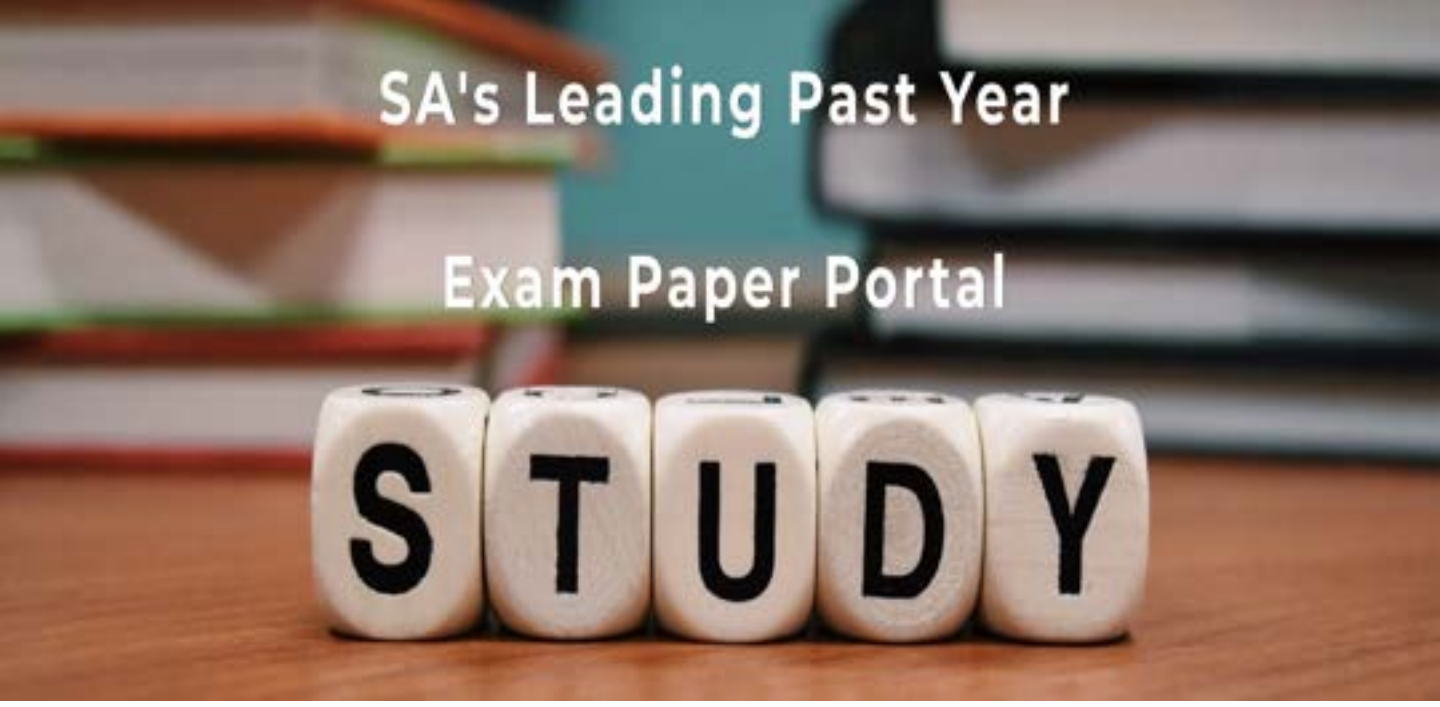

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SENIOR CERTIFICATE/ NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of NINE 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 subquestions, e.g. 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 SHEETS.

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, etc. where required.

12 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, e.g. 1.11 D.

1.1 An object of mass **m** rests on a flat table. The Earth pulls this object with force **mg**, which is known as the action force. Which ONE of the following statements gives the best description of the reaction force?

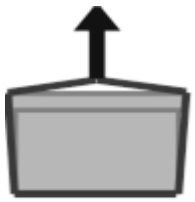
A The table is pushing the object up with force **mg**.

B The object is pushing the table down with force **mg**.

C The table is pushing the floor down with force **mg**.

D The object is pulling the Earth upward with force **mg**. (2)

1.2 A man lifts a 60 kg load with a rope at a constant velocity. What is the tension (force) in the rope? Ignore air friction.



