UMALUSI

COUNCIL FOR QUALITY ASSURANCE IN GENERAL AND FURTHER EDUCATION AND TRAINING

Exemplar Book on Effective Questioning

Mathematical Literacy

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 Mathematical Literacy 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

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This Mathematical Literacy 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, Mathematical Literacy 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:

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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 Mathematical Literacy 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 Mathematical Literacy 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) Mathematical Literacy 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 Mathematical Literacy 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

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 Mathematical Literacy 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 Mathematical

Literacy 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 Mathematical Literacy evaluators from previous DBE and the IEB Mathematical Literacy 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 Mathematical Literacy 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 Mathematical Literacy 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 MATHEMATICAL LITERACY 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 Mathematical Literacy CAPS document states that Grade 12 NSC Mathematical Literacy examination papers should examine three levels of cognitive demand (Table 1).

TABLE 1: THE TAXONOMY OF COGNITIVE DEMAND LEVELS FOR THE MATHEMATICAL LITERACY NSC EXAMINATIONS

Level of cognitive demand	Type of cognitive demand
Level 1	Knowing: **K**
Level 2	Applying Routine Procedures in familiar contexts: **RP**
Level 3	Applying Multi-step **Procedures** in a variety of contexts**: MP**
Level 4	Reasoning and Reflecting: **RR**

Source: CAPS (DBE, 2011: 98)

To facilitate reading of this section, each of the above cognitive demand levels in the Mathematical Literacy Taxonomy are explained, and the explanation is followed by at least **three** examples of questions from previous Mathematical Literacy 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 Mathematical Literacy 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.

Note: In the examples provided most of the questions have been selected from past DBE examination Papers (2008-2012). However, because the intention of this exemplar book is to assist examiners and moderators in going forward with the CAPS assessment some of the questions have been specifically created in order to demonstrate a specific level of cognitive demand. This has been done because the design of the examination Papers 1 and 2 in the CAPS is very different from the NCS.

In CAPS **all** questions are to be contextualized and integrated across the four topics, with the basic mathematical skills embedded in the questions. By comparison, Paper 1 in the NCS contained approximately 35 marks for questions which were either (i) pure arithmetic or (ii) focused on only one learning outcome. In the CAPS, there are also topics not covered in the NCS, for instance financial documents and some aspects of measurement. In order to make this instrument as helpful as possible some questions have been created to exemplify these topics and to demonstrate the integrated nature of the CPS assessment requirements. These questions are indicated in *italics.*

Examples 1-3 show questions at Level 1: Knowing.

Example 4 shows a question at Level 2: Applying Routine Procedures in familiar contexts.

Examples 5 and 6 include both Level 1 and Level 2, which is how the questions in Paper 1 of the examination papers will be.

Examples 7-12 show questions at Level 2, Level 3 and Level 4, namely Applying Routine Procedures in familiar contexts, MP, and RR. This is done because the questions in Paper 2 are designed to be about many topics at various levels of cognitive demand but set in one context.

Throughout this document the following abbreviations have been used:

Level 1: Knowing: **K**

Level 2: Applying Routine Procedures in familiar contexts: **RP**

Level 3: Applying Multi-step Procedures in a variety of contexts**: MP**

Level 4: Reasoning and Reflecting: **RR**

Brief explanation (examples) of Cognitive Levels in Mathematical Literacy

Level 1: Knowing (testing basic knowledge)

- Reading information directly from a table/graph.
- Perform basic operations on numbers.
- Measuring accurately.
- Rounding answers appropriately.
- Identifying the appropriate formula to be used in a given calculation.
- Recognising and explaining vocabulary appropriate in a particular scenario.
- Perform conversions within the metric system.

Level 2: Routine Procedure (testing well-known procedure, single-step calculations when everything is given

- Substituting given values into given formula.
- Solving equations by means of trial and improvement or algebraic processes.
- Drawing graphs from given tables of values.
- Constructing a budget from a small household project.
- Using tax deduction tables to determine the amount of tax to be deducted from an employee's salary.
- Measuring the dimensions of the floor of a room and using the dimensions to determine how many running metres of carpeting to buy to cover the floor of the room.
- Calculating the mean, median and/or modal averages of a set of data.
- Increasing or descreasing an amount by a percentage.
- Estimating values provided on a graph/table.
- Converting units of measurements between different systems of measurement using given conversion tables and/or factors.
- Using a given scale to determine actual length or distance.

Level 3: Multi-step Procedure (solving problems where there is no guidance or scaffolding, method to solve the problem not obvious, one or two preliminary calculations need to be perfomed before solving the problem)

- Deciding on the most appropriate graph and an appropriate means of constructing that graph to represent a particular scenario.

- Determining the most appropriate scale in which to draw a plan, determining dimensions according to that scale, and then draw the plan according to those scaled dimensions.
- Determine the quantity of paint needed to paint the wallsof a building by determining the surface area of the walls of a building, using conversion ration to convert the surface area value from square metres to litres, rounding the litres value up to the nearest whole and then making a decision about the most appropriate quantity of paint to be bought based on available tin sizes.
- Using maps, a distance chart, weather report information and other travel resources to plan a trip, giving consideration to where to stop for fuel, estimated travelling distance and time, and estimated travel costs
- Researching the costs involved in a fund-raising activity and preparing a budget for the activity.
- Using given inflation rate to investigate the estimated value of an item over a multiple time period.

Level 4: Reasoning and Reflecting (questions that requires a decision/ opinion/prediction about a particular scenario based on previous calculations or given information)

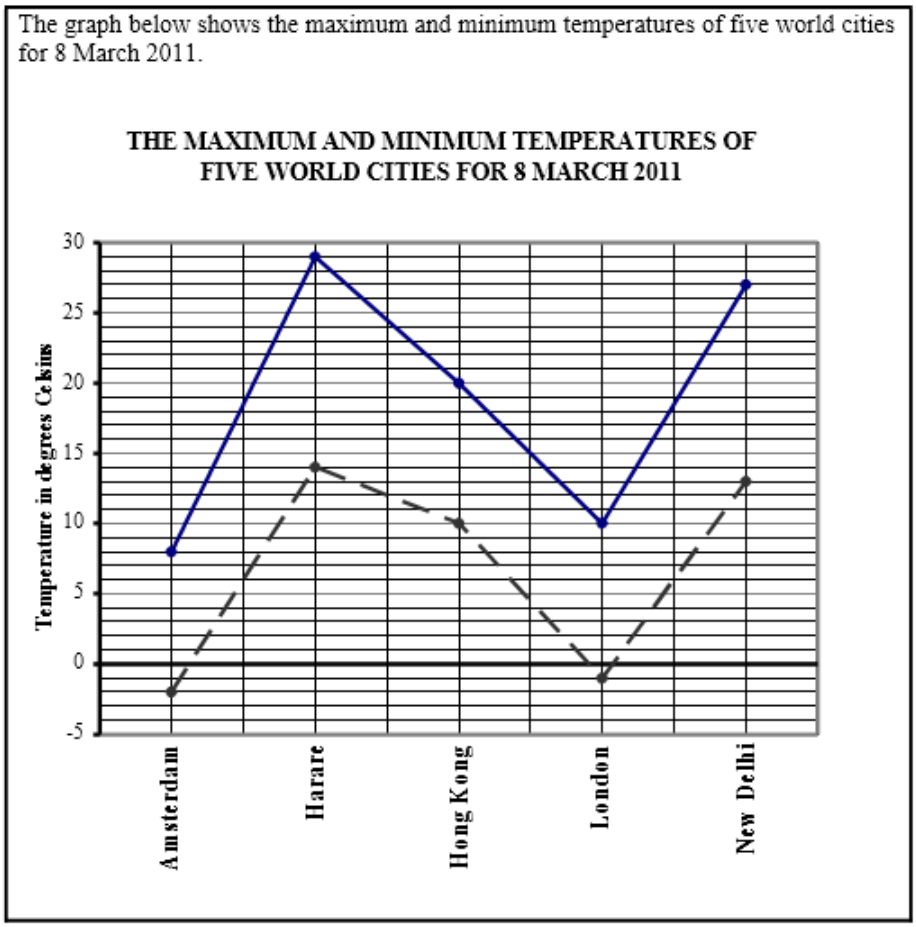
- Providing an opinion on how a particular government minister might react to a particular set of statistics.
- Analysing a completed income-and-expenditure statement for a household and making suggestions on how the members of the household could change their expenditure to improve their financial position.
- Comparing bank charges on two different types of accounts for various transactins and making a decision about the most suitable account for an individual with particular needs.
- Constructing a table to model a loan scenario, taking into account the interest calculated on the loan, the monthly repayment and the closing balance on the loan every month.
- Using the model of the loan scenario to investigate the effect of changes in the interst rate on the loan and the impact of increasing the monthly repayment on the real cost of the loan.
- Designing TWO different types of boxes for packaging an item, comparing the boxes in terms of wasted space (volume) and materials (surface area), and making a decision about the most cost-effective box for packaging the item.
- Questions that require learners to pose and answer questions about mathematics they require to solve a problem, select and use that mathematical cintent, recognise the limitations of using mathematics to solve the problem, and consider non-mathematical techniques and factors that may define or determine a solution to the problem.

TABLE 2: EXAMPLES OF QUESTIONS AT LEVEL 1: (KNOWING)

Example 1:

Question 2, 2011 Paper 1, DBE:

2.1 The graph below shows the maximum and minimum temperatures of five world cities for 8 March 2011.



THE MAXIMUM AND MINIMUM TEMPERATURES OF FIVE WORLD CITIES FOR 8 MARCH 2011.

2.1.1 Write down New Delhi's maximum temperature. (1) **(K)**

Memorandum/Marking guidelines

Question	Solution	Explanation
2.1.1	27 °C ✓A	1A answer (1)

Discussion:

Q2.1.1 requires candidates to read information directly from a simple line graph. The basic skill is knowing how to read simple information accurately from a simple visual representation. All the values and descriptors are provided on the graph. The scale on the vertical axis is unambiguous. There is no interpretation or calculation required. On Page 113 of CAPS document, 2nd bullet from the top, this is classified

as Level 1 question.

Example 2:

Question 3, 2010, Paper 1, DBE:

Each year South Africa generates income from exports (products sold to other countries). The income generated from these exports varies from year to y ear.
Part of the income generated by exports comes from agricultural products.
The table below shows the total income from exports, as well as the percentages of the total earned from agricultural products.

TABLE 2: Relationship between South African exports of agricultural and other products.

YEAR	Total income generated by South African exports (in millions of rand)	Income generated by agricultural exports (in millions of rand)	Percentage of the total income earned by agricultural products
2002	314 927	25 460	8,1
2003	273 127	22 670	8,3
2004	292 079	22 074	7,6
2005	326 385	25 458	7,8
2006	393 047	26 978	6,9

[Source: *South African Year Book*, 2007]

Q3.1.1 Calculate the total income generated by agricultural exports from 2002 to the end of 2006. (2)

Memorandum/Marking guidelines

Ques	Solution	Explanation
3.1.1	R25 460 000 000 + R22 670 000 000 + R22 074 000 000 + R25 458 000 000 + R26 978 000 000 ✓M = R122 640 000 000 or R122 640 million ✓A	1M adding correct numbers 1A simplifying to thecorrect number (2) Max 1 for R 1 599 565 000 000 or R1 599 565 million

Discussion:

The question require candidates to perform basic operations (addition) on numbers (See CAPS document page 112, the fourth last bullet). It is, therefore, classified as a Cognitive Level 1 question.

Example 3:

The following illustrative example was devised by a Mathematical Literacy expert.

Question 1

Mrs Nchunu makes school bags for a pre-school. Here is a list of her materials and expenses.

Item	***Cost***
Blue denim material (fabric)	*R49.99 per metre*
Velcro strips	*R12.50 per metre*
Name tag for each child	*R74.99 for 10*

Each bag requires 1.25m of denim material to make. The pockets and flaps need 20cm of Velcro in total. Mrs Nchunu gets a contract to make 40 bags for a pre-school. She sells them to the parents of the pre-school for R85.00 a bag.

1.1 What is the cost of the denim material for one bag? (2)

Memorandum/Marking guidelines

Ques	Solution	Explanation
1.1	Denim per bag = R49,99 × 1,25 = R62,49 ✓A ✓M	1M correct multiplication 1A simplifying to thecorrect number (2)

Discussion:
The expenses are set out clearly for the denim material for one bag. The list of expenses is also realistic in that material is sold by the metre, as is denim material.

Q 1.1 entails multiplying the length, as given, by the price per metre. This question is classified as Cognitive Level 1 as stated on the fourth last bullet of Page 112 of the CAPS document, viz. performing basic operations on numbers.

TABLE 3: EXAMPLES OF QUESTIONS AT LEVEL 2: (ROUTINE PROCEDURE)

Example 1:

This question was developed by a subject expert.

Question 1

The following illustrative example was devised by a Mathematics Literacy expert.

The tables below contain the Geography marks as a % for the boys and girls in Grade 12.

Boys

56	***75***	***79***	***45***	***57***	***90***	***46***	***57***	***39***	***50***
51	***56***	***82***	***57***	***67***	***60***	***47***	***60***	***77***	***34***

Girls

45	***67***	***80***	***49***	***72***	***57***	***68***	***52***	***91***	***66***
63	***66***	***48***	***35***	***48***	***66***	***73***	***58***	***79***	

1.1.5 What is the mean mark for the boys? (3)

Memorandum/Marking guidelines

Ques	Solution	Explanation
1.1.5	Mean mark for the boys = $\frac{(56+75+79+45+57+90+46+57+39+50+51+56+82+57+67+60+47+60+77+34)}{20}$ ✓MA ✓MA $= \frac{1185}{20}$ $= 59{,}25$ ✓A	1MA adding correct values 1MA dividing by the correct value A correct answer (3)

Discussion:

Q1.1.5 entails calculating the mean by adding all data values of boys and dividing by the number of data values of boys. This is a cognitive Level 2 question as indicated on on top of Page 114 of the CAPS document.

Example 2:

QUESTION 6: 2011, Paper 1, DBE (Adapted)

6.1 The Golden Girls Hockey Club qualified to play in the Wilken Cup Final. In an attempt to encourage her team to score as many goals as possible, the owner of the club developed the following bonus options as an incentive:

OPTION A:

Each player will receive a basic bonus of R4 600 per game plus an extra R250 for each goal scored by the team.
This can be written as:
OPTION A = R4 600 + R250 × number of goals scored

OPTION B:

Each player will receive a basic payment of R4 000 per game plus an extra R400 for each goal scored by the team.

This can be written as:

OPTION B = R4 000 + R400 × number of goals scored

TABLE 2 below shows the total bonus that each team member could receive based on the number of goals scored.

