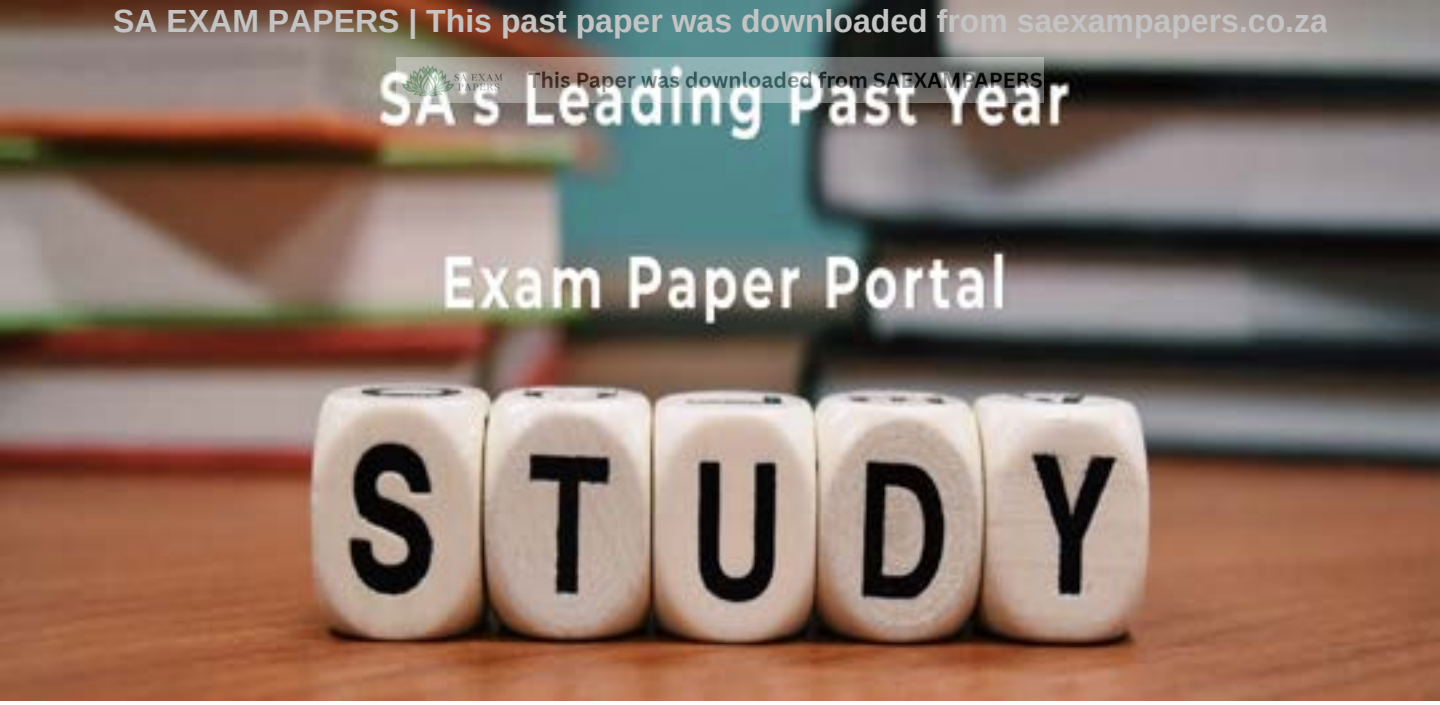


GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2025

TECHNICAL SCIENCES

(PAPER 1)

TECHNICAL SCIENCES P1

C2101E

TIME: 3 hours
MARKS: 150
11 pages + 2 data sheets

X05

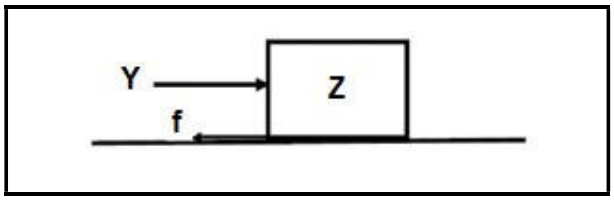
INSTRUCTIONS AND INFORMATION

1. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Number the answers correctly according to the numbering system used in this question paper.
3. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions etc. where required.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A force, **Y**, pushes a box, **Z**, horizontally at a constant velocity on a rough surface.



