



# education

Department of  
Education  
FREE STATE PROVINCE

**CONTROL TEST**

**GRADE 10**

**TECHNICAL SCIENCES**

**SEPTEMBER 2017**

**MARKS: 100**

**TIME: 2 HOURS**

**This paper consists of 10 pages, one data sheet and one answer sheet.**

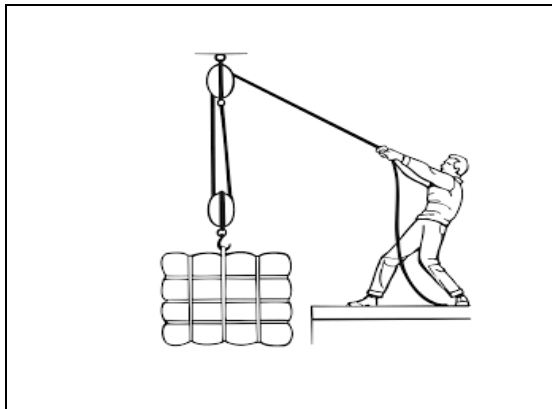
## **INSTRUCTIONS AND INFORMATION**

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of FIVE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

### QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter A, B, C or D next to the question number (1.1–1.10) in the ANSWER BOOK.

- 1.1 A man uses a pulley system to lift a heavy wool-bale as shown in the diagram below.



What type of force/s is/are acting on the bale when it is suspended in the air?

- A Only a frictional force
- B Only a normal force
- C Tension and gravity
- D Only gravity (2)

- 1.2 Which one of the following is the correct SI unit of force?

- A N
- B N·m
- C  $\text{N}\cdot\text{m}^{-1}$
- D  $\text{N}\cdot\text{m}^2$  (2)

1.3 Which one of the following is an example of a non-contact force?

- A Air resistance
- B Spring force
- C Tension
- D Gravity (2)

1.4 Consider the following statements about the normal force.

- i) It acts perpendicular to the surface on which the object lies.
- ii) It acts parallel to the surface on which the object lies.
- iii) In some cases, it acts perpendicular to the surface on which the object is.

Which of the statements is/are true?

- A (i) only
- B (ii) only
- C (i) and (ii)
- D (ii) and (iii) (2)

1.5 Forces are in equilibrium ...

- A only when there is no movement.
- B when a resultant force greater than 0 N acts on an object.
- C when the resultant is equal in magnitude but opposite in direction to the equilibrant.
- D when the only force acting on an object is gravity. (2)

1.6 Which one of the following is NOT a characteristic of a beam?

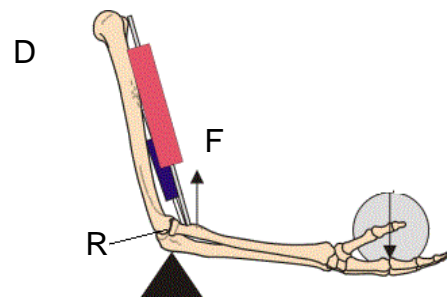
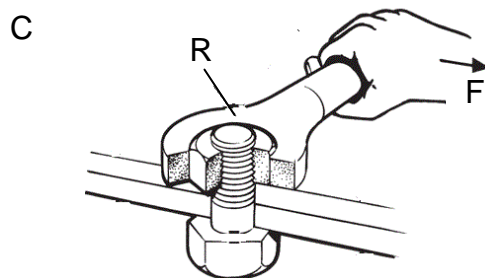
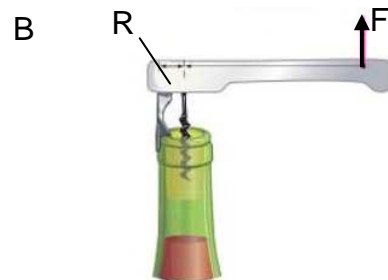
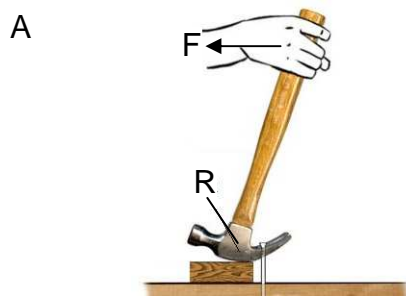
- A The centre of gravity is in the middle.
- B Gravity acts through the midpoint.
- C The cross-sectional area is usually constant.
- D Beams are bendable and stretchable. (2)

1.7 Shear forces are ...

- A acting out of alignment with one another.
- B acting perpendicular to one another.
- C downward forces.
- D upward forces.