TABLE 2: Total bonus payments for each player

Number of goals scored	**0**	**2**	**4**	**Q**	**7**	**8**
OPTION A (in rand)	4 600	**P**	5 600	6 100	6 350	6 600
OPTION B (in rand)	4 000	4 800	5 600	6 400	6 800	7 200

6.1.1 Calculate the missing values **P**. (2)

Memorandum/Marking guidelines

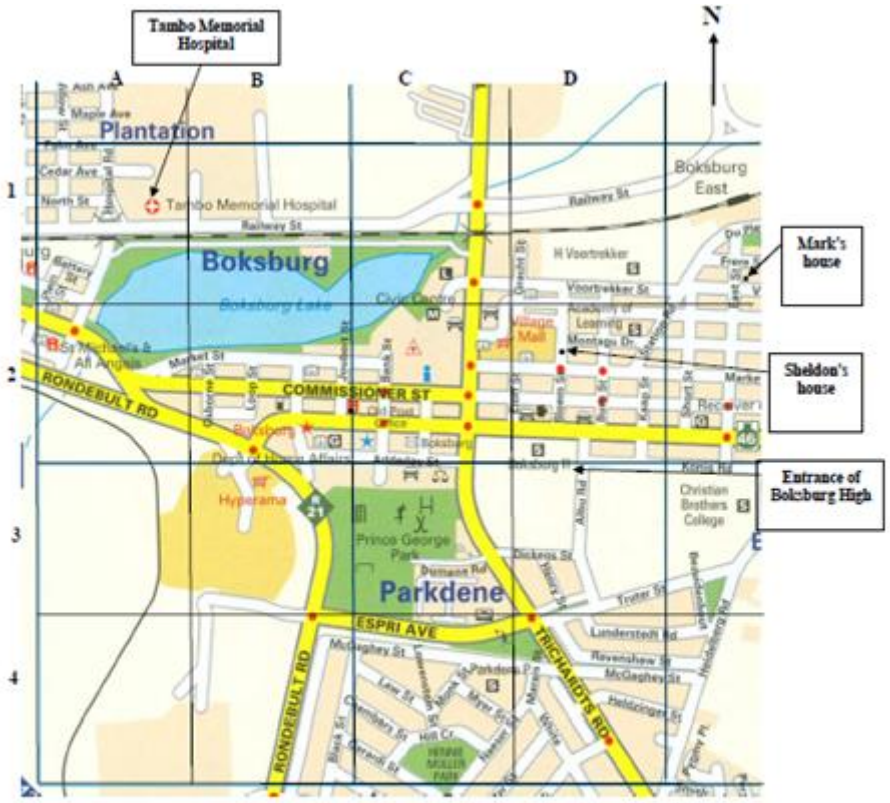
Ques	**Solution**	**Explanation**
6.1.1	P = R4 600 + (R250 × 2) ✓SF = R5 100 ✓A	1SF substitution 1A answer (4)

Q6.1.1 Calculating the value of **P** requires choosing the correct formula from the two given formulae above after reading the table carefully. It then requires a substitution into the formula to find the correct answer. This calculation is a basic, familiar, routine calculation (see the first bullet ubder heading Level 2, on page 113 of the CAPS document).

Example 3:

QUESTION 6, 2008 Paper 1

Detach the map of part of Boksburg on ANNEXURE C from the question paper and use it to answer the questions below.



Sheldon lives in Boksburg and goes to Boksburg High School. He earns some pocket money after school by delivering newspapers.

6.1 …

6.2 Sheldon lives on the corner of Bloem Street and Montagu Drive.

6.2.1 His friend, Mark, lives in East Street between Frere Street and Voortrekker Street. Describe ONE of the routes from his home to Mark's home. (2)

Memorandum/Marking guidelines

Ques	Solution	Explanation
6.2.1	✓M Turn right into Montagu Drive. Go straight until the intersection of Montagu Drive and East Street.✓A Turn left into East Street. Go along until you pass Voortrekker Street. Find friend's house before reaching Frere Street. **OR** ✓M Turn right into Montagu Drive. Go straight until the intersection of Montagu Drive and Station Road. Turn left into Station Road. Go along until you find	1M method for route 1A accuracy for description 1M method for route 1A accuracy for description

✓A

	Voortrekker Street. Turn right into Voortrekker Street and go straight until you find East Street. Turn left into East Street. Find friend's house before reaching Frere Street. **OR** Turn right into Montagu Drive. Go straight until the intersection of Montagu Drive and Short Street. ✓M Turn left into Short Street. Go along until you find Voortrekker Street. Turn right in Voortrekkker Street and go straight until you find East Street. Find friend's house before reaching Frere Street. ✓A **OR** Follow learners own solution.	1M method for route 1A accuracy for description **1 mark if any road mentioned** (2)

Discussion:

Q6.2.1 involves providing a set of directions to travel between two locations in a town using street names. The last bullet from the table on page 124 of the CAPS document, under column "Level 2" of the "Maps" row, classifies this question as Cognitive Level 2.

TABLE 4: EXAMPLES OF QUESTIONS AT LEVEL 3 (MULTI-STEP PROCEDURES) AND AT LEVEL 4 (REASONING AND REFLECTING)

Note: The reason for combining levels 3 and 4 type questions on this table is to provide more authentic and contextualised examples so that those who use this exemplar book can see how the questions relate to one another and affect one another.

Example 1:

QUESTION 1, 2011 Paper 2, DBE

Timothy is a newly qualified marketing graduate. He has been offered two positions, one as a medical sales representative for Meds SA and the other as a tobacco sales representative for ABC Cigs.

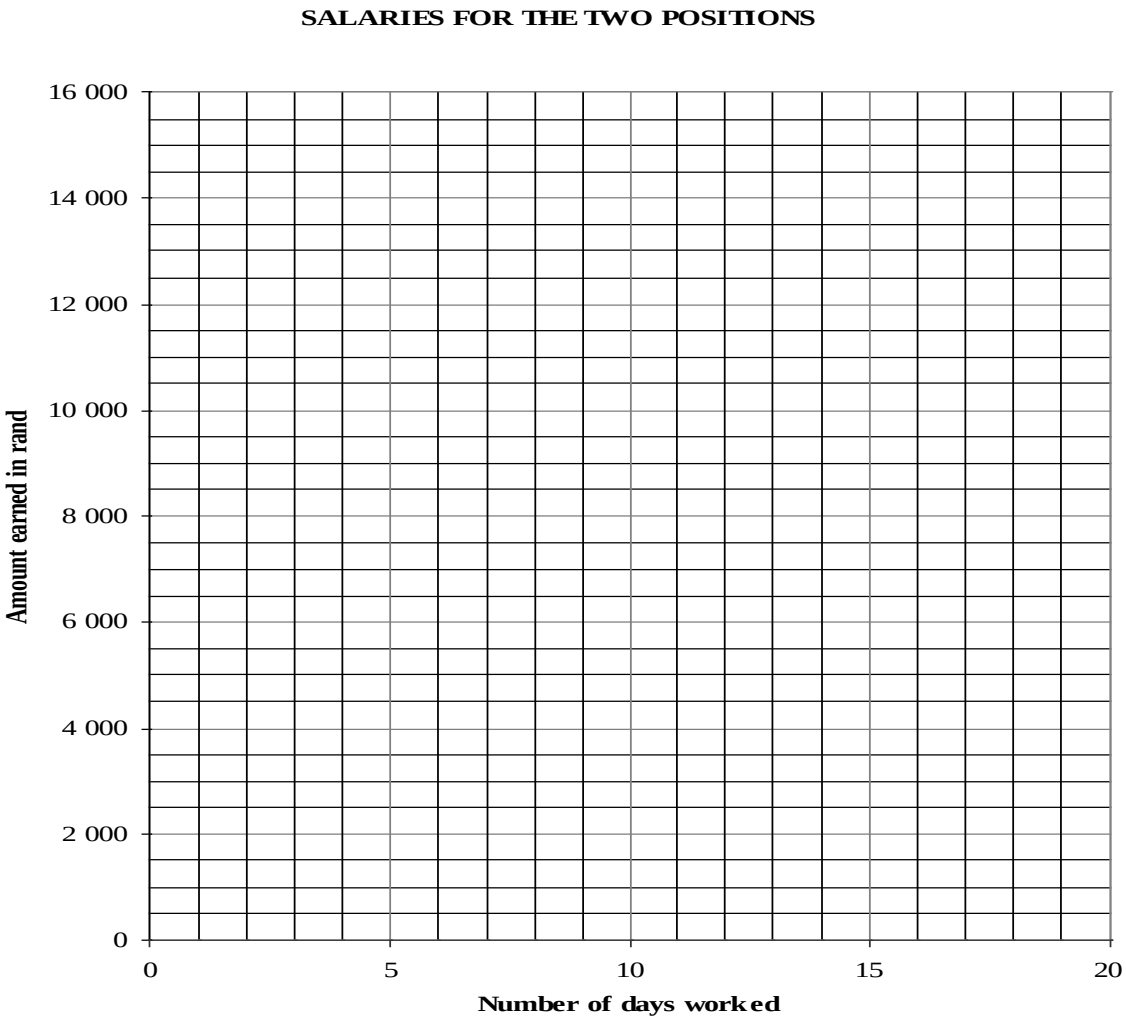
The formula for calculating the monthly salary for a medical sales representative is:

Salary = R3 000 + R500 x number of days worked.

As a tobacco sales representative, he will earn a salary of R750 per day for each day worked in a month. He will only receive a salary if he works for one or more days in a month.

1.1.1 ...

1.1.2 Draw TWO line graphs on the same grid on ANNEXURE A to represent the monthly salaries for both the positions of medical and tobacco sales representatives. Clearly label each graph. (8)



1.1.3 ...

1.2 …

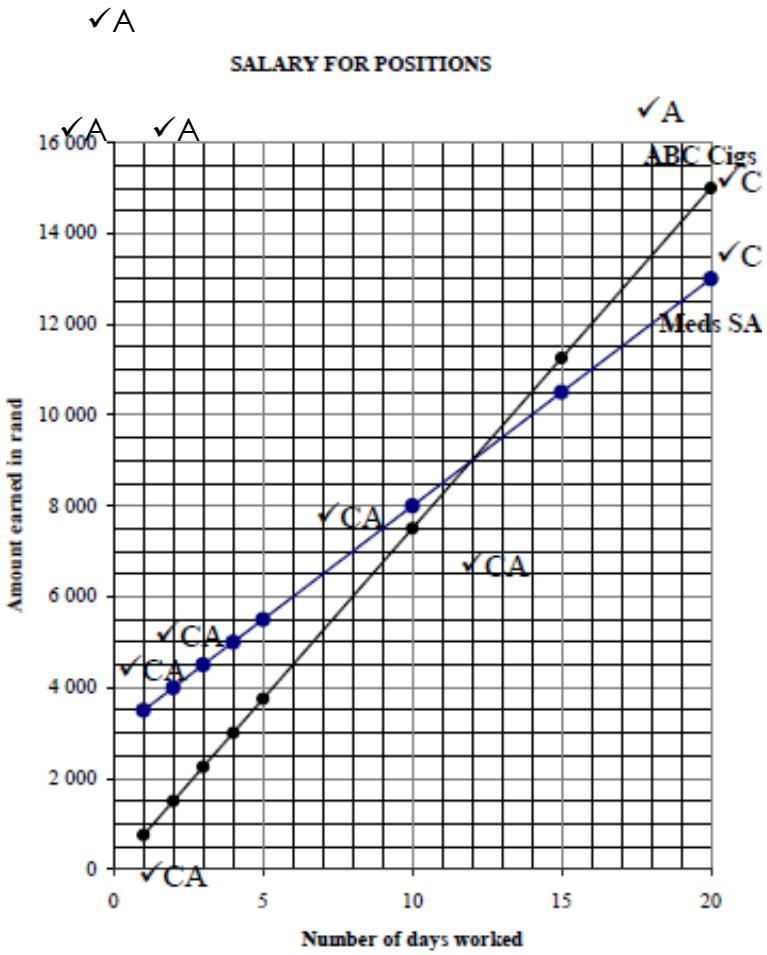
Timothy has difficulty deciding which position to accept as there are other factors besides the salary to consider. Firstly, the offices of ABC Cigs are 40 km further from his home than the offices of Meds SA, and secondly, he is against the smoking of cigarettes. Timothy plans on working for 20 days every month.

- The petrol consumption of Timothy's car is 7,5 ℓ per 100 km. The average cost of petrol is R9,82 per litre.
- He has a car maintenance plan that costs him 70 cents per kilometre travelled.

1.2.1 Determine how much more it would cost him to travel to work each month if he accepted the position at ABC Cigs. (8) **(MP)**

1.2.2 Use the salary and the travel calculations to advise Timothy which of the two positions he should accept. Justify your answer. (4)**(RR)**

Memorandum/Marking guidelines

Ques	Solution	Explanation
1.1.2		SA Meds graph: 1CA (1; 3 500) plotted correctly 1CA (2; 4 000) or any other correct point plotted correctly 1CA (20; 13 000) 1CA joining points 1A correct label for either graph ABC Cigs graph: 1CA (1; 750) 1CA (20; 15 000) 1CA joining points **Penalty 1 mark if Y-axis is joined** (8)
1.2.1	✓A ✓M Total extra distance travelled = 20 × 2 × 40 km = 1 600 km ✓A Extra petrol needed = 1 600 km × 7,5100 km ✓M = 120 λ ✓CA Extra cost = petrol cost + maintenance cost ✓M = 120 λ × R9,82 + 1600 × R0,70 ✓CA = R1 178,40 + R1 120,00 = R2 298,40 ✓CA **OR**	1A number of days and trips 1M extra distance/trip 1Atotal distance **Penalty 2 marks if one way distance calculated** 1M multiplying and dividing 1CA extra petrol needed

	Extra cost per single trip ✓M = 40 km × 7,5 λ ÷ 100 km × R9,82/χ ✓A = R29,46 ✓A Extra maintenance cost per single trip = 40 km × R0,70/km ✓A = R28,00 ✓A Total extra cost per single trip = R29,46 + R28,00 = R57,46 ✓CA ✓A Total extra cost for 2 trips = 2 ×20 × R57,46 = R2 298,40✓CA **OR** Extra cost ✓A ✓M ✓M ✓A ✓A = (20 × 2 × 40km) × 7,5 λ ÷ 100 km × R9,82 ✓A ✓A + (20 × 2 × 40km) × R0,70 = R2 298,40 ✓CA	1M petrol cost 1CA maintenance 1CA simplification OR 1M multiplying and dividing 1A using petrol cost 1A extra petrol cost 1A using maintenance cost 1A extra maintenance cost 1CA cost per single trip 1A number of days and trips 1CA simplification OR 1A number of days and trips 1M extra distance/trip 1M multiplying and dividing 1A petrol needed 1A petrol cost 1A distance maintenance cost 1CA simplification Answer only full marks (8)
1.2.2	He should accept the job at Meds SA. ✓CA ✓CA He will earn R2 000 more per month t ABC Cigs, but will have to pay R2 298,40 more per month for travel. ✓✓J	1CA choice 1CA difference in salary 2J justification

	✓CA OR ✓CA He must choose Meds SA because he earns R298,40 more ✓✓J	(4)

Discussion:

Q1.2.1 entails performing a complicated and unfamiliar calculation involving petrol consumption costs. Learners are expected to calculate total extra distance; the extra petrol required for the extra distance; and the extra cost that considers the petrol cost and maintenance cost as a results of the extra distance. The last sentence of the first paragraph under the heading "Level 3: ..." on page 114 of the CAPS document classifies this question as level 3, as learners are expected to perform one or more preliminary calculations/tasks before determining the solution. (MP)

Q1.2.2 entails performing two complicated and unfamiliar calculations involving many factors, and making a decision about the best option. The first bullt under heading "Level 4:..." on page 115 of the CAPS documentclassifies this question as reasoning and reflection, as learners are expected to make a decision/give opinion about a particular scenario based on calculations in previous questions (Q1.1.2 and Q1.2.1) (RR)

Example 2:

QUESTION 4, 2010 Paper 2, DBE

Triggers Enterprises was awarded the tender for making rectangular cardboard boxes to package bottles of cough syrup. Each bottle is packed in a cardboard box with a square base, as shown below.

