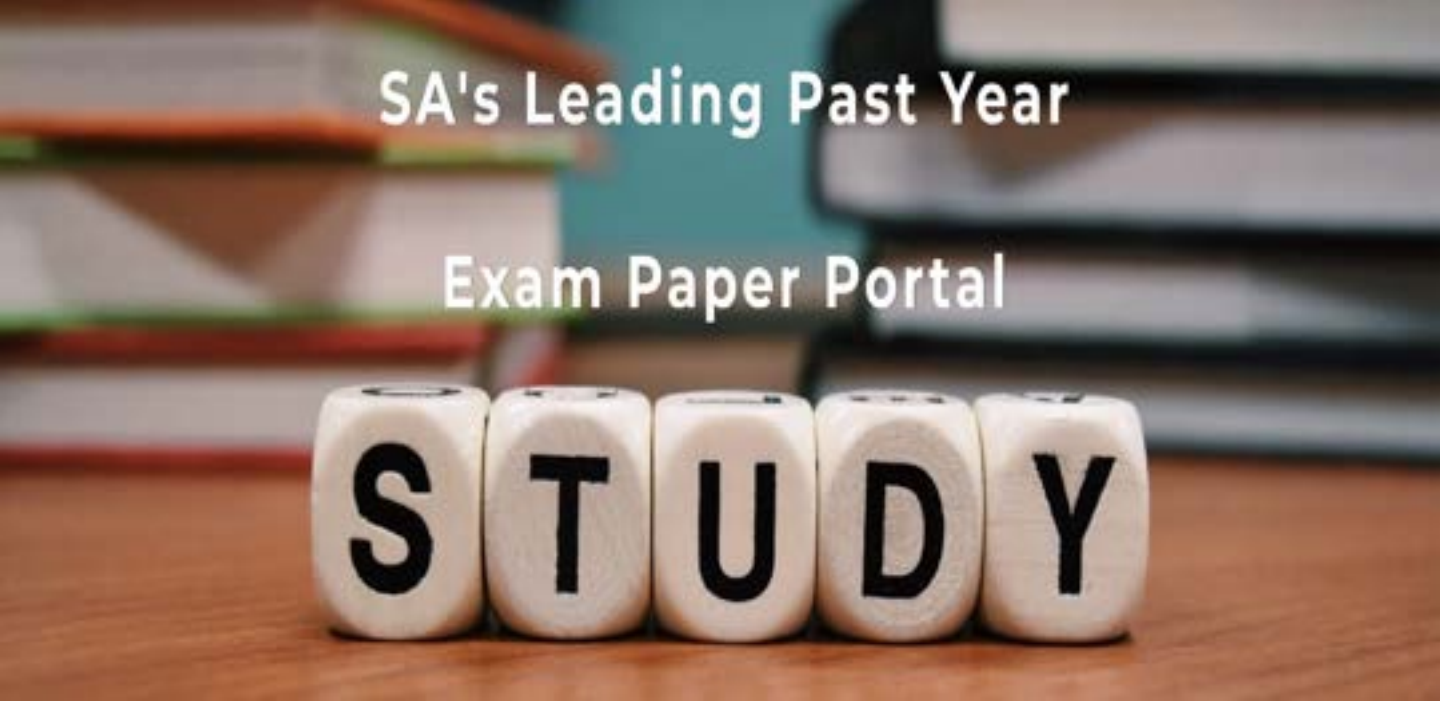

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GAUTENG PROVINCE
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REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2022

