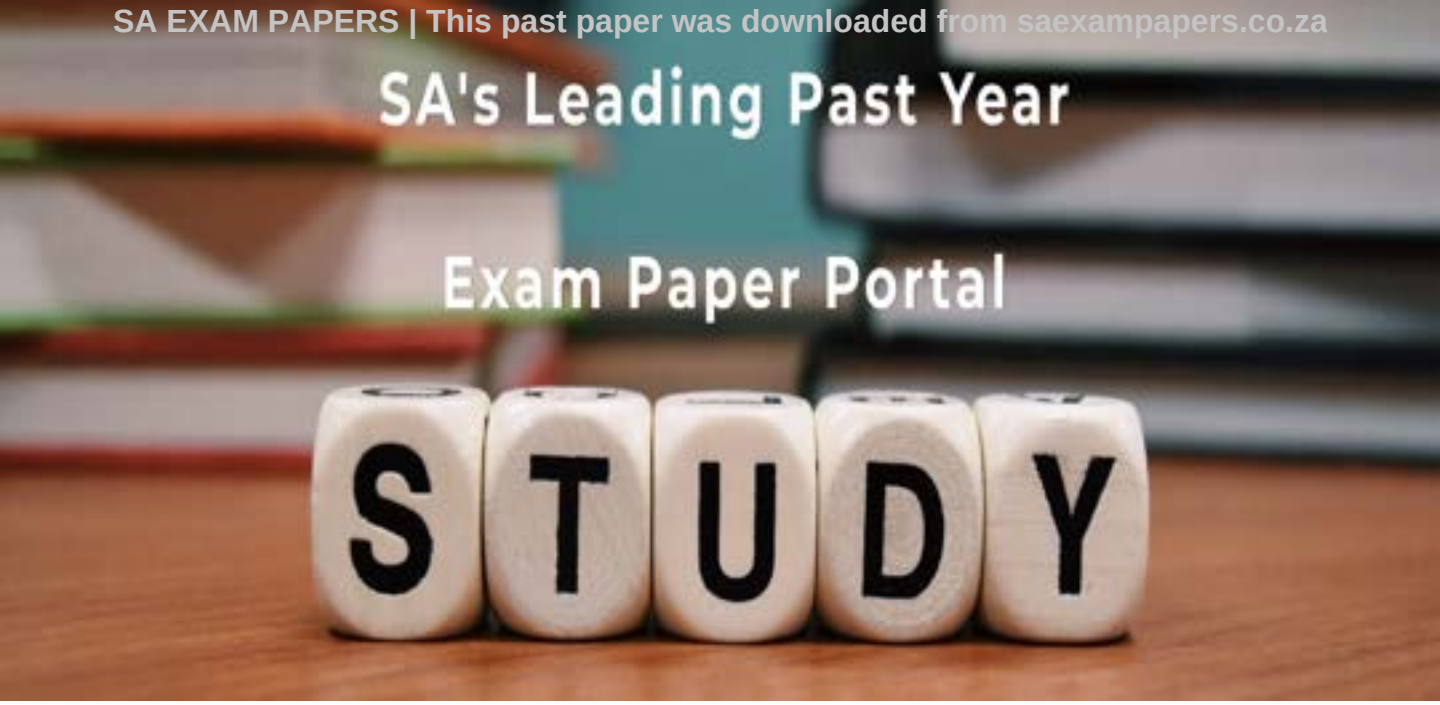


basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL SCIENCES P1

MAY/JUNE 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

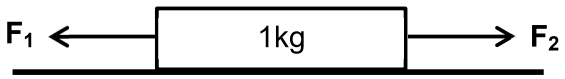
1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering 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 Forces $\mathbf{F_1}$ and $\mathbf{F_2}$ are applied simultaneously on a crate of mass 1 kg. The crate accelerates to the right on a frictionless surface, as shown in the diagram below.

Which ONE of the following is CORRECT about the magnitudes of $\mathbf{F_1}$ and $\mathbf{F_2}$?



A $F_2 > F_1$

B $F_2 = F_1$

C $F_1 > F_2$

D $F_1 = 2F_2$ (2)

1.2 Frictional force acts in the …

A direction of motion of an object and perpendicular to the surface the object is in contact with.

B opposite direction to the direction of motion of an object and perpendicular to the surface the object is in contact with.

C direction of motion of an object and parallel to the surface the object is in contact with.

D opposite direction to the direction of motion of an object and parallel to the surface the object is in contact with. (2)

1.3 The impulse of a ball bouncing off a wall is equal to the …

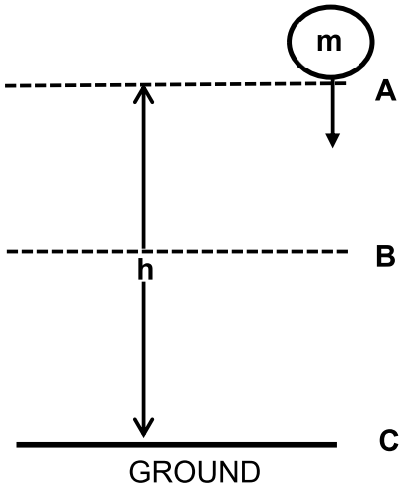
A change in its momentum.

