GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2024

11101

TECHNICAL SCIENCES

(PAPER 1)

TIME: 3 hours

MARKS: 150

18 pages + 3 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name and grade on 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 subsections, 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, et cetera where required.
12. Write neatly and legibly.

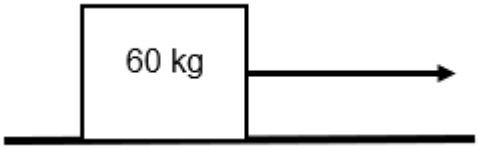
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Newton's First Law of Motion implies that an object will continue to move at a constant velocity as long as the ...

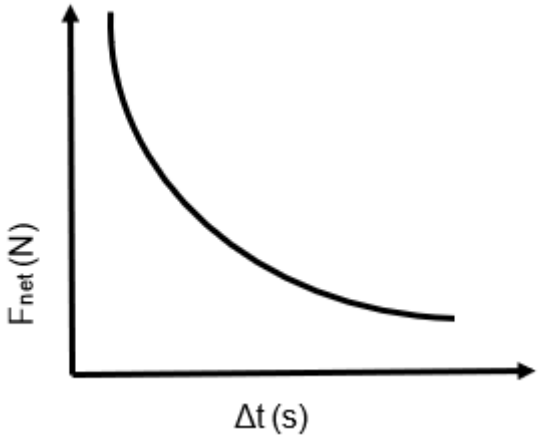
A net force acting on the object is zero.
B net force experienced by the object is greater than zero.
C net force experienced by the object is less than zero.
D sum of all the forces acting on the object is greater than zero but less than one. (2)

1.2 A 60 kg box is pulled to the right on a frictionless surface at a constant velocity with a rope. The mass of the rope is ignored. What is the magnitude of the tension in the rope?



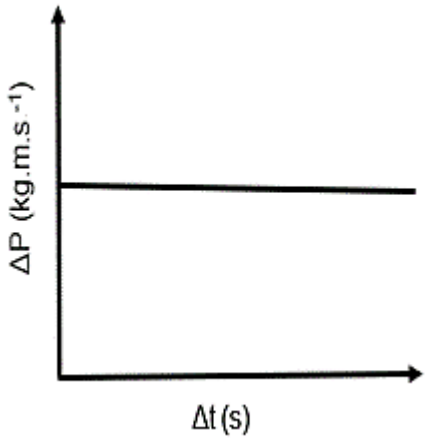
A 568 N, to the left
B 578 N, to the right
C 588 N, to the right
D 588 N, to the left (2)

1.3 The graph below represents the relationship between a net force (F_{net}) on an object and a change in time (Δt).

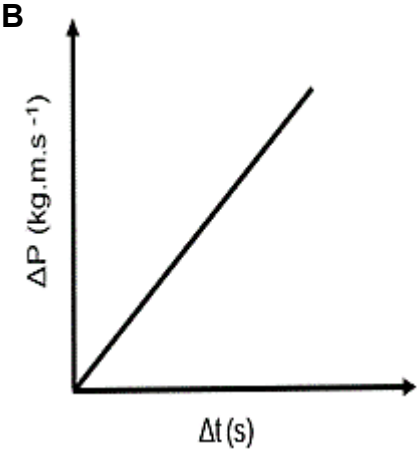


Which of the following graphs represents a corresponding ΔP versus time graph?

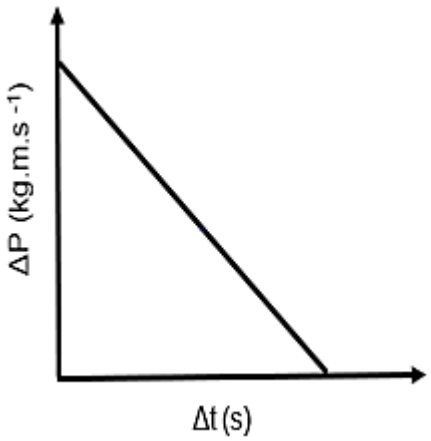
A



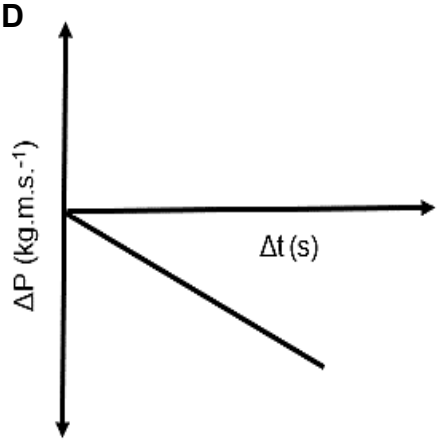
B



C



D



(2)

1.4 The force that the surface exerts on an object and is perpendicular to the surface is called the ...

A mechanical energy.
B weight.
C kinetic energy.
D normal force. (2)

1.5 The property of a body by which it regains its original shape and size when the deforming force is removed is known as ...

