basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

TECHNICAL SCIENCES P1

NOVEMBER 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 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 TEN 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   The resultant force acting on a body is equal to the ...

    A   product of the mass and velocity of the body.

    B   rate of change in momentum of the body.

    C   rate at which work is done on the body.

    D   change in momentum of the body.   (2)

1.2   A block is placed on a horizontal surface with negligible friction. Forces **2F** and **4F** are applied simultaneously on the block, as shown below.

    Which ONE of the following CORRECTLY describes the motion of the block?

    The block moves …

    A   with increasing acceleration to the right.

    B   with constant velocity to the right.

    C   with increasing acceleration to the left.

    D   at constant acceleration to the right.   (2)

1.3   A net force, F_{net}, which acts on a body of mass **m** causes acceleration **a**. If the same net force is applied to a body of mass **2m**, the acceleration of the body will be …
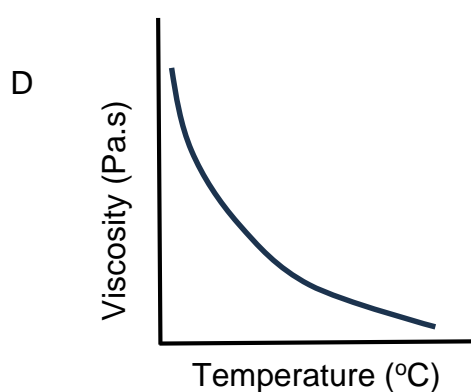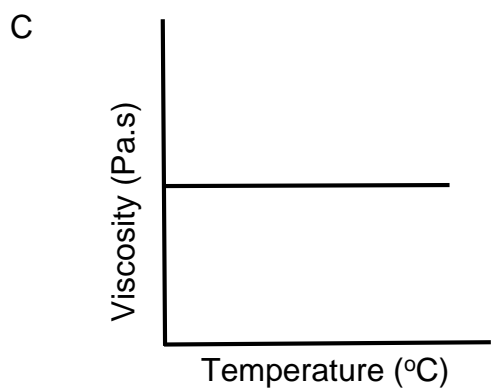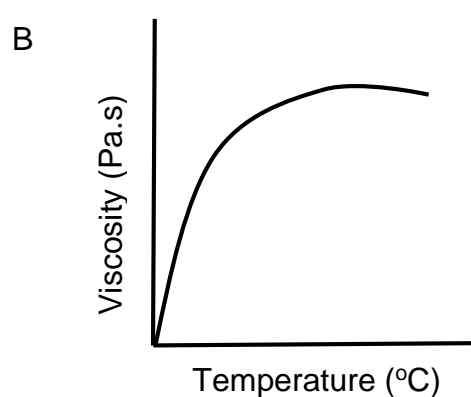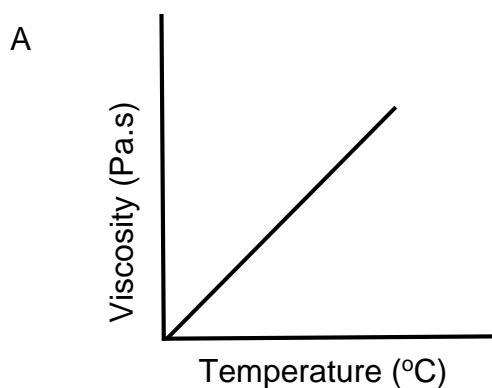
    A   ¼ a

    B   ½ a

    C   2a

    D   4a   (2)

1.4   No work is done on an object if …

        A   its speed is decreased until it comes to rest.

        B   it is lifted from the floor to a specific height.

        C   it is moved along the floor against friction.