B rate of change in its momentum.

C average force of the ball on the wall.

D product of the mass and the acceleration of the ball. (2)

1.4 An object of mass of **m** is released from rest at point **A** and it falls down to point **C**, as shown in the diagram below. Ignore the effect of air friction.



Which ONE of the following statements regarding the kinetic and gravitational potential energy of the object is CORRECT?

A $(\frac{1}{2}mv^2)_B = (mgh)_C$

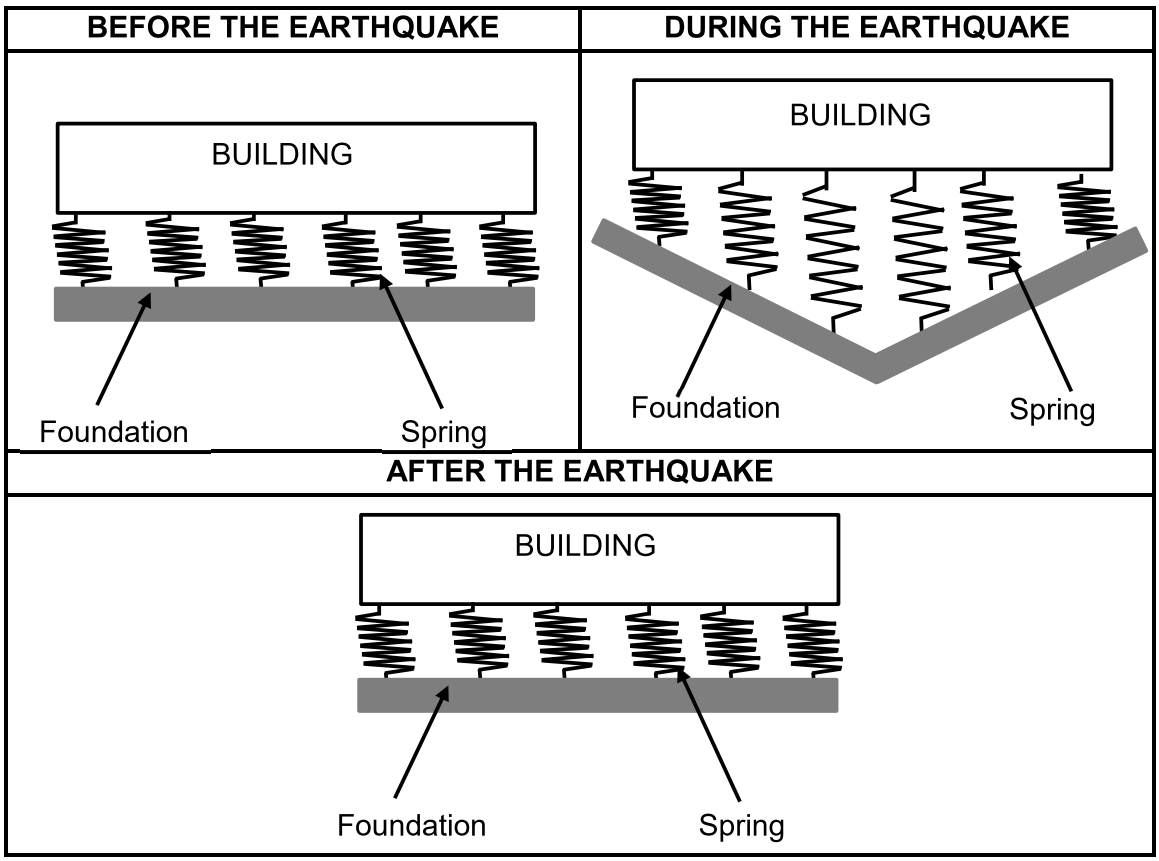
B $(\frac{1}{2}mv^2)_A = (mgh)_B$

C $(\frac{1}{2}mv^2)_C = (mgh)_A$

D $(\frac{1}{2}mv^2)_C = (mgh)_B$

(2)

1.5 The diagram below is a design for earthquake-proof buildings, where the spring allows the building to move.



The spring will prevent the building from breaking apart as a result of the shaking because the spring is perfectly …

A elastic and will regain its shape and size when the force of the earthquake is removed.

B plastic and will regain its shape and size when the force of the earthquake is removed.

C elastic and will not regain its shape and size when the force of the earthquake is removed.