A elasticity.
B stress.
C deforming force.
D restoring force. (2)

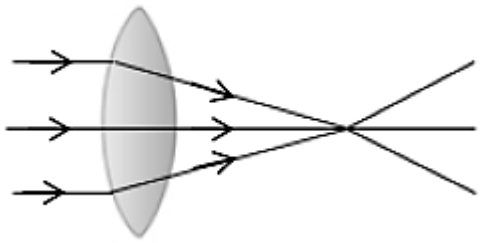
1.6 The unit for pressure can be expressed as …

A Newton.
B Calories.
C Pascal.
D Joules. (2)

1.7 Which of the following statements is TRUE about the position and size of the image in a convex lens when the object is placed between F and 2F?

A Further than 2F, real, inverted, enlarged
B Further than 2F, real, inverted, diminished
C At 2F, real, inverted, same size as object
D At 2F, real, inverted, enlarged (2)

1.8 The point at which the light rays meet, is known as the …



A focal length.
B focal point.
C optic axis.
D principal axis. (2)

1.9 Electromagnetic waves with the lowest frequency and longest wavelength are called ...

A microwaves.
B infrared waves.
C gamma rays.
D radio waves. (2)

1.10 An electrical machine that uses a commutator (split-ring) and converts mechanical energy to electrical energy is called a/an …

A AC generator.
B AC motor.
C DC motor.
D DC generator. (2)
[20]

QUESTION 2 (Start on a new page.)

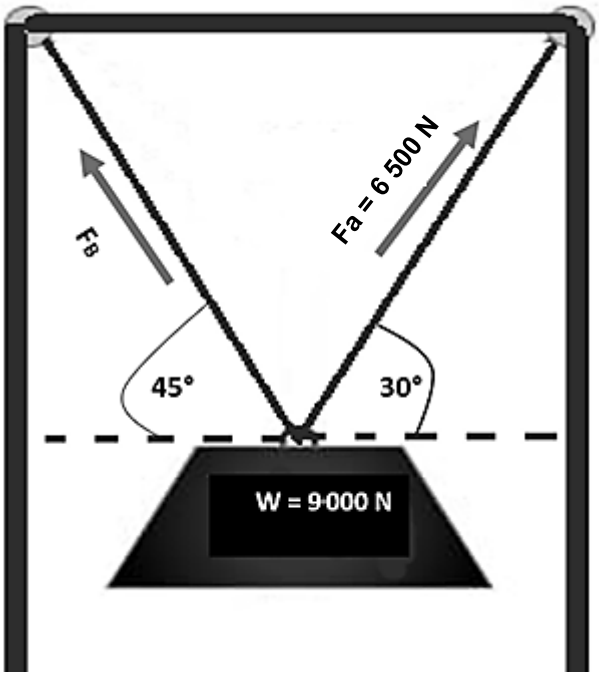
Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A – H) next to the question numbers (2.1 to 2.8) in the ANSWER BOOK, e.g. 2.9 I.

COLUMN A		COLUMN B	
2.1	The force parallel to the surface that opposes the motion of an object and acts in the opposite direction to the motion of the object	A	Kinetic Energy
2.2	The property of a body to resist any change in its state of motion or rest	B	Capacitance
2.3	The energy of an object due to its motion	C	Electromagnetic waves
2.4	Internal restoring force per unit area of a body	D	Frictional force
2.5	The amount of charge it can store per volt	E	Lenz's law
2.6	In a continuous liquid at equilibrium, the pressure applied at a point is transmitted equally to the other parts of the liquid.	F	Stress
2.7	A changing magnetic and electric field mutually perpendicular to each other and in the direction of propagation of the wave	G	Pascal's law
2.8	The direction of induced emf in the coil opposes the effect that produces it	H	Inertia

(8 x 1) **[8]**

QUESTION 3 (Start on a new page.)