        D   it is held stationary above the floor.   (2)

1.5   Which ONE of the graphs below best describes the relationship between the viscosity of a fluid and temperature?
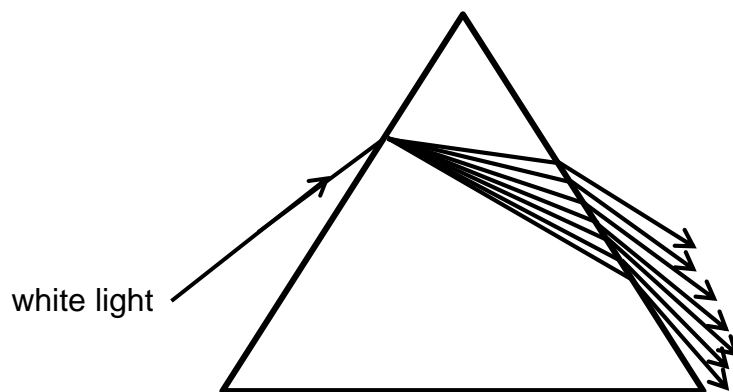

        (2)

1.6   The elastic limit of a material can be defined as …

        A   the maximum force that can be applied to a body so that the body regains its original form completely upon removal of the force.

        B   a force that develops inside a body so that it regains its original shape and size.

        C   a force that causes a body to change its original shape and size.

        D   the internal restoring force per unit area of a body.   (2)

1.7   The diagram below illustrates some phenomena of light.

white light

These physical phenomena are …

A   refraction and dispersion.

B   reflection and dispersion.

C   refraction and reflection.

D   total internal reflection and dispersion.   (2)

1.8   Which ONE of the following statements is a definition of a transformer?

A device that …

A   is used to store electric charge.

B   is used to step up or step down the voltage.

C   converts mechanical energy into electrical energy.

D   converts electrical energy into mechanical energy.   (2)

1.9   The equivalent unit for the farad is …

A $V{\cdot}m^{-1}$

B $C{\cdot}s^{-1}$

C $N{\cdot}C^{-1}$

D $C{\cdot}V^{-1}$ (2)
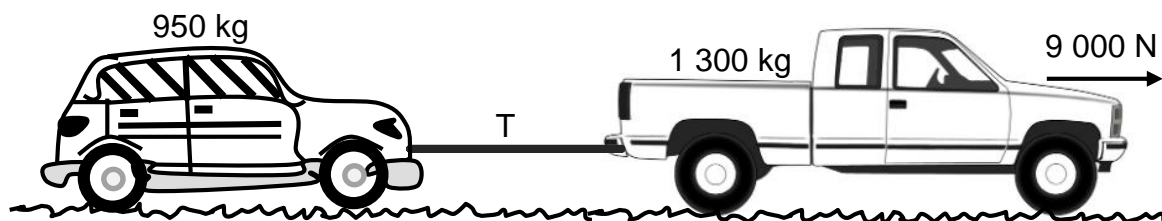
1.10   The components found in an AC generator include …

A   slip rings and armature.

B   split ring and armature.

C   split ring and battery.

D   slip rings and battery.   (2)

[20]

QUESTION 2 (Start on a new page.)

After experiencing a breakdown, car **A** of mass 950 kg is towed by bakkie **B** of mass 1 300 kg. The two vehicles are linked using an inextensible tow bar of negligible mass, as shown in the diagram below.

The bakkie and the car move at a CONSTANT VELOCITY and the force applied by the engine of the bakkie is 9 000 N.

2.1   Name and state the law that explains why the tension experienced by both the car and the bakkie has the same magnitude.   (3)

2.2   Draw a labelled free-body diagram to show ALL the forces acting on the bakkie.   (5)
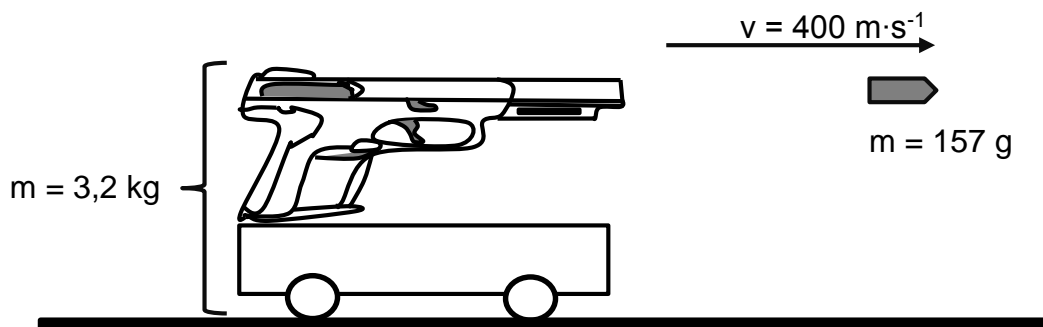
2.3   Define the term *frictional force*.   (2)

The coefficient of kinetic friction between the road surface and the tyres of the bakkie is 0,45.

