

# Sample Questions for the Module Mathematics, Computer Science and Natural Sciences

## Subtest „Analysing Scientific Interrelationships“

The subtest “Analysing Scientific Interrelationships” presents texts and illustrations with natural sciences content on which questions are then posed.

This test measures how well people can grasp and analyse simple natural sciences topics. It is also a matter of recognising interrelationships, separating important data from unimportant data, and drawing the right conclusions from the presented information. Relevant background information is provided.

### Instructions

Working time: **60 minutes**

These items contain questions from various fields of science. You are to picture various scientific processes and recognise scientific interrelationships. Unless otherwise specified, the axes (scales) in the diagrams are linearly subdivided. In several items, you are asked to identify the “qualitatively” correct diagram. In these cases, decide which diagram shows the curve that best expresses the circumstances described. Even the correct diagram may not be drawn in numerically precise manner.

### Example 1

An experiment is conducted on three plants of the same species:

- Plant 1 is not treated.
- The tip of the main shoot of plant 2 is cut off.
- The tip of the main shoot of plant 3 is cut off. Afterwards a phytohormone is applied to the cut surface on the plant.

The plants are now placed under observation:

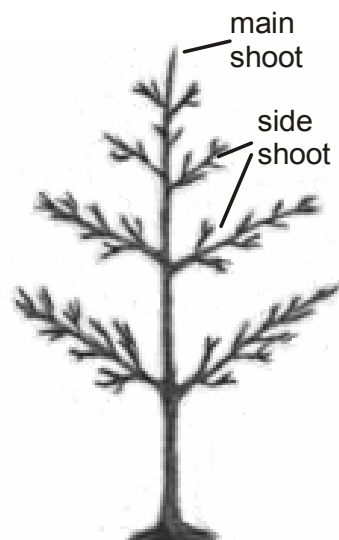
- The main shoot and the side shoots on plant 1 grow.
- The main shoot on plant 2 does not grow. The side shoots grow.
- The main shoot on plant 3 grows. The side shoots do not grow.

These results are generally applicable to this species of plant.

Which of the following two statements is/are correct?

- I. The phytohormone promotes the growth of the main shoot of this plant species.
- II. The phytohormone hinders the growth of the side shoots of this plant species.

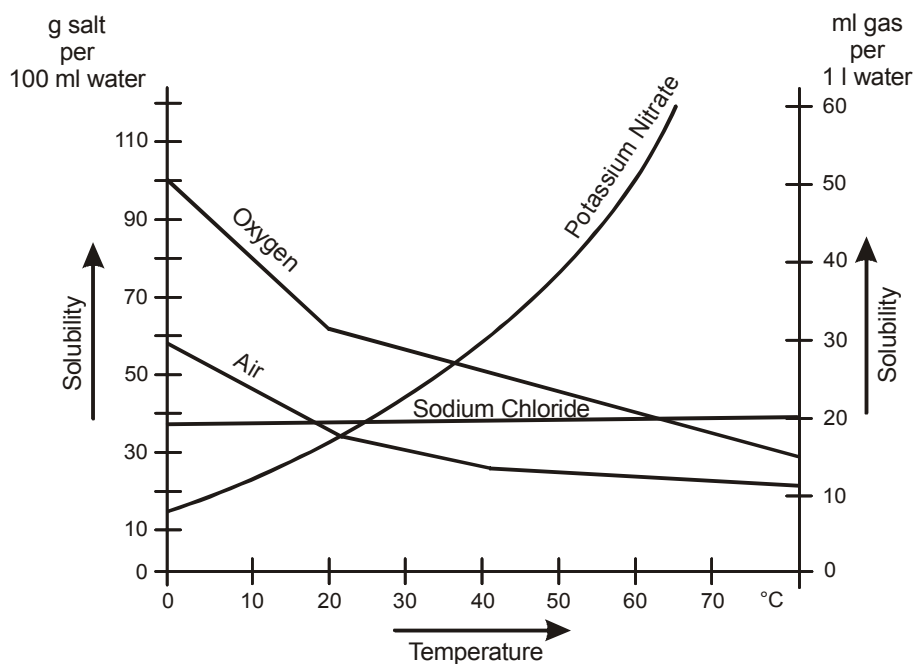
- (A) Only statement I is correct.
- (B) Only statement II is correct.
- (C) Both statements are correct.
- (D) Neither of the two statements is correct.