11101

TECHNICAL SCIENCES

PAPER 1

TIME: 3 hours

MARKS: 150

15 pages + 1 graph sheet and 3 data sheets

11101E

X05

INSTRUCTIONS AND INFORMATION

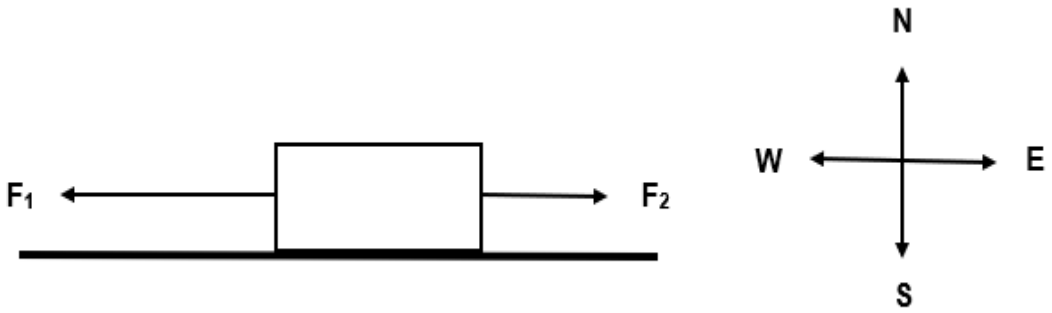
1. Write your name in the ANSWER BOOK.
2. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-sections, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round-off your final numerical answers to a minimum of TWO decimal places.
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 down only the letter (A – D) next to the question numbers (1.1 to 1.10) in your ANSWER BOOK.

1.1 Two forces, $\mathbf{F_1}$ and $\mathbf{F_2}$, are applied on a crate lying on a frictionless, horizontal surface, as shown in the diagram below.

The magnitude of force $\mathbf{F_1}$ is greater than that of force $\mathbf{F_2}$.



The crate will ...

A accelerate towards the west.
B accelerate towards the east.
C move at a constant speed towards the east.
D move at a constant speed toward the west. (2)

1.2 A stone is dropped from a certain height above the ground. Which of the following combinations is TRUE while the stone is moving downwards? Ignore the effects of air resistance.

	NET FORCE ACTING ON THE STONE	MECHANICAL ENERGY OF THE STONE
A	Remains the same	Increases
B	Decreases	Remains the same
C	Remains the same	Remains the same
D	Increases	Decreases

(2)

1.3 The mechanical energy of a free falling body is conserved. It can be concluded that:

A The body experiences no air friction as it falls through the air.
B The potential energy is equal to the kinetic energy at any point during the motion.
C The sum of the potential and kinetic energies at any point during the motion is zero.
D The work done by Earth on the body is zero throughout its fall. (2)

1.4 Which of the following statements defines Hooke's Law?

A Instantaneous force divided by the original cross-sectional area of the test material
B Stress value required to produce unit strain in a tensile specimen of a particular material
C A measurement of the deformation produced by the application of the external forces
D Strain is directly proportional to the stress causing it, provided the limit of elasticity is not exceeded (2)

1.5 The viscosity of motor oil increases when the ... the oil decreases.

A mass of
B density of
C pressure on
D temperature of (2)

1.6 A force $\mathbf{F_X}$ is applied to a piston in a hydraulic pipeline. The area of the piston is $\mathbf{A_X}$. Another piston in the same pipeline has an area $\mathbf{A_Y}$ and this piston can exert a force $\mathbf{F_Y}$. Which of the following equations is INCORRECT according to Pascal's law?

A $\frac{F_x}{F_y} = \frac{A_x}{A_y}$

B $F_xA_y = F_yA_x$

C $\frac{A_y}{F_y} = \frac{A_x}{F_x}$

D $F_xA_x = F_yA_y$ (2)

1.7 Which of the following is not used for a capacitor?

A Filter circuits in power supply
B Separation of frequency between woofer and tweeter speakers
C Power supply improvement in an electrical transmission system
D Turn the power on and off (2)

1.8 Current in a circuit is measured in ...

A volts.
B amperes.
C coulombs.
D ferrads. (2)

1.9 Dispersion is the phenomenon where the following happens:

A White light reflects from a smooth surface.
B White light breaks up in the component colours.
C White light breaks away from the normal, as soon as the beam moves from one medium to another.
D White light is absorbed and does not reflect at all. (2)

1.10 Electromagnetic waves are formed by …

A stationary electric charges.
B accelerating electric charges without any magnetic field around them.
C the change in magnetic and electric fields that are perpendicular to one another.
D increase in current. (2)

[20]

QUESTION 2 (Start on a new page.)