2.4   Calculate the magnitude of the tension in the tow bar.   (4)

2.5   The tow bar suddenly becomes detached from the car while the vehicles are still in motion. The coefficient of kinetic friction between the road surface and the tyres of the car is 0,35.

     2.5.1   Explain what happens to the car after the tow bar has become detached.   (2)

     2.5.2   Calculate the magnitude of the acceleration of the car during this motion.   (4)
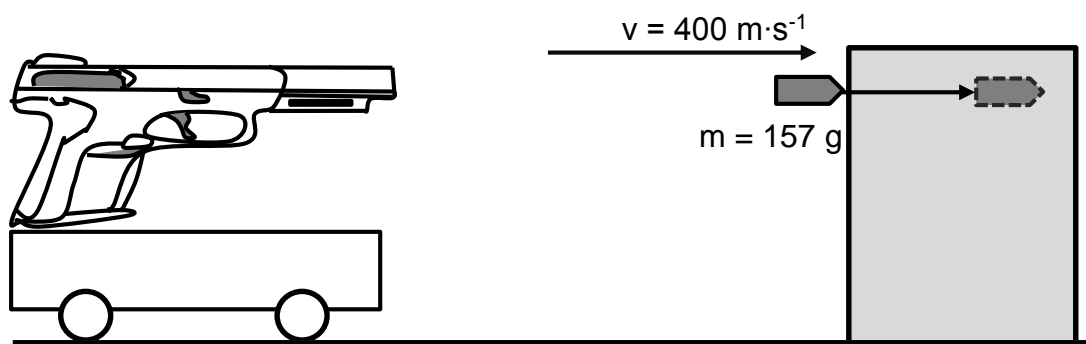
     [20]

QUESTION 3 (Start on a new page.)

A gun that is loaded with a bullet of mass 157 g is mounted on a trolley at rest on a frictionless surface. The combined mass of the gun and trolley is 3,2 kg. The bullet is fired at 400 m·s⁻¹ due east.

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

3.2 Calculate the velocity of the gun-trolley system after the bullet was fired. (5)

3.3 What type of collision is this? Write down only ELASTIC or INELASTIC. Explain the answer WITHOUT any calculation. (2)

3.4 The change in velocity of the gun-trolley system is noticeably less than that of the bullet.

Give a brief explanation for this observation. (2)

3.5 After the bullet is fired from the gun, it strikes a stationary block of wood horizontally and then comes to rest inside the block, as shown in the diagram below.
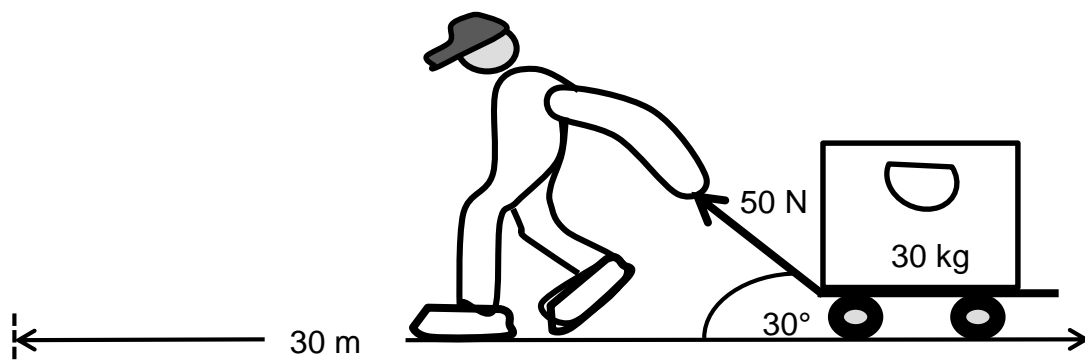