(2)

1.8 In which one of the following diagrams does force  $F$  have a CLOCKWISE torque (moment of force) about pivot  $R$ ?



(2)

1.9 Which one of the following is the best description of a lever?

- A A horizontal bar supported by one fulcrum and used to lift heavy objects.
- B A single rigid length of material supported horizontally to carry vertical loads.
- C A vertical bar used to support heavy buildings.
- D A curved structure that supports the entrances to buildings.

(2)

1.10 Which one of the following is the best description of a TYPE 2 lever?

- A The fulcrum is between the load and the effort.
- B The load is between the fulcrum and the effort.
- C The effort is between the fulcrum and the load.

(2)

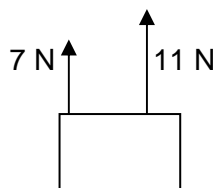
[20]

## QUESTION 2

- 2.1 A man is pushing a trolley by applying a horizontal force of 30 N to the right on the trolley. The floor exerts a frictional force on the trolley and the trolley is in EQUILIBRIUM while it is moving.



- 2.1.1 Define the term *net force*. (2)
- 2.1.2 Write down the MAGNITUDE of the NET force, in newton, acting on the trolley in the HORIZONTAL plane. (1)
- 2.1.3 What is the MAGNITUDE and DIRECTION of the frictional force, in newton, acting on the trolley? (2)
- 2.2 The man sees that boxes are delivered and pushes the trolley with a greater force of 70 N to the right in order to load the boxes.
- 2.2.1 Draw a free-body diagram, with labels, of ALL the forces now acting on the trolley. (4)
- 2.2.2 Calculate the MAGNITUDE and DIRECTION of the NET force, in newton, now acting on the trolley in the HORIZONTAL plane. (4)
- 2.3 Two parallel ropes are used to suspend a box. The box is stationary. The forces exerted by the ropes on the box are 7 N and 11 N as shown in the diagram.

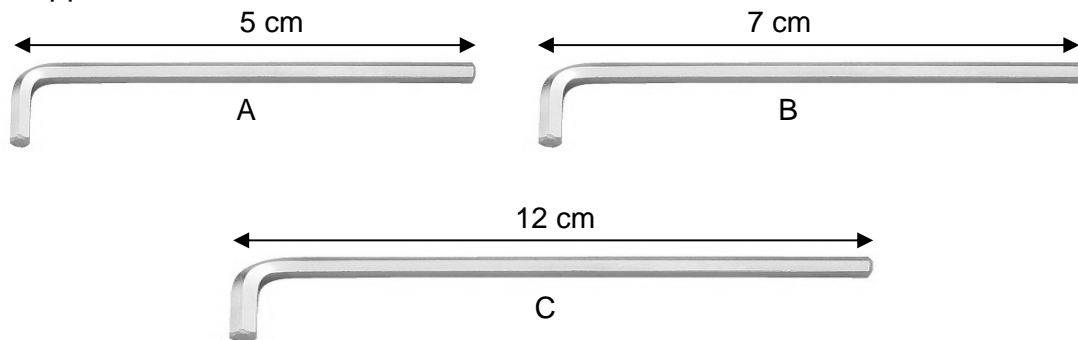


- 2.3.1 Define the term *equilibrant*. (2)
- 2.3.2 Calculate the MAGNITUDE of the upward NET force acting on the box. (3)
- 2.3.3 Write down the MAGNITUDE of the equilibrant, in newton, on the box. (1)