D plastic and will not regain its shape and size when the force of the earthquake is removed. (2)

1.6 A perpendicular force **F** is applied to a certain area **A** and delivers pressure of **P**. If the same force of **F** is applied to an area of 2**A**, the pressure delivered will be …

A ¼**P**.

B ½**P**.

C **P**.

D 2**P**. (2)

1.7 Reflection is defined as the …

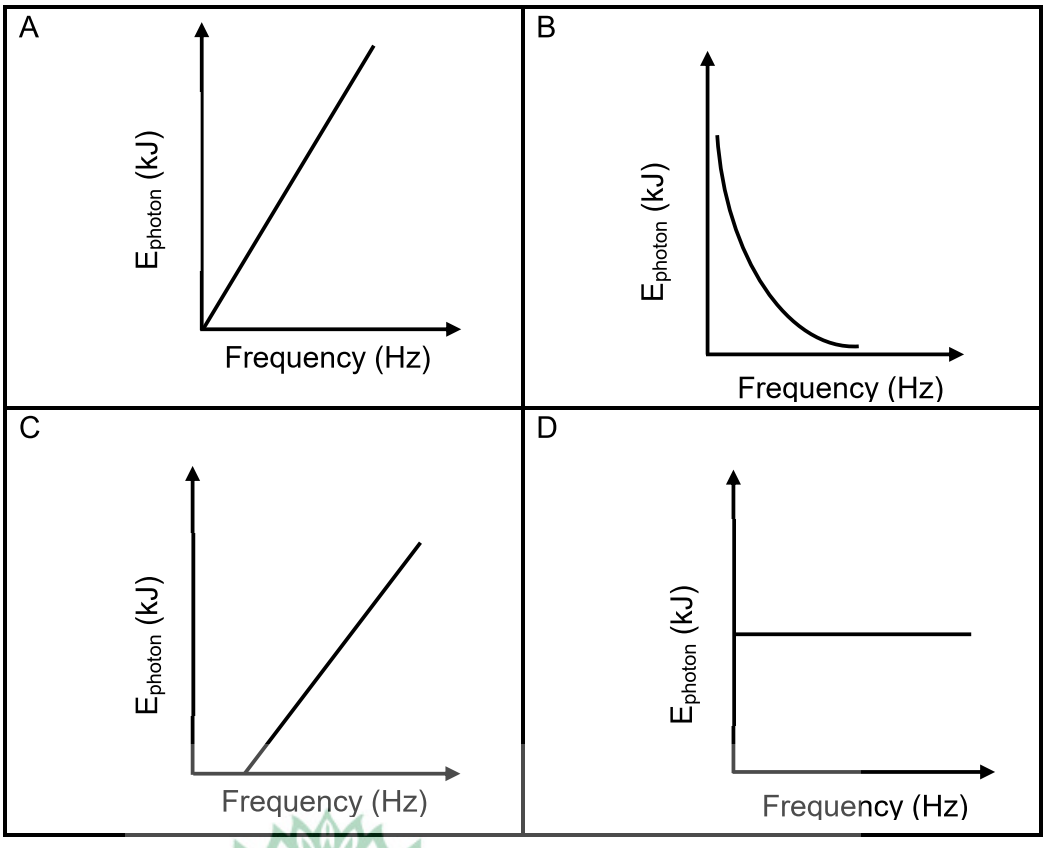
A splitting of white light into its component colours.

B disturbance that transfers energy through matter or space.

C bending of light when it passes from one medium to another.

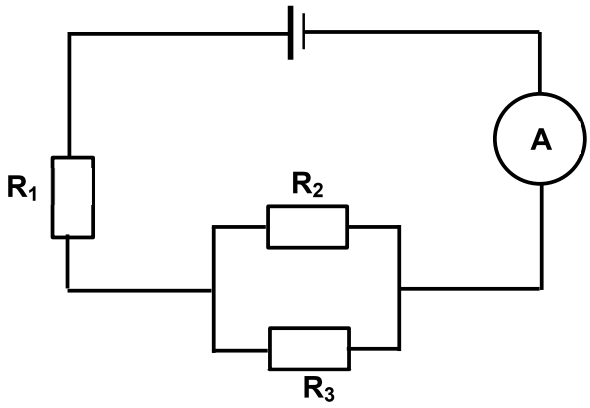
D change in the direction of a wave at an interface between two materials. (2)

1.8 Which ONE of the following graphs best describes the relationship between the frequency of a light wave and the energy of its photons?



(2)

1.9 Consider the circuit diagram below consisting of three identical resistors, R_1, R_2 and R_3.

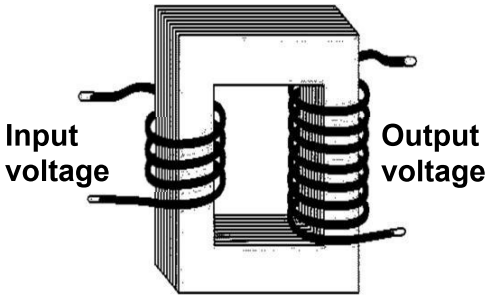


Which ONE of the following combinations is CORRECT when R_2 is removed from the circuit?