3.5.1 Calculate the change in momentum of the bullet. (3)

3.5.2 Calculate the time taken for the bullet to come to rest if it experiences a net force of 1 000 N. (4)
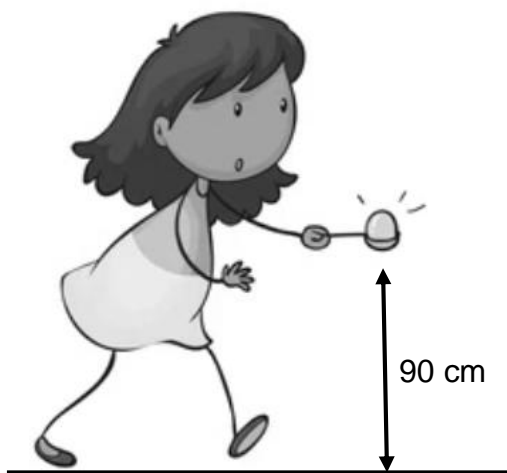
[18]

QUESTION 4 (Start on a new page.)

4.1   An airport worker needs to transport a passenger bag of mass 30 kg to the aircraft. He decides to load the bag onto a trolley of mass 10 kg and then pulls the handle of the trolley using a force of 50 N at an angle of 30° to the ground.

The trolley experiences a frictional force of 15 N and the bag is transported over a distance of 30 m from the loading zone to the aircraft.

4.1.1   Draw a labelled free-body diagram showing ALL the horizontal forces on the trolley.   (2)

4.1.2   Calculate the work done by the applied force on the trolley.   (3)

4.2   A learner participates in an egg-and-spoon race. After placing an egg of mass 60 g on the spoon, it falls downwards immediately and hits the ground.

4.2.1   Differentiate between the terms *energy* and *power.*   (4)

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

The spoon and the egg were held at a height of 90 cm above the ground.

Calculate the:

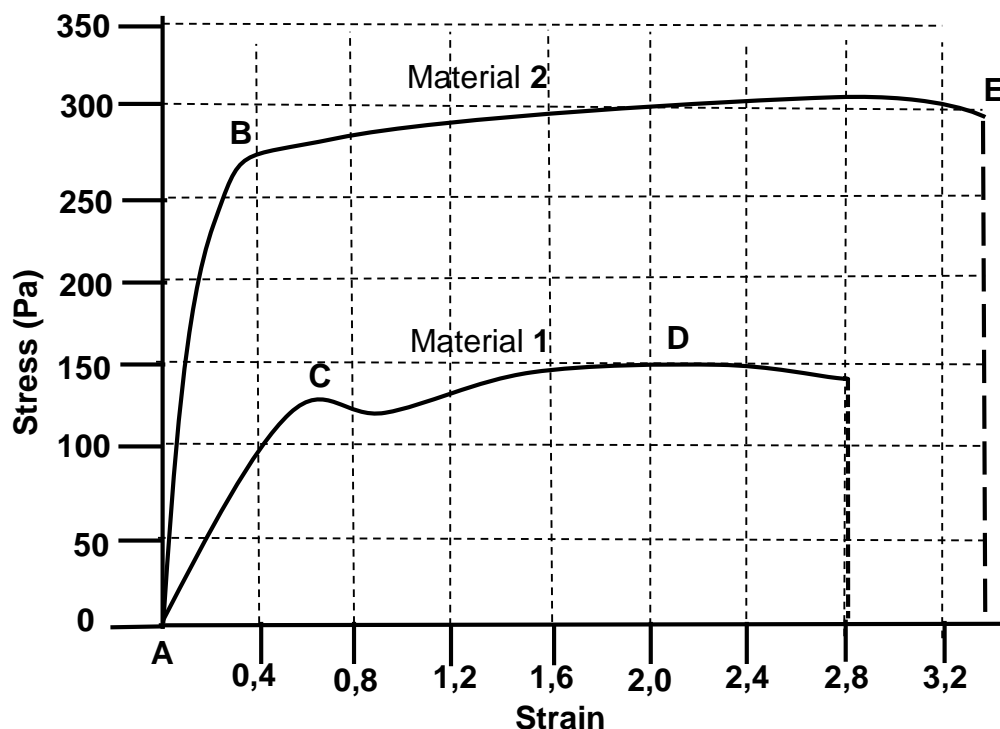4.2.3   Gravitational potential energy of the egg when it was placed on the spoon (3)

4.2.4   Kinetic energy of the egg when it had fallen exactly half the distance towards the ground (1)

4.2.5   Speed at which the egg hits the ground (4)

4.3   How would the mechanical energy change if the 60 g egg is replaced with a larger egg of mass 70 g? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[20]

QUESTION 5 (Start on a new page.)

