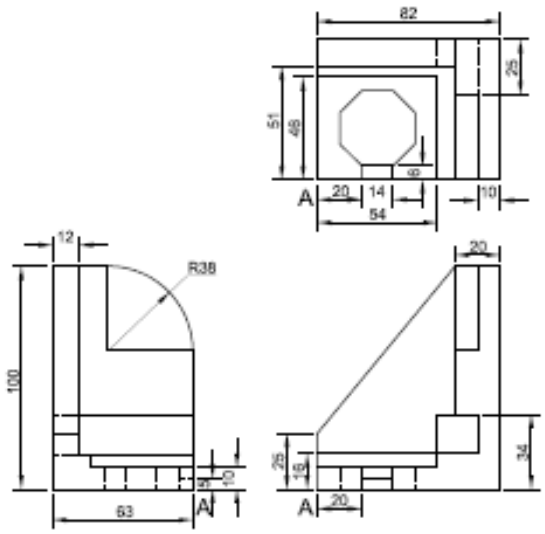
Given:

- The front view, top view and left view of a bracket with a regular octagonal hole.
- The position of point A on the drawing sheet.

Instructions:

Using scale 1:1 convert the orthographic views of the bracket into an isometric drawing.

- Make A the lowest point on your drawing.
- Show all necessary construction.
- NO stencils may be used.
- NO hidden detail is required. (36 marks)



Discussion:

- The degree of challenge resides in the complexity of the graphics provided, which the ideal Grade 12 candidate must interpret in order to respond. No hints are provided to guide the candidate in any way. In this question, the stimulus differentiation relates to the rectangular groove, octagonal hole, rib and circular feature **(stimulus)**.
- The content difficulty is varied by changing the number of knowledge operations that are assessed. The heights and depth of the features of the octagonal hole, rectangular groove, rib and semi-circular feature distinguishes this from the previous questions. In this question, the left view is provided instead of the right view. These operations are abstract and the ideal Grade 12 candidate has to visually imagine the completed isometric view **(content)**.
- The ideal Grade 12 candidate uses a high level of subject specific and specialised skills in their response. It requires of them to create a complex graphical representation of a three-dimensional view from an equally complex given 3rd angle orthographic view. The provision of a left view also distinguishes the level of complexity **(task)**.
- The ideal Grade 12 candidate must have the necessary knowledge in the specific subject area of EGD in general, they will have difficulty synthesizing, analysing or evaluating what is required in the answer. The octagonal hole, horizontal groove, semi- circle, slots and rib all contributed to the level of difficulty **(expected response)**.

Memorandum/Marking guidelines

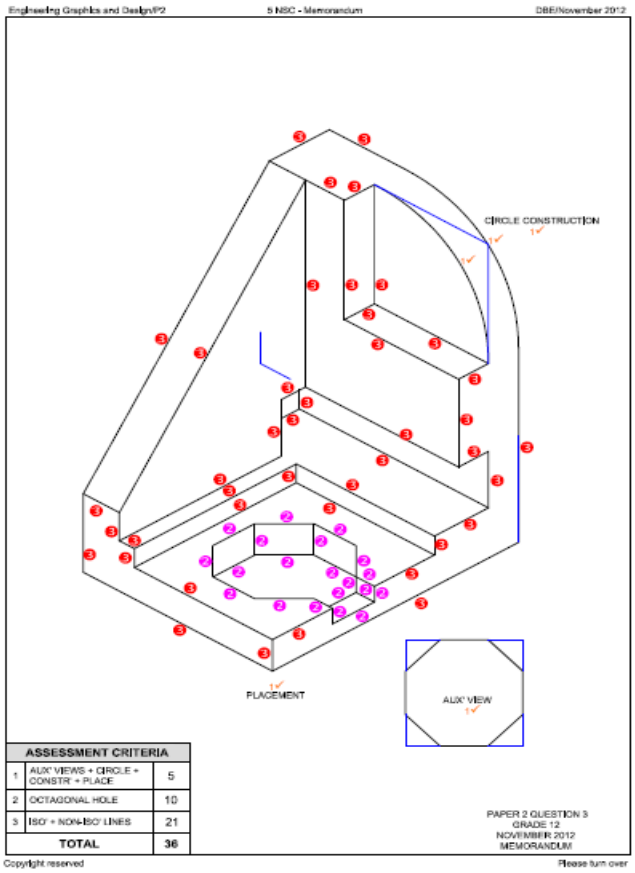


TABLE 10: EXAMPLES OF QUESTIONS AT DIFFICULTY LEVEL 4 – VERY DIFFICULT

Note:
During the development of the exemplar book some subject specialist argued that there is a faint line between a difficult and a very difficult question. It was also evident that in some subjects question papers did not have questions that could be categorised as very difficult. In order to cater for this category, subject specialists were requested to adapt existing questions and make them very difficult or create their own examples of very difficult question. However, it was noted that in some instances attempts to create very difficult questions introduced invalid sources of difficulty which in turn rendered the questions invalid. Hence Umalusi acknowledges that the very difficult category may be problematic and therefore requires especially careful scrutiny.