If the applied force **Y** is reduced, which of the followings statements is correct?

A The frictional force acting on the box decreases.
B The acceleration of the box increases.
C The velocity of the box decreases.
D The normal force increases. (2)

1.2 If the velocity of an object is doubled while its mass remains constant, explain how this affects its kinetic energy.

A The momentum stays the same while the kinetic energy doubles.
B Both momentum and kinetic energy are doubled.
C Both momentum and kinetic energy are quadrupled.
D Momentum is doubled, and the kinetic energy is quadrupled. (2)

1.3 Impulse is …

A the change in an object's kinetic energy.
B the product of the net force acting on an object and the object's mass.
C the rate of change in momentum.
D the product of the net force acting on an object and the time the net force acts on the object. (2)

1.4 Which of the following situations involves no work being done?

A A person pushes a box across the floor with a constant force in the direction of motion.
B A person holds a heavy suitcase at a constant height while standing still.
C A car accelerates along a straight road.
D A person pulls a sledge up a hill with a constant force along the slope. (2)

1.5 A force, **F**, is required to break a copper wire with a radius, **R**. What will the required force be to break a copper wire with a radius of 2**R**?

A $\frac{F}{2}$
B $\frac{F}{4}$
C 2F
D 4F (2)

1.6 What does the "15W-40" label on motor oil indicate?

A It is suitable only for cold weather conditions due to its low viscosity.
B The "15W" indicates the oil's viscosity in cold temperatures, while "40" represents its viscosity at high temperatures.
C It is a mono-grade oil designed for use in a narrow range of temperatures.
D The "40" indicates the oil's maximum temperature tolerance, and "15W" represents its lubrication properties. (2)

1.7 Which of the following statements about the viscosity of oil, vinegar and syrup is correct?

A Syrup has the highest viscosity because it flows the slowest, while vinegar has the lowest viscosity.
B Oil has the highest viscosity because it forms a thick layer, and vinegar has the lowest viscosity.
C Vinegar has the highest viscosity because it flows easily, while oil and syrup have similar viscosities.
D All three substances have the same viscosity since they are all liquids. (2)

1.8 Which of the following is NOT an example of Pascal's Law?

A A hydraulic brake system in a car
B A syringe pushing fluid through a needle
C A bicycle pump inflating a tyre
D A hydraulic lift lifting a vehicle (2)

1.9 Which of the following conditions is necessary for total internal reflection to occur?

A The light must travel from a medium with a higher refractive index to a medium with a lower refractive index.
B The angle of incidence must be smaller than the critical angle.
C The angle of refraction must be larger than the critical angle.
D The light must travel from a medium with a lower refractive index to a medium with a higher refractive index. (2)

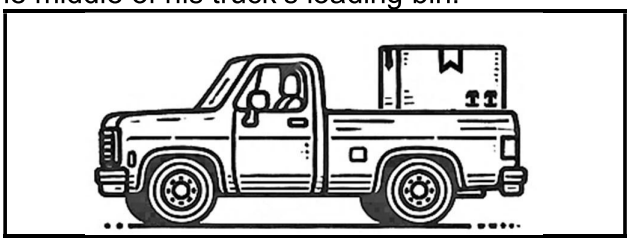
1.10 Which type of wave does NOT travel at $3,0 \times 10^8$ $m \cdot s^{-1}$?

A Radio
B Gamma
C Sound
D Microwave (2)

[20]

QUESTION 2 (Start on a new page.)

John places a box against the tailgate of his truck, as indicated in the drawing below. He stops at numerous traffic lights on his way home. After arriving home, John notices the box is now in the middle of his truck's loading bin.



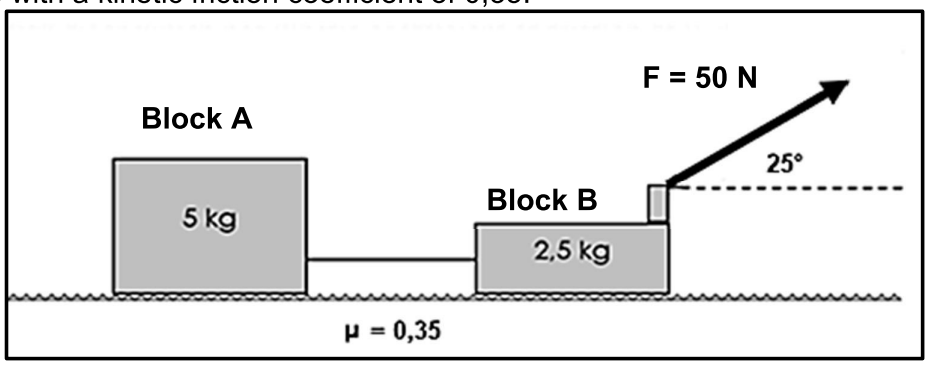
2.1 Name and define the law illustrated in the above scenario. (3)