	TOTAL RESISTANCE	AMMETER READING
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

(2)

1.10 What is the NAME of the electromagnetic device represented by the diagram below?



A DC generator

B AC generator

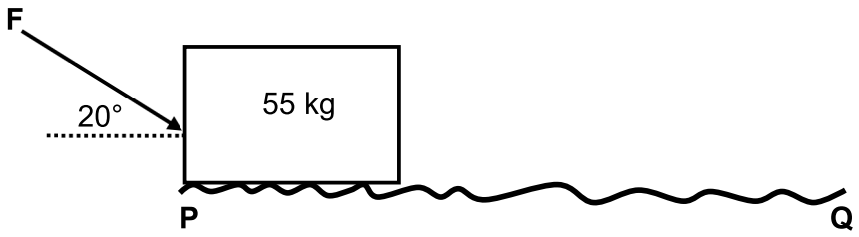
C Step-up transformer

D Step-down transformer (2)

[20]

QUESTION 2 (Start on a new page.)

A force **F**, with a magnitude of 193,19 N, is applied at an angle of 20° with the horizontal to a block of mass 55 kg. The block moves at a CONSTANT velocity over a rough horizontal surface, **PQ**, as shown in the diagram below. The coefficient of kinetic friction between the block and the surface is 0,3.



2.1 Draw a labelled free-body diagram showing ALL the forces acting on the block. (4)

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

2.3 Write down the magnitude of the net horizontal force acting on the block. Use a physics equation to explain the answer. (3)

2.4 Calculate the magnitude of the:

2.4.1 Vertical component of **F** (2)

2.4.2 Normal force (3)

2.4.3 Frictional force (3)

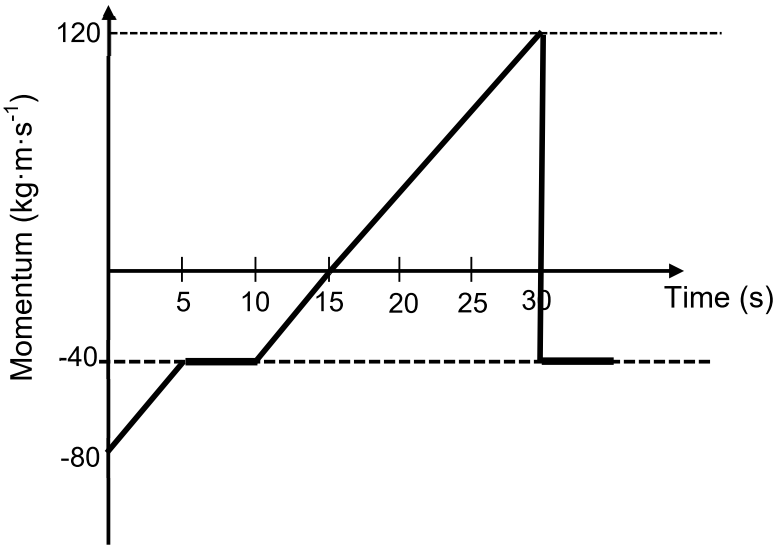
2.5 When the same force, **F**, is applied at an angle of 0° to the horizontal over the same rough horizontal surface, the magnitude of the normal force decreases.

Explain why the magnitude of the normal force decreases. (2)
[19]

QUESTION 3 (Start on a new page.)

An object, **X**, is originally moving horizontally to the right. The momentum versus time graph of the object's motion is shown below. Consider the system as isolated.