Degree of difficulty: low

### Example 2

The diagram shows how the solubility of substances in water is dependent on temperature. Potassium nitrate and sodium chloride are salts (shown as grams of salt per 100 millilitres of water). Oxygen and air are gases (shown as millilitres of gas per 1 litre of water).



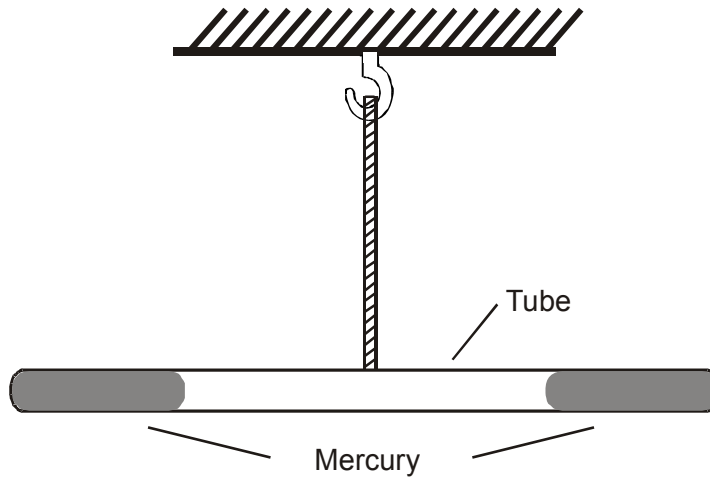
Which of the following two statements is/are correct?

- I. 60 g of potassium nitrate does not fully dissolve in 100 ml of water at 50°C.
  - II. Within a temperature range of 0°C to 20°C, the solubility of oxygen is more dependent on temperature than in the temperature range from 20°C to 80°C.
- (A) Only statement I is correct.  
(B) Only statement II is correct.  
(C) Both statements are correct.  
(D) Neither of the two statements is correct.

Degree of difficulty: medium

### Example 3

A closed tube is hung up so that it is in a balanced state. Both ends are filled with mercury; the space between is filled with air.



The mercury on the right side of the tube is now heated.

Which of the two statements on the impact of this heating action is or are correct (please note: the weight of the air in the tube is to be ignored)?

- I. The left side will go down.
  - II. The right side will become lighter.
- 
- (A) Only statement I is correct.
  - (B) Only statement II is correct.
  - (C) Both statements are correct.
  - (D) Neither of the two statements is correct.

Degree of difficulty: high

## Solutions

### Subtest „Analysing Scientific Interrelationships“

#### Example 1

The observation results show that the main shoot and the side shoots of the untreated plant grow. If the tip of the main shoot is cut off, the main shoot stops growing. However, the phytohormone can be used to make a main shoot continue to grow after its tip has been cut off. The phytohormone hence promotes the growth of the main shoot. **Statement I** is therefore **correct**.

The side shoots grow on the untreated plant and they also grow on the plant where the main shoot was cut off at the tip. If the phytohormone is applied, however, the side shoots stopped growing. The phytohormone hence hinders the growth of the side shoots. **Statement II** is hence **also correct**.

Alternative (C) is therefore the correct answer.

### Example 2

Potassium nitrate is a salt. The solubility of potassium nitrate must therefore be read from the left scale. One starts off from 50°C (on the horizontal temperature scale) and goes up vertically to the potassium nitrate curve, and from there horizontally to the left solubility scale. The solubility value for potassium nitrate readable here is greater than 70 g per 100 ml of water. **Statement I** is therefore **incorrect**.

