



هيئة جودة التعليم والتدريب
Education & Training Quality Authority
Kingdom of Bahrain - مملكة البحرين

Directorate of National Examination

Subject: Mathematical Skills – Grade 12

Test Specifications

2023

Kingdom of Bahrain

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All details in this document are correct at the time of publishing, but may be subject to change as a result of ongoing efforts to ensure the quality of the examination product.

1 PURPOSE

The main purpose of the examinations is to provide information about the performance of students in Mathematical Skills in the Kingdom of Bahrain.

Their performance on subject content aims to identify what students should be able to do after 12 years of formal schooling and to establish whether they have the skills and the knowledge to be able to find work within the global marketplace of the 21st century using Mathematical Skills and higher thinking skills.

Additional purposes of the National Examinations are to:

- to be of use in the selection processes for Further Education, Higher Education or employment;
- provide a beacon of good assessment practice;
- provide robust information for the monitoring of standards over time.

1.1 Aims of the Grade 12 Mathematical Skills examinations

The aims of the grade 12 Mathematical Skills examinations are:

- to assess a student's ability to analyse numerical and graphical information, which is based in real life situations, and apply the right numerical techniques to find new information or derive solutions;
- to develop the use of a range of skills such as data handling, reading, logic and reasoning. Students will be assessed on these various sub-skills, which are the building blocks to successfully solving wider and more complex problems;
- to encourage the application of simple mathematics to new situations to show that students can manipulate numerical and graphical data. They need to extract and use relevant data, and find ways of drawing conclusions from information. Students need to be able to present that same data in different forms. They are expected to think critically about information, find possible reasons for unexpected variations and be able to use information for informed decision-making.

2 DEFINITIONS

2.1 Skills

In Grade 12 examinations a number of skills will be assessed:

- Extracting relevant data (Skill 1)
- Processing data (Skill 2)
- Finding procedures for solving problems (Skill 3)
- Searching for solutions (Skill 4)
- Identifying similar data (Skill 5)
- Using spatial reasoning (Skill 6)
- Choosing and working with models (Skill 7)
- Making choices and decisions (Skill 8)

Students need to be familiar with basic techniques of mathematical.

Mathematical Skills is about using logical methods of handling numerical, graphical and pictorial data. Mathematical Skills are not only desirable but essential to lawyers, sociologists, geographers, historians and those in other professions. They have to understand and use numerical information, to analyse it and to draw conclusions from it. For example, a lawyer may need to know about and understand the probabilities of a DNA test being conclusive. Sociologists frequently employ statistics and demographic data.

2.2 Questions and items

A question consists of one item only.

3 TEST CONSTRUCT

3.1 Description of papers

There will be 1 question paper, assessing Mathematical Skills. Students answer on the question paper. Students have 120 minutes to complete 30 multiple choice questions, each made up of a stimulus, a question and 4 options – only one of which is the correct answer. Each question will have a skill focus, however, frequently, the question will involve one or more other skills, but to a lesser degree. Paper tests all of the skills.

3.2 Additional materials

Students are permitted to use calculators in the exam.

4 Mathematical Skills PAPER

The questions examine the student's abilities to use the following skills:

1. Extracting relevant data (Skill 1)
2. Processing data (Skill 2)
3. Finding procedures for solving problems (Skill 3)
4. Searching for solutions (Skill 4)
5. Identifying similar data (Skill 5)
6. Using spatial reasoning (Skill 6)
7. Choosing and working with models (Skill 7)
8. Making choices and decisions (Skill 8)

The questions are multiple choice with a short stimulus passage. The students select the most appropriate response from four options A to D.

Information may be presented in five categories: tables, graphs, words, pictures or diagrams.

The stimulus may include information in more than one category. The stimulus material is based on a realistic scenario. In general, students should be able to answer the question from the stimulus, rather than having to work backwards from the list of possible answers. However, there will be some questions where the options in effect form part of the stimulus. Students do not have to have knowledge specific to any subject, for example knowledge of physics or statistics; they do have to have knowledge of the basic mathematics required.

Each of the 8 sub-skill categories for Mathematical Skills is explained below. An example of a question that tests the sub-skill is also provided in section 7.