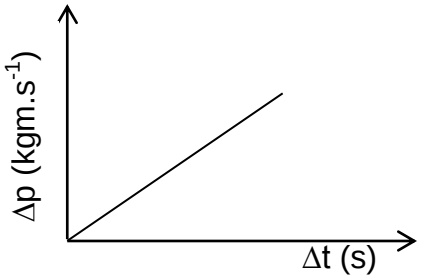
A 568 N, downwards

B 578 N, upwards

C 588 N, upwards

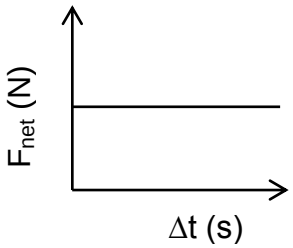
D 588 N, downwards (2)

1.3 The graph below represents the relationship between a change in momentum (Δp) of an object and change in time (Δt).

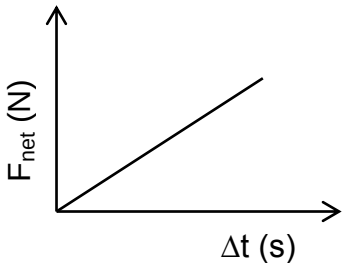


Which ONE of the following graphs represents a corresponding F_{net} versus time graph?

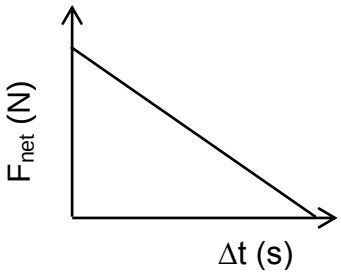
A



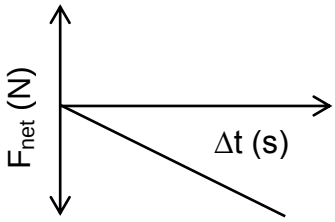
B



C

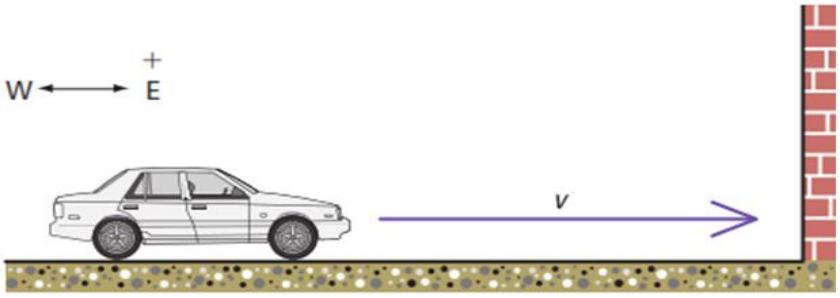


D



(2)

1.4 John and Thabo watched a car approaching a wall. The car hit the wall while travelling at velocity **v**. After a long argument about conservation of the car's momentum, they both agreed that total linear momentum will only be conserved if the net …



A force acting on the system is zero.

B external force acting on the system is zero.

C force acting on the system is greater than zero.

D external force acting on the system is greater than zero. (2)

1.5 Which ONE of the following statements on work is TRUE? Work is done when …

A the force is at 90° with the direction of displacement.

B the displacement is in the direction of the force.

C there is no resultant force and the displacement is zero.

D the displacement is zero and the applied force is greater than zero. (2)

1.6 The standard unit of pressure is ...

A pascal.

B newton.

C metres.

D kilograms. (2)

1.7 What is understood by the term *Young's modulus of elasticity*?

A The force required to produce a unit area in a tensile test.

B The ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded.

C A measurement of the extension or contraction of material due to the load experienced.

D The extent of the deformation because of the application of an external force. (2)

1.8 Electric power is measured in ...

A amperes.

B watts.

C volts.

D ohms. (2)

1.9 Magnetic flux can be defined as the number of magnetic field lines produced by a magnet … to a given surface.

A perpendicular

B horizontally

C diagonally

D parallel (2)

1.10 Faraday's law implies that when the rate of change of the magnetic flux increases, the induced emf will …

A stay the same.

B decrease.

C increase.

D be zero. (2)
[20]

QUESTION 2 (Start on a new page.)