Choose a statement from COLUMN A that matches the term in COLUMN B. Write only the letter (A – K) next to the question numbers (2.1 to 2.10) in the ANSWER BOOK, e.g., 2.11 L.

	COLUMN A		COLUMN B
2.1	The property of a body to resist any change in its state of motion or rest	A	Viscocity
2.2	The product of the net force acting on an object and the time it takes the net force to act on the object	B	Strain
2.3	The product of the applied force on an object and the displacement in the direction of the force	C	Newton's first law
2.4	The energy the object has because of its position from the surface of the Earth	D	Impulse
2.5	The ratio of change in dimension to the original dimension	E	Right hand rule
2.6	The property of the fluid to oppose relative motion between the two adjacent layers	F	Pascal's law
2.7	A body will remain at rest or continue to move on a straight line with constant velocity unless an external force acts upon it.	G	Power
2.8	A continuous liquid at equilibrium, the pressure applied at a point is transmitted equally to the other parts of the liquid	H	Inertia
2.9	The rate at which electrical energy in an electrical circuit is converted	I	Newton's third law
2.10	The rule used to determine the direction of the magnetic field around the current-carrying conductor	J	Gravitational potential energy
		K	Work done

[10]

QUESTION 3 (Start on a new page.)

Two crates with mass 30 kg and 50 kg are connected with a strong string on a horizontal smooth surface as shown in the sketch below. A force of 500 N is applied on the 50 kg crate. The mass of the string is ignored.

3.1 State *Newton's second law of motion* in words. (2)

3.2 Draw a labelled free-body diagram of all the forces acting on the 50 kg crate. (4)

3.3 Calculate the magnitude of the tension force on the string if the 50 kg crate is moving TO THE RIGHT, with an acceleration of 3 $m.s^{-2}$. (4)

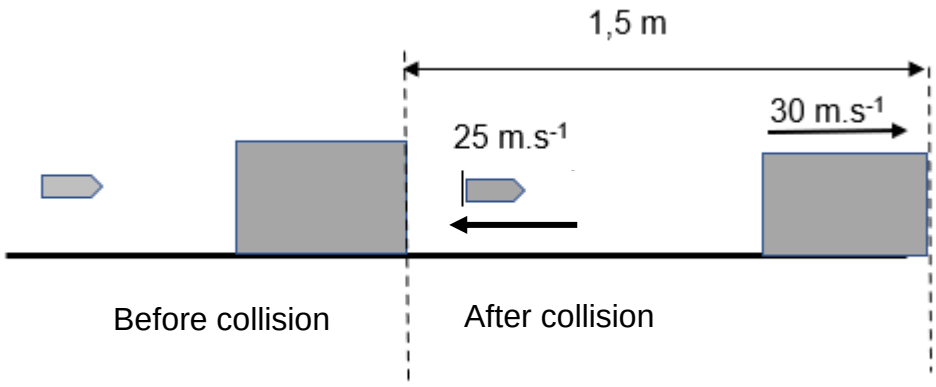
3.4 If the applied force is decreased from 500 N to 150 N, indicate by using calculations, if the tension will INCREASE, DECREASE or REMAIN THE SAME. (4)

3.5 State *Newton's third law* in words. (2)

[16]

QUESTION 4 (Start on a new page.)

4.1 A bullet of mass 0,8 g is travelling horizontally to the right and strikes a 2 kg metal block which is at rest.



During collision with the bullet, the metal block moves at the velocity of 30 $m.s^{-1}$ and the bullet moves at the velocity of 25 $m.s^{-1}$ as shown in the diagram above.

4.1.1 State the law of *Conservation of linear momentum* in words. (2)

4.1.2 Calculate the initial velocity of the bullet before it hit the metal block. (4)

4.2 The bullet was in contact with the metal block for 5 s and exerted the force of 12 N while in contact with the metal block.