Skill 1 : Extracting relevant data

- Questions may give information in words, tables or graphs. Most is quantitative but some qualitative elements may be included (e.g. colour or shape).
- Students are given criteria for choosing one item or a range of items from the data presented. The skill is to select the correct item or range of items from a set which includes some unnecessary data.
- This type of question may also include a small amount of simple processing, e.g. to find a journey time from a timetable giving departure and arrival criteria; the correct departure and arrival time should be found from the timetable and the journey time found by subtraction.

Skill 2 : Processing data

- Students are given information in words, tables or graphs.
- This data needs to be used to answer a question.
- One or more items from the data should be used correctly to give an answer. The method of using the data will be clear and will not need to be clarified. The skill is to choose and use the data correctly.
- This category of question may rely on some data extraction as well as processing, but this will not be the main emphasis of the question.

Skill 3 : Finding procedures for solving problems

- Questions may give information in words, tables, graphs, pictures or diagrams.
- Students are given a problem to solve (this will in most cases have a numerical solution but it may also be in other forms e.g. a spatial manipulation).
- The method of solution is not immediately obvious and the student has to choose a suitable method of using the data to come up with the answer. The skill is to work out how to use the data in a suitable way to solve the problem, and then produce a solution.

Skill 4 : Searching for solutions

- Questions may give information in words, tables, graphs, pictures or diagrams.
- Students have to solve a problem by searching for a solution.
- Searching can be in two forms. It may be necessary to search the data given to find the correct pieces of information to use. In general, it will also be necessary to consider several possible scenarios which may solve the problem, then to decide which, for example, is the best according to a given factor.
- The required skills are to identify a suitable method of searching and to carry it out correctly.

Skill 5 : Identifying similar data

- Students will be asked to match information in one form to the same information in another form (e.g. table to graph), or in a different representation of the same form (e.g. matching a time-distance graph with the same data presented as a time-velocity graph).
- The information given and derived may be in words, tables, graphs, pictures or diagrams.
- The skill required from the student is to recognise the correct data item or data set from several others which are presented.

Skill 6 : Using spatial reasoning

- Students are given information, usually as pictures (although other forms such as a written description may be used).
- They have to identify the result of a spatial operation such as deformation, reflection or rotation or, for example, to identify a view from a different direction.
- The skill is in being able to visualise shapes and views, and how they may change, in two or three dimensions.

Skill 7 : Choosing and working with models

- A model of a set of data may be in the form of a graph, a diagram or a written description.
- Students are given a scenario which includes information on the way in which a parameter or a process varies.
- They are then asked to choose a representation of this variation in another form which models the data presented.
- A more difficult question might expect the student to derive a mathematical model and use it to produce an answer.
- The skill is to recognise how one set of information may model either another set or a real situation.

Skill 8 : Making choices and decisions

- Questions give data in words, tables, graphs, pictures or diagrams and a set of criteria.
- Students choose from a set of options based on the given data and criteria. This involves a search of some sort.
- In the simplest sense, this would be just extracting an item from the data set (and would be equivalent to type PS1) or the search may involve an amount of data handling. The skill is to be able to make an informed decision by combining a set of information and given criteria for selection.

5 EXAMPLE MATERIALS

Sample question (Extracting relevant data) (Skill 1)

The cost of sending letters from the United Kingdom to continental Europe is shown below.

Not over	£ p
20 g	0.22
60 g	0.37
100 g	0.53
150 g	0.70
200 g	0.88
250 g	1.06
300 g	1.25
350 g	1.44
400 g	1.64
450 g	1.83
500 g	2.02
750 g	2.77
1000 g	3.52
1250 g	4.07
1500 g	4.62

A firm in London wishes to send two letters to separate clients in continental Europe. The letters weigh 75 g and 215 g.

What is the total cost of sending the two letters?

- A £1.25
- B £1.41
- C £1.43
- D £1.59

Key D**Stimulus Type Table****Justification**

The 75 g letter will cost 53p to post (over 60 g but under 100 g) and the 215 g letter will cost £1.06p (over 200 g but under 250 g). The total cost is $53\text{p} + £1.06\text{p} = £1.59\text{p}$.

Candidates are expected to select the two correct values from the table, given the weights of the parcels, and add these together. The primary skill is extraction with a small amount of processing.

sample question (Processing data) (Skill 2)

We had 76 people wanting orange juice at a conference. The caterers provided enough orange juice for each of 80 people to have a 400 ml cup three-quarters full. We carefully filled each cup to exactly three-quarters full as we handed them out, but failed to notice that they had given us 500 ml cups.

How many people went without?