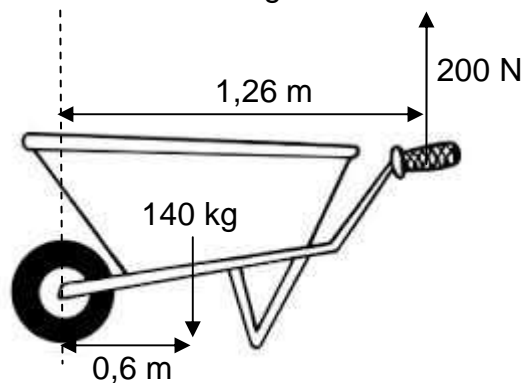
**[19]**

### QUESTION 3

- 3.1 You have three Allen keys (LN keys), **A**, **B** and **C**. The angle between the applied force at the end of the handle and the handle is  $90^\circ$ .

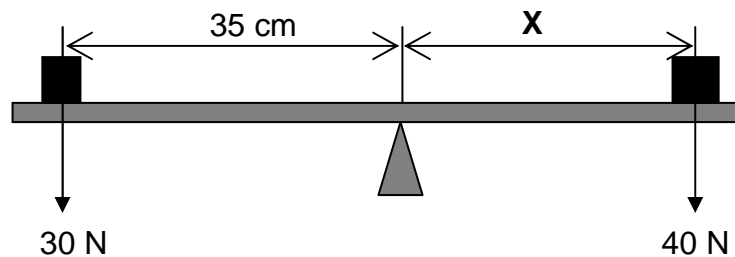


- 3.1.1 Define the term *moment of force*. (2)
- 3.1.2 Which one of **B** or **C** has the greatest moment of force (torque) if a force of 20 N is applied to the end of the handle of each one? Show the necessary calculations to support your answer. (6)
- 3.1.3 Which ONE of **A**, **B** or **C** will you use if you want to apply the SMALLEST possible force at the end of the handle to get a certain torque? Explain your answer. (3)
- 3.2 A builder wants to lift a wheelbarrow, filled with concrete, by applying a total vertical force of 200 N to the handles (on each handle 100 N). The total mass of wheelbarrow and concrete is 140 kg. This mass acts through a point 0,6 m from the axis of the wheel and the point of application of the 200 N is 1,26 m from the axis as shown in the diagram.

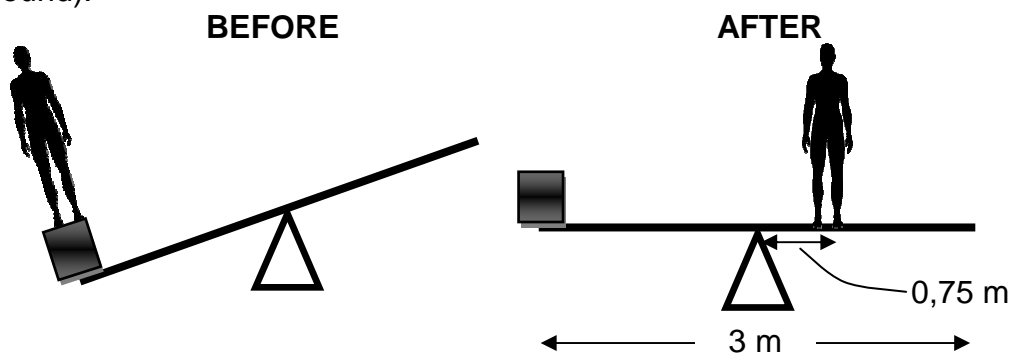


- 3.2.1 Calculate the moment of force due to the mass of the wheelbarrow with concrete. (4)
- 3.2.2 Calculate the moment of force due to the total force exerted by the builder. (3)
- 3.2.3 Is the force of the builder great enough to lift the wheelbarrow? Write YES or NO and explain your answer by referring to FORCE MOMENTS. (2)

- 3.3 The figure shows a balanced metre rule. A 30 N force, acting at a distance of 35 cm from the pivot, is balanced by a 40 N force, which is acting at an unknown distance **X** from the pivot. Ignore the mass of the metre rule.



- 3.3.1 Write down the *law of moments* in words. (2)
- 3.3.2 Calculate the magnitude of **X** in m. (4)
- 3.4 A man, mass 80 kg, stands on a wooden block, with an unknown mass, on the left side of a 3 m seesaw. The pivot of the seesaw is exactly in the middle. The man walks to the right and when he reaches a point that is 0,75 m to the right of the pivot, the seesaw is balanced (parallel to the ground).



