



Province of the
EASTERN CAPE
EDUCATION



NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2024

TECHNICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages, including 2 data sheets.

INSTRUCTIONS AND INFORMATION

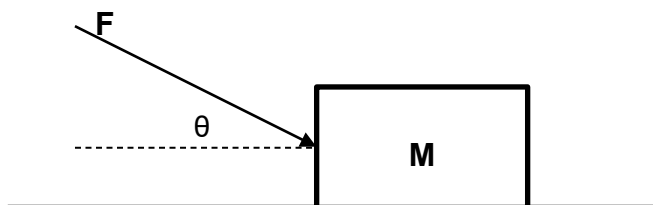
Read the following instructions carefully before answering the questions.

1. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Show ALL formulae and substitutions in ALL calculations.
7. Round off your FINAL numerical answers to a minimum of TWO decimal places.
8. Give brief motivations, discussions et cetera where required.
9. You are advised to use the attached DATA SHEETS.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

- 1.1 Which ONE of the following is the best definition of acceleration?
- A The rate of change of speed.
 - B The rate of change of velocity.
 - C The rate of change of position.
 - D The rate of change of distance. (2)
- 1.2 The inertia of a body can be defined as ...
- A the rate of change of its velocity.
 - B a force acting on a string or a rope.
 - C a force acting parallel to the surface and opposing motion.
 - D the property of a body to resist any change in its state of motion or rest. (2)
- 1.3 Block **M** is resting on a table. Force **F** is applied to the block as shown in the diagram below and the block remains at rest.



Which ONE of the following factors will NOT influence the magnitude of the frictional force on block **M**?

- A The angle θ between force **F** and the horizontal is decreased.
- B The contact area of the block on the table is increased.
- C The magnitude of force **F** is decreased.
- D The mass of **M** is increased. (2)

1.4 The linear momentum of an object is a ...

- A vector quantity with the same direction as the velocity of the object.
- B scalar quantity with the same direction as the velocity of the object.
- C scalar quantity with a direction opposite to that of the velocity of the object.
- D vector quantity with a direction opposite to that of the velocity of the object.

(2)

1.5 The momentum of car **A** changes with time just before and just after a head-on collision with car **B**. The masses of the two cars are the same. Assume that the system is isolated. The velocity of car **B** DECREASES after the collision.

Which ONE of the following combinations about the momentum and kinetic energy of the system is correct?

	MOMENTUM	KINETIC ENERGY
A	Conserved	Not conserved
B	Not conserved	Not conserved
C	Conserved	Conserved
D	Not conserved	Conserved

(2)

1.6 Power is defined as the ...

- A ability to do work.
- B rate at which work is done.
- C product of mass and acceleration.
- D product of force and displacement.

(2)

1.7 A ball is thrown vertically upwards and returns to the ground. Work done by the gravitational force on the ball is ...

- A positive on its way upwards and negative on its way downwards.
- B negative on its way upwards and negative on its way downwards.
- C negative on its way upwards and positive on its way downwards.
- D positive on its way upwards and positive on its way downwards.

(2)

1.8 Which ONE of the following statements is correct?

If the stress applied to a body is more than the elastic limit of the body and is then removed, the body ...

- A becomes hot.
- B opposes the stress.
- C cannot return to its original shape and size.
- D returns to its original shape and size. (2)

1.9 The pressure at a point in a liquid DOES NOT depend on the ...

- A area.
- B depth.
- C density.
- D gravitational acceleration. (2)

1.10 A light ray is directed from water to air with an angle of incidence of 0° . Which ONE of the following is true?

- A The light ray is refracted along the normal.
- B The light ray undergoes total internal reflection.
- C The light ray is refracted towards the normal.
- D The light ray is refracted away from the normal. (2)

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QUESTION 2

- 2.1 Mpho is pulling a suitcase with a mass of 10 kg at a **CONSTANT** velocity. She pulls the suitcase over a rough, horizontal surface with a force **F** of 50 N at an angle of 60° to the horizontal.