The oxygen curve is steeper from 0°C to 20°C than from 20°C to 80°C. Hence a temperature change of x°C between 0°C and 20°C leads to a stronger change in solubility than between 20°C and 80°C. **Statement II** is hence **correct**.

The correct solution is therefore (B).

### Example 3

If one heats the right side of the tube, the mercury on this side expands to the left (pressing the air in the tube together). Since the mercury expands on the right side, its centre of gravity shifts, along with the centre of gravity of the entire tube, to the left. The left side of the tube goes down. **Statement I** is therefore **correct**.

However, the expansion of the mercury on the right side and the shift in the centre of gravity does not make the right side lighter. **Statement II** is hence **incorrect**.

Alternative (A) is therefore the correct answer.

## Subtest „Understanding Formal Depictions“

The subtest “Understanding Formal Depictions” involves transposing information from a text into a diagrammatic illustration (“flow chart”) and vice versa.

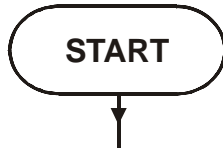
This test, in one respect, measures the ability to transpose concrete natural sciences content into models and the ability to think in terms of formalised systems. In another respect, it measures critical thinking skills in the sense that the information provided has to be checked for correctness. What is more, this subtest seeks to verify the existence of a basic understanding of natural sciences.

## Instructions

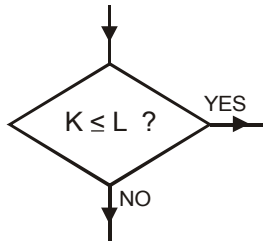
Working time: **85 minutes**

In this group of items, a process or a model has to be transferred to a flow chart or a given flow chart has to be analysed.

The flow charts can contain the following **elements**:



**Beginning** of the process

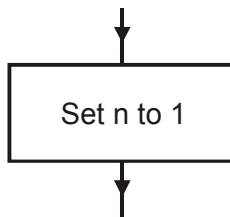


**Decision point:** The further process depends on the answer given to the question set here.

Example: If the question "K ≤ L?" is answered with "YES", then the path marked "YES" has to be followed.

If the question "K ≤ L?" is answered with "NO", then the path marked "NO" has to be followed.

(The answer to the question "K ≤ L?" is "YES" if quantity K is smaller than quantity L, or if both quantities are of equal size. The answer is "NO" if K is larger than L.)



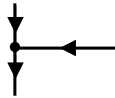
**Operation** that is carried out, or an alternative that is selected. In the example, "n" is set to 1.

**Examples of notation:**

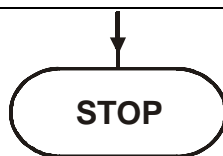
M:= 2          M is allocated a value of 2.

M:= M + 1      the value of M is increased by 1.

M:= M – N      Value M is decreased by the value of N.