Example 1:

Question 3: November 2010, P2

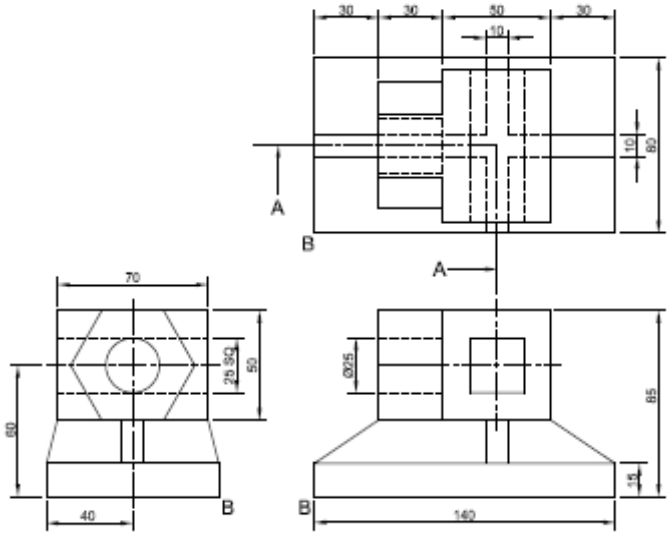
ISOMETRIC DRAWING
Given:

- The front view, top view and left view of a channel drilling jig with cutting plane A-A.
- The position of point B on the drawing sheet.

Instructions:
Convert the orthographic views of the channel drilling jig into a scale 1:1 sectional isometric drawing on cutting plane A-A.

- Make corner B the lowest point on the drawing.
- Show ALL necessary circle and other construction.

NO hidden detail is required. (40 marks)

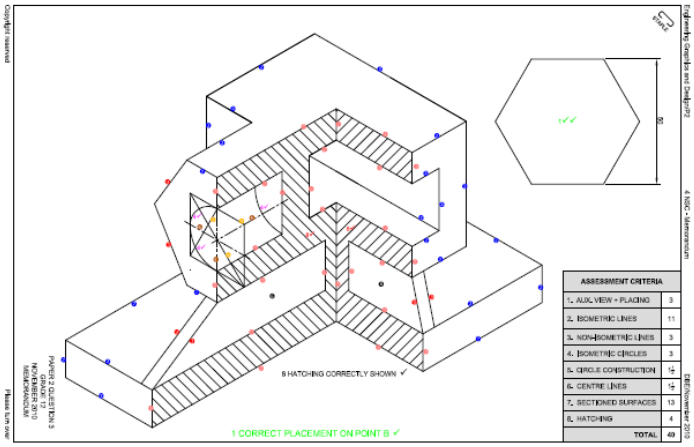


Discussion:

- The degree of challenge resides in the complexity of the graphics provided, which the ideal Grade 12 candidate must interpret in order to respond. No hints are provided to guide the candidate in any way **(stimulus)**.
- In this instance, the content difficulty is varied by changing the number of knowledge operations that are assessed. These operations are abstract and the candidate has to visually imagine the completed sectional isometric view **(content)**.
- This question requires the candidate to use a high level of subject specific and specialised skills in their response. It also requires of them to create a complex graphical representation (sectional isometric view) from an equally complex given 3rd angle orthographic views **(task)**.
- Unless the ideal Grade 12 candidate has the necessary knowledge in a specific subject area, they will have a difficult time synthesizing, analysing, or evaluating the 3rd angle graphical representation. The circles, semi- circle, slots and rib plus the half-sectional view all contributed to the level of difficulty. Apart from the basic technical features (hexagon, circles, ribs), the holes in the block added to the complexity of the question. The complexity of the question relates to learners being able to perceive what the expected answer will look like. It assesses the candidate's spatial perception of the given diagram and allows the ideal Grade 12 candidate the opportunity to create a complete sectioned model from the given views. The ideal Grade