Graphs of stress versus strain for materials **1** and **2** were plotted, as indicated in the figure below.

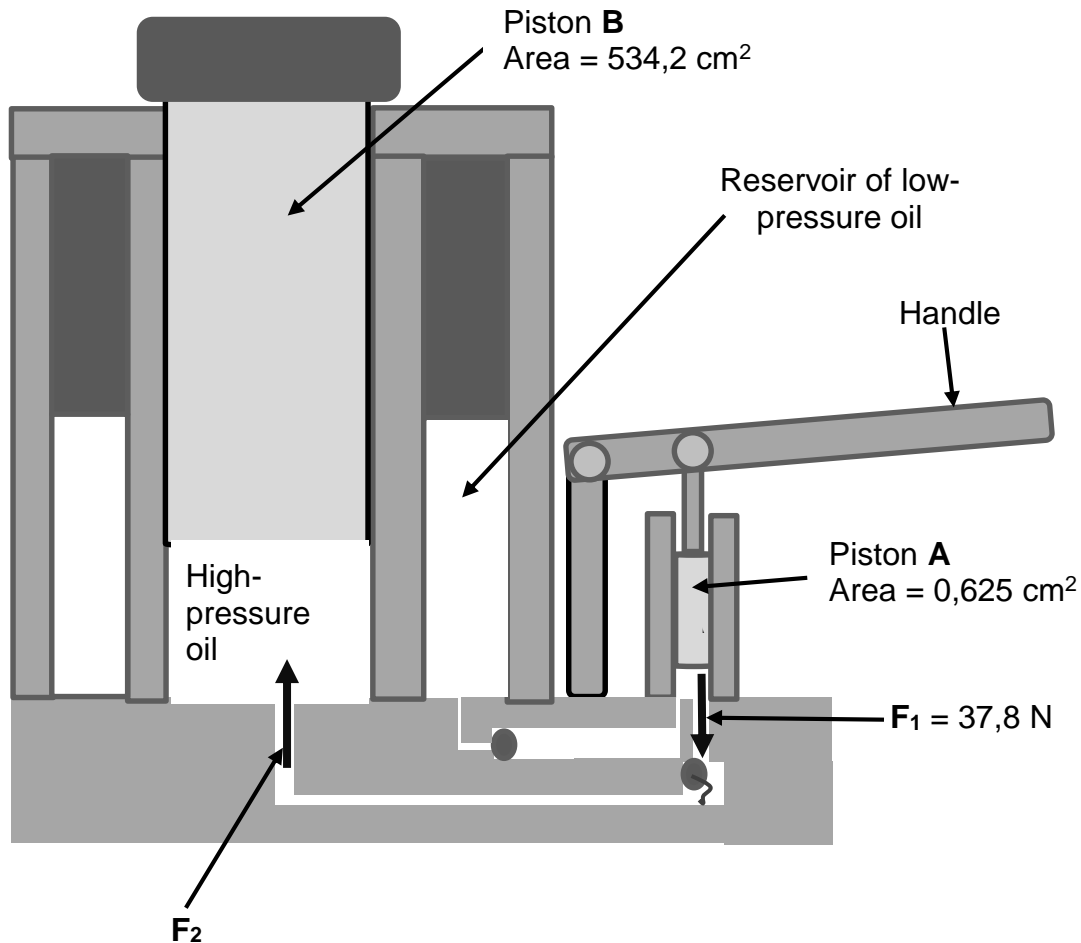Study the graphs below and answer the questions that follow.