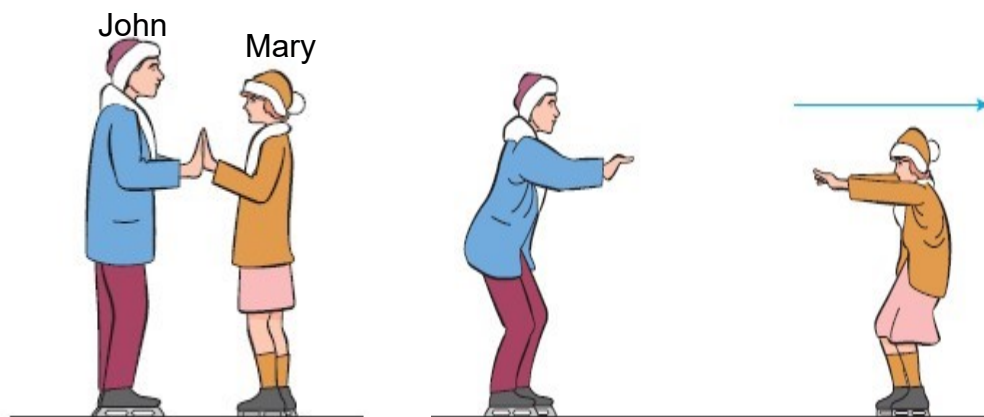
- 2.1.1 State Newton's First Law of Motion in words. (2)
- 2.1.2 Name the non-contact force acting on the suitcase. (1)
- 2.1.3 Calculate the coefficient of friction of the frictional force on the suitcase. (5)
- 2.2 A force (**F**₁) with a magnitude of 40 N is applied at an angle of 35° with the horizontal on a 40 kg block standing on a **ROUGH** surface. The 40 kg block is attached to a 10 kg block and a force (**F**₂) of 20 N is applied, parallel to the surface, on the 10 kg block. The frictional force between the 10 kg block and the surface is 2,5 N and the frictional coefficient between the 40 kg block and the surface is 0,04.



- 2.2.1 State Newton's Second Law of Motion in words. (2)
- 2.2.2 Draw a labelled free body diagram to indicate **ALL** the forces acting on the 10 kg block. (5)
- 2.2.3 Calculate the magnitude of the vertical component of **F**₁. (2)
- 2.2.4 Calculate the magnitude of the normal force acting on the 40 kg block. (2)
- 2.2.5 Calculate the frictional force acting on the 40 kg block. (4)
- 2.2.6 Calculate the magnitude of the acceleration of the system. (5)

2.2.7 What will the influence be on the acceleration of the system if F_2 is applied at an angle of 30° with the horizontal? Only write INCREASE, DECREASE or REMAINS THE SAME. (2)

2.3 John with a mass of 70 kg, and Mary with a mass of 50 kg, are standing on an ice rink as shown below. Then John pushes Mary away with a force of 50 N to the right and they glide away from each other.

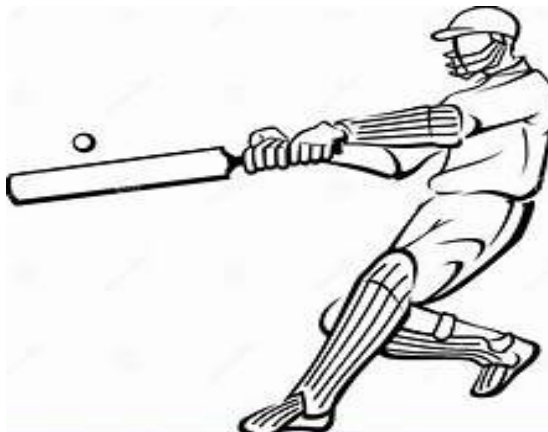


2.3.1 What is the direction and magnitude of the force experienced by John while he is pushing against Mary? (2)

2.3.2 Explain in terms of inertia and other applicable concepts why John and Mary would not cover equal distances from their starting points. (3)
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QUESTION 3

- 3.1 A cricket ball, mass 175 g, is thrown directly towards a batsman at a horizontal velocity of $12 \text{ m}\cdot\text{s}^{-1}$. He hits it back in the opposite direction with a velocity of $30 \text{ m}\cdot\text{s}^{-1}$. The ball is in contact with the bat for a period of 0,05 s.

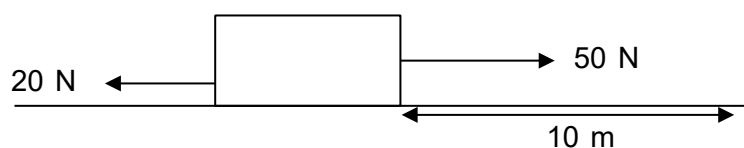


- 3.1.1 Define the term *impulse* in words. (2)
- 3.1.2 Calculate the change in momentum of the ball in magnitude and direction. (5)
- 3.1.3 Calculate the magnitude of the force exerted by the bat on the ball. (3)
- 3.1.4 Modern cars use crumple zones on the front and the sides as a safety measure to reduce injuries during a collision.
Explain, by using the concept of impulse, how crumple zones reduce injuries. (4)
- 3.2 Block **X**, mass 2 kg, slides at $3 \text{ m}\cdot\text{s}^{-1}$ to the right and collides with a stationary block **Y**, mass 3,5 kg. Block **X** rebounds at a velocity of $1 \text{ m}\cdot\text{s}^{-1}$ to the left.
- 3.2.1 Write down the principle of conservation of linear momentum in words. (2)
- 3.2.2 Calculate the velocity of block **Y** after the collision. (5)

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QUESTION 4

- 4.1 An applied force of 50 N acts on a block and it moves a distance of 10 m in a straight line. The force of friction on the block during the motion is 20 N.