- The diameter of the base of the bottle is 58 mm and the height of the box is 143 mm.
- The length of the side of the base of the box must be approximately 105% of the diameter of the base of the bottle.
- The height of the box is approximately 102% of the height of the bottle.

The following formulae may be used:

Area of circle = $\pi \times (\text{radius})^2$, and using $\pi = 3{,}14$

Area of square = $(\text{side length})^2$

Area of rectangle = length × breadth

Area of opened cardboard box = $4(A + D) + 2(B + C) + E$

(See design of open cardboard box in QUESTION 4.3)

The following conversions may be useful:

$1\ cm^2 = 100\ mm^2$

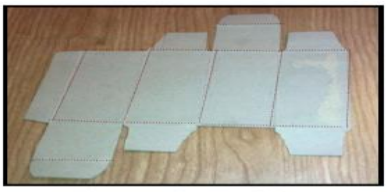
1 m² = 10 000 cm²

4.1 …

4.2 …

To ensure that the box is strong enough, the cardboard used for the box has a mass of 240 grams per m^2 (g/m^2).

The layout of the opened cardboard box is shown below.



Picture of opened box

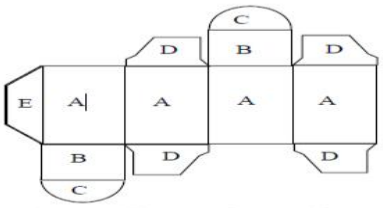


Diagram of layout of opened box

- Section C is semicircular.
- The area of each section D = 1 832 mm^2
- The area of section E = 2 855 mm^2.

4.3.1 Calculate the total mass of the cardboard needed for one box, to the nearest gram. (11) (MP)

Memorandum/Marking guidelines

Ques	Solution	Explanation
4.3.1	Area A = 143 mm × 60,9 mm ✓M = 8 708,7 mm^2 ✓CA	1M calculating area 1CA simplifying
	Area B = $(60,9\ mm)^2$ = 3 708,81 mm^2 ✓CA	1CA area B
	Area C = $\frac{1}{2} \times 3,14 \times \left(\frac{60,9\,mm}{2}\right)^2$ ✓SF	1SF substitution into correct formula
	= $\frac{1}{2} \times 2\,911,41585\ mm^2$	
	= 1 455,71 mm^2 ✓CA	1CA simplifying
	Area of open box = 4 (A + D) + 2(B + C) + E ✓SF = 4 (8 708,7 + 1 832) mm^2 + 2 (3 708,81 + 1 455,71)	

	mm^2	1SF (CA) substitution
	$+ 2\ 855\ mm^2$	
	$= 55\ 346{,}84\ mm^2$ ✓CA	1CA simplifying
	$= \frac{55346{,}84}{1000000} m^2$ ✓C	1C converting to m^2
	$= 0{,}055346...\ m^2$	
	Mass of box = $240\ g/m^2 \times \frac{55346{,}84}{1000000} m^2$ ✓M	1M multiplication 1S simplifying 1R rounding
	$= 13{,}2832...g$ ✓S	Accept 13 g
	$= 14\ g$ ✓R	If area rounded off to $0{,}06\ m^2$ then mass = 15 g
	OR	
	Area A = 143 mm × 61 mm ✓SF $= 8\ 723\ mm^2$ ✓CA	1SF substitution 1CA area A
	Area B = 61 mm × 61 mm $= 3\ 721\ mm^2$ ✓CA	1CA area B
	Area C = $\frac{1}{2} \times 3{,}14 \times \left(\frac{61mm}{2}\right)^2$ ✓SF	1SF substitution
	$= \frac{1}{2} \times\ 2\ 920,\ 985\ mm^2$	
	$= 1\ 460{,}49\ mm^2$ ✓CA	1CA area C
	Surface area	
	$= 4\ (A + D\ ) + 2(B + C) + E$ ✓SF	
	$= 4\ (8\ 723 + 1\ 832)\ mm^2 + 2\ (3\ 721 + 1\ 460{,}49)\ mm^2$ $+ 2\ 855\ mm^2$ ✓CA	1SF substitution
	$= 55\ 437{,}98\ mm^2$	
	$= \frac{55437{,}98}{1000000} m^2$ ✓C	1CA surface area

	$= 0{,}055...\ m^2$ Mass of box $= 240\ g/m^2 \times 0{,}055...$ ✓M $= 13{,}31\ g$ ✓S $= 14\ g$ ✓R	1C converting to m^2 1M multiplication 1S simplification 1R rounding (11)

Discussion:
Q4.3.1 involves calculating the area of each shape on the box, then the total surface area of an open rectangular box, converting square mm to square metres. Lastly, multiplying the mass per area by the total surface area in order to determine the required mass. On page 114 of the CAPS document, the first paragraph under the heading "Level 3", classifies this question as Cognitive Level 3 as it consists of preliminary calculations to be performed, (MP).

Example 3:

QUESTION 1, 2012 Paper 2, DBE

1.1

The Nel family lives in Klerksdorp in North West. They travelled by car to George in the Western Cape for a holiday. A map of South Africa is provided below.

MAP OF SOUTH AFRICA SHOWING THE NATIONAL ROADS

KEY: N1–N12, N17 represent national roads.

Use the map above to answer the following questions.

1.1.1 …

1.1.2 …

1.1.3 …

1.2 The Nel family (two adults and two children) were on holiday for nearly one week.

- They left home after breakfast on Saturday morning and arrived at the guesthouse in time for supper.
- On Sunday and Wednesday they ate all their meals at the guesthouse.
- On Monday they visited a game park.
- On Tuesday they went on a nature walk.
- On Thursday they went on a boat cruise.
- They left George after breakfast on Friday and returned to Klerksdorp.

Table 1: The Nel family's holiday costs.

Table 1: The Nel family's holiday costs.

	ITEM	COST	
1	Accomodation only	R1 050 per day per family	
2	Meals at the guesthouse:		
	Breakfast	R60 per person per day	
	Lunch	R90 per person per day	
	Supper	R120 per person per day	
3	Travelling costs:		
	Long distance driving (to and from Klerksdorp) and meal costs en route	R1 602,86 for the return trip	
	Local driving (in and around George)	R513, 60 for the duration of the holiday	
4	Entertainment costs:		
	Nature walk, including breakfast	R120 per adult and R100 per child	
	Visit to the game park, including lunch	R200 per person	
	Boat cruise, including supper	R200 per adult and R150 per child	
	Other entertainment	R2 000	
*All costs above include value-added tax (VAT).			

Use the information above to answer the following questions.

1.2.1 …

1.2.2 (a) …

(b) Use TABLE 1 and the equation obtained in QUESTION 1.2.2(a) to calculate the total cost of the meals that they ate at the guesthouse if they ate THREE meals daily. (4) (MP)

1.2.3 Mr Nel stated that the total cost of the holiday was less than R20 000. Verify whether or not Mr Nel's statement is correct. ALL calculations must be shown. (9) (MP) (RR)

Memorandum/Marking guidelines

Question	Solution	Explanation
1.2.2 (b)	Total cost (in rand) ✓S ✓S = (60 ×4×5) + (90×4 ×4)+ (120×4 ×5) = 1200 + 1440 + 2400✓CA = 5040✓CA	REFER TO CANDIDATE'S FORMULA Correct answer only – full marks
	OR Total cost (in rand) = (60 × *x*+90 ×*y* +120×*z*)×4 ✓S✓S = (60 ×5 +90 ×4 +120 ×5)×4 = 1260 ×4✓CA = 5040✓CA	1S correct substitution of number of people 1S correct substitution of number of meals 1CA simplification 1CA total
	OR (using equation rom 1.2.2 (a) working with dailycost) Total cost (in rand) = 1260 ×4✓S✓S = 5040 ✓CA ✓CA	1S correct subst. no. ofpeople 1S correct subst. no. ofmeals 1CAsimplificatio n 1CAtotal
	OR (calculating total daily costs) Cost of meals: Saturday = R120 ×4 = R480 Sunday = (R60+R90 +R120)×4 = R1080 Monday = (R60 +R120)×4= R720 ✓S Tuesday = (R90+R120)×4 = R840 Wednesday = (R60 +R90 +R120)×4 = R1080 Thursday = (R60 + R90)×4 = R600 ✓S Friday = R60 ×4 = R240✓CA	2S substitution ofno. ofpeople 2CAtotal
	Total cost (in rand) = 480 +1 080 +720+840+1 080+600+240 = 5040 ✓CA	2S correct subst. dailycost
	OR (calculating total cost of types ofmeals)	1CAsimplification
	Total cost ofbreakfast =R60 ×5×4 = R1200✓S	1CAtotal
	Total cost oflunches = R90 ×4×4 = R1440✓S	2S correct subst. meal cost

	Total cost ofsuppers = R120 ×5 ×4 =R2400 ✓CA Total cost (in rand) = 1 200 +1440+2400 = 5040✓CA	1CAsimplification 1CAtotal (4)
1.2.3	Cost fornaturewalk = (R120 ×2) +(R100 ×2) ✓M/A = R440 ✓CA Cost forgamepark = R200 ×4 = R800 ✓A Cost for boat cruise = (R200 ×2)+ (R150×2)✓M/A = R700 ✓CA Total entertainment cost=R440 +R800 +R700 +R2 000 =R3 940 ✓CA Six day option: Total cost forthetrip (accom. +meals +longdist.+local +ent) ✓ M / A = R6300 +R5040 +R1602,86 +R513,60 +R3940 = R17396,46✓CA **OR** Seven day option: Total cost forthetrip (accom. +meals +longdist.+local +ent) ✓ M/A = R7350 +R5040 +R1602,86 +R513,60 +R3940 = R18 446,46✓CA ∴MrNel'sestimatewasCORRECT ✓J	1M/A expression for cost 1CAsimplification 1A cost forgame park 1M/A expression for cost 1CA simplificaion 1CA total cost 1M/A adding all costs 1CAtotal cost 1M/A adding all costs 1CAtotal cost 1Jverification (9)

Discussion:
Q1.2.2(b) involves using a derived formula to calculate an amount by reading text and then substituting values from a table of values. This entails determining the cost per meal per days and for a certain number of people. In this question, there is far less direction or guidance on how to solve this question (see the third paragraph under heading "Level 3" on Page 114 of the CAPS document. (MP)
Q1.2.3 entails using amounts calculated in previous questions. Candidates also

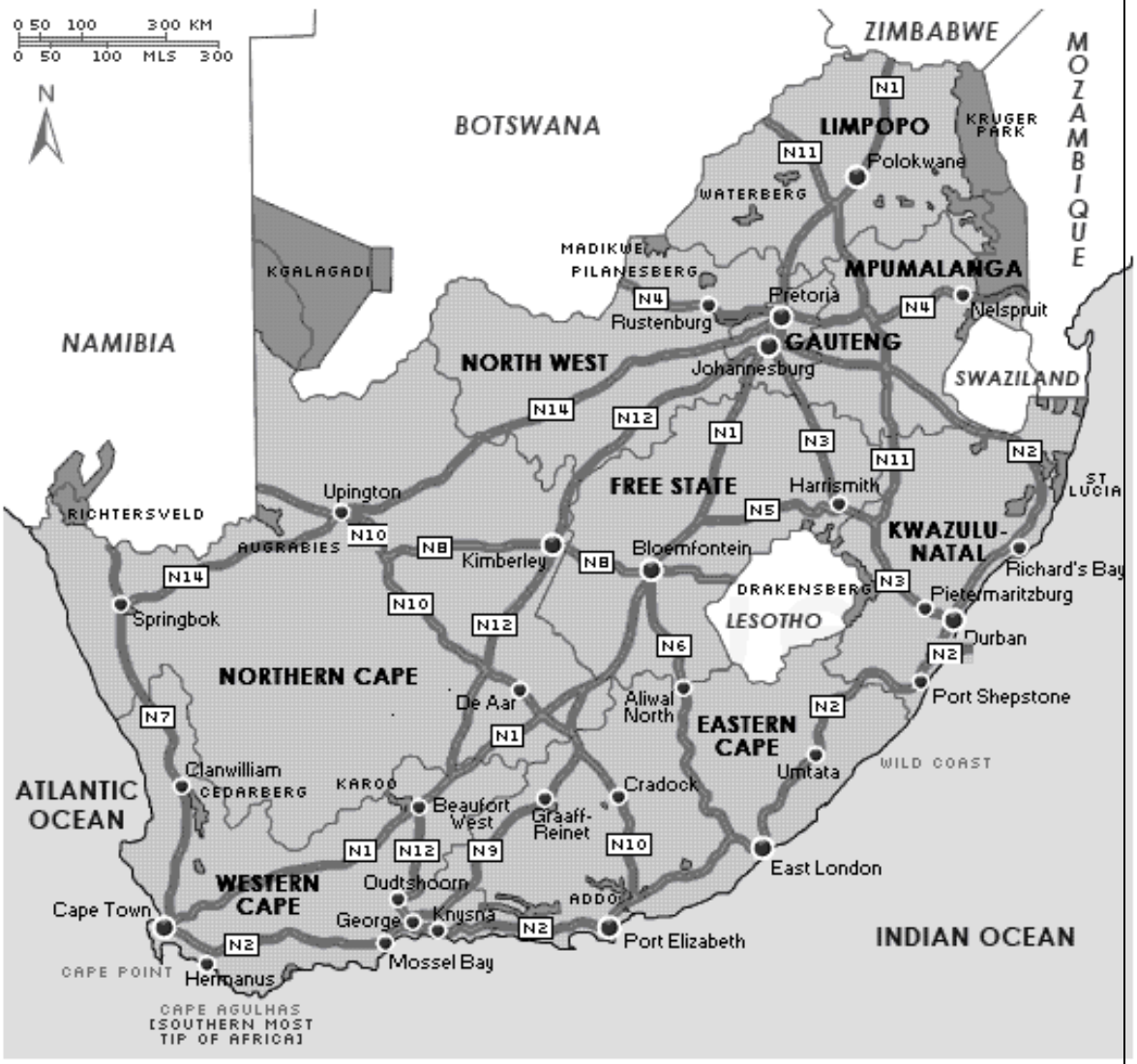
have to calculate sub-totals in different age categories, and calculate a total amount. They have to draw a conclusion about the total amount. The first bullet under heading "Level 4" on Page 115 of the CAPS document, classifies this question as Cognitive Level 4 as it requires a learner to make a decision about a particular scenario based on calculations. (RR)

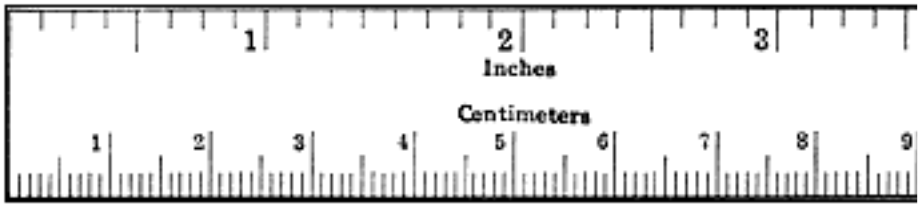
Example 4:

QUESTION 3, 2011 Paper 2

The Naidoo family live in Pietermaritzburg. A map of South Africa showing the national roads (marked N1, N2, et cetera) is given on ANNEXURE D.