- A 0
- B 4
- C 8
- D 12

Key D

Stimulus Type Words

Justification

The amount of orange juice provided by the caterers was 80 (people) \times 400 (ml cups) \times $\frac{3}{4}$ (full) = 24000 ml. The amount of orange juice in one of the larger cups is 500 (ml) \times $\frac{3}{4}$ (full) = 375 ml.

The number of people that can be catered for is 24000 (the amount of orange juice provided) \div 375 (in each cup) = 64 .

There are 76 people so $76 - 64 = 12$ people will go without.

The candidate must use the data correctly (all the data is relevant so the only extraction skill is to use the correct numbers at the correct time). The skill is processing. Finding a method is a minor part of the answer, as the method of solution is straightforward.

sample question (Finding procedures for solving problems) (Skill 3)

Each of two identical cars can carry enough fuel to travel 100 km only. To make a longer journey over a deserted area, they set out together and then at some stage the first car transfers fuel to the other and returns home. The second car travels on.

What, approximately, is the furthest distance from home that the second car can travel?

- A 125 km
- B 133 km
- C 150 km
- D 167 km

Key B

Stimulus Type Words

Justification

A method must be developed to solve this problem – it cannot be done just using extraction or processing.

One way is by trial and error. For example, if the two cars travel 50 km together, it would be possible to transfer 50 km worth of fuel from one to another but then the car donating the fuel would be empty so this is clearly too far. Similarly, at 25 km only 25 km worth could be transferred so the donor car would have 25 km left when it reaches home.

It becomes clear that the donor car must divide its fuel into 3: $\frac{1}{3}$ each for the outward journey, to transfer to the other car and to return. At 33 km the car which is continuing is completely refilled and would have enough for another 100 km, making 133 km in total.

sample question (Searching for solutions) (Skill 4)

A private mail delivery company makes the following charges for delivering letters and packages:

Weight up to 60 g	250 fils
Each extra 10 g or part thereof	50 fils

A woman wishes to use this company to send a manuscript either as a single package of weight 138 g or two or more packages with a total weight of 138 g.

What is the lowest cost of postage with this company?

- A 590 fils
- B 600 fils
- C 640 fils
- D 650 fils

Key B

Stimulus Type Words/Table

Justification

The skill is in performing a search of the options on splitting up the package to find how many pieces, and of what weights, is most effective.

As a single package it would cost 250 fils for the first 60 g and 8×50 fils for the remaining 78 g, or 650 fils in total.

If sent as two packages, it is most economical to have both at 60 g or more, as the first 60 g is pro-rata cheaper than the remaining weight. Thus 60 g + 78 g is as effective as any other split.

This costs: $250 \text{ fils} + 250 \text{ fils} + (2 \times 50 \text{ fils}) = 600 \text{ fils}$.

If sent as three packages, once again it is best to keep as many as possible at 60 g or more. They would then divide as 60 g + 60 g + 18 g at $3 \times 250 \text{ fils} = 750 \text{ fils}$.

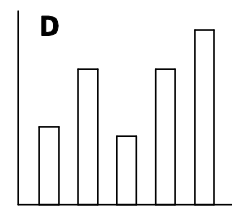
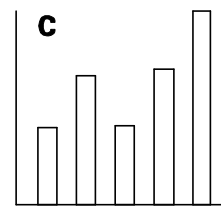
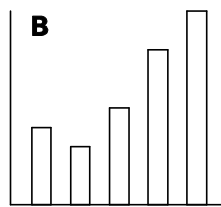
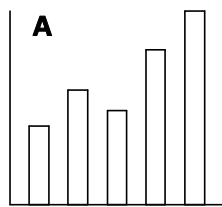
The two package option is the best at 600 fils.

sample question (Identifying similar data) (Skill 5)

The table shows the age distribution of the inhabitants of a small town:

Age group	0–15	16–25	26–45	46–64	65 +
Number of inhabitants	2997	4432	3761	5980	7440

Which of the following charts, if suitably labelled, could represent the data above?



Key A

Stimulus Type Table

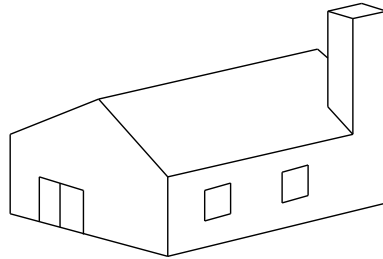
Justification

The second bar should be approximately $1.5 \times$ the height of the first, the third should be in between the first and second, the fourth approximately twice the height of the first and the fifth the largest.