**Joining together:** Two "paths" are joined together to form a joint "path".

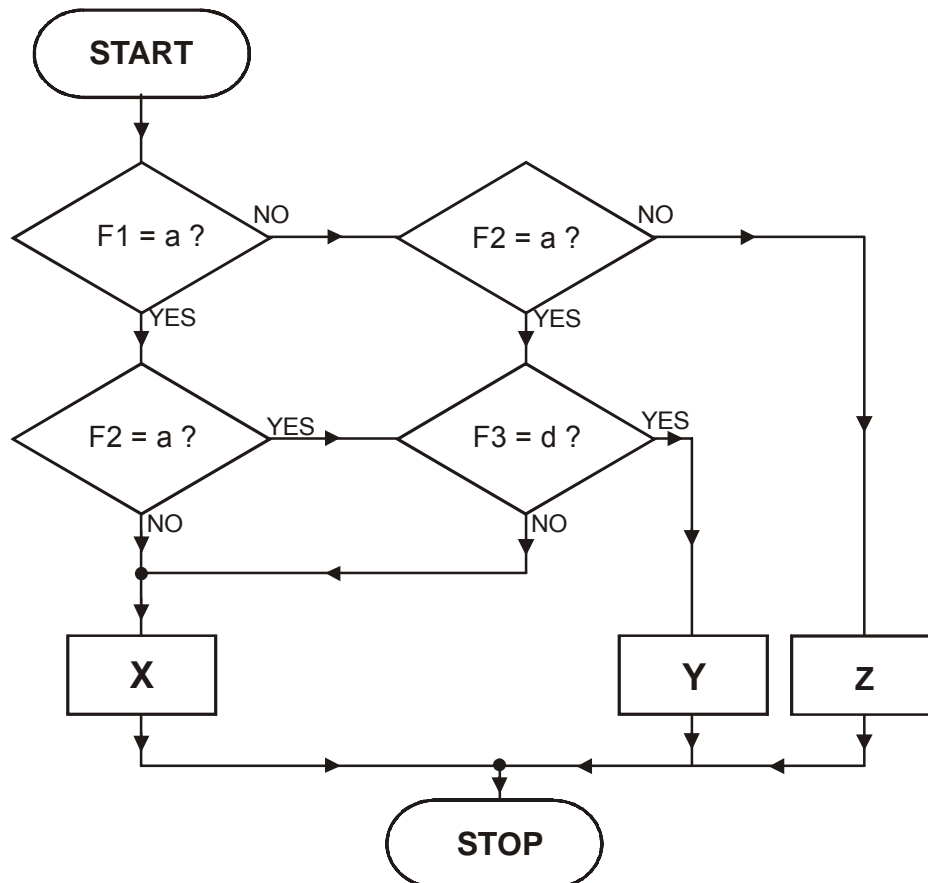


**End** of the process

### Example 1

A decision between X, Y, and Z depends on the factors F1, F2, and F3.

F1 may take the value a or b, F2 may take the value a or b, and F3 may take the value c or d. The flow chart shows how the decision is taken.



Which of the following statements is or are correct?

- I. If  $F1 = a$ , then X is always selected.
  - II. If  $F2 = b$ , then X is always selected.
- (A) Only statement I is correct.  
(B) Only statement II is correct.  
(C) Both statements are correct.  
(D) Neither of the two statements is correct.