ANNEXURE D: MAP OF SOUTH AFRICA





RULER

Use the map on ANNEXURE D to answer the following questions.

3.1 …

3.1.1 (a) …

(b) …

3.1.2 …

3.1.3 The family left Pietermaritzburg with a full tank of petrol. Along the way they stopped at a petrol station to refuel at a cost of R455,40. The capacity of the tank is 60 litres and the cost of fuel is R10,12 per litre.

(a) Before refuelling, the fuel gauge indicated that the tank was half full. Verify, showing ALL calculations, whether the fuel gauge was working properly. (6) **(RR)**
(b) If the car's fuel consumption was 9 litres per 100 km, determine how far they were from Johannesburg when they refuelled. (3) **(MP)**

Memorandum/Marking guidelines

Ques	Solution	Explanation
3.1.3 (a)	Amount of fuel bought $\times$ R10,12 per litre = R455,40 Amount of uel bought = $\frac{\text{R455,40}}{\text{R10,12 per litre}}$ ✓M ✓A = 45 litres ✓CA Fuel left in the tank = 60 λ - 45 λ ✓M = 15 λ ✓CA The gauge was NOT working correctly. ✓CA	1M division 1A using correct values 1CA petrol filled 1M subtracting 1CA petrol before filling 1CA decision (6)
3.1.3 (b)	They used 9 λ to cover 100 km 1 λ to cover $\frac{100}{9}$ km	

✓CA

	45 λ to cover $\frac{100}{9} \times$ 45 km ✓M = 500 km ✓CA Distance from Johannesburg = 600 km – 500 km = 100 km	1M dividing by the consumption rate 1CA distance travelled 1CA solution **(accept 55 km to 145 km)** (3)

Discussion:
Q3.1.3(a) entails verifying the claim that half the fuel was used (what the fuel gauge shows). Candidates have to calculate the cost of filling a half tank of petrol from unit cost (of litres) and number of units (litres). They have to compare that to the given amount paid for filling tank and draw a conclusion (make a decision based on calculations – see Page 115 of CAPS document) about the fuel gauge. **(RR)**

Q3.1.3(b) involves calculating the distance travelled by first determining the distance covered by 45 litres using the distance covered by 1 litre, and then subtracting it from the total distance to be covered between the two places. This is a multiple step procedure, as there are preliminary calculations to be performed before solving the problem. **(MP)**

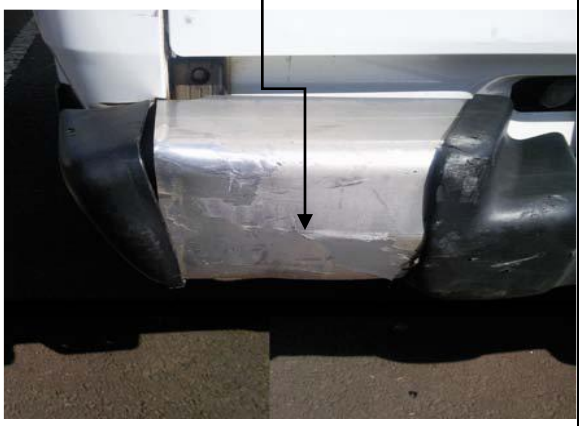
QUESTION 2, 2011 Paper 2

Ms Vermaas had an accident with her bakkie. The left rear end of her vehicle was hit, resulting in damage to the bumper and the tail gate. Below are pictures of the damages to Ms Vermaas' bakkie.

Tailgate

THE LEFT REAR END OF THE BAKKIE

Bumper



ENLARGED PICTURE OF THE DAMAGED BUMPER

She obtained quotations from three panel beaters (Gail's Panel Beaters, TBOS' Panel Shop and Dong's Panel Beaters) for the repair of the damages to the

bakkie.
Each of the quotations (summarised in ANNEXURE B) lists the parts to be replaced, repair work and paint work. The quotations excluded 14% VAT (Value Added Tax).

An additional amount has to be added to each quotation for sundries and consumables. Sundries: administrative cost like telephone calls made to clients and suppliers. Consumables: cleaning materials.

2.1 …

ANNEXURE B

QUESTION 2.1: SUMMARY OF QUOTATIONS FROM PANELBEATERS

GAIL'S PANELBEATERS			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip and assemble				3,75	750,00
Paint	Rear bumper		1	850,00		
Replace	1 tailgate	5 348,26				
	1 L/Rear bumper	298,35				
	1 L/Rear bumper end	368,17				
	1 centre bumper rubber	584,75				
Total Parts Costs		R6 599,53	Total Labour Costs = R1 600,00			

TBOS' PANELSHOP			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble/ Repair work	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip and assemble				2,5	400,00
Paint	Repaired areas		1	1 000,00		
Replace	Towbar cover	514,08				
	Towbar centre step	505,22				
	Towbar ends	638,36				
Repair	Tailgate				5,0	800,00
	Towbar				3,75	600,00
Total Parts Costs		R1 657,66	Total Labour Costs = R2 800,00			

DONG'S PANELBEATERS			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip & assemble				3,5	700,00
Paint	Repaired areas		2	1 800,00		
Replace	1 tailgate	5 348,26				
	1 tailgate badges	749,13				
	1 rear bumper and tow hitch	2 592,50				
Total Parts Costs		R8 689,89	Total Labour Costs = R2 500,00			

SUMMARY OF QUOTATIONS FROM PANELBEATERS

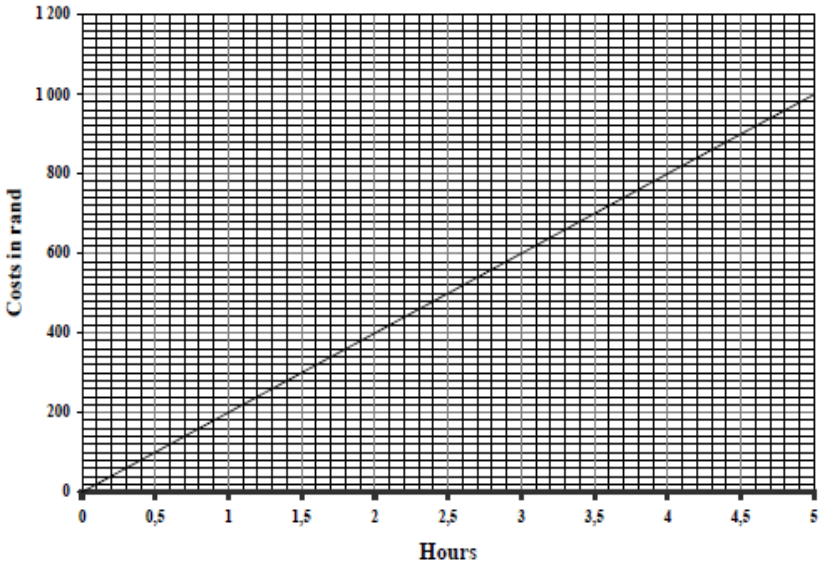
2.2

Dong's Panel Beaters and TBOS' Panel Shop displayed graphs in their offices, showing their charges per hour for stripping and assembling a vehicle. The graphs of the two companies are drawn on ANNEXURE C.

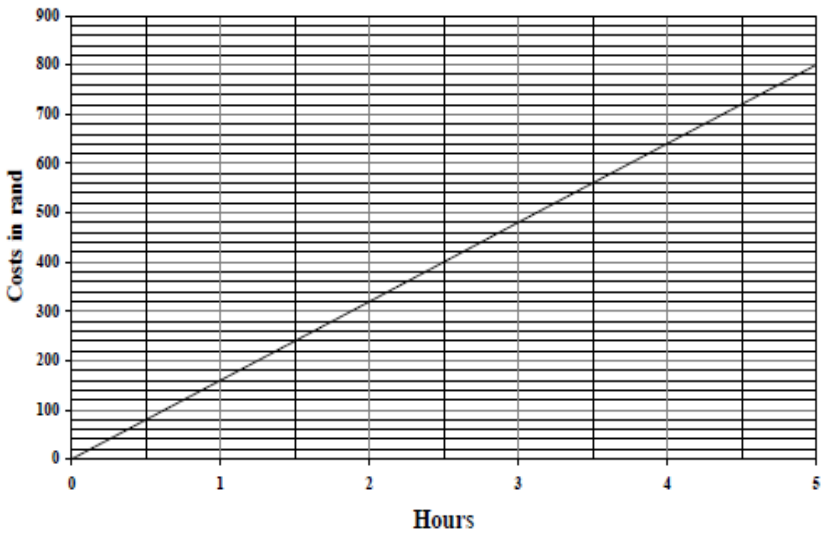
ANNEXURE C

QUESTION 2.2

GRAPH X: COSTS FOR STRIP AND ASSEMBLE



GRAPH Y: COSTS FOR STRIP AND ASSEMBLE



2.2.1 Use ANNEXURE B and the graphs drawn on ANNEXURE C to identify which graph (GRAPH X or GRAPH Y) represents the charges for stripping and assembling by TBOS' Panel Shop. Explain your answer. (2)**(RR)**

Memorandum/Marking guidelines

Ques	Solution	Explanation
2.2.1	Graph Y We know this because Graph Y passes through the point (2,5;400) **OR** (1; 160)	1A identifying correct graph 1RG any correct point used in explanation (2)

Discussion:
Q2.2.1 entails interpreting two graphs to identify the one which corresponds with information in a complex table. This is done by first finding the gradient of the graphs, and then compare that with the charge rates from different companies on the table. Lastly, making a decision. This is a typical Cognitive Level 4 question, where there is a lot of reasoning and reflection, with a decision to be made eventually. **(RR)**

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'withthe allocated percentageof marks for questionsat 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 contribute to the cognitive challenge of a 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 levelson theirown 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 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 Mathematical Literacy NSC examination **candidate**.
4. Question difficulty is determinedusing **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 *typeof cognitive process* that is required to answer a question, and this does not necessarily

equate or align with the *levelof difficulty*of other aspects of a question, such as the difficulty of the content knowledge that is being assessed. For

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 5.

TABLE 5: LEVELS OF DIFFICULTY OF EXAMINATION QUESTIONS

1	2	3	4
Easy for the envisaged Grade 12 student to answer.	**Moderatelych allenging** 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 Mathematical Literacy 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 5). In other words, assessment of question difficultyis 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 Mathematical Literacy 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 Mathematical Literacy 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 ideal 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 difficultyof examination questionsin this framework are as follows.

1. '**Content difficulty'**refers to the difficultyinherent 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 difficultyimposed 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 makingconnections. 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 presentfora question to beratedas 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 thanmultiple-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 l 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 difficultyor 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 difficultyor 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 difficultyor 'easiness' refer to those features of question difficultyor '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 difficultyof 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, andquestion 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

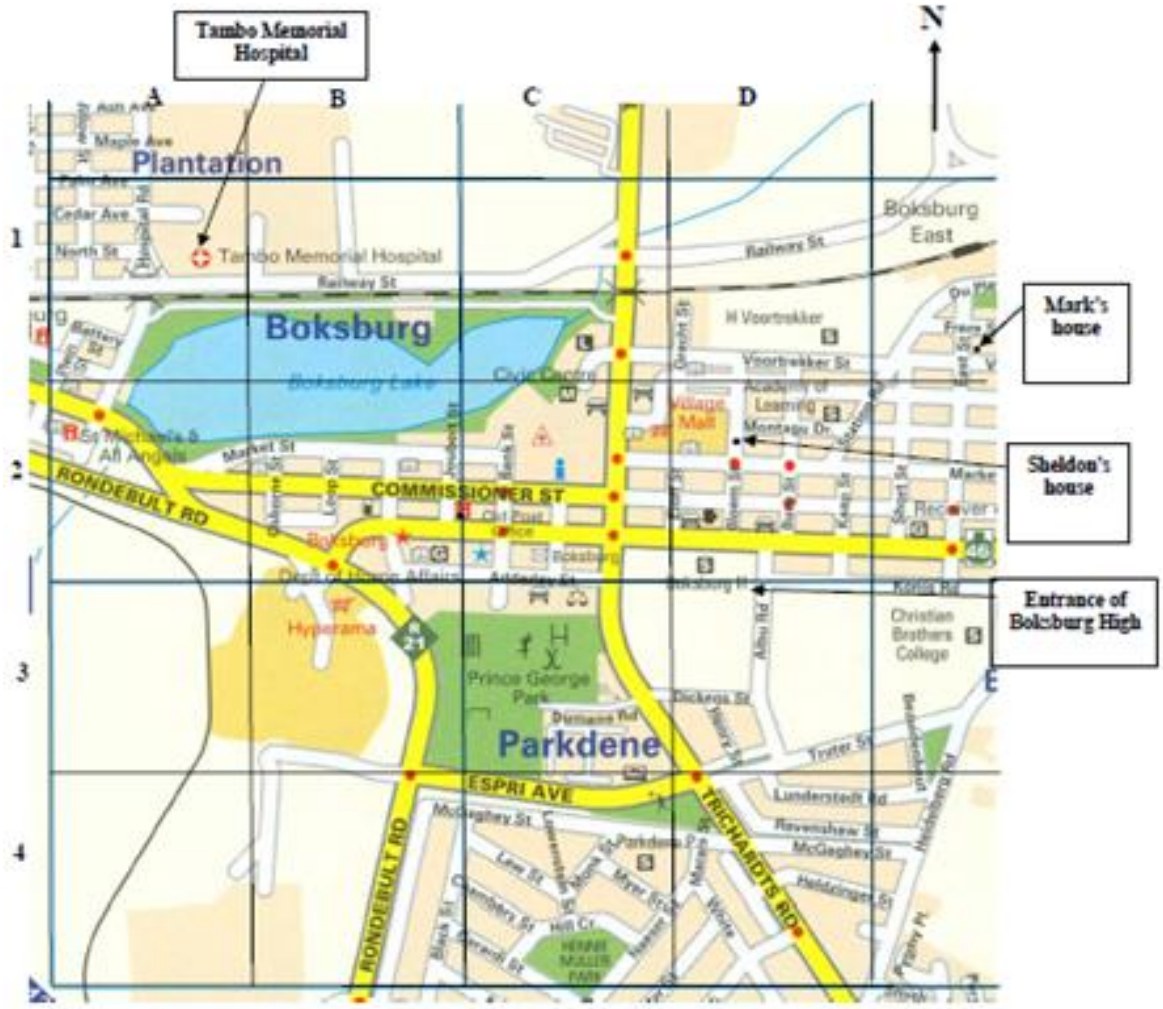
This section provides at least **three** examples of questions from previous Mathematical Literacy NSC examinations (Table 7 to Table 10) categorised at each of the four levels of difficulty described in Section 7 (Table 5), above. These examples were selected to represent the **best and clearest** examples of each level of difficulty that the Mathematical Literacy 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 6, 2008 Paper 1, DBE

Detach the map of part of Boksburg on ANNEXURE C from the question paper and use it to answer the questions below.