Graph of momentum versus time



3.1 Define the term *momentum*. (2)

3.2 Write down the physical quantity that is represented by the gradient of the graph. (1)

3.3 Calculate the:

3.3.1 Impulse that object **X** experiences between t = 10 s and t = 30 s (4)

3.3.2 Average net force acting on object **X** between t = 10 s and t = 30 s (4)

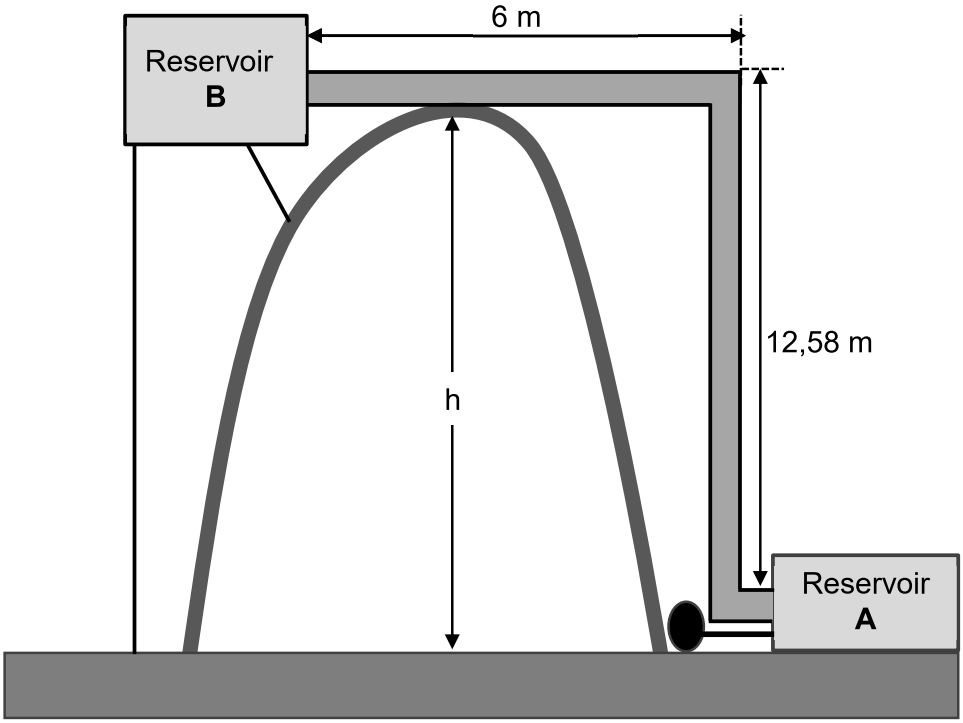
3.4 At t = 30 s object **X** collides with another object **Y**, which has a momentum of 50 kg·m·s^{-1} to the right.

3.4.1 Use the information from the graph and the relevant physics principle to calculate the momentum of object **Y** after the collision. (5)

3.4.2 State in words the physics principle that was used to answer QUESTION 3.4.1 above. (2)
[18]

QUESTION 4 (Start on a new page.)

A construction worker has to pump water from reservoir **A** to reservoir **B** over a hill using an electric water pump, as illustrated in the diagram below.



4.1 The electric water pump generates a power output of 7 200 W to pump 850 kg of water from reservoir **A** to reservoir **B** through the pipe at CONSTANT VELOCITY. Ignore the effects of friction.

4.1.1 Draw a labelled free-body diagram showing ALL forces acting on the 850 kg mass of water as it is pumped through the pipe to a height of 12,58 m. (2)

Consider the motion of the 850 kg mass of water as it moves along the height of 12,58 m.

Calculate the:

4.1.2 Force applied on the water (3)

4.1.3 Velocity at which the water moves (3)

4.2 The total mass of water passing through the 6 m section of the pipe at any given point in time is 274 kg.

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

4.2.2 Write down the magnitude of the work done by the gravitational force in moving the water across the 6 m section of the pipe. (1)

4.2.3 Explain the answer to QUESTION 4.2.2 above. Use a relevant formula to support the explanation. (2)

4.3 Calculate the:

4.3.1 Gravitational potential energy of the 274 kg mass of water at the height of 12,58 m (3)

4.3.2 Mechanical energy of the 274 kg mass of water at the 6 m pipe (4)
[20]

QUESTION 5 (Start on a new page.)

A tensile stress of $5,5 \times 10^6$ Pa is applied to the ends of a round bar with a length of 115 cm. The desired strain on the bar is $2,75 \times 10^{-4}$.

TYPES OF MATERIAL	YOUNG'S MODULUS (Pa)
Iron	2×10^{12}
Brass	2×10^{11}
Wood	2×10^{10}
Rubber	2×10^{7}

A table of Young's modulus of elasticity of different types of materials that can be used to make the round bar is given above.