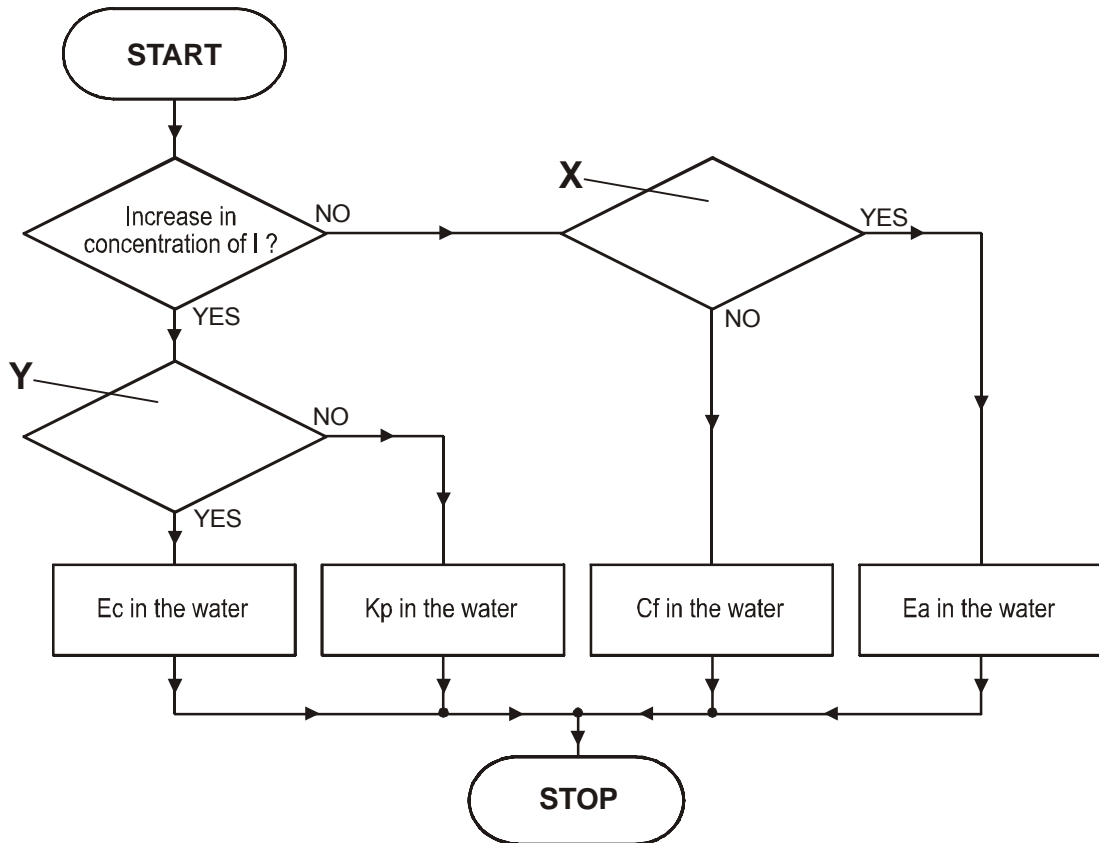
Degree of difficulty: low

### Example 2

Water may contain bacteria. Bacteria produce substances which can be traced in water. If the concentration of these substances is increased, one can draw the conclusion that the water contains bacteria.

The bacteria Ec and Kp produce indol (I). The bacteria Cf and Ec produce acid (S). The bacteria Ea and Kp produce acetoin (A).

If one has a water sample which contains exactly *one* type of bacteria, of this bacteria type can be detected by conducting a test. The flow chart shows how the test is conducted.



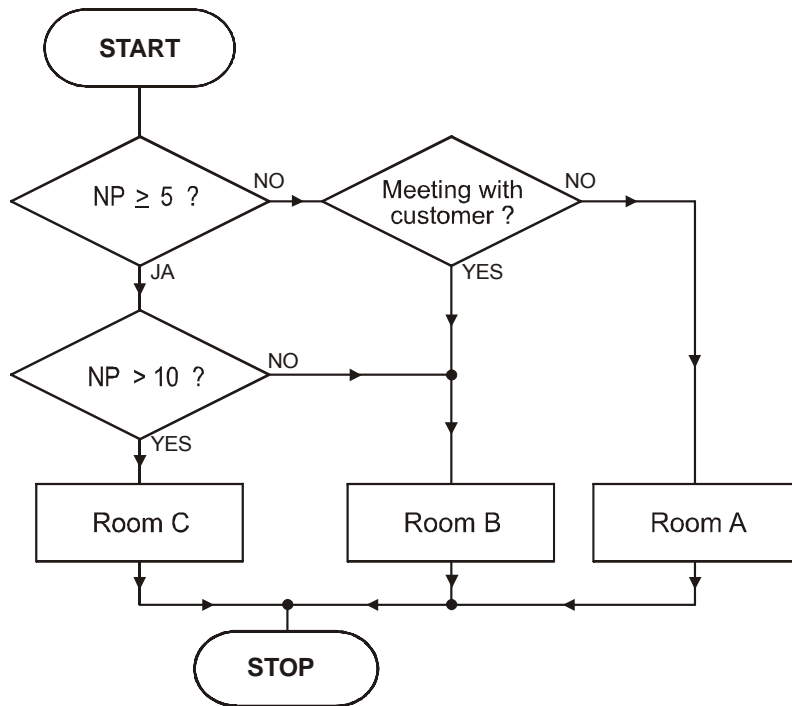
Which of the following statements is/are correct?