The scale of the map is 1:16 000.

Sheldon lives in Boksburg and goes to Boksburg High School. He earns some pocket money after school by delivering newspapers.

6.1 Write down the grid reference for the Tambo Memorial Hospital. (1)

Memorandum/Marking guidelines

Question	Solution	Explanation
6.1	A1 or 1A ✓A	1A correct grid reference (1)

Discussion:

- The two sentence scenario is easy to understand and describes an 'everyday' setting which should be familiar to Grade 12 candidates. Question 6.1 is simply phrased. The term 'grid reference' should be familiar to all Grade 12 Maths Literacy candidates. The source material comprising a grid map of part of Boksburg has textboxes with arrows which clearly indicate where four different buildings are located including the Tambo Memorial Hospital. The location of the textbox for the Hospital is on the top left corner of the map, which means that it is probably the first textbox that candidates will see and read. All these factors make the **stimulus** easy to read and understand in relation to answering this question.
- Candidates have to know how to identify a position on a map in terms of a grid reference. This **content** is easy.
- The **task** of writing down a grid reference should be familiar to the envisaged Grade 12 candidate. They should find it easy to locate and read the labels of the column and row where the Hospital is especially as the clearly labelled textboxes with arrows point to its location. The place they have to locate is on the top left corner of the map, which makes it easier to find than if it was somewhere in the middle of the map.
- One mark is allocated for the correct grid reference which consists of writing just one correct letter and one correct number. It is not important whether they write the number or the letter in any particular order. Marking the question is thus straightforward as the **expected response** is easy

This question is, therefore, easy for an envisaged Grade 12 learner.

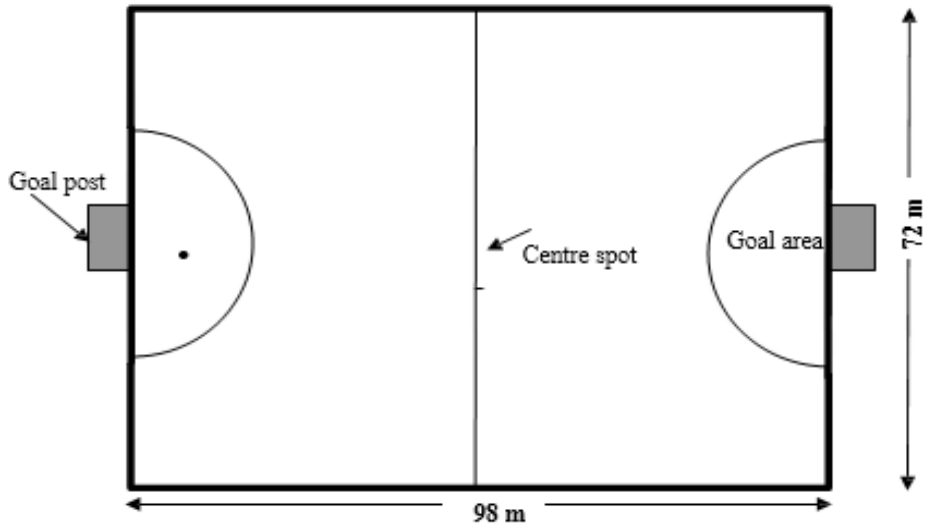
Example 2:

QUESTION 6: 2011, Paper 1, DBE (adapted)

6.2 Two weeks before the final hockey match, a concert was held on the hockey field. The stadium manager inspected the field after the concert and found that some of the lines on the field were unclear and part of the grass on the field was damaged.

The dimensions of the hockey field are: length = 98 m

breadth = 72 m



The following formulae may be used:

Perimeter of a rectangle = 2 (*l* + *b*), where ***l*** = length and ***b*** = breadth

Area of a circle = π × **(radius)**^{2}, using π **=** 3,14

6.2.1 All the outside boundary lines (bold lines) have to be re-marked and one of the goal areas (semicircle) has to be re-grassed.

(a) Determine the total length of the boundary lines of the hockey field that need to be re-marked.
(NB: the entire boundry must be remarked, including the part occupied by the goal posts on the boundry line) (3)

Memorandum/Marking guidelines

Question	Solution	Explanation
6.2.1 (a)	Perimeter = 2 (98 m + 72 m) ✓M = 340 m ✓A ✓A	1M substitution 1A simplification 1A unit (3)

Discussion:

- The leading sentence of Question 6.2.1 "all the boundary lines (bold lines) … " is giving an idea of what to look for from a provided diagram, hence making the question easy. Question 6.2.1 (a) itself is very explicit and easy to understand. Grade 12 candidates should know that a 'boundary' is a perimeter. The source material for answering this question consists of a short description of the scenario and a simple diagram of the hockey field. The length and breadth of the hockey field are clearly labelled and marked on the diagram and both are shown in the same units. The boundary line is also clear as it is drawn in a very thick line compared to the rest of the lines on the diagram. In addition, the formula for calculating the perimeter is even provided in the source material, with the explanation of its variables. The information inside the bracket (bolded) is giving clear guidance as to which parts of the boundry line must be considered). All these factors make the

stimulus easy to understand**.**

- Here the task entails doing a familiar, basic calculation by substituting the given values into a known given formula, or simply adding all the given sides of a rectangle. This **task** is easy, as the given values are of the same units, and the shape is a rectangle.
- Candidates need to know how to calculate the perimeter by substituting given values into a given formula, or how to calculate a perimeter of a rectangle by adding all its sides. This **content** is easy for the envisaged Grade 12 candidate as it would have been dealt with in Grade 10 and 11).
- According to the memorandum, one mark is awarded for choosing the correct formula, one mark for substituting the given values into the formula, and one mark for getting the correct answer. However, candidates can also get all 3 marks for simply adding all the given sides of the rectangle (knowing that the opposites sides of a rectangle are equal) mentally/or by means of a calculator, and just writing the correct answer. The **expected response** is therefore easy.

The level of difficiculty is, therefore, easy.

Example 3:

Question

QUESTION 2, 2011 Paper 2, DBE

Ms Vermaas had an accident with her bakkie. The left rear end of her vehicle was hit, resulting in damage to the bumper and the tail gate. Below are pictures of the damages to Ms Vermaas' bakkie.

Tailgate

THE LEFT REAR END OF THE BAKKIE

Bumper

ENLARGED PICTURE OF THE DAMAGED BUMPER

She obtained quotations from three panel beaters (Gail's Panel Beaters, TBOS' Panel Shop and Dong's Panel Beaters) for the repair of the damages to the bakkie.

Each of the quotations (summarised in ANNEXURE B) lists the parts to be replaced, repair work and paint work. The quotations excluded 14% VAT (Value Added Tax).

An additional amount has to be added to each quotation for sundries and

consumables. Sundries: administrative cost like telephone calls made to clients and suppliers. Consumables: cleaning materials.

ANNEXURE B

QUESTION 2.1: SUMMARY OF QUOTATIONS FROM PANELBEATERS

GAIL'S PANELBEATERS			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip and assemble				3,75	750,00
Paint	Rear bumper		1	850,00		
Replace	1 tailgate	5 348,26				
	1 L/Rear bumper	298,35				
	1 L/Rear bumper end	368,17				
	1 centre bumper rubber	584,75				
Total Parts Costs		R6 599,53	Total Labour Costs = R1 600,00			

TBOS' PANELSHOP			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble/ Repair work	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip and assemble				2,5	400,00
Paint	Repaired areas		1	1 000,00		
Replace	Towbar cover	514,08				
	Towbar centre step	505,22				
	Towbar ends	638,36				
Repair	Tailgate				5,0	800,00
	Towbar				3,75	600,00
Total Parts Costs		R1 657,66	Total Labour Costs = R2 800,00			

DONG'S PANELBEATERS			LABOUR COSTS			
			Paint/ Spray		Strip and Assemble	
Method	Parts/Description	Price in rand	Hours	Total in rand	Hours	Total in rand
Strip	Strip & assemble				3,5	700,00
Paint	Repaired areas		2	1 800,00		
Replace	1 tailgate	5 348,26				
	1 tailgate badges	749,13				
	1 rear bumper and tow hitch	2 592,50				
Total Parts Costs		R8 689,89	Total Labour Costs = R2 500,00			

2.3

Ms Vermaas had to decide which panel beater to use and also whether she wanted the tailgate to be repaired or replaced.

The final total costs, inclusive of VAT, sundries and consumables, are given in TABLE 1 below:

TABLE 1: Final total costs, inclusive of VAT, sundries and consumables

NAME OF COMPANY	FINAL TOTAL COSTS
Gail's Panel Beaters	R9 497,93
TBOS' Panel Shop	R5 132,55
Dong's Panel Shop	R12 983,11

Ms Vermaas decided that the tailgate had to be replaced. Use ANNEXURE B and TABLE 1 above to answer the following questions.

2.3.1 Briefly explain why she did not choose TBOS' Panel Shop. (1)

Memorandum/Marking guidelines

Question	Solution	Explanation
2.3.1	Because TBO's will repair the tailgate. ✓J **OR** Because TBO's is not replacing it. ✓J **OR** Because TBO's will take longer. ✓J	1J justification (1)

Discussion:

- The instruction for Question 2.3.1 is easy to understand; it requires an explanation based on information provided in Annexure B and Table 1. The information provided Table 1 (showing comparative total costs) may confuse some candidates who could think that because TBOS's Panel Shop is the cheapest it would be the obvious choice, and that therefore the question was incorrect. However, the first column of the tables in Annexure B (Summary of Quotations) which is headed **Method** clearly shows that TBOS's Panel Shop is the only one of the three panel beater that does not only replace damaged parts, but also repairs them. Repairing is something the opening statement explicitly says that MS Vermaas does not want. The duration of the work (Hours) is also clear from the table for Annexure B under section headed: Labour costs. It is easy to see from the comparative information on the tables that TBOS' Panel shop takes more time to repair the tailgate than the two other panel beaters take to complete the entire job **(stimulus).**
- To answer the question, candidates need to know how compare and interpret information across tables (two tables) and to give a reasoned judgement based on the interpretation and comparison of information in tables **(content)**.
- To answer this question, candidates have to draw on non-mathematical skills. The task involves carefully reading and understanding the question, taking note of the information in the lead sentence (specifically, that the

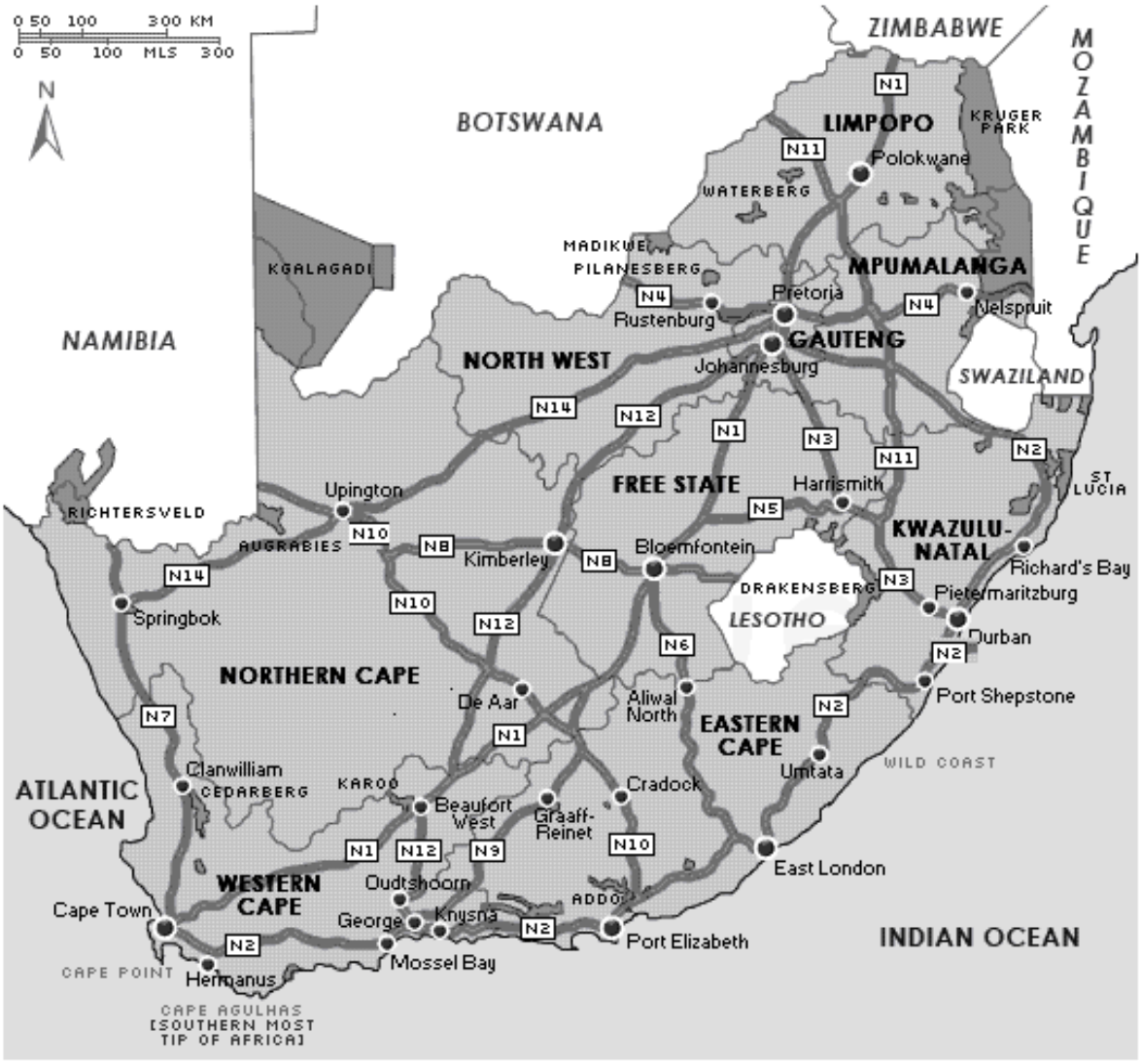
client wants to replace not repair), and realising that the information on Table 1 regarding cost is not the main criteria for the decision taken. Candidates then have to compare information provided on the table in Annexure B, draw a conclusion and write a short explanation based on information on the table in Annexure B about the method used to fix the car, or on the time taken to fix the car. To do this, they have to recognise that Ms Vermaas's requirement to 'replace the tailgate' is not met in TBO's quote, and/or they need to notice that the time taken by TBOS' panel shop is more than double the time taken by any other Panel shop **(task).**

- According to the memo, responses can be based on the method used to fix the car (replacement but not repair), or on the time taken to fix the car. One mark is awarded for providing one short reason. As there are TWO possible reasons that could be given in answering this question and candidates are expected to give only one of them, the expected response should be easy for the envisaged Grade 12 candidate **(expected response).**

The level of difficulty for this question is easy.