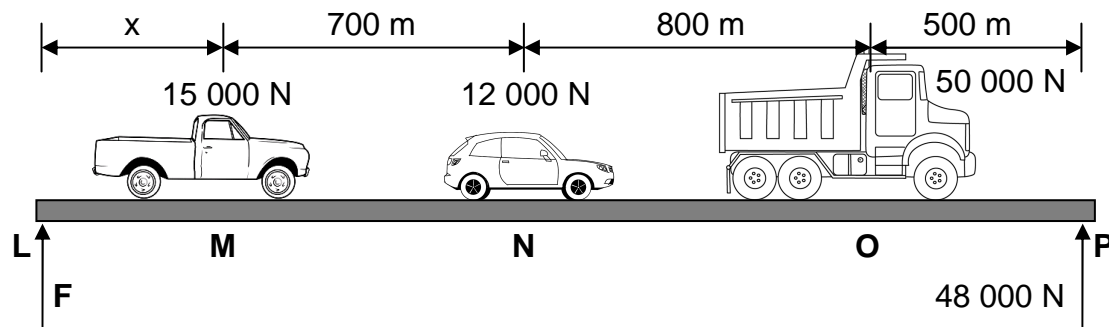
Study the diagram given above and calculate the **WEIGHT** of the **WOODEN BLOCK**.

(4)  
[30]

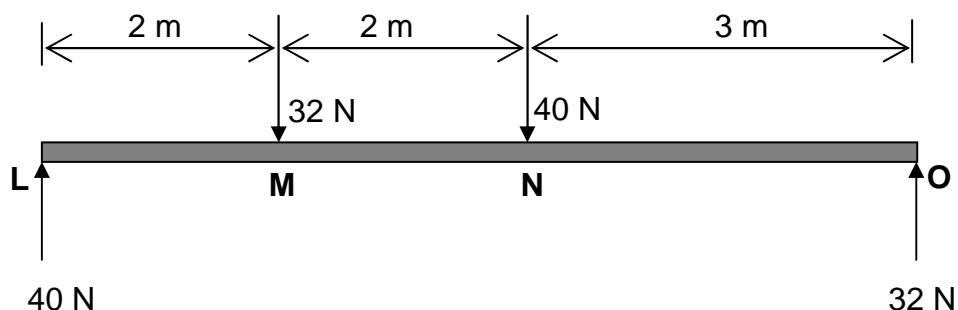


## QUESTION 4

- 4.1 A bakkie (at **M**), a car (at **N**) and a truck (at **O**) exert downward forces of 15 000 N, 12 000 N and 50 000 N respectively on a bridge as shown in the diagram below. Assume that the weight of each vehicle exerts a point load at each of **M**, **N** and **O**. The bridge is supported by two upward forces at **L** and **P**. The magnitude of the force at **P** is 48 000 N. Ignore the mass of the bridge.



- 4.1.1 Use the fact that the vertical net force is equal to zero to show that the magnitude of force **F** (at **L**) is equal to 29 000 N. (3)
- 4.1.2 Calculate the length of  $x$  by taking **FORCE MOMENTS ABOUT POINT N**. (6)
- 4.2 Four forces are exerted on a beam at **L**, **M**, **N** and **O** as shown in the diagram. The beam is balanced. Ignore the mass of the beam.



Use the answer sheet attached at the end of the question paper to draw the following diagrams for this beam:




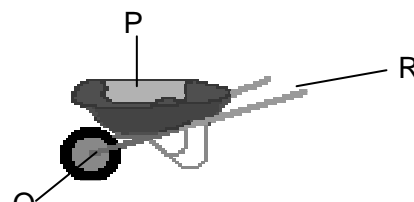
- 4.2.1 Shear force diagram (5)
- 4.2.2 Bending moment diagram. (5)

**Remember to HAND IN your answer sheet with the rest of your answers.**

[19]

## QUESTION 5

The table shows different types of levers that we commonly use.