2.2 Explain, using scientific principles, why the box is no longer positioned against the tailgate. (2)

[5]

QUESTION 3 (Start on a new page.)

Two blocks, **A**, of mass 5 kg, and **B**, of mass 2,5 kg are connected by a light inextensible string. A 50 N force is applied at an angle of 25° to block **B** as shown in the diagram below. This force causes both blocks to accelerate across a rough surface with a kinetic friction coefficient of 0,35.



3.1 Define the term *tension.* (2)

3.2 Draw a labelled, free-body diagram showing ALL the forces acting on block **B**. (5)

3.3 Explain the difference in the magnitude of the frictional forces acting on block **A** and block **B**, considering their masses, the applied force and the coefficient of friction. (3)

3.4 Calculate the acceleration of block **A**, given that block **A** and block **B** experience friction forces of 17,15 N and 3,37 N, respectively. (6)

3.5 Calculate the tension experienced by block B. (2)

3.6 Will the tension experienced by block **A** be different from that of block **B**? Explain the answer. (2)

3.7 Name and state the law that is used to answer QUESTION 3.6. (3)

3.8 If the angle of the applied force is increased to 45°, how would this impact the system's acceleration? Choose between INCREASES, DECREASES, or STAYS THE SAME, and provide a justification for your answer (2)

3.9 The string between block **A** and block **B** breaks. Explain in detail what will happen to the acceleration of block **A**. (2)
[27]

QUESTION 4 (Start on a new page.)

A boy with a mass of 70 kg is riding on a skateboard with a mass of 5 kg. Together, they are moving at a velocity of 4 $m \cdot s^{-1}$ in a straight line towards the curb of the road. The skateboard collides with the curb, and the boy is propelled forward. The skateboard is in contact with the pavement for 2 seconds.

4.1 Define the term *momentum*. (2)

4.2 Calculate the magnitude of the boy's momentum before he hits the pavement. (3)

4.3 Determine the force that the pavement exerts on the skateboard during the impact. (4)

4.4 If the skateboard comes to rest after the collision with the pavement, calculate the impulse experienced by the skateboard. (3)
[12]

QUESTION 5 (Start on a new page.)

A car with a mass of 1 000 kg is traveling to the left at a velocity of 20 $m \cdot s^{-1}$ along a narrow road. It collides head-on with a pickup truck, with a mass of 1 800 kg and which is moving in the opposite direction at a velocity of 15 $m \cdot s^{-1}$. Following the collision, the two vehicles become entangled and move together as a single unit.

5.1 State the principle of conservation of linear momentum in words. (2)

5.2 Calculate the momentum of the car before the collision. (3)

5.3 Calculate the magnitude of the velocity of the pickup truck-car system after the collision. (4)

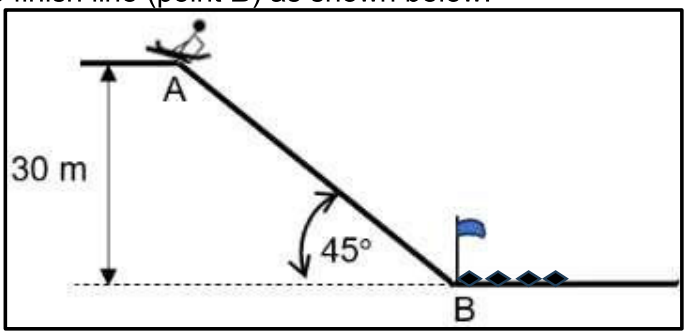
5.4 Is the collision elastic or inelastic? Determine by means of calculations and explain the answer. (5)

5.5 The driver of the car was wearing a seatbelt during the collision. Name and describe one additional safety feature in the vehicle that utilises the concept of impulse to enhance road safety. Refer to net force and time in the answer. (3)

[17]

QUESTION 6 (Start on a new page.)