The picture below shows a young boy on a sled ride with the assistance of his older brother. As the older brother applied a force of 80 N with his foot, at an angle of 40° to the horizontal, the sled and the boy moved at a constant velocity of 9 $m.s^{-1}$. The boy and the sled had a combined mass of 25 kg.

2.1 State Newton's First Law of Motion in words. (2)

2.2 What is the magnitude of the frictional force experienced by sled? (3)

2.3 The combined mass of the boy and the sled is now increased, while the force applied by the brother remains constant.

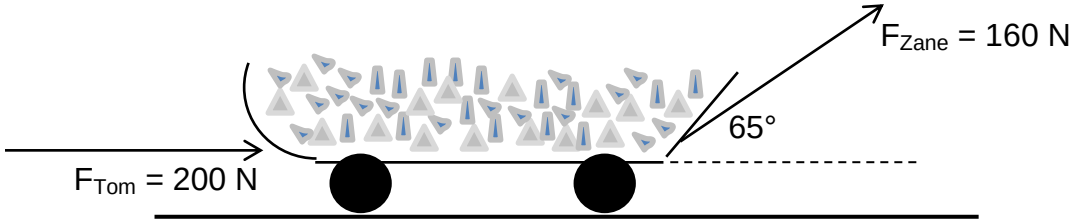
2.3.1 Define *inertia*. (2)

2.3.2 How will the inertia experienced by the brother be affected? Write only INCREASE, DECREASE or REMAIN CONSTANT. Explain your answer. (3)

[10]

QUESTION 3 (Start on a new page.)

3.1 Tom is pushing and Zane is pulling a trolley, loaded with crushed stone, over a rough surface on a construction site. The mass of the trolley and its contents is 350 kg. Tom pushes with a force of 200 N and Zane pulls with a force of 160 N using a string, which makes an angle of 65° with the horizontal, as shown in the diagram below.



3.1.1 Define *tension force*, and give an example of such a force in the diagram above. (3)

3.1.2 How will the frictional force on the trolley be affected by Zane's applied force? Write only INCREASES, DECREASES or REMAINS CONSTANT. (2)

3.1.3 Draw a free-body diagram of ALL the forces acting on the trolley and its contents. (5)

3.2 If the net force acting on the trolley and its contents is 205 N, calculate the coefficient of kinetic friction (μ_k) between the surface and the trolley. (6)
[16]

QUESTION 4 (Start on a new page.)

4.1 An electrician, rushing to an urban area with a power outage, drives a truck of mass 1 350 kg towards the east travelling at 120 $km.h^{-1}$. The truck collides head-on with a car of mass 1 050 kg travelling at 16,67 $m.s^{-1}$.

4.1.1 Define *momentum*. (2)

4.1.2 What is the velocity of the truck before the collision in $m.s^{-1}$? (2)

4.1.3 Calculate the initial momentum of the car. (3)

4.2 After the collision, the truck continues to move towards the east at 20,3 $m.s^{-1}$ and the car moves backwards at 5,32 $m.s^{-1}$. The system is isolated.

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

4.2.2 Use a calculation to determine whether the collision was elastic or inelastic. (5)

4.3 The driver of a car with a mass of 1 150 kg crashes into a tree with a velocity of 15 $m.s^{-1}$ as shown in the diagram below. The car comes to rest after the crash. The car experiences a constant net force of 57 500 N before it comes to rest.

4.3.1 What is the relationship between the net force experienced by the car and the contact time during the crash? (2)

4.3.2 How does the impulse experienced by the car compare to its change in momentum? Write only SMALLER THAN, GREATER THAN or EQUAL TO. (1)

4.3.3 The car is equipped with airbags. Explain, using impulse, how this would reduce the extent of the driver's injuries. (3)

4.3.4 Calculate the contact time during the crash. (4)

[24]