4.2.1 Calculate the impulse of the metal block. (3)

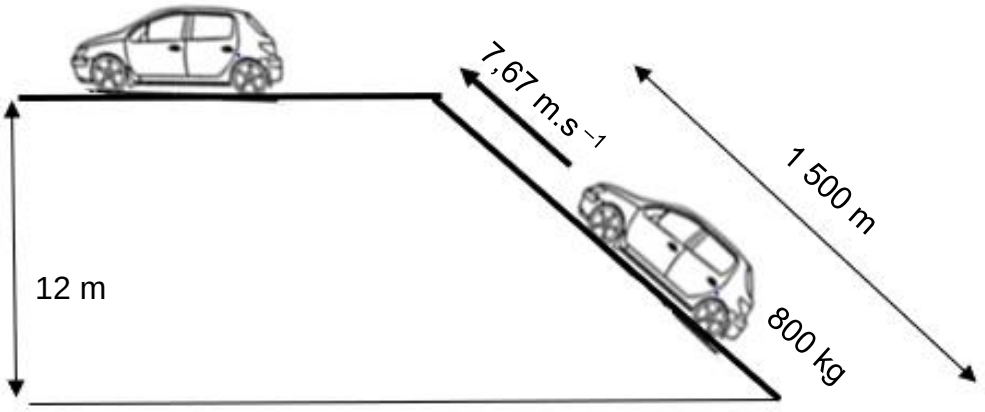
4.2.2 Determine the change in momentum of the block. (2)

4.2.3 If the contact time between the bullet and the metal block increases, will the impulse INCREASE, DECREASE or REMAIN THE SAME? Give a reason for your answer. (3)

[14]

QUESTION 5 (Start on a new page.)

A car with mass of 800 kg and engine power of 50 kW needs to climb an incline with a constant speed of 7,67 $m \cdot s^{-1}$. The length of the incline is 1 500 m and its vertical height is 12 m. The car experiences a frictional force of 750 N while moving up the incline. Ignore the rotational effects of the wheels of the car.



5.1 State the *principle of conservation of mechanical energy*. (2)

5.2 If the car is climbing the incline at a constant velocity of 7,67 $m.s^{-1}$, will the mechanical energy be conserved? Explain your answer by using calculations. (5)

At the end of the incline there is a rough horizontal surface. The car climbed the incline while moving on the rough horizontal surface.

5.3 Draw the free body diagram for the car after it has reached the horizontal surface. (4)

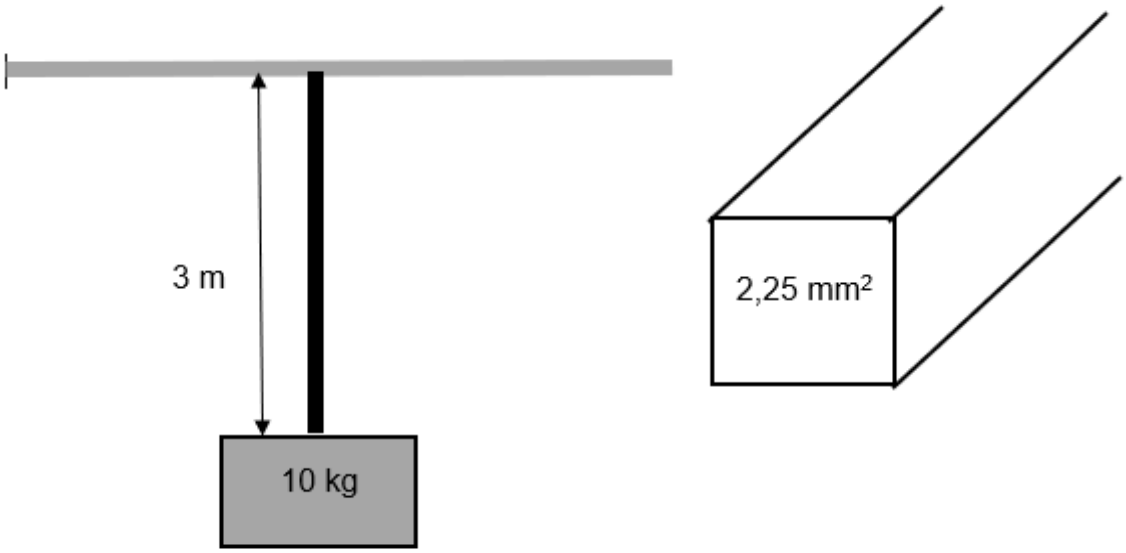
5.4 Calculate the work done by the gravitational force on the car after it reached the top of the incline. (5)