- 4.1.1 Define the term *work* in words. (2)

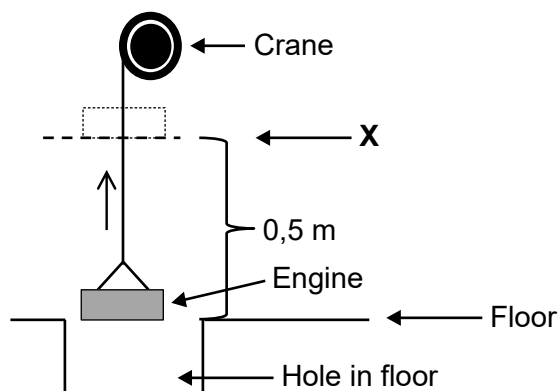
Calculate the:

- 4.1.2 Work done by the applied force (4)

- 4.1.3 Work done by friction (3)

- 4.1.4 Net work done on the block (3)

- 4.2 A motor mechanic stores an engine in a hole in the floor of his workshop. He uses a crane to lift the engine out of the hole. The mass of the engine is 1 500 kg. From floor level to point **X** the engine moves to a height of 0,5 m at CONSTANT velocity. The power dissipated by the crane during this distance is 7,35 kW. Ignore the mass of the cable and the effects of friction.



- 4.2.1 Draw a free-body diagram to show all the forces acting on the engine when moving between the floor and point **X**. (2)

Calculate the:

- 4.2.2 Speed at which the engine is lifted (4)

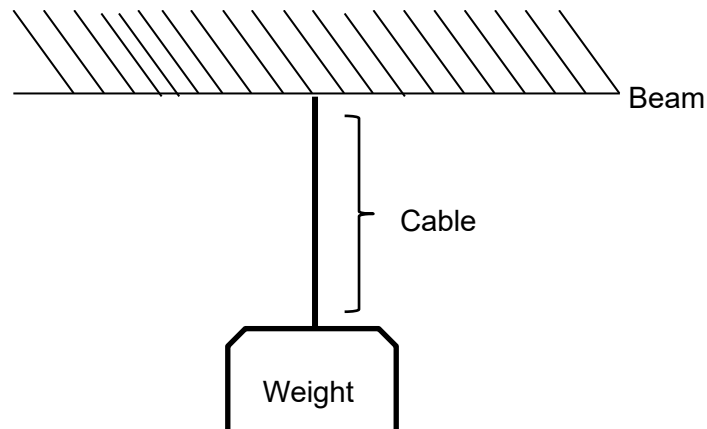
- 4.2.3 Work done by the applied force on the engine between the floor and point **X**. (3)

- 4.2.4 Gravitational potential energy of the engine at point **X** with respect to the floor. (3)

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QUESTION 5

- 5.1 A wire, length 335 cm, with a cross-sectional area of $5 \times 10^{-5} \text{ m}^2$, is used to suspend a 3,5 kN weight from a horizontal beam. The weight causes the length of the wire to increase by 12 mm.



- 5.1 State Hooke's law in words. (2)
- 5.2 Calculate the:
- 5.2.1 Stress (3)
- 5.2.2 Strain (3)
- 5.2.3 Modulus of elasticity (3)
- 5.3 Give TWO examples of perfect plastic bodies. (2)

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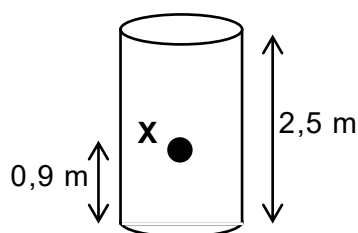
QUESTION 6

- 6.1 A 250 kg metal cylinder stands (vertically) upright on a workshop floor and the cross-sectional area in touch with the floor is $3,15 \times 10^4 \text{ mm}^2$.