<p><b>A</b></p> 	<p><b>B</b></p> 
<p><b>C</b></p> 	<p><b>D</b></p> 

5.1 To which class does each of the following levers belong? Only write down 1, 2 or 3.

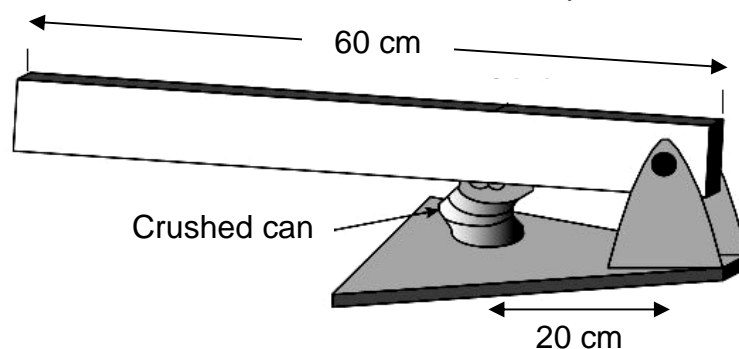
5.1.1 **A** (1)

5.1.2 **B** (1)

5.1.3 **C** (1)

5.2 Give labels for the **P**, **Q** and **R** (in this order) of lever **D**. (3)

5.3 The diagram below shows a tool that is used to crush cool drink cans. The length of the arm is 60 cm and the distance from the pivot to the can is 20 cm.



5.3.1 Calculate the maximum mechanical advantage of the tool. Accept that all forces acting on the tool is perpendicular to the tool. (3)

5.3.2 For the can to be even more easily crushed, should it be placed towards or away from the pivot? Write only TOWARDS or AWAY and give a reason for your answer. (3)

[12]

**GRAND TOTAL: 100**

**DATA FOR TECHNICALSCIENCES GRADE 10  
CONTROLTEST 2**

**GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 10  
KONTROLETOETS 2**

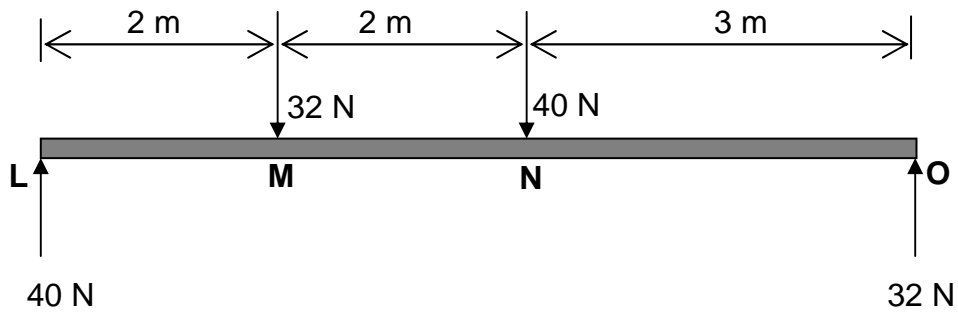
**TABLE 1: FORMULAE/TABEL 1: FORMULES**

<p>Torque / Moment of force</p> <p><i>Draaimoment / Wringkrag / Kragmoment</i></p>	<p><math>\tau = F \times d_{\perp}</math></p> <p>OR / OF</p> <p>Moment = Force x perpendicular distance <i>Moment = Krag x loodregte afstand</i></p>
<p>Weight / Gewig</p>	<p><math>w = mg</math>      (<math>g = 9,8 \text{ m} \cdot \text{s}^{-2}</math>)</p>
<p>Mechanical advantage (MA)</p> <p><i>Meganiese voordeel (MV)</i></p>	<p> <math>MA = \frac{\text{Load}}{\text{Effort}}</math>      OR      <math>MA = \frac{\text{Output force}}{\text{Input force}}</math>  OR  <math>MA = \frac{\text{Effort distance}}{\text{Load distance}}</math>  OR  <math>MA = \frac{\text{Input arm distance}}{\text{Output arm distance}}</math> </p> <p> <math>MV = \frac{Las}{Krag}</math>      OF      <math>MV = \frac{Uitsetkrag}{Insetkrag}</math>  OF  <math>MV = \frac{Kragafstand}{Lasafstand}</math>  OF  <math>MV = \frac{Insetkragafstand}{Uitsetkragafstand}</math> </p>