5.5 Calculate the time taken by the car to reach the top of the incline. (3)

[19]

QUESTION 6 (Start on a new page.)

A steel wire, with a length of 3 m and a square cross area of 2,25 mm^2, is connected by means of an inextensible material to a roof strut. A 10 kg block is attached to the bottom end of the wire which causes the wire to stretch by 2×10^{-4} m.



6.1 Define the term *deforming force*. (2)

6.2 Calculate the stress on the steel wire. (4)

6.3 Calculate the strain on the steel wire. (3)

6.4 Calculate the wire's elasticity modulus. (3)

6.5 Define a *perfectly elastic body* and give ONE example. (3)

[15]

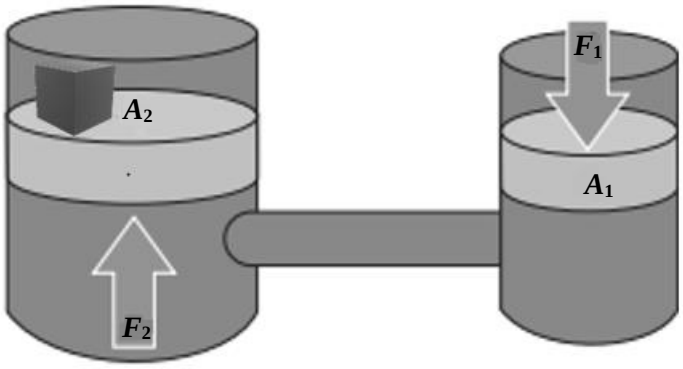
QUESTION 7 (Start on a new page.)

Fluids are preferred in designing hydraulic machines because of their ability to flow. Different fluids have different abilities to flow.

7.1 Define the term *pressure*. (2)

7.2 Give TWO applications of hydraulics principles. (2)

7.3 A hydraulic system is used to lift a 200 kg box in a workshop. The box sits on piston A_2 of area 0,9 m^2, and a force (F_1) is applied to piston A_1 of area 0,2 m^2 as shown in the diagram below.



Calculate the minimum force that must be applied to lift the box. (5)
[9]

QUESTION 8 (Start on a new page.)

8.1 The capacitor is made up of two plates separated by a dielectric (insulating) material. Capacitors are used in most electronics such as TVs, radios etc.

8.1.1 Complete the sentence below:

The SI unit for capacitance is the farad. 1 farad equals to ... (1)

8.1.2 Name TWO factors that influence capacitance. (3)

8.2 A group of Grade 12 learners performs an experiment to investigate the relationship between the charge stored in a capacitor and the potential difference. This was achieved by changing the potential difference and recording the corresponding charge stored as shown in the table below.