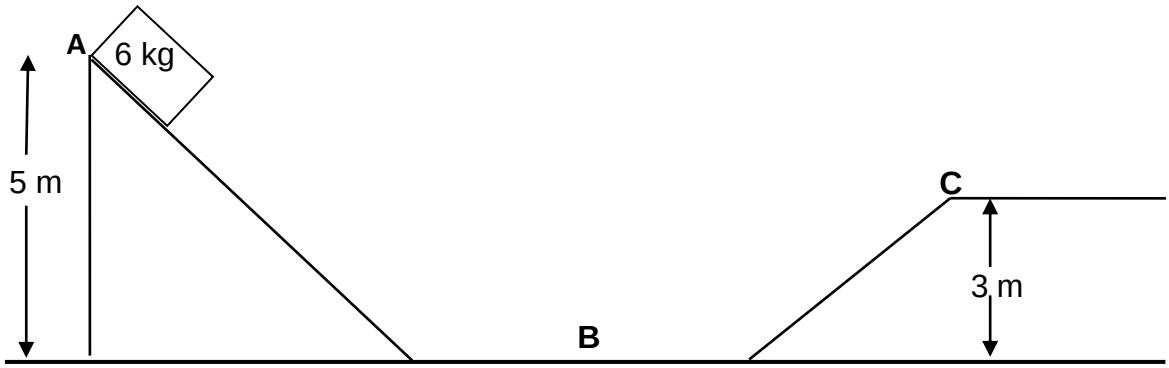
QUESTION 5 (Start on a new page.)

5.1 A learner lifts her school bag straight from the ground to a height of 0,9 m above the ground. She applies a force of 25 N to lift the bag. Ignore the effect of air resistance.

5.1.1 Calculate the work done by the learner. (3)

5.1.2 If the mass of the bag is 2 kg, determine the net work done on the bag. (4)

5.2 The diagram below represents a frictionless track. A 6 kg block starts from rest at point **A** and slides along the track.



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

5.2.2 Calculate the mechanical energy of the block at point **A**. (4)

5.2.3 What will be the speed of the block at point **B**? (4)

5.2.4 Calculate the speed of the block at point **C**. (4)
[21]

QUESTION 6 (Start on a new page.)

6.1 Define the following terms:

6.1.1 Stress (2)

6.1.2 Strain (2)

6.2 A steel bar experiences a stress of 250 MPa. The modulus of elasticity is 190 GPa. The bar has a diameter of 60 mm and is 220 mm long.

Calculate the:

6.2.1 Strain on the bar (3)

6.2.2 Force exerted on the bar (4)

6.3 What is the effect of an increase in temperature on the viscosity of a fluid? (2)

6.4 Define a *perfectly plastic body*. (2)

6.5 Give TWO examples of perfectly plastic bodies. (2)

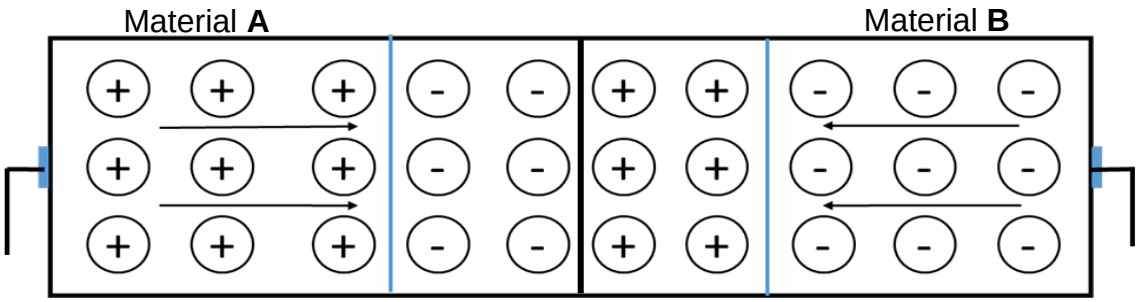
6.6 State Pascal's law in words. (2)

6.7 A hydraulic system is used to lift a 20 000 N vehicle in a workshop. If the vehicle sits on a piston of area 0,8 m^2, and a force is applied to another piston of 0,05 m^2, what is the minimum force that must be applied to lift the vehicle? (4)

6.8 Define the *thrust* of a liquid. (2)
[25]

QUESTION 7 (Start on a new page.)

7.1 This diagram represents a p-n junction diode.



7.1.1 Name the type of material indicated by **A** and **B**. (2)

7.1.2 Draw the symbol for this p-n junction diode. (2)

7.1.3 How many valence electrons does an intrinsic semiconductor have? (1)

7.2 Define a *capacitor*. (2)

7.3 State the relationship between the capacitance and the charge on the plates. (2)

7.4 State TWO changes that you can make to the capacitor to decrease the capacitance. (2)

7.5 A lamp filament has a resistance of 60 Ω and draws a current of 2 A when connected across a 120 V supply. Calculate the cost of electricity consumed in two hours, if the tariff is R1,75 per kWh. (7)
[18]

QUESTION 8 (Start on a new page.)