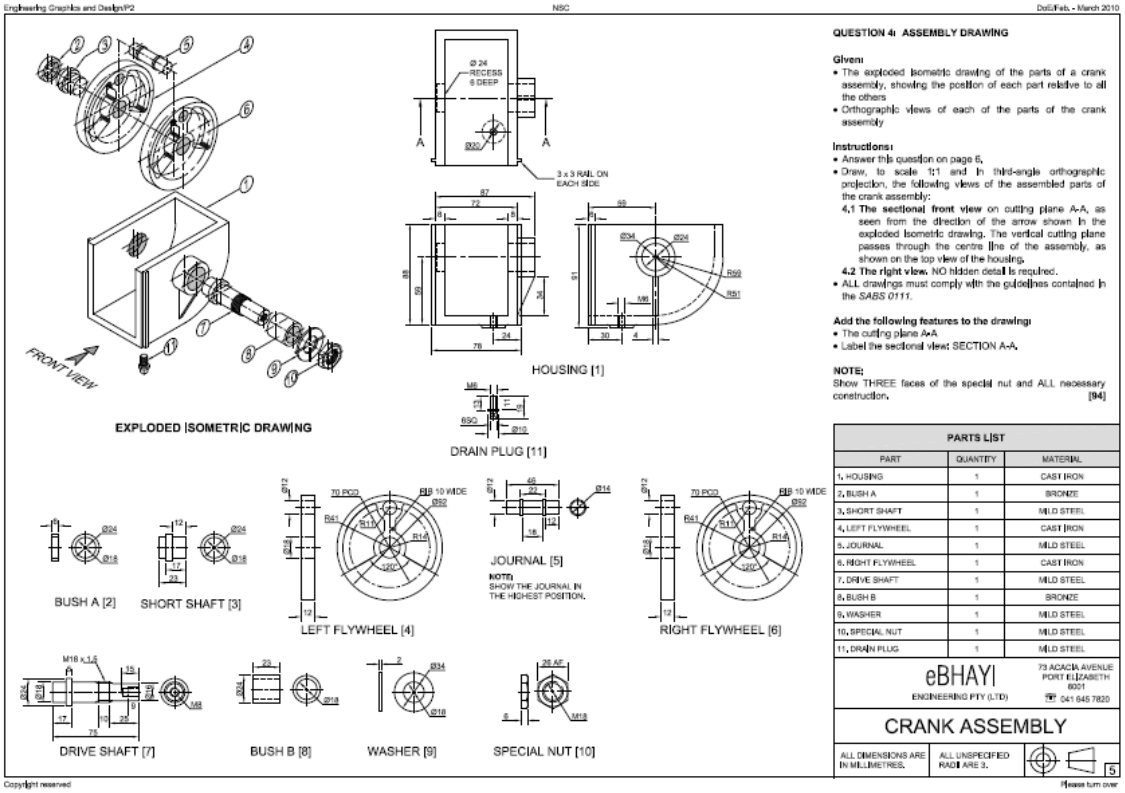
12 candidate uses previous technical knowledge and skills to reproduce a model that is sectioned (expected response).

Memorandum/Marking guidelines



Example 2:

Question 4: February/March 2010, Q4



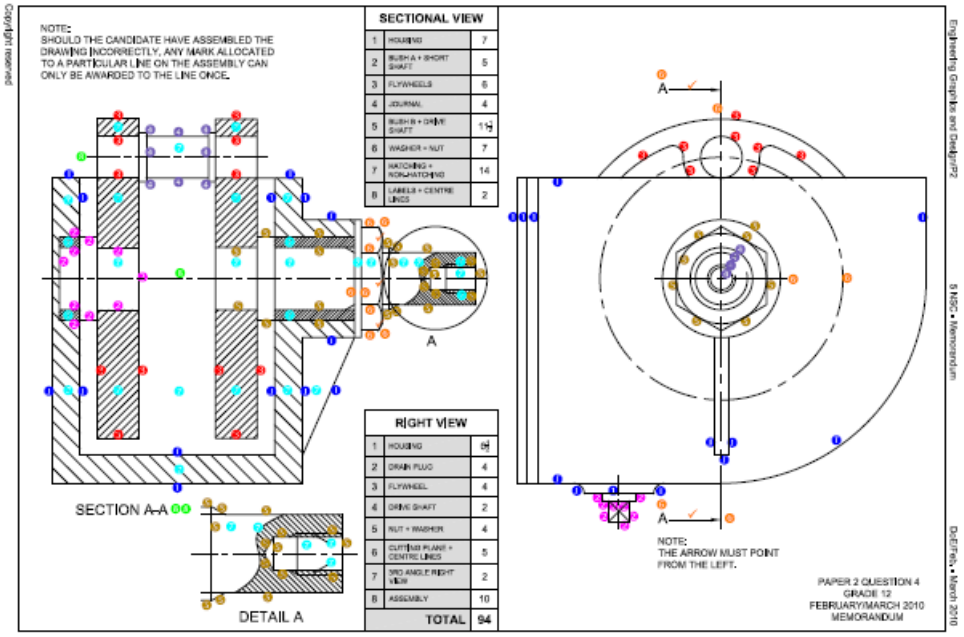
Discussion:

- The complexity of the orthographic projection makes the interpretation of the drawing very difficult. The ideal Grade 12 candidate has to read and interpret the given graphics by unpacking each of the views. Due to the number of components in the assembly, the question is very difficult **(stimulus)**.
- Machine drawing and assemblies content is abstract and very specialised. The ideal Grade 12 candidate has to visually imagine what the overall

section and outside view will look like while determining the answer in 3rd angle orthographic projection **(content)**.

- The assembly of the components is rather complex even though the exploded isometric view is given. If the ideal Grade 12 candidate does not position the components correctly then the sectioned orthographic view will be incorrect. Drawing the outside right view is also a very difficult task **(task)**.
- Although this type of question is generally not difficult to mark, the question itself may generate many alternative answers by the ideal Grade 12 candidates, which are not altogether correct. However, candidates will get part marks for correct aspects of the drawing. The question is marked by a team of subject experts who mark aspects of the question to ensure consistency in marking of all scripts **(expected response)**.

Memorandum/Marking guidelines



Example 3:

Question 3: February/March 2011 P1

Isometric Drawing

Given:

- The front view, top view and left view of a movable coupling.
- The position of point A on the drawing sheet.

Instructions:

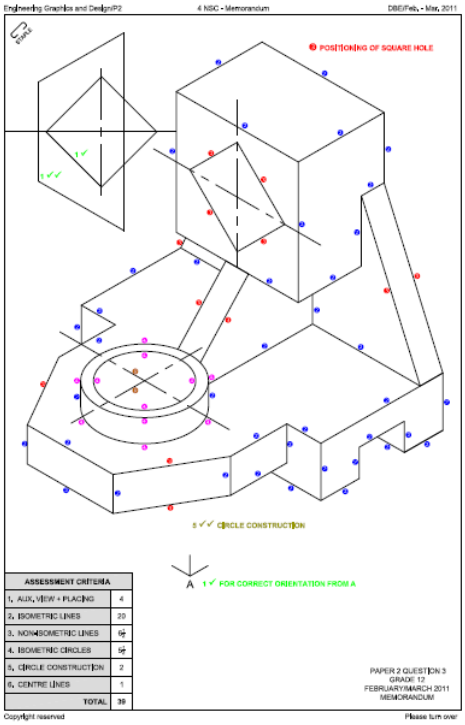
Convert the orthographic views of the movable coupling into a scale 1: 1 isometric drawing.

- Make corner A the lowest point of your drawing.
- Show all necessary circle and other construction.
- No hidden detail is required. (39)

Discussion:

- The complexity of the orthographic projection makes the interpretation of the drawing very difficult. The ideal Grade 12 candidate has to read and interpret the given graphics by unpacking each of the views **(stimulus)**.
- The content in Paper 1 of complex isometric drawings is abstract and very specialised. The content includes spatial perception, circles and auxiliary views. The ideal Grade 12 candidate has to visually imagine what the overall isometric view will look like **(content)**.
- The positioning of the square hole is rather complex. If the ideal Grade 12 candidate does not position the hole on the auxiliary view correctly then the isometric view will be incorrect. The levels (positioning) of each component also contributed to this question being very difficult **(task)**.
- Although this type of question is generally rather easy to mark, the question itself may generate many alternative answers by candidates however, candidates will get part marks for correct aspects of the drawing **(expected response)**.

Memorandum/Marking guidelines



9. Concluding remarks

This exemplar book is intended to be used as a training tool to ensure that all role players in the Engineering Graphics and Design Examination are working from a common set of principles, concepts, tools and frameworks for assessing cognitive challenge when examinations are set, moderated and evaluated. We hope that the discussion provided and the examples of questions shown by level and type of cognitive demand and later by level of difficulty assist users of the exemplar book to achieve this goal.

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