Charge stored (C)	7,5	30	60	75	90
Potential difference (V)	1	4	8	10	12

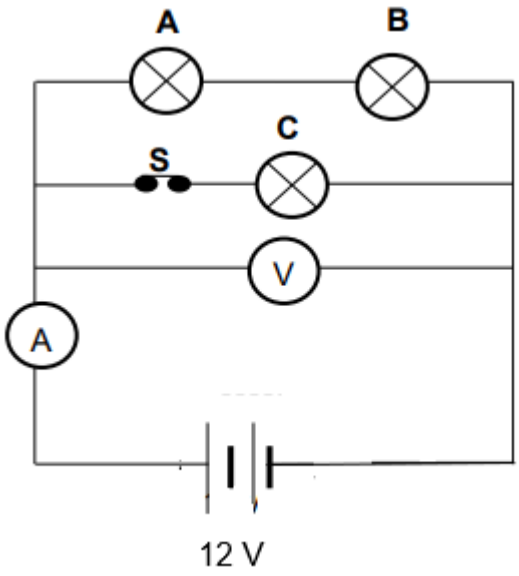
8.2.1 Using the table above, draw the graph of charge stored against the potential difference on the GRAPH SHEET provided. (5)

8.2.2 Use the graph to calculate the capacitance of the capacitor. (4)

[13]

QUESTION 9 (Start on a new page.)

Three lightbulbs, **A**, **B** and **C**, with a resistance of 2 Ω, 3 Ω and 4 Ω respectively, are connected to a battery with emf 12 V as shown in the circuit diagram below. The resistance of the connecting wires and the ammeter may be ignored.



Switch **S** is closed. The ammeter reading is 2 A.

9.1 State *Ohm's law* in words. (2)

9.2 Calculate the total resistance of the circuit. (4)

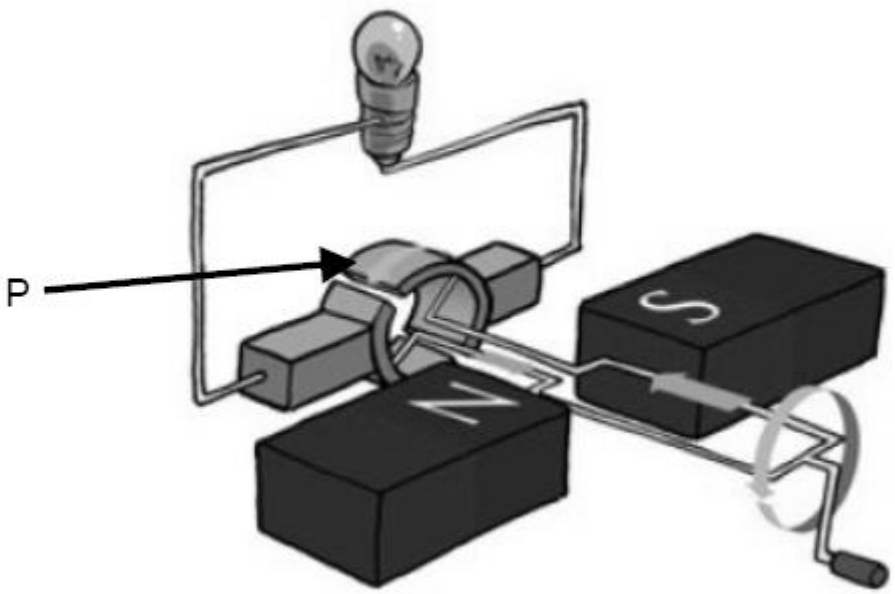
9.3 Define the term *EMF* in words. (2)

9.4 Compare the brightness of lightbulbs **A**, **B** and **C**. Justify the answer. (3)

[11]

QUESTION 10 (Start on a new page.)

The simplified diagrams below represent two electrical machines.