5.1   Define the term *elasticity*.   (2)

5.2   What is the significance of understanding Young's modulus of elasticity in industry?   (2)

5.3   Use the information provided in the graphs and calculate the following:

      5.3.1   Young's modulus of elasticity for material **1**, when the strain is 2,0   (3)

      5.3.2   Young's modulus of elasticity for material **2**, when the strain is 2,0   (2)

5.4   What does the difference in the values of the moduli of elasticity for these materials indicate about their nature?   (2)

5.5   For material **2**, write down the letter(s) of the part that represent the:

      5.5.1   Elastic region   (1)

      5.5.2   Point at which the material breaks   (1)
                                                          [13]
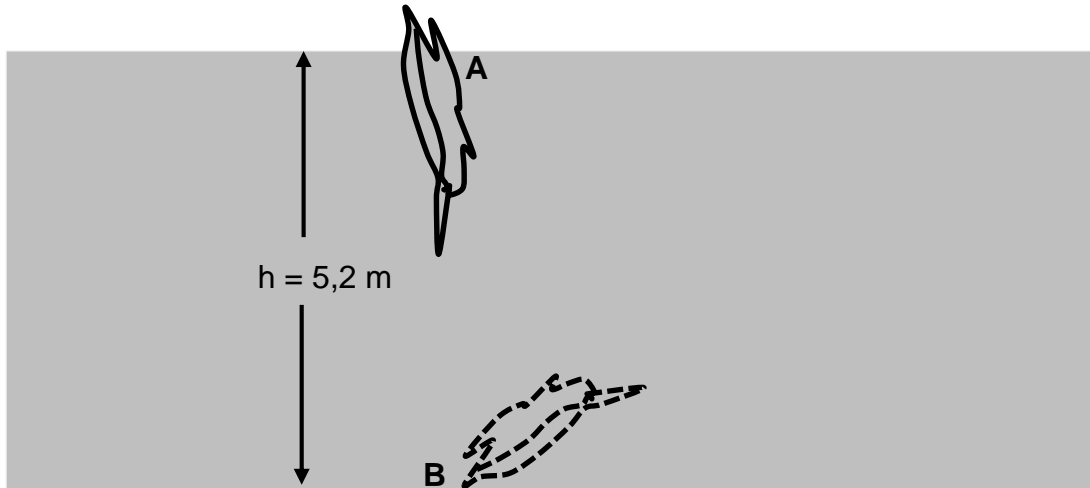
QUESTION 6 (Start on a new page.)

Study the diagram below of a hydraulic jack and answer the questions that follow.

Piston **B**
Area = 534,2 cm^2

Reservoir of low-pressure oil

Handle

High-pressure oil

Piston **A**
Area = 0,625 cm^2

F_1 = 37,8 N

F_2

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

6.2   The areas of piston **A** and piston **B** are 0,625 cm^2 and 534,2 cm^2 respectively. When the handle is pushed down with a force, F_1, of magnitude 37,8 N, piston **A** moves downwards.

Calculate the force that will be experienced by piston **B**. (4)

6.3　　A bird with a mass of 27 g dives into water at point **A**, until it reaches the bottom at point **B**, as shown in the diagram below.

The density of water is 1 000 kg·m^{-3}.
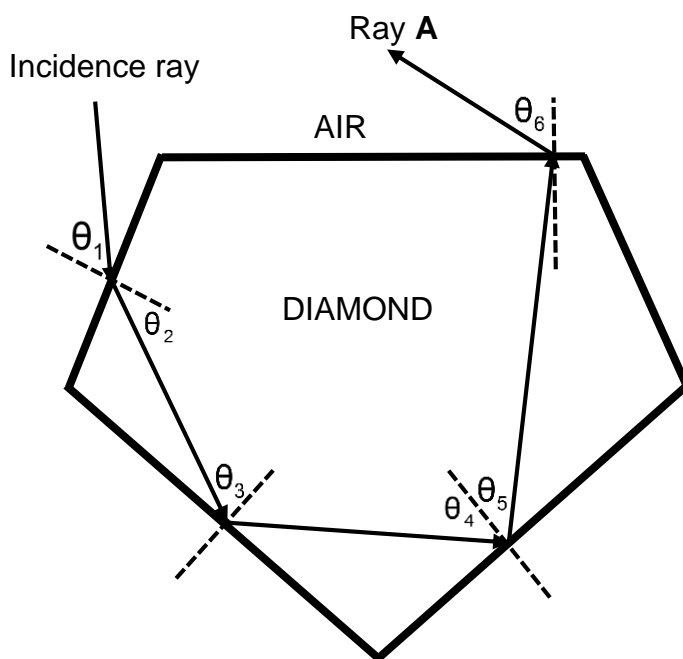

6.3.1　Write down ONE physical factor that determines the pressure of a static fluid at a given depth.　　　　(1)

6.3.2　Calculate the pressure that is exerted by the water on the bird at point **B**.　　　　(3)

[10]

QUESTION 7 (Start on a new page.)