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

Example 1:
QUESTION 3, 2011 Paper 2, DBE The Naidoo family live in Pietermaritzburg. A map of South Africa showing the national roads (marked N1, N2, et cetera) is given on ANNEXURE D.



Use the map on ANNEXURE D to answer the following questions.

3.1 The family travelled from Pietermaritzburg to Johannesburg by car, using the N3.

3.1.1 (a) Use the map on ANNEXURE D and a ruler to measure the distance (in centimetres), following the road on the map between these two cities. (2)

Memorandum/Marking guidelines

Question	Solution	Explanation
3.1.1 (a)	4,0 cm ✓✓A	2A measurements **(Accept from 3,7 cm to 4,3 cm)** **Maximum 1 mark if answer in mm** (2)

Discussion:

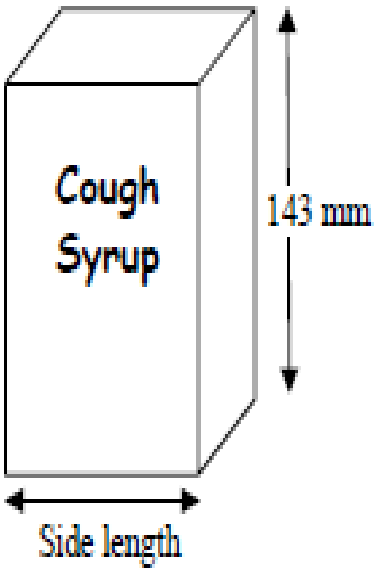
- The lead sentence and Question 3.1.1 contain no terms that would be unfamiliar or difficult for the envisaged Grade 12 candidate. A ruler usually shows measurements in centimetres and millimetres, and the question expects the answer to be in centimetres. The material also includes a map of South Africa showing cities and national roads. What makes the map moderately difficult for the envisaged Grade 12 candidate to use is that the roads on the map are not straight, hence they may experience some difficulty in using a ruler to measure the distance of the winding road (N3) accurately **(stimulus)**.
- To answer this question, candidates need to know where to find Johannesburg and Pietermaritzburg on a map of South Africa. They also need to know how to use a ruler to measure the distance between two points on a map by following a certain path/route. If they simply had to measure the distance between the two cities 'as the crow flies' task would be easy but because they have to follow path, the task is moderately difficult for the envisaged candidate **(content)**.
- Candidates first have to find Johannesburg and Pietermaritzburg and the N3 on the map. They then have to measure the distance in cm using a ruler. They have to follow the route of the N3 when measuring. The N3 is not a straight road, whereas the ruler is a solid straight line. Thus using a ruler would lead to a degree of inaccuracy in the measured values. If they simply had to measure the distance between the two cities 'as the crow flies the' task would be easy but because they have to follow path, the task is moderately difficult for the envisaged candidate **(task)**.
- Two marks are allocated for this question. The memorandum allows for a 0.3cm deviation in answers to allow for the fact that the ruler is a solid straight line whereas the N3 road is not a straight road. If the answer candidates give is the distance as a measured in a straight line, they will not get any marks in this question as they will not be following the instructions from the question. If they measure it this way, their answer will not fit into the 0.3cm deviation allowance. The deviation 'allowance' makes the expected response moderately difficult as opposed to difficult Also, according to the memorandum, there is a penalty of one mark if candidates give the answer in mm instead of cm. If they don't write cm, i.e. leave it out, they will not get full marks, as the question ask them to write the answer in cm. Candidates may not realise how important it is to use the correct unit of measurement in their response. This factor also makes the expected response moderately difficult **(expected response).**

The level of difficulty of this question is moderate.

Example 2:

QUESTION 4, 2010 Paper 2, DBE

Triggers Enterprises was awarded the tender for making rectangular cardboard boxes into package bottles of cough syrup. Each bottle is packed in a cardboard box with a square base, as shown below.



- The diameter of the base of the bottle is 58 mm and the height of the box is 143 mm.
- The length of the side of the base of the box must be approximately 105% of the diameter of the base of the bottle.
- The height of the box is approximately 102% of the height of the bottle.

The following formulae may be used:

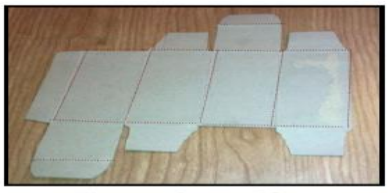
Area of circle = π × (radius)² , and using π = 3,14

Area of square = (side length)²

Area of rectangle = length × breadth

Area of opened cardboard box = 4(A + D) + 2(B + C) + E

(See design of open cardboard box below)



Picture of opened box

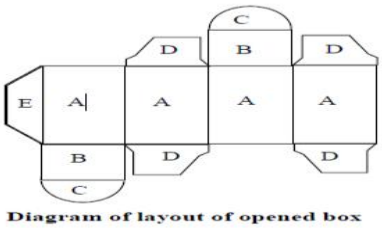


Diagram of layout of opened box

The following conversions may be useful:

1 cm² = 100 mm²

1 m² = 10 000 cm²

4.1 Calculate the height of the bottle to the nearest millimetre. (3)

Memorandum/Marking guidelines

Question	Solution	Explanation
4.1	✓A Height of bottle = $\frac{143\text{mm}}{102\%}$ ✓M $= \frac{143\text{mm}}{1{,}02}$ **OR** $\frac{143\text{mm}}{102\%} \times 100\%$ = 140,196...mm ✓CA/R ≈ 140 mm	1M dividing 1A using correct values 1CA/R simplifying to nearest mm Max 1 for rounding off if method is incorrect **Answer only full marks** (3)

Discussion:

- The stimulus material provided the height of the box, but it is expressed as the percentage of the height of the bottle. This relationship is not given in a clear formula format, hence, making the stimulus material for the question moderately difficult. The height of the box is not clearly labelled as such, but only the value of the dimension written next to the side. The square base is not clearly labelled to indicate that all sides of the base are the same. There should have been a cylinder diagram that illustrates the bottle with its measurements, particularly its height and diameter **(stimulus)**.
- To answer this question, candidates must knowhow to perform a complex percentage calculation to determine an unknown height when given the increased dimension. They have to know how to find the original value when they are given an increased value by a known percentage. The calculation requires knowledge of proportional reasoning. This factor makes the knowledge required moderately difficult **(content)**.
- To answer this question, candidates have to use proportionality concept in finding the unknown height. They have to find the original value when given an increased value by a known percentage. In doing this they will have to multiply the height of the box by 100, and then divide the product by 105. What makes the task moderately difficult is that the increased height is not of the same object. Answering the question also entails using the unfamiliar concept of an object equal to 102% of another object. The unknown sides are smaller than the given sides, hence this is a reverse calculation **(task)**.
- Candidates will get a mark for dividing 143 by 105, a mark for multiplying the quotient by 100, and a mark for the correct answer. The **expected response** is easy.

This level of difficulty of this question is, therefore, moderate.

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

Example 1:

QUESTION 5, 2011 Paper 2, DBE

5.1

Bathini High School and Vuka Secondary School entered some of their learners in a science competition. The scores (in percentages) for the first round of the competition are given below.

BATHINI HIGH SCHOOL

59 67 67 67 67 72 78 87 87 90 99

VUKA SECONDARY SCHOOL

90 67 67 89 50 78 54 67 95 90 98 57 49 78

5.1.4

The science competition consisted of 30 multiple-choice questions worth 2 marks each, 10 questions with one-word answers worth 1 mark each, and 10 short questions worth 3 marks each.

(a) Except for 23 multiple-choice questions, Lindiwe answered all the other questions correctly. The competition records showed that she was a learner from Bathini High School. Verify, by calculation, whether the records were correct. (5)

Memorandum/Marking guidelines

Ques	Solution	Explanation
5.1.4 (a)	✓A ✓A ✓A ✓CA Lindiwe's score = (7×2) + (10 × 1) + (10 ×3) marks = (14 + 10 + 30) marks = 54 marks ✓CA ∴ The records were NOT correct ✓J OR Lindiwe lost only 2 x 23 = 46 marks √A Lindiwe's score = (100 – 46) marks√M = 54 marks√CA	3A correct values 1CA simplification 1J conclusion (5) 2A calculating 1M Substraction 1CA Simplification 1J conclusion Maximum 2 marks for for conclusion with no calculations

Discussion:

- The lack of separation between the data values, e.g. semi commas, may have caused confusion and increased the level of difficulty. There was no clear separation between the two sets of data. Statements like 'except for 23 multiple choice questions', instead of a formula, made the question difficult to comprehend and create a correct mathematical formula/argument **(stimulus)**.

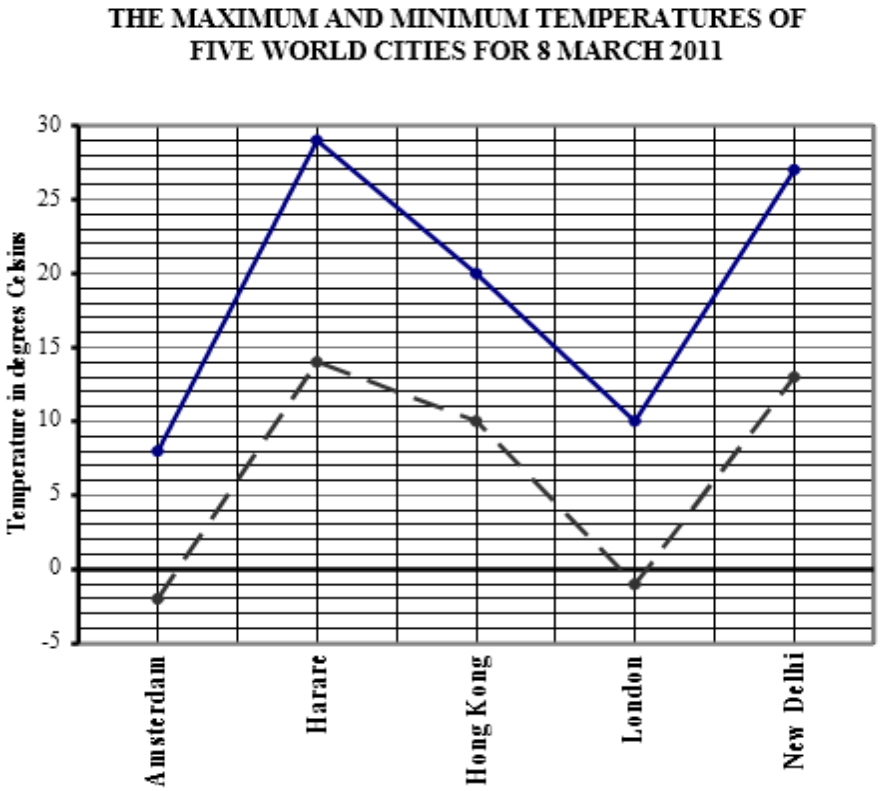
- Here candidates need to know how to interpret text and perform calculations in order to verify a claim. The question consists of a high degree of logical reasoning and reflection in proving/disproving a given statement, which is difficult for an envisaged Grade 12 learner. Word sums often pose serious challenges for learners in Mathematical Literacy, even for mathematics learners. Candidates need to be mindful of the concept of a whole, in that all the scores need to add up to a particular total **(content)**.
- The *task* entails interpreting the given text and making a final judgment on the claim based on the calculation of the score. The difficulty lies in the question asked to calculate a score, and being able to place that score to a correct dataset. Transferring a word sum/problem into mathematical equations/concepts; solve it using correct and relevant mathematics concepts; and then interprete the solution using normal everyday life language is a challenging concept in Mathematical Literacy, even in mathematics!The task would have not been that difficult if the formulae to calculate the scores were given, it is always a challenge for an envisaged Grade 12 learner to perform calculations without given formulae **(task)**.
- 2 marks are allocated for calculating the correct total for the multiple- choice questions by multiplying 23 by 2. Candidates get 2 marks for subtracting the multiple choice question marks from the total of 100 in order to get total marks for Lindiwe. Note that the total for Lindiwe could have been determined by: subtracting 23 incorrect questions from the 30 multiple choice questions and multiply the difference by 2 (2 marks awarded for this calculation); add this to the 1 times 10 one-word answer (1 mark allocated for this); and get another mark for adding this to product of 3 times 10 short questions that Lindiwe got correct. Get a mark for comparing her marks with the ones for the dataset of Bathini High, and making the correct conclusion. Since it is not found amongst Bathini High values, but in Vukani High school, the statement is incorrect. This is difficult for an envisaged Grade 12 learner **(expected response).**

This question is, therefore, difficult.

Example 2:

Question 2, 2011 Paper 1, DBE:

2.1 The graph below shows the maximum and minimum temperatures of five world cities for 8 March 2011.



THE MAXIMUM AND MINIMUM TEMPERATURES OF FIVE WORLD CITIES FOR 8 MARCH 2011

2.1.5 Determine the temperature range for Amsterdam. (2)

Memorandum/Marking guidelines

Question	Solution	Explanation
2.1.5	8 °C – (–2 °C) ✓M = 10 °C ✓A **OR** Start at (–2 °C) and count until 8 °C ✓M ∴ Range = 10 °C ✓A	1M concept of range 1A simplification (2)

Discussion:

- The graph has many towns, and has TWO graphs to consider. There is no given key to explain which graph represents what. The type of graph used is also confusing; it should not be a continuous straight line graph but a compound bar graph. The points to be read are on the gridline but interpretation of the scale used is needed to get the correct values. The lowest point falls on the negative values of the graph; this is an unusual value to read. The dark horizontal line (x-axes) appears like another graph, it is distractive **(stimulus)**.

- Here candidates need to know how to read two values directly from TWO simple line graphs. For a Grade 12 learner, this should not be a challenge, as they are expected in Grade 11 already to work with TWO graphs on the same system of axes. Learners also need to know how to read and work with integer values. Working with negative values posses a challenge to some learners. The knowledge that candidates must draw on to answer the question is moderately difficult **(content)**.
- However, one of the values is a negative value. Thus the calculation involves subtraction of a negative value making this particular *task* difficult. It must be mentioned that the task could have been made less difficult if the learner just counted from the lowest point of the minimum temperature to the highest point of maximum temperature for Amsterdam **(task)**.
- A mark for subtracting TWO correct values from the graphs, and a mark for the correct answer in degrees Celsius. The correct use of signs, the subtraction and the negative sign of the second value, makes the expected response difficult **(expected response)**.