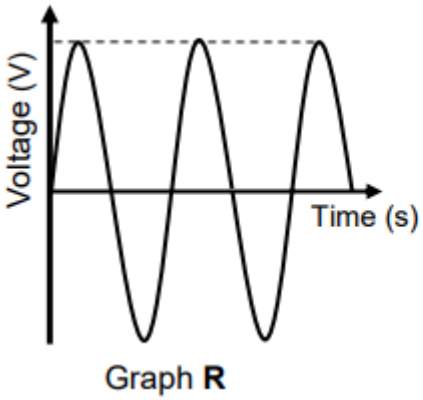


10.1 Define the term *generator*. (2)

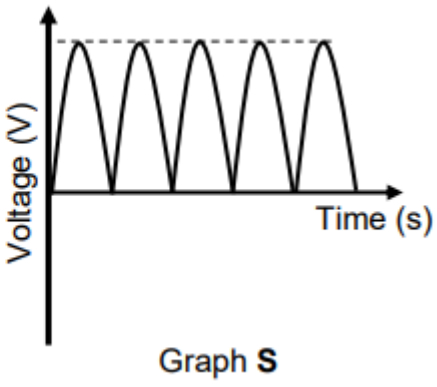
10.2 What type of generator (AC or DC) is represented in the simplified diagrams above? Give a reason for your answer. (2)

10.3 Name the principle on which generators work. (1)

10.4 Which of the following graphs (**R** or **S**) represents the voltage output of the generator identified in QUESTION 10.2 above?



Graph **R**

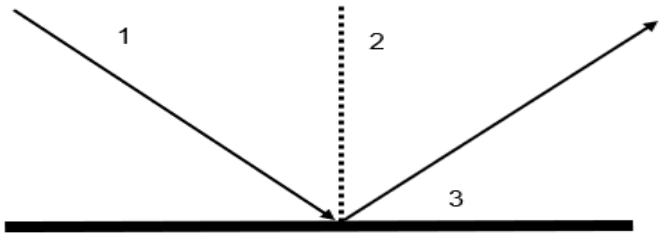


Graph **S**

(1)
[6]

QUESTION 11 (Start on a new page.)

The sketch below represents the light coming in to the smooth surface and reflects into the air.



11.1 Give the names represented by numbers 1, 2 and 3 in the diagram above. (3)

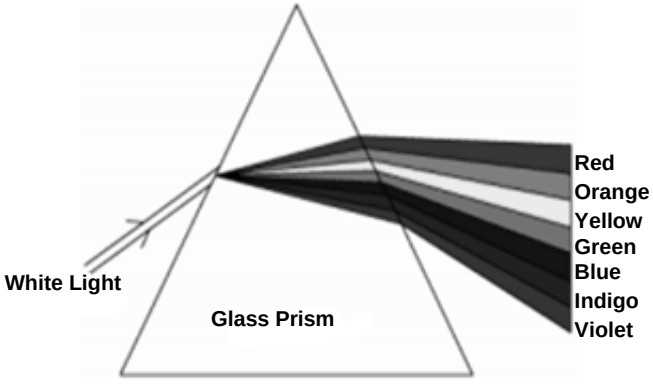
11.2 Define *total internal reflection*. (2)

11.3 Explain what will happen to a ray of light if the angle of incidence and the critical angle are the same size. (2)

11.4 By using a sketch, illustrate what will happen to a ray of light if the angle of incidence is 30˚, and the ray of light shines on a rectangular perspex block. (5)

11.5 Give an appropriate name for the phenomenon illustrated in QUESTION 11.4 above. (1)

11.6 When white light falls onto a triangular prism, the following phenomenon is observed, as illustrated in the diagram below.



11.6.1 Provide a suitable name for the phenomenon shown above. (1)

11.6.2 Define the phenomenon named in QUESTION 11.6.1 above. (2)

11.6.3 Which colour of light is refracted the least? (1)

[17]