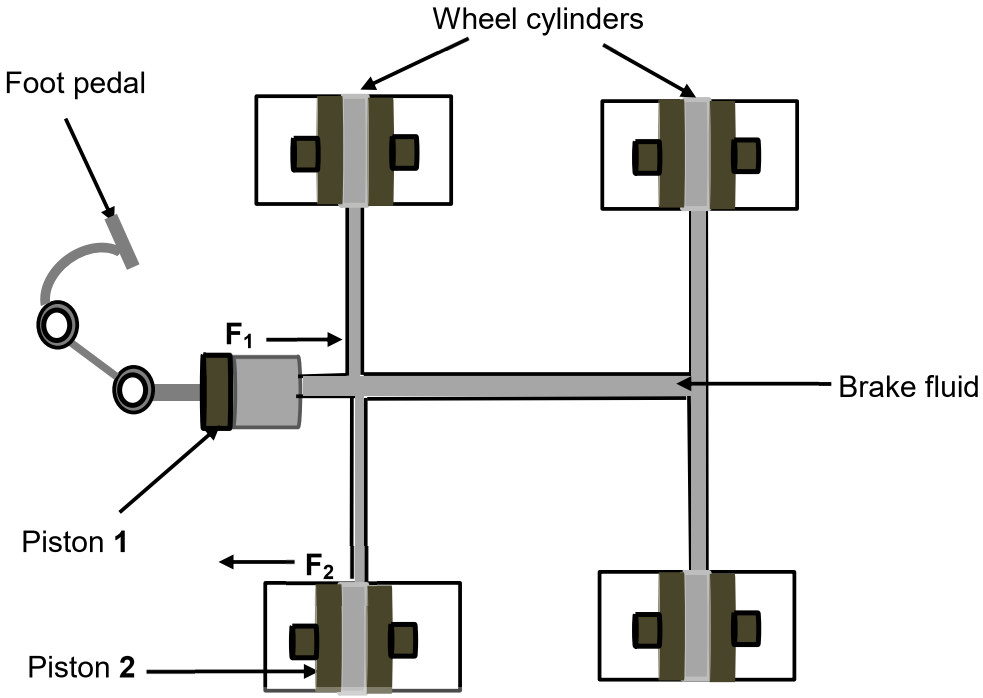
5.1 State Hooke's law in words. (2)

5.2 Use a relevant calculation to determine the most appropriate material for this bar. (4)

5.3 Calculate the change in length of the bar. (4)

5.4 A driver applies a force, $\mathbf{F_1}$, of 5 N to a foot pedal of a hydraulic brake system, as indicated in the diagram below.

Piston **1** has a diameter of 12 cm and the diameter of piston **2** is twice that of piston **1**.



5.4.1 Define the term *thrust.* (2)

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

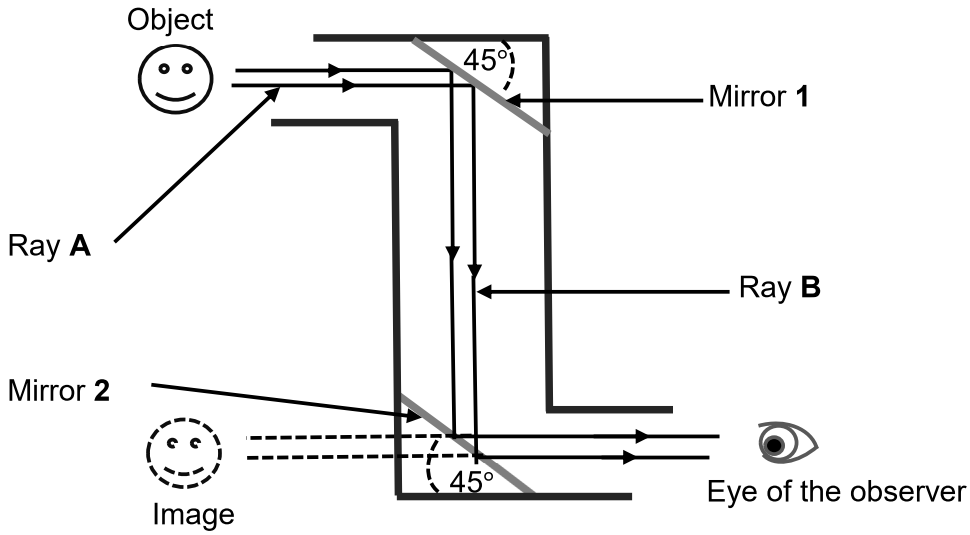
Calculate the:

5.4.3 Area of piston **2** (3)

5.4.4 Magnitude of $\mathbf{F_2}$ (3)
[20]

QUESTION 6 (Start on a new page.)

Study the diagram of a periscope below in which light rays **A** and **B** strike mirrors **1** and **2** respectively. Use the information given in the diagram to answer the questions that follow.



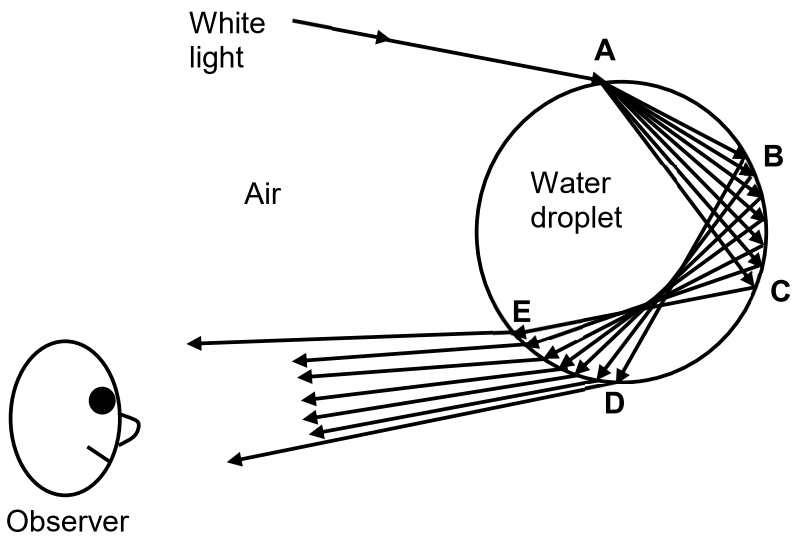
6.1 What types of mirrors are used in the diagram? Explain. (3)