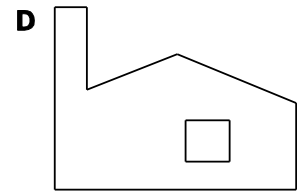
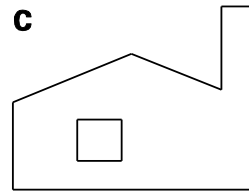
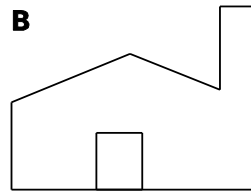
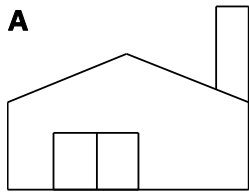
Only chart A shows this.

sample question (Using spatial reasoning) (Skill 6)

The diagram shows a factory. There is a square chimney in the south-eastern corner of the factory. There is an entrance in the western end which can be seen in the diagram. There are two windows in the southern wall. There is also a door in the northern wall of the factory and a window in the eastern wall of the factory, which are hidden in the diagram.



Which of these is a possible view of the eastern end of the factory?



Key D

Stimulus Type Picture and Words

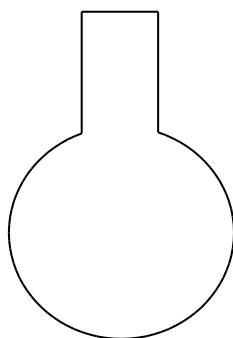
Justification

The view from the eastern end of the factory should show the chimney on the left and a window in the wall. The roofline should appear behind the chimney. Only figure D shows this.

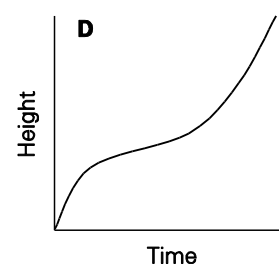
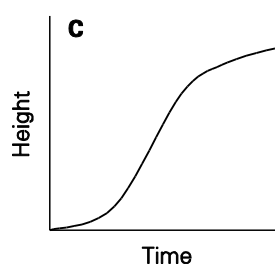
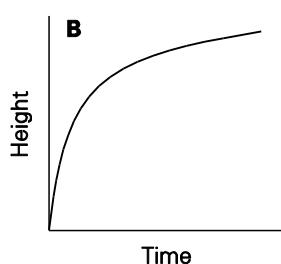
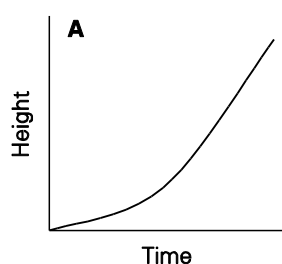
sample question (Choosing and working with models) (Skill 7)

The diagram below shows a bottle used in a laboratory. In order to determine the volume of liquid in the bottle for various heights, water is allowed to flow into the bottle at a constant rate.

An observer makes frequent notes of the height the water has reached and of the time. He draws a graph to illustrate his observations.



Which of the following graphs could be the one drawn by the observer?



Key D

Stimulus Type Words and Picture

Justification

The height will rise quickly at first (as the bottle is narrow at the bottom), it will then rise more slowly as the level reaches the wider section and more quickly again at the narrower section towards the top. All these segments will show curves as the area changes continuously. The rate of rise will then become constant in the cylindrical section at the top, giving a straight line segment. D is the only graph to show this.

sample question (Making choices and decisions) (Skill 8)

I have none of my nephew's favourite biscuits left. My nephew visits me at least 3 times a week, though never more than five times. On each visit I know he will eat at least 6 biscuits but I won't let him have more than 8. Packets of biscuits can contain as few as 10 biscuits, or as many as 12.

How many packets of biscuits must I buy to make sure I do not run out within the next **two** weeks?

- A 4
- B 5
- C 6
- D 8

Key D

Stimulus Type Words

Justification

A decision on how many to buy is made by dividing my nephew's maximum requirement by the minimum number of biscuits in a pack. This is the only way of ensuring there are enough.

The most biscuits my nephew will eat in two weeks is 2 (weeks) \times 5 (maximum visits per week) \times 8 (maximum number of biscuits per visit) = 80 . The minimum number of biscuits in a pack is 10 , so 8 packets will be required. D is correct.