In the Winter Olympics, a skier with a mass of 75 kg (including skis) pushes off from the starting point at **A** at a speed of 2 $m \cdot s^{-1}$ and moves along a frictionless (**A** to **B**) racecourse to the finish line (point **B**) as shown below.



6.1 State the principle of conservation of mechanical energy in words. (2)

6.2 Draw a force diagram showing all the forces acting on the skier at point **A** (3)

6.3 Calculate the skier's total mechanical energy at point **A**. (4)

6.4 Calculate the speed at which the skier crosses the finish line at point **B**. (3)

6.5 Once the skier crosses the finish line, he experiences a frictional force of 4,5 N as he lifts one of the 300 g ski poles above his head and moves another 15 m before coming to a rest.

Determine the work done by the frictional force on the skier as he raises the ski pole after crossing point **B**. (4)

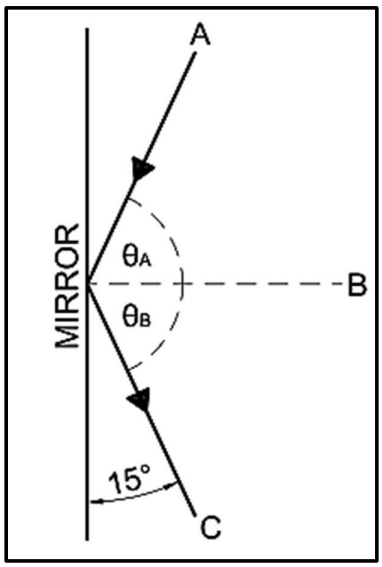
6.6 The skier makes use of a ski lift as transportation up the slope to point **A**. The lift is powered by an electric motor that applies a force of 497 N to the chairs and moves at a constant velocity of 3 $m \cdot s^{-1}$ up the slope.

Calculate the power output of the ski lift in horsepower. (4)

[20]

QUESTION 7 (Start on a new page.)

Study the diagram below and answer the questions that follow.



7.1 Define the concept represented by the diagram above. (2)

7.2 Identify the following from the diagram:

7.2.1 **A** (1)

7.2.2 **B** (1)

7.2.3 **C** (1)

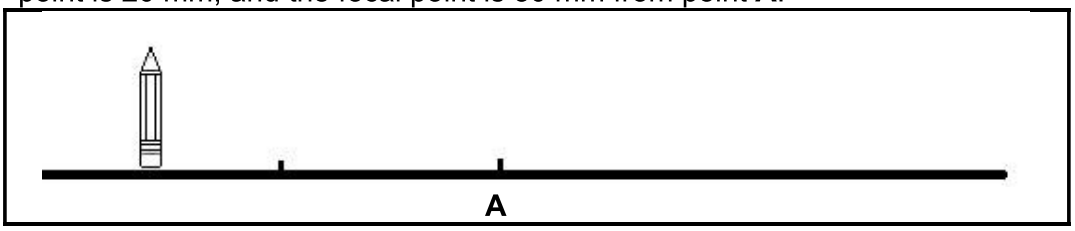
7.2.4 The magnitude of θ_A (1)

7.3 The angle of θ_A increases.

7.3.1 How will the value of θ_B change? Write only INCREASES, DECREASES, or REMAINS THE SAME. (1)

7.3.2 Explain the answer to QUESTION 7.3.1. (2)

7.4 An incomplete diagram (not drawn to scale) of an experiment of a lens and a 25 mm pencil is shown below. The distance between the pencil and the focal point is 20 mm, and the focal point is 30 mm from point **A**.



A convex lens was used and placed at point **A** on the diagram.

7.4.1 Copy the diagram onto your ANSWER BOOK and draw a labelled, ray diagram to illustrate the size and position of the image of the pencil that will be formed. (4)

7.4.2 Describe how the size of the image of the pencil changes when the pencil is moved closer to the lens. (2)

7.4.3 Provide TWO characteristics of the formed image. (2)

7.4.4 Evaluate the impact of replacing the convex lens with a concave lens on the size and position of the image. (3)

[20]

QUESTION 8 (Start on a new page.)

The following are some electromagnetic waves and their corresponding wavelengths.