6.2 The angle of incidence at which ray **A** strikes mirror **1** is **Y°**.

6.2.1 Describe the term *angle of incidence*. (2)

6.2.2 How will the magnitude of the angle at which ray **A** is reflected compare to angle **Y°**? Write down EQUAL TO, SMALLER THAN or GREATER THAN. (1)

6.3 The diagram below illustrates different physical phenomena that occur as white light passes between air and a water droplet. Study the diagram carefully and then answer the questions that follow.



6.3.1 Write down the NAMES of TWO physical phenomena that take place at point **A** as white light strikes the water droplet. (2)

6.3.2 Explain why white light splits into its component colours as it passes the air-water interface. (2)

6.4 From section **BC** the light rays <u>bounce back into the water droplet, to section **DE**, because the angles of incidence are greater than the critical angle of water</u>.

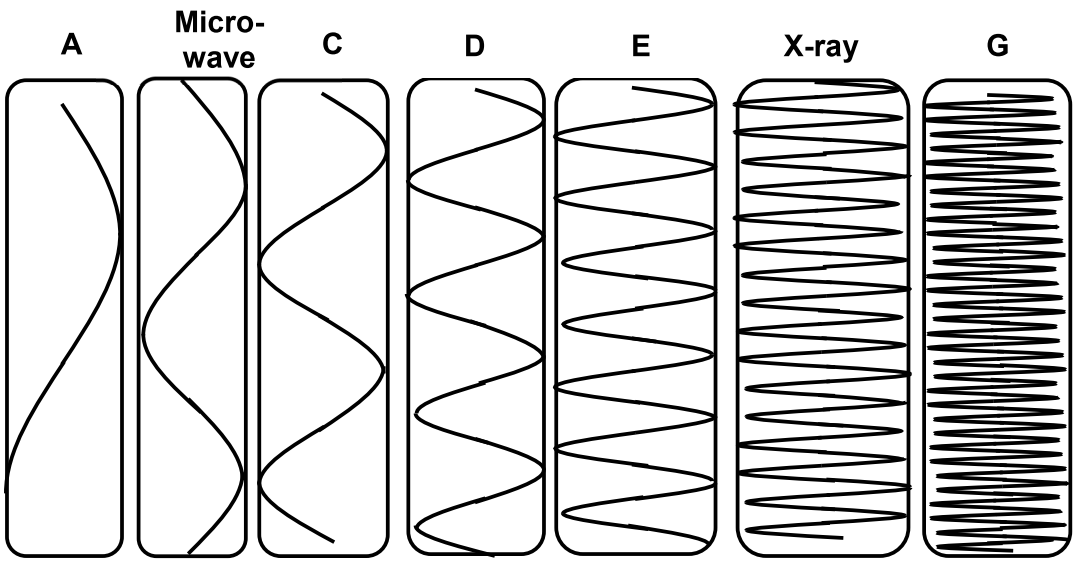
6.4.1 Define the term *critical angle*. (2)

6.4.2 Write down the NAME of the phenomenon described by the underlined words. (1)

6.4.3 Write down ONE practical application of the phenomenon taking place from section **BC** to **DE**. (1)
[14]

QUESTION 7 (Start on a new page.)

A diagram of an electromagnetic spectrum is given below. Study the diagram carefully and then answer the questions that follow.



7.1 Use the information in the diagram above and write down:

7.1.1 The name of the waves marked **E** (1)

7.1.2 ONE practical application of the waves marked **C** (1)

7.2 Explain why it is necessary for electromagnetic radiation protection features to be installed in buildings in order to protect humans from exposure to radiation **E**. (2)

7.3 A certain electromagnetic wave has a frequency of $2,3 \times 10^{14}$ Hz.

Calculate the energy of its photons. (3)
[7]

QUESTION 8 (Start on a new page.)

A capacitor is a device used in an electric circuit for storing electric charge.