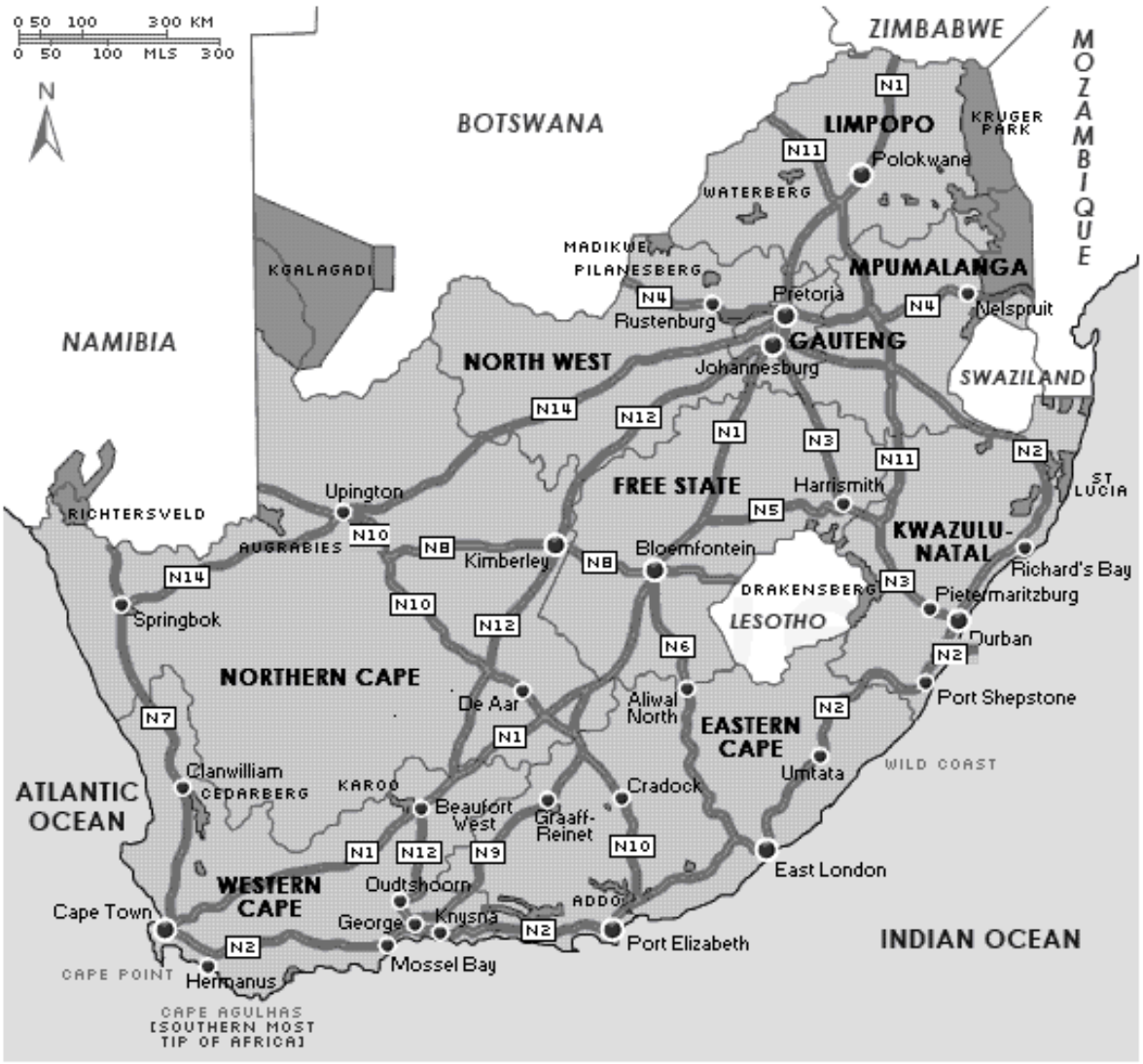
This question is, therefore, regarded as difficult.

Example 3:

QUESTION 3, 2011 Paper 2

The Naidoo family live in Pietermaritzburg. A map of South Africa showing the national roads (marked N1, N2, *et cetera*) is given on ANNEXURE D.

ANNEXURE D: MAP OF SOUTH AFRICA



Use the map on ANNEXURE D to answer the following questions.

3.1 The family travelled from Pietermaritzburg to Johannesburg by car, using the N3.

3.1.1 (a) …

3.1.1 (b) Hence, use the scale given on the map and a ruler to calculate the actual distance, in kilometres, between these two cities. (5)

Memorandum/Marking guidelines

Question	Solution	Explanation
3.1.1 (b)	2 cm represent 300 km ✓M ✓CA ∴ 4,0 cm represent (300 + 300) km = 600 km ✓CA **OR** ✓M 2 cm represent 300 km ✓A	1M measuring 1A scale 1M adding the correct scale values 1CA using correct values 1CA simplification 1M measuring

2 cm represent 30 000 000 cm

∴ the scale is 1: 15 000 000 ✓CA

Actual distance = 4,0 × 15 000 000

= 60 000 000 cm ✓M

= 600 km ✓C

1A scale

1CA ratio

1M multiplying

1C conversion

OR

✓M ✓A

2 cm represents 300 km

✓CA

4,0 cm represents $\frac{300\,\text{km} \times 4{,}0\,\text{cm}}{2\,\text{cm}}$ ✓CA

= 600 km ✓CA

1M measuring
1A scale
1CA multiplying
1CA dividing
1CA solution
(accept 555 km to 645 km)

OR

✓M

0,8 cm represent 100 km ✓A

There are 5 (0,8cm) on 4 cm ✓M

∴ 4,0 represent (100 + 100 + 100 + 100 + 100) km ✓CA

= 500 km ✓CA

If 1,8 cm = 300 km distance will be 666,67 km to 716,67 km

1M measuring
1A scale
1M adding the correct values
1CA using correct values
1CA simplification

OR

✓M

0,8 cm represent 100 km ✓A

0,8 cm represent 10 000 000 cm

∴ the scale is 1: 125 000 000 ✓CA

Actual distance = 4,0 cm × 125 000 000

= 500 000 000 cm ✓M

= 500 km ✓C

1M measuring
1A scale
1CA ratio

1M multiplying
1C conversion

OR

✓A

0,8 cm: 100 km = 4:x ✓M

$x = \frac{100\,\text{km} \times 4{,}0\,\text{cm}}{0{,}8\,\text{cm}}$ ✓CA ✓CA

= 500 km ✓CA

1A scale
1M proportion
1CA multiplying
1CA dividing

1CA solution
(accept 462,5 km to 537,5 km)

(5)

Discussion:

- The question says 'hence', because candidates need to realise that they will have to use the answer that they have already calculated in the previous question. The bar scale on the maps of South Africa (provided as source material) is clearly indicated on the map in km. The fact that a bar scale is used on the map, instead of a normal number scale, makes the stimulus moderately difficult. With only the bar scale given, candidates will have to first determine their normal scale by using a ruler, and then determine the actual distance using proportionality. Candidates will have to realise that the 'actual distance' is the distance in real life, and not on the map **(stimulus)**.
- To answer the question, candidates need to know how to use the bar scale given on the map and the ruler to derive a number scale in order to calculate the measured distance. They need to understand proportionality to determine the actual distance. What makes this question difficult is the fact that candidates must determine a number scale from a bar scale, apply the concept of proportionality in context, and convert from cm to km **(content)**.
- The task is difficult because it involves a number of steps. Firstly, candidates need to measure the bar scale, using a ruler, use proportionality to determine how many cm on the map are equal to how many km on the ground. They need to use convert the measured distance from cm to km. The envisaged Grade 12 candidate will find this task difficult **(task)**.
- 5 marks are allocated for this question. According to the memorandum one mark is allocated for correctly interpreting the bar scale; one mark for writing the values in the same unit; one mark for expressing the scale as the unit scale; and one mark for applying proportionality to get the actual distance in cm, and one mark for writing the correct answer in km. A novice marker may also find it difficult to mark this type of question, simply because there are a lot of follow through marks **(expected response)**.

The level of difficulty for this question is, therefore, difficult.

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

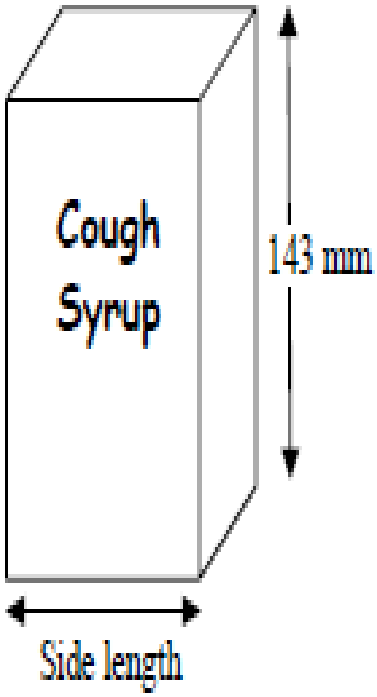
Note:
During the development of the exemplar book some subject specialist argued that there is a fine line between a difficult and a very difficult question. It was also evident that in some subjects question papers did not have questions that could be categorised as very difficult. In order to cater 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 4, 2010 Paper 2, DBE

Triggers Enterprises was awarded the tender for making rectangular cardboard boxes to package bottles of cough syrup. Each bottle is packed in a cardboard box with a square base, as shown below.

- The diameter of the base of the bottle is 58 mm and the height of the box is 143 mm.
- The length of the side of the base of the box must be approximately 105% of the diameter of the base of the bottle.
- The height of the box is approximately 102% of the height of the bottle.



The following formulae may be used:

Area of circle = π × (radius)² , and using π = 3,14

Area of square = (side length)²

Area of rectangle = length × breadth

Area of opened cardboard box = 4(A + D) + 2(B + C) + E

(See design of open cardboard box below)

The following conversions may be useful:

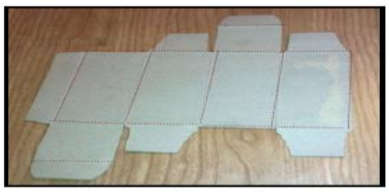
1 cm² = 100 mm²

1 m² = 10 000 cm²

4.3

To ensure that the box is strong enough, the cardboard used for the box has a mass of 240 grams per m² (g/m²).

The layout of the opened cardboard box is shown below.



Picture of opened box

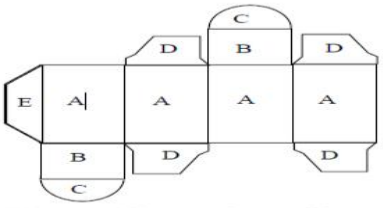


Diagram of layout of opened box

- Section C is semicircular.
- The area of each section D = 1 832 mm2
- The area of section E = 2 855 mm2.

4.3.1 Calculate the total mass of the cardboard needed for one box, to the nearest gram. (11)

Memorandum/Marking guidelines

Question	Solution	Explanation
4.3.1	Area A = 143 mm × 60,9 mm ✓SF = 8 708,7 mm² ✓CA	1M calculating area 1CA simplifying
	Area B = (60,9 mm)² = 3 708,81 mm² ✓CA	1CA area B
	Area C = $\frac{1}{2} \times 3{,}14 \times \left(\frac{60{,}9\,\text{mm}}{2}\right)^2$ ✓SF	1SF substitution into correct formula
	= $\frac{1}{2} \times 2\,911{,}41585\ \text{mm}^2$ = 1 455,71 mm² ✓CA	1CA simplifying
	Area of open box = 4 (A + D) + 2(B + C) + E ✓SF	
	= 4 (8 708,7 + 1 832) mm² + 2 (3 708,81 + 1 455,71) mm²	1SF (CA) substitution

	+ 2 855 mm ^{2}	
	= 55 346,84 mm ^{2} ✓CA	1CA simplifying
	= $\frac{55346,84}{1000000}$ m^2 ✓C	1C converting to m ^{2}
	= 0,055346... m ^{2}	
	Mass of box = 240 g/ m ^{2} × $\frac{55346,84}{1000000}$ m^2 ✓M	1M multiplication 1S simplifying 1R rounding
	= 13,2832...g ✓S	Accept 13 g
	= 14 g ✓R	If area rounded off to 0,06 m ^{2} then mass = 15 g
	OR	
	Area A = 143 mm × 61 mm ✓SF = 8 723 mm ^{2} ✓CA	1SF substitution 1CA area A
	Area B = 61 mm × 61 mm = 3 721 mm ^{2} ✓CA	1CA area B
	Area C = $\frac{1}{2}\times 3,14\times\left(\frac{61\text{mm}}{2}\right)^2$ ✓SF	1SF substitution
	= $\frac{1}{2}\times$ 2 920, 985 mm ^{2} = 1 460,49 mm ^{2} ✓CA	1CA area C
	Surface area = 4 (A + D) + 2(B + C) + E ✓SF = 4 (8 723 + 1 832) mm ^{2} + 2 (3 721 + 1 460,49) mm ^{2} + 2 855 mm ^{2}	1SF substitution
	= 55 437,98 mm ^{2} ✓CA	1CA surface area
	= $\frac{55437,98}{1000000}$ m^2 ✓C	1C converting to m ^{2}
	= 0,055... m ^{2}	
	Mass of box = 240 g/m ^{2} × 0,055.. ✓M = 13,31 g ✓S	1M multiplication

	= 14 g ✓R	1S simplification 1R rounding (11)

Discussion:

- Except the height of the box, the given dimensions are not indicated on the given diagrams. A cylinder, to represent a bottle, was not shown by means of a diagram. The other dimensions of the box are given as a percentage of the bottle dimensions, and the percentage given is more than 100 %. This is very difficult for the envisaged Grade 12 learner to comprehend. The diameter of the bottle is given, but the formula provided is expressed in terms of radius. The rectangular box does not show that the sides of its base are equal. It is not clearly indicated from the net diagram that the diameter of Section C (semicircle) is the same as the side of the base of the rectangular box. Also, none of the dimensions of the net are labelled. The question is not broken down into sub-questions that lead to the main question. It lacks scaffolding and guidance, hence making it very difficult for the envisaged Grade 12 learner **(stimulus)**.
- They have to know how to calculate the mass of the area of cardboard by multiplying the area by the mass/cm^2. All of the above is conceptually difficult for the envisaged Grade 12 learner and the concept of density is completely unknown to Mathematical Literacy candidates. Candidates need to know how to convert square mm to square metres, and g to kg. The concept of converting 2-dimensional units poses serious challenges to learners **(content)**.
- The *task* requires candidates to determine the unknown side of the box, when given a dimension of a bottle, and the relationship between the two if expressed as a percentage more than 100. Determine the unknown areas of other sections (Section A - rectangle; B – squares; and C - semicircles) using the given formulae, and making sense of the 3-D and 2-D net diagram, and add them to the given areas. Convert the total area from square mm into square meters. This unit conversion is also very difficult because the relationship of cm^2 to m^2 is given but the formula is worked in mm^2. This expected conversion means that candidates must convert mm^2 to cm^2 using no provided help, and then to m^2 using the equation given. The candidates need to multiply their final area by the mass per square metre. This process is very difficult for the envisaged Grade 12 learner **(task)**.
- Candidates get 2 marks for determining the area of Section A (using the already calculated dimension of the side of the box); 1 mark for the area of Section B; and 2 marks for determining the area of Section C. For adding the all the areas of the given and calculated sections of the box, candidates get 2 marks. For converting from square mm to square meter, a mark is allocated. Multiplying the total area (in square meters) by given mass per square meter, 2 marks are allocated. Finally, a mark for rounding. Based on the above, the expected response is very difficult for the envisaged Grade 12 learner **(expected response)**.