8.1 Define *electromagnetic induction*. (2)

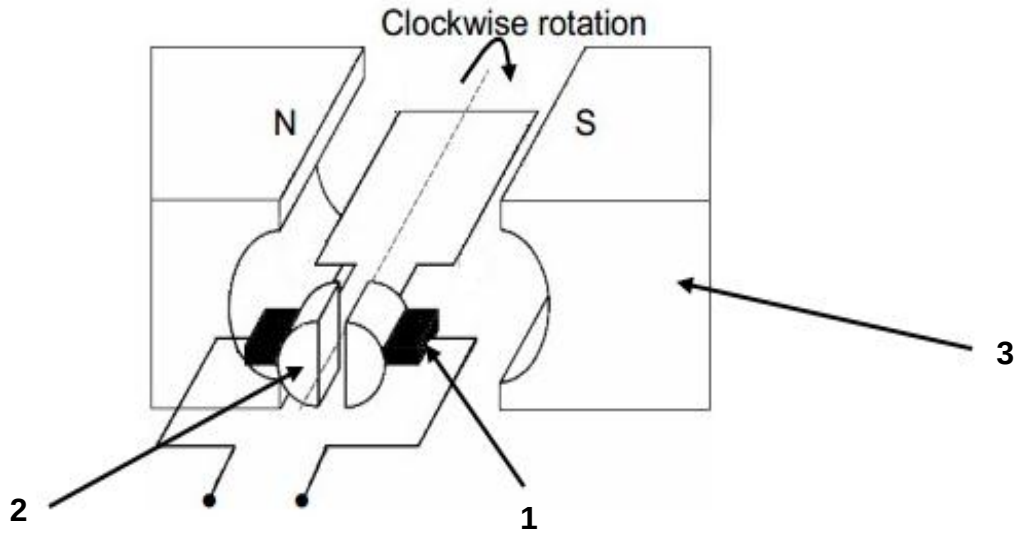
8.2 Name TWO factors that influence the induced emf. (2)

8.3 State Lenz's law in words. (2)

8.4 Give THREE examples where Lenz's law is applied. (3)
[9]

QUESTION 9 (Start on a new page.)

9.1 Study the diagram of a motor below and answer the questions that follow.



9.1.1 Label parts **1**, **2** and **3**. (3)

9.1.2 Identify the type of motor. (1)

9.2 A transformer has 1 200 turns on the primary coil, 110 turns on the secondary coil and the secondary voltage is 20 V. Determine the primary voltage. (3)
[7]

TOTAL: 150

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	$9,8\ m\cdot s^{-2}$
Permittivity of free space Permittiwiteit van vry ruimte	ε_o	$8,85 \times 10^{-12}\ F.m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$

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* $E_k = \frac{1}{2}mv^2$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

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

$\sigma = \frac{F}{A}$ / $\text{Stress} = \frac{\text{Force}}{\text{Area}}$ $\text{Spanning} = \frac{\text{Krag}}{\text{Area}}$	$\varepsilon = \frac{\Delta\ell}{L}$ / $\text{Strain} = \frac{\text{change in length}}{\text{original length}}$ $\text{Vervorming} = \frac{\text{verandering in lengte}}{\text{oorspronklike lengte}}$
$P = \rho gh$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{\sigma}{\varepsilon} = K$ / $\text{modulus of elasticity} = \frac{\text{stress}}{\text{strain}}$ $\text{modulus van elastisiteit} = \frac{\text{spanning}}{\text{vervorming}}$	$\text{Pressure (P)} = \frac{\text{Force (F)}}{\text{Area}}$ $\text{Druk (P)} = \frac{\text{Krag(F)}}{\text{Area}}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{Q}{V}$	$C = \frac{\varepsilon_o A}{d}$

CURRENT ELECTRICITY/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ $R_P = \frac{R_1 x R_2}{R_1 + R_2}$	$q = I \Delta t$
$W = VQ$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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