8.1 Define the term *capacitance*. (2)

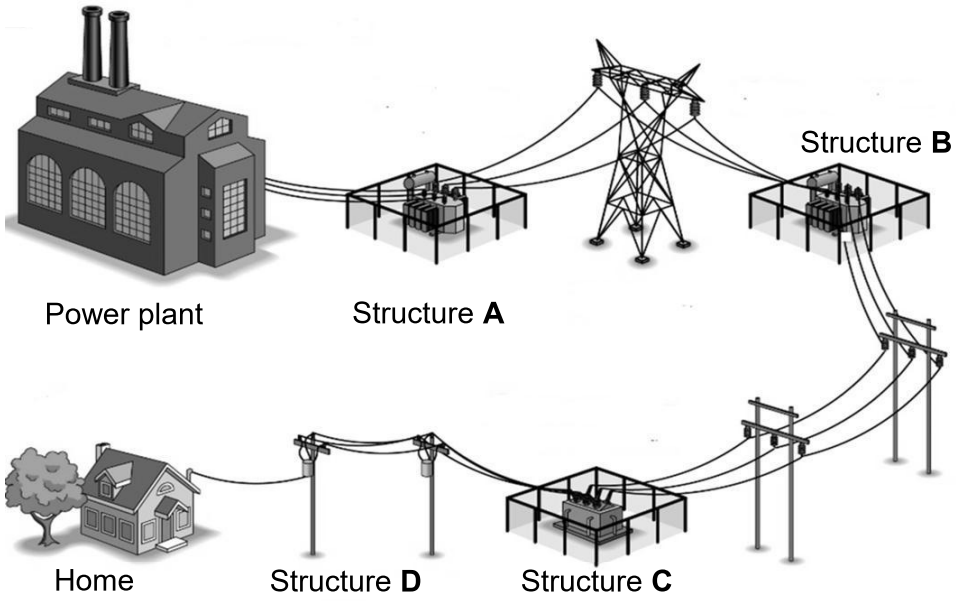
8.2 Name THREE factors that influence the capacitance of a capacitor. (3)

8.3 A parallel plate capacitor has an area of 2×10^{-4} m^2 and the distance between the plates is 2×10^{-3} m.

Calculate the potential difference across the capacitor plates if each plate can store $4,5 \times 10^{-11}$ C. (5)
[10]

QUESTION 9 (Start on a new page.)

The diagram below shows the transmission of electrical energy from a power plant to a residential area. Structures **A**, **B**, **C** and **D** contain transformers.



The power plant generates a voltage of 4 875 V. The transformer in structure **A** steps up the voltage that is generated by the power plant before it enters the transmission lines.

9.1 Why is it important for the voltage generated by the power plant to be stepped up before long distance transmission? (2)

9.2 What type of transformers are in structures **B**, **C** and **D**? Give a reason for the answer. (2)

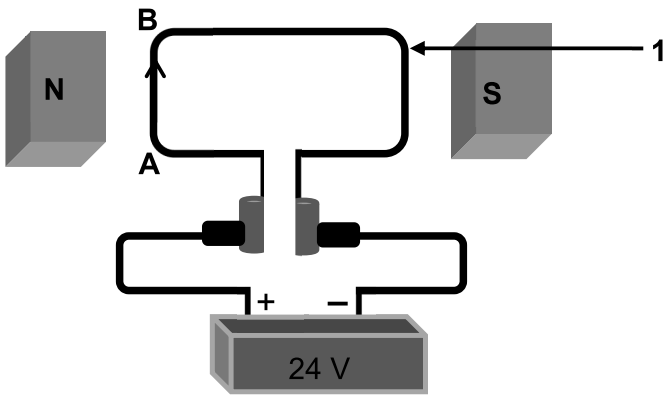
The transformer in structure **A** converts the voltage to 6 200 V which then enters the transmission lines. The primary coil of the transformer in structure **B** consists of 9 000 turns.

9.3 Calculate the voltage in the secondary coil of the transformer in structure **B** if it has 4 900 turns. (3)

9.4 Calculate the electric power in the transmission lines between structures **A** and **B** if the resistance is 560 Ω. (3)
[10]

QUESTION 10 (Start on a new page.)

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



10.1 Define a *motor*. (2)

10.2 Write down the NAME of the component labelled **1**. (1)

10.3 When the motor is in operation, the current in section **AB** of component **1** flows from **A** to **B**, as indicated in the diagram. Component **1** begins to rotate.

10.3.1 Give a reason why component **1** begins to rotate. (1)

10.3.2 In which direction will component **1** rotate?
Write ANTICLOCKWISE or CLOCKWISE. (1)

10.4 Sketch a graph of an AC circuit for ONE complete cycle. (2)

10.5 A coil of wire which has 300 turns is in a magnetic field that is perpendicular to its area. The magnetic flux is 5 x 10^4 Wb. The coil moves such that the magnetic flux changes to 3,21 x 10^4 Wb in 0,3 s.

10.5.1 State Faraday's law of electromagnetic induction in words. (2)

10.5.2 Calculate the magnitude of the induced emf for the coil. (3)
[12]

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 $m \cdot s^{-2}$
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
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Permittivity of free space *Permatiwiteit van vrye spasie*	ε_o	$8,85 \times 10^{-12}$ $F.m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

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

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

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

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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

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

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