3.1 An object of weight 9 000 N is suspended from a steel stand. Force **A** with a magnitude of 6 500 N, is used to pull the object to the right at an angle of 30° to the horizontal and force **B** is used to pull the object to the left at an angle of 45° to the horizontal to keep the crate stationary. (The diagram below is not drawn to scale.)



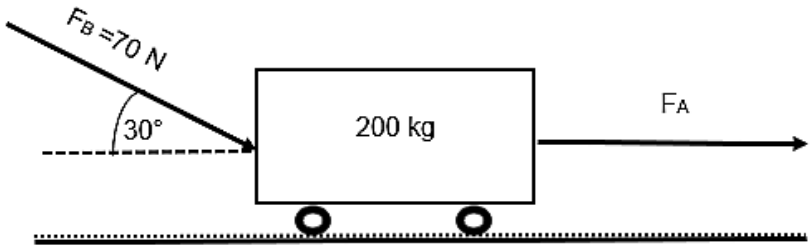
3.1.1 State Newton's First Law of Motion in words. (2)

3.1.2 Draw a labelled, free-body diagram showing ALL the forces acting on the object. (3)

3.1.3 Calculate the mass of the object. (3)

3.1.4 Calculate the magnitude of force **B** exerted at an angle of 45°. (4)

3.2 Two workers are moving a trolley as shown in the diagram below. Worker A pulls the trolley with an unknown magnitude of a force F_A to the east. Worker B pushes the trolley with a force of 70 N at an angle of 30° with the horizontal.



The frictional force experienced by the trolley is 25 N.

3.2.1 State Newton's Second Law of Motion in words. (2)

3.2.2 If the system accelerates at 2 $m \cdot s^{-2}$, calculate the force (F_A). (4)

3.2.3 If worker B now pushes the trolley with the same force, but at an angle of 60° with the horizontal, what will happen to the normal force experienced by the trolley? Write only INCREASE, DECREASE or REMAIN THE SAME. (1)

3.2.4 Explain your answer to QUESTION 3.2.3. (2)
[21]

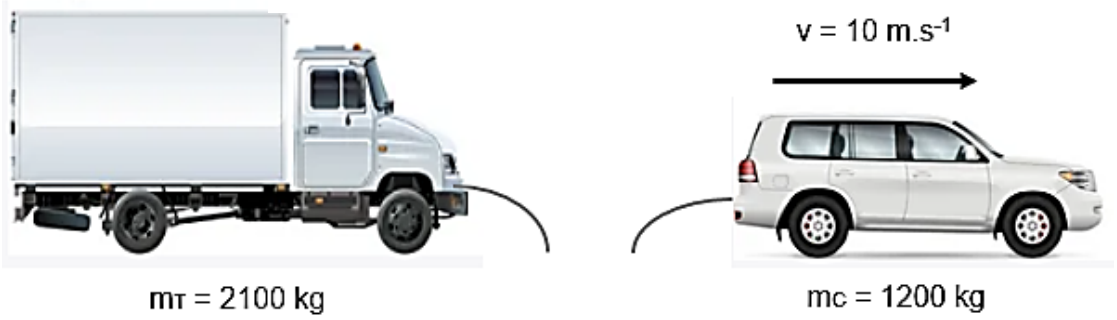
QUESTION 4 (Start on a new page.)

4.1 A car with a mass of 1 200 kg pulls a truck with a mass of 2 100 kg using an inextensible rope. (Ignore the mass of the rope.) The car and the truck are moving at a velocity of 7 $m \cdot s^{-1}$ in a straight line to the right. After a while, the rope breaks, causing the car and the truck to move separately. The car is now moving at a speed of 10 $m \cdot s^{-1}$ to the right.

BEFORE THE ROPE BREAKS



AFTER THE ROPE BROKE



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

4.1.2 Calculate the velocity of the truck after the rope breaks. (4)

4.2 A car, with a mass of 1 000 kg, crashes into a wall with a velocity of 12 $m \cdot s^{-1}$, as shown in the diagram below. The car comes to rest after the crash. The car experiences a constant net force of 55 000 N before it stops.



4.2.1 Define the term *impulse*. (2)

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

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