6.1.1 Define the term *pressure*. (2)

6.1.2 Calculate the pressure the cylinder exerts on the floor. (4)

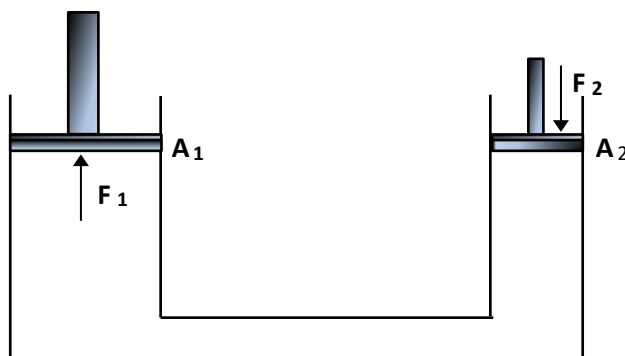
- 6.2 A water tank has a height of 2,5 m and is filled with water. The density of the water is $1\,000 \text{ kg}\cdot\text{m}^{-3}$.



6.2.1 Calculate the pressure of the water at point X in the tank. Point X is 0,9 m from the bottom of the tank. (4)

6.2.2 The water is replaced with petrol, which has a lower density than water. Will the fluid pressure in petrol at X be GREATER THAN, LESS THAN or the SAME AS before? Explain your answer. (4)

- 6.3 In the hydraulic lift shown below, the large piston has a cross-sectional area (A_1) of 200 cm^2 and the small piston has a cross-sectional area (A_2) of 5 cm^2 . A force of 250 N is applied to the small piston.



6.3.1 State Pascal's law in words. (2)

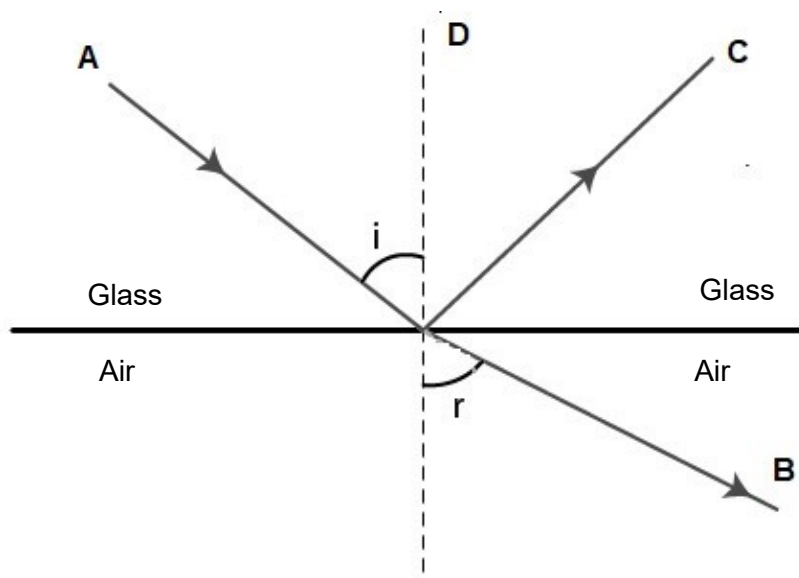
6.3.2 Calculate the force F_1 on the large piston. (4)

6.3.3 Give TWO reasons why liquids, and not gasses, are preferred for use in hydraulic systems. (2)

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QUESTION 7

The path of a ray of light which is directed from glass to air, is shown in the diagram below. The critical angle of the glass is 55° .



- 7.1 Define the term *refraction*. (2)
- 7.2 Label the following:
- 7.2.1 **A** (1)
- 7.2.2 **D** (1)
- 7.3 Define *critical angle*. (2)
- 7.4 What is the phenomenon called which occurs when the angle of incidence (*i*) is greater than 55° ? (1)
- 7.5 Will the angle of refraction (*r*) be GREATER THAN, SMALLER THAN or EQUAL TO the angle of incidence (*i*)? (1)
- 7.6 Give a reason for your answer to QUESTION 7.5. (2)
- 7.7 Draw a beam/ray diagram to determine the position and size of the image that will be formed when the focal point distance **F** for a convex lens and an object with a height of 3 cm is placed at a distance of **2F**. (5)

[15]**TOTAL: 150**

DATA FOR TECHNICAL SCIENCES GRADE 12

PAPER 1

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12

VRAESTEL 1

TABLE 1/TABEL 1

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	$-e$	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$
Torque = $F \times r$	$MA = \frac{L}{E} = \frac{e}{I}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F\Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2}mv^2$ or/of $E_k = \frac{1}{2}mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	$M_E = E_k + E_p$

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

Speed/Speed	$c = f\lambda$
Energy/Energie	$E = hf$ or/of $E = \frac{hc}{\lambda}$

ELASTICITY, VISCOSITY AND HYDRAULICS/ELASTISITEIT, VISKOSITEIT EN HIDROULIKA

$\sigma = \frac{F}{A}$	$\varepsilon = \frac{\Delta \ell}{L}$
$\frac{\sigma}{\varepsilon} = K$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$