ELECTROMAGNETIC RADIATION	WAVELENGTH (M)
Wave **Z**	5×10^{-3}
X- rays	2×10^{-10}
Ultraviolet	3×10^{-7}
Visible light	5×10^{-6}
Infra-red	4×10^{-5}

8.1 Name ONE source of ultraviolet radiation. (1)

8.2 Give TWO properties of electromagnetic waves. (2)

8.3 Which of the waves has the highest frequency? Use the data in the table to explain your reasoning. (2)

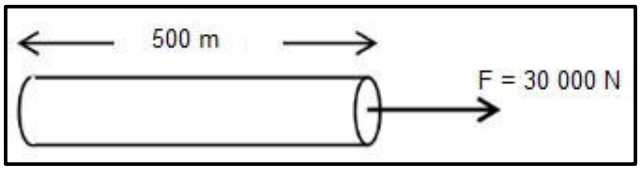
8.4 Calculate the energy of an X-ray photon. (3)

8.5 Identify the electromagnetic radiation labelled **Z**. (2)

[10]

QUESTION 9 (Start on a new page.)

A force of 30 000 N is used to stretch a steel alloy cable. The cross-sectional area of the cable, where the force is applied, has a diameter of 115 cm. The length of the cable is 500 m before it is stretched.

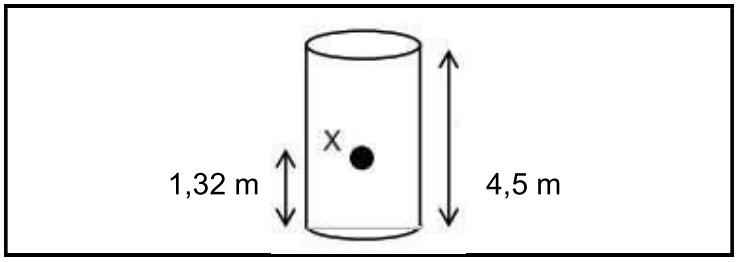


9.1 Define *stress*. (2)

9.2 Calculate the stress experienced by the cable. (4)
[6]

QUESTION 10 (Start on a new page.)

A water tank has a height of 4,5 m and is filled with water. The density of water is 1 000 kg·m^{-3}.



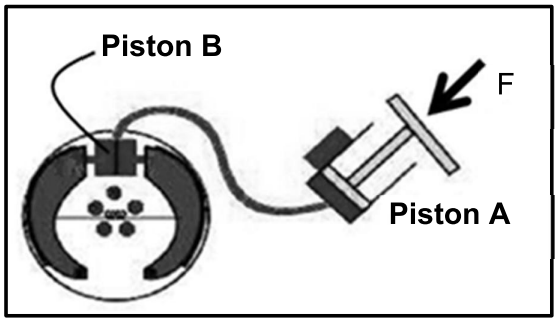
10.1 Define *pressure at a particular point*. (2)

10.2 Calculate the pressure of the water at point **X** in the tank. Point **X** is located 1,32 m from the bottom of the tank. (3)

10.3 The water is replaced with petrol, which has a lower density than water. Will the fluid pressure at point **X** be MORE THAN, THE SAME AS, or LESS THAN before? Explain the answer. (2)
[7]

QUESTION 11 (Start on a new page.)

The image below represents the hydraulic braking system of a car, which operates based on Pascal's law



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

11.2 The driver applies a force of 200 N on piston **A**, which has an area of $3{,}14 \times 10^{-4}$ m², to stop the car. The area of piston **B** is $1{,}256 \times 10^{-3}$ m². Calculate the force exerted by piston **B** that presses the brake pads against the brake disc. (4)
[6]

TOTAL: 150

END

DATA FOR TECHNICAL SCIENCES GRADE 12 JUNE EXAMINATION

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12 JUNIE EKSAMEN

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8$ $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ $J \cdot s$
Permittivity of free space *Permittiwiteit van vrye spasie*	ε_o	$8,85 \times 10^{-12}$ $F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$ / $f_{s(maks)} = \mu_s N$	$f_k = \mu_k N$
$F_{net} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$

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* $E_k = \frac{1}{2}mv^2$	$\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$M_E = E_k + E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemiddeld} = Fv_{gemiddeld}$	

ELASTICITY, VISCOSITY & HYDRAULICS
ELASTISITEIT, VISKOSITEIT & HIDROULIKA

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

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$E = hf$ or/*of* $E = h\frac{c}{\lambda}$	