- I. If decision step Y is labeled "Increase in concentration of S?", the flow chart may be correct.
  - II. If decision step X is labeled "Concentration of A normal?", the flow chart may be correct.
- (A) Only statement I is correct.  
(B) Only statement II is correct.  
(C) Both statements are correct.  
(D) Neither of the two statements is correct.

Degree of difficulty: low

### Example 3

A business consulting company has three rooms, A, B, and C, available for meetings. Room A is the smallest and seats a maximum of 4 people. Room B seats 10 people. Room C is the largest and seats 30 people. The flow chart shows how a choice is made between the three rooms. "NP" = number of people.



Which of the following two statements is/are correct?

- I. If there are 10 participants, Room B is always chosen.
  - II. Room B is only chosen if the number of people is between 5 and 10.
- (A) Only statement I is correct.  
(B) Only statement II is correct.  
(C) Both statements are correct.  
(D) Neither of the two statements is correct.

Degree of difficulty: high

## Solutions

### Subtest „Understanding Formal Depictions“

#### Example 1

Correct solution: (D)

Solution method:

Statement I is incorrect:

If  $F1 = a$ , then the first question is answered "YES". Then you come to the decision step below that. If  $F2 = a$ , then the second question is also answered "YES" and you go right to the next decision step. If  $F3 = d$ , this question is also answered "YES" and you come to decision Y. Hence it is possible that  $F1 = a$  and Y is selected, not X.

Statement II is also incorrect:

If  $F1 = b$ , you go right from the first decision step. The question in this decision step is " $F2 = a?$ ". If  $F2 = b$  and you hence answer the question "NO", you come directly to decision Z. Hence it is possible that  $F2 = b$  and Z is selected, not X.

### Example 2

Correct solution: (A)

Solution method:

| Bacteria in water: | I         | S         | A         |
|--------------------|-----------|-----------|-----------|
| Ec                 | Increased | Increased | Normal    |
| Kp                 | Increased | Normal    | Increased |
| Cf                 | Normal    | Increased | Normal    |
| Ea                 | Normal    | Normal    | Increased |

Statement I is correct:

If I is increased, then you come to decision step Y, since you answer the first question "YES". If decision step Y is labeled "Increase in concentration of S?", an increase in S leads to the decision in the flow chart that the water sample contains Ec. This is correct, for if the water contains Ec, I and S are increased. However, if S is normal, then the question in decision step Y is answered "NO" and you come to the decision "Kp in water". This is correct, for if the water contains Kp, I is increased and S is normal.

If I is not increased, then you come to decision step X and the question posed there decides whether the flow chart is correct. Hence the flow chart may be correct.

Statement II is incorrect:

If decision step X is labeled "Concentration of A normal?", the flow chart leads to the wrong decision in two cases: if Ea are in the water or if Cf are in the water.

If Ea are in the water, then I is normal and A is increased. The question in the first decision step must therefore be answered "NO" and you come to decision step X. If decision step X is labeled "Concentration of A normal?", then the question in decision step X must be answered "NO" and you come to the wrong decision "Cf in water".

If Cf are in the water, then I is normal and A is normal. If decision step X is labeled "Concentration of A normal?", then the question in decision step X must be answered "YES" and you come to the wrong decision "Ea in water".

### Example 3

Correct solution: (A)

Solution method:

Statement I is correct:

In the case of 10 participants, the question " $NP \geq 5?$ " is answered "YES" and the question " $NP > 10?$ " is answered "NO", meaning that Room B is always chosen.

Statement II is incorrect.

Even if there are fewer than 5 people, Room B can still be chosen. For example, in the case of 4 participants, the question " $NP \geq 5?$ " is answered "NO". If customers are taking part in the meeting, the next question is answered "YES" and the meeting with 4 participants is held in Room B.