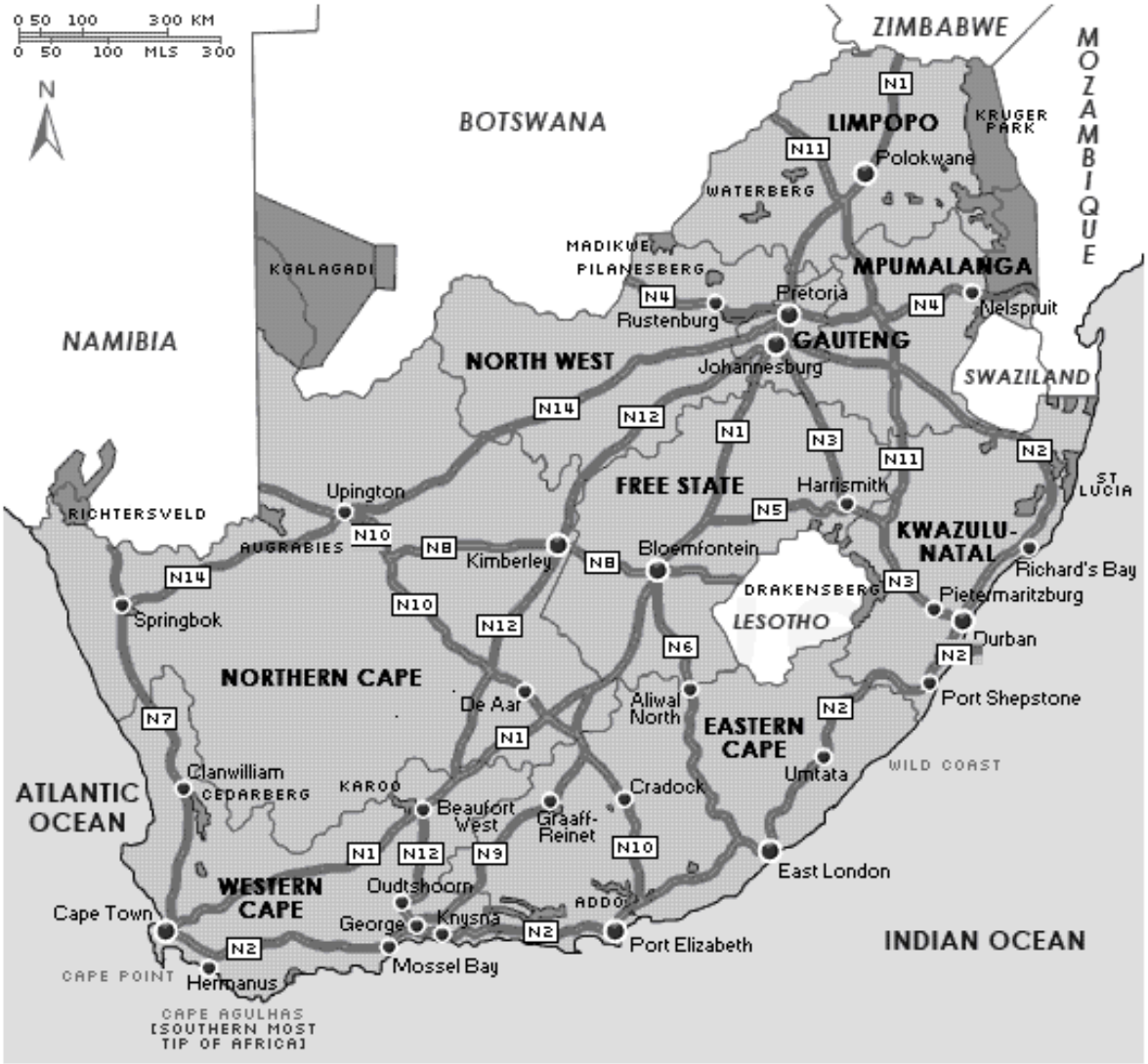
This question is very difficult for the envisaged Grade 12 learner.

Example 2:

QUESTION 3, 2011 Paper 2, DBE

The Naidoo family live in Pietermaritzburg. A map of South Africa showing the national roads (marked N1, N2, et cetera) is given on ANNEXURE D.

ANNEXURE D: MAP OF SOUTH AFRICA



Use the map on ANNEXURE D to answer the following questions.

3.1 The family travelled from Pietermaritzburg to Johannesburg by car, using the N3 road.

3.1.3
The family left Pietermaritzburg with a full tank of petrol. Along the way they stopped at a petrol station to refuel at a cost of R455,40.

The capacity of the tank is 60 litres and the cost of fuel is R10,12 per litre.

(a) Before refuelling, the fuel gauge indicated that the tank was half full. Verify, showing ALL calculations, whether the fuel gauge was working properly. (6)

Memorandum/Marking guidelines

Question	Solution	Explanation
3.1.3 (a)	Amount of fuel bought $\times$ R10,12 per litre = R455,40 Amount of uel bought = $\frac{\text{R}455{,}40}{\text{R}10{,}12\,\text{per litre}}$ ✓M ✓A = 45 litres ✓CA Fuel left in the tank = 60 λ - 45 λ ✓M = 15 λ ✓CA The gauge was NOT working correctly. ✓CA	1M division 1A using correct values 1CA petrol filled 1M subtracting 1CA petrol before filling 1CA decision (6)

Discussion:

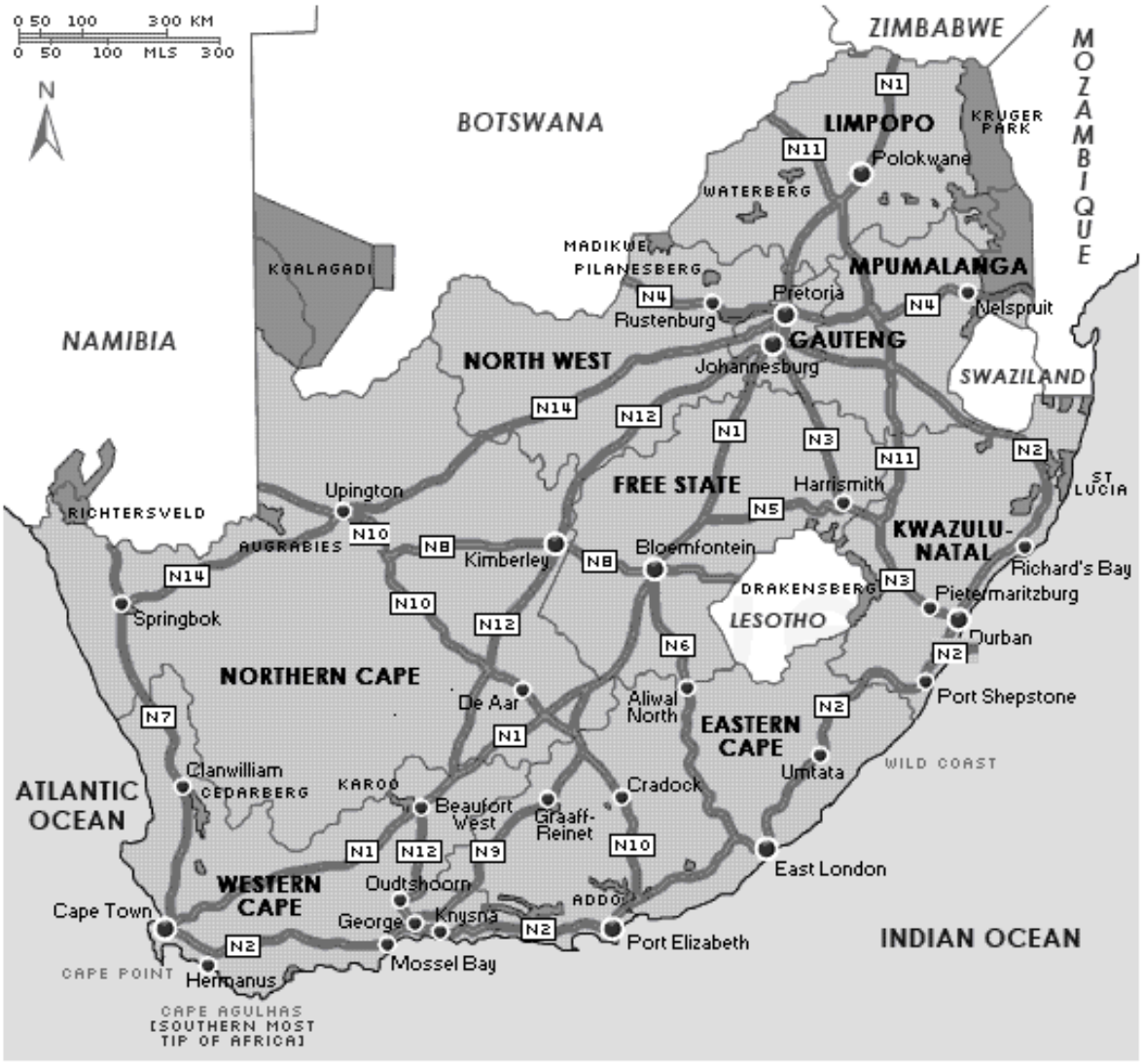
- The stimulus material is complex. The given values are not multiples of 30 or factors of 30, which is the half tank. The cost per litre and the total amount that they filled the tank are also not multiples or factors, making the stimulus very difficult. The practicalities of the context of this question are also outside the realm of experience of the envisaged Grade 12 candidate in South Africa, which also makes the stimulus material very difficult for them to read and understand **(stimulus)**.
- To answer this question, candidates need to know how to verify the claim that half the fuel was used (what the fuel gauge shows). They have to know how to calculate the cost of filling a half tank of petrol from unit cost (of litres) and number of units (litres). They also have to know how to compare that to the given amount paid for filling tank and draw a conclusion about the fuel gauge **(content)**.
- The *task* is very difficult because the determination of the amount of fuel used is done by computing the cost of the fuel used. In addition a kind of reverse logic must be applied, namely, the amount of fuel used to fill the tank is the amount that was used. This given amount that was used to fill the tank must be compared to the cost of half the capacity of the fuel tank **(task)**.
- According to the memo 2 marks are allocated for dividing the amount used to fill the tank by the cost per litre, a mark for getting the amount of fuel in litres, 2 marks for finding the fuel left in the tank, and 1 mark for correct conclusion **(expected response)**.

Example 3:

QUESTION 3, 2011 Paper 2, DBE (same as Example 2 above)

The Naidoo family live in Pietermaritzburg. A map of South Africa showing the national roads (marked N1, N2, et cetera) is given on ANNEXURE D.

ANNEXURE D: MAP OF SOUTH AFRICA



Use the map on ANNEXURE D to answer the following questions.

3.1 The family travelled from Pietermaritzburg to Johannesburg by car, using the N3.

3.1.3 The family left Pietermaritzburg with a full tank of petrol. Along the way they stopped at a petrol station to refuel at a cost of R455,40. The capacity of the tank is 60 litres and the cost of fuel is R10,12 per litre.

(a) …

(b) If the car's fuel consumption was 9 litres per 100 km, determine how far they were from Johannesburg when they refuelled. (3)

Memorandum/Marking guidelines

Quesion	Solution	Explanation
3.1.3 (b)	They used 9 λ to cover 100 km $1\,\lambda$ to cover $\frac{100}{9}$ km $45\ \lambda$ to cover $\frac{100}{9} \times 45$ km ✓M = 500 km ✓CA Distance from Johannesburg = 600 km – 500 km = 100 km ✓CA	1M dividing by the consumption rate 1CA distance travelled 1CA solution **(accept 55 km to 145 km)** (3)

Discussion:

- The context provided in the source material is outside of the life experience of the envisaged Grade 12 candidate in South Africa. Many of them use public transport, and don't really concern themselves with these details and knowledge. There seem to be no connection from what is given, the car's fuel consumption, and what is asked, the distance travelled before refuelling. The question doesn't give any suggestion on the use of the previous answer in solving this question, e.g. it could have started by saying 'hence, or otherwise'. The question doesn't also suggest the usage of the previous answer of a distance between Pietermaritzburg and Johannesburg. The stimulus makes this question very difficult for the envisaged Grade 12 learner to answer **(stimulus)**.
- To answer this question, candidates need to know how to calculate the distance travelled by dividing the cost of filling the tank by the unit cost of a litre and dividing by the fuel consumption. Candidates need to understand the concept of rate and how to apply it in context. Dividing the fuel consumed by the rate requires a correct cancellation of units, in order to end up with the required distance. Candidates need to know the concept of dividing a number by a fraction, where the division must be changed to multiplication, and the denominator must be 'reciprocated' (written as a reciprocal). The concept of multiplying a number by its multiplicative inverse needs to be fully understood. This concept is very difficult for the envisaged Grade 12 leaner **(content)**.
- The *task* is a multi-step one and is very difficult for the envisaged Grade 12. The cost of filling the tank must be divided by the cost per litre to obtain the numbers of litres put into the tank. Then the petrol consumption '9 litres per 100 km' must be used to determine the number of kilometres travelled using the previously calculated number of litres. This distance then has to be subtracted from the calculated distance of Pietermaritzburg to Johannesburg, Q3.1.1 (b), to find out how far they are from Johannesburg **(task)**.

- Three marks are allocated for this question. According to the memo, candidates are awarded one mark for getting the correct distance in km, a litre of petrol can cover. One mark is awarded for determining the distance, in km, the consumed fuel of 45 litres of petrol can cover. Also note that candidates could have scored 2 marks when determining the distance covered by simply dividing the amount of fuel consumed thus far by the given fuel consumption rate. One mark is awarded for finding the difference between the distance already covered, with the total distance from Pietermaritzburg to Johannesburg. It is very difficult for the average Grade 12 learner to respond to a question using calculated answers from two previous questions **(expected response)**.

The level of difficult for this question is, therefore, very difficult.

9. CONCLUDING REMARKS

This exemplar book is intended to be used as a training tool to ensure that all role players in the Religion Studies 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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