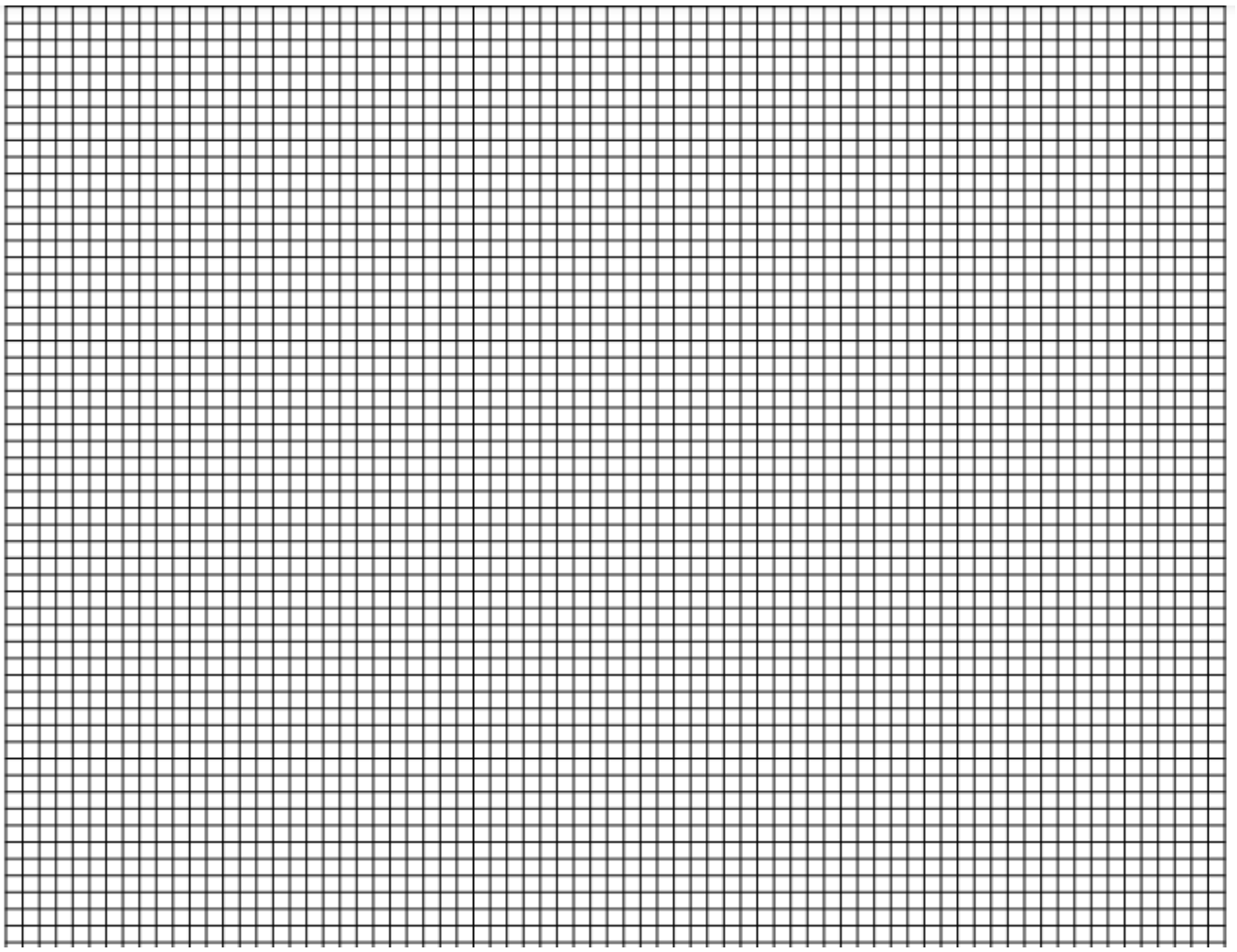
TOTAL: 150

END

GRAPH SHEET

NAME: _____

QUESTION 8.2.1



DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 1

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 1

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·s
Permittivity of the free space/ *Permittiviteit van vrye ruimte*	ε_o	$8,85 \times 10^{-12}$ F.m

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

FORCE/*KRAG*

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

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* $\Delta E_k = E_{kf} - E_{ki}$
ME = K + U or/of ME= E_k + E_p	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

ELASTICITY, VISCOSITY AND HYDRAULICS/*ELASTISITEIT, VISKOSITEIT EN HIDROULIKA*

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

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{\kappa\varepsilon_0 A}{d}$ and $C = \frac{\varepsilon_0 A}{d}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\phi = BA$	$\varepsilon = -N\frac{\Delta\phi}{\Delta t}$
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	

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

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