When white light strikes one face of a diamond, the light is reflected multiple times inside the diamond before it emerges. This is what gives a diamond its sparkle and brilliance.

The diagram below shows the path of a light ray as it enters the diamond.

7.1   Name and define the phenomenon of light that takes place inside the diamond.   (3)

7.2   Consider angles θ_4 and θ_5.

       7.2.1   How does the magnitude of θ_4 compare to that of θ_5? Write down only SMALLER THAN, EQUAL TO or GREATER THAN.   (1)

       7.2.2   Explain the answer to QUESTION 7.2.1.   (1)

The critical angle for a diamond is 24,4°.

7.3   Explain the statement above.   (2)

7.4   At the diamond-air interface, ray **A** exits the diamond.

       7.4.1   Write down the name of ray **A**.   (1)

       7.4.2   Write down ALL the changes that occur at the diamond-air interface as light ray **A** exits the diamond.   (2)
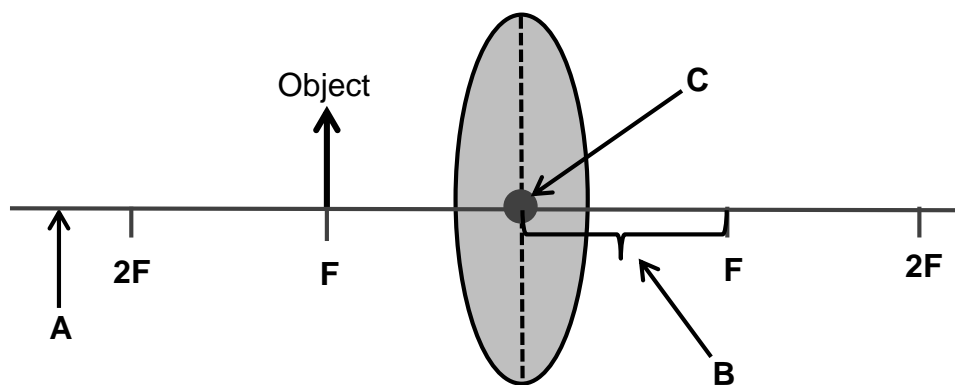
       [10]

QUESTION 8 (Start on a new page.)

8.1　　A certain news channel broadcasts at a frequency of 94,5 MHz.

　　　8.1.1　What type of electromagnetic wave is used to broadcast at this news channel?　　(1)

　　　8.1.2　Calculate the energy of this electromagnetic wave.　　(3)

8.2　　Consider the diagram below of a certain type of lens with an object placed at **F**.

　　　8.2.1　Label **A**, **B** and **C**.　　(3)

　　　8.2.2　Identify the type of lens that is used in this diagram.　　(1)

8.3　　The object is now moved to a position between **F** and **2F**.

　　　8.3.1　Where will the image be formed?　　(1)

　　　8.3.2　Write down THREE properties of the image formed.　　(3)

　　　　　　　[12]

QUESTION 9 (Start on a new page.)