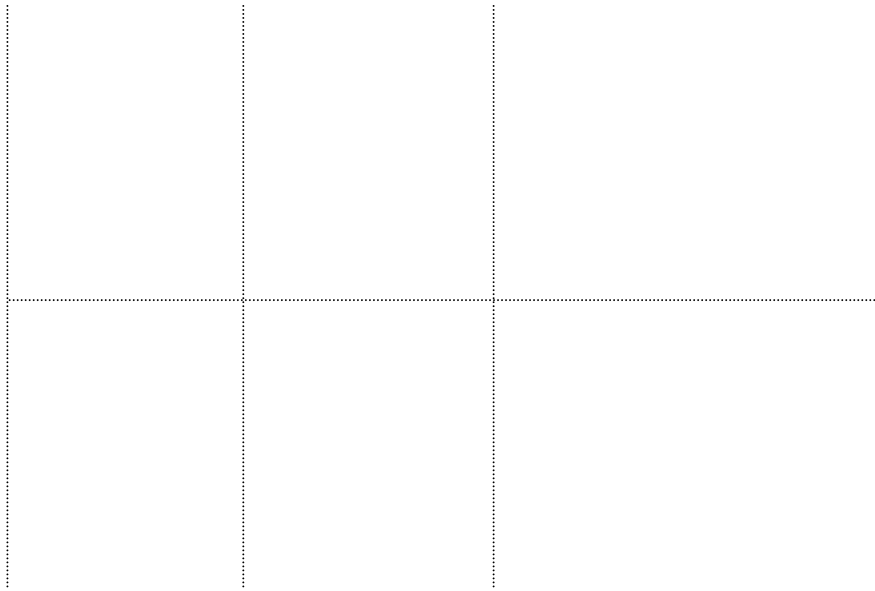
DO YOUR SHEAR FORCE AND BENDING MOMENT DIAGRAMS ON THIS SHEET. REMEMBER TO **HAND IT IN WITH YOUR ANSWER BOOK.**

Name of learner: \_\_\_\_\_ Class: \_\_\_\_\_

4.2

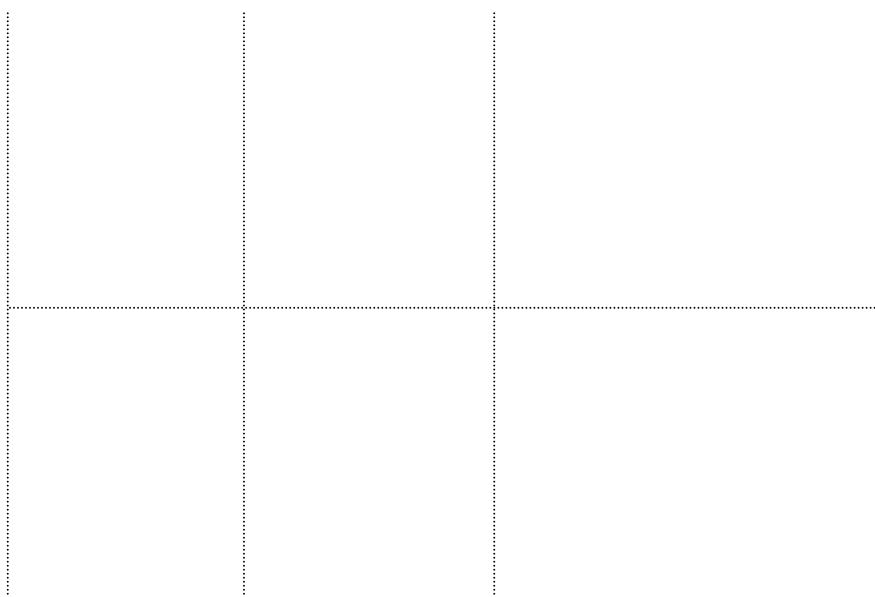


4.2.1



(5)

4.2.2



(5)