9.1   The specifications of a capacitor are as follows: 10 V; 60 pF

       9.1.1   Capacitors are seen as batteries of the future.
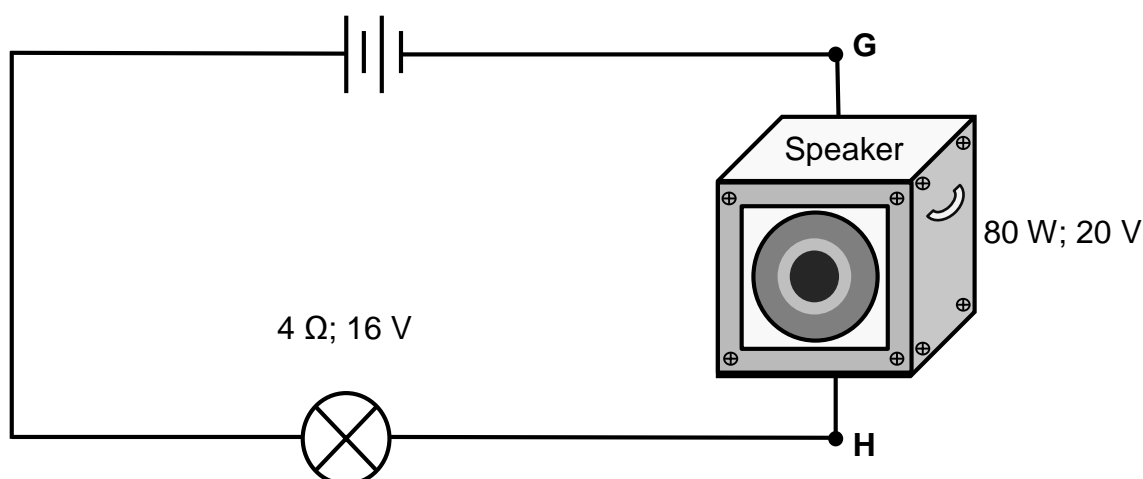
              State TWO factors that affect the capacitance.   (2)

       9.1.2   Calculate the charge of the capacitor when it is fully charged.   (3)

       9.1.3   Appliances such as microwave ovens and television sets have large capacitors.

              Give a reason why such appliances need to be fully discharged before they are serviced.   (2)

9.2   A speaker with specifications 80 W; 20 V and a light bulb with specifications of 4 Ω; 16 V are connected in series, as shown in the circuit diagram below.

       9.2.1   Define the term *current*.   (2)

       9.2.2   Calculate the current flowing through the speaker when it is operating according to its specifications.   (3)

       9.2.3   When a second speaker, also with specifications 80 W; 20 V, is connected across points **G** and **H**, the bulb burns out and does not work anymore.

              Briefly explain why the bulb burns out.   (3)

       9.2.4   Name ONE component that could have been connected in this circuit to prevent the light bulb from burning out.   (1)

       9.2.5   How should the component named in QUESTION 9.2.4 be connected in the circuit? Write down only SERIES or PARALLEL.   (1)

                                                    [17]

QUESTION 10 (Start on a new page.)

10.1 The table below shows a comparison between motors and generators.

Complete the table by writing down only the answer next to the question numbers (10.1.1 to 10.1.4) in the ANSWER BOOK.

	GENERATOR	MOTOR
Principle/Law used	10.1.1	10.1.2
Energy conversion	10.1.3	10.1.4

(4)

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

10.3 A transformer with 800 windings on the primary coil is connected to a 0,25 kV power supply. The voltage on the secondary coil is 18 V.

Calculate the number of windings on the secondary coil. (4)

[10]

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	$9{,}8 \text{ m·s}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3{,}0 \times 10^{8} \text{ m·s}^{-1}$
Planck's constant *Planck se konstante*	h	$6{,}63 \times 10^{-34} \text{ J·s}$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31} \text{ kg}$
Permittivity of free space *Permittiwiteit van vrye ruimte*	ε_o	$8{,}85 \times 10^{-12} \text{ F.m}^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

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

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x \cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \dfrac{1}{2} mv^2$ or/*of* $E_k = \dfrac{1}{2} mv^2$	$M_E = E_k + E_p$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$P = \dfrac{W}{\Delta t}$

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

$\sigma = \dfrac{F}{A}$	$\varepsilon = \dfrac{\Delta \ell}{L}$
$\dfrac{\sigma}{\varepsilon} = K$	$\dfrac{F_1}{A_1} = \dfrac{F_2}{A_2}$
$P = \dfrac{F}{A}$	$P = \rho g h$

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \dfrac{Q}{V}$	$C = \dfrac{\varepsilon_0 A}{d}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\Phi = BA$	$\varepsilon = -N\,\dfrac{\Delta\Phi}{\Delta t}$
$\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p}$	

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

$v = f\,\lambda$	$T = \dfrac{1}{f}$
$E = hf \qquad \text{or/}of \qquad E = h\dfrac{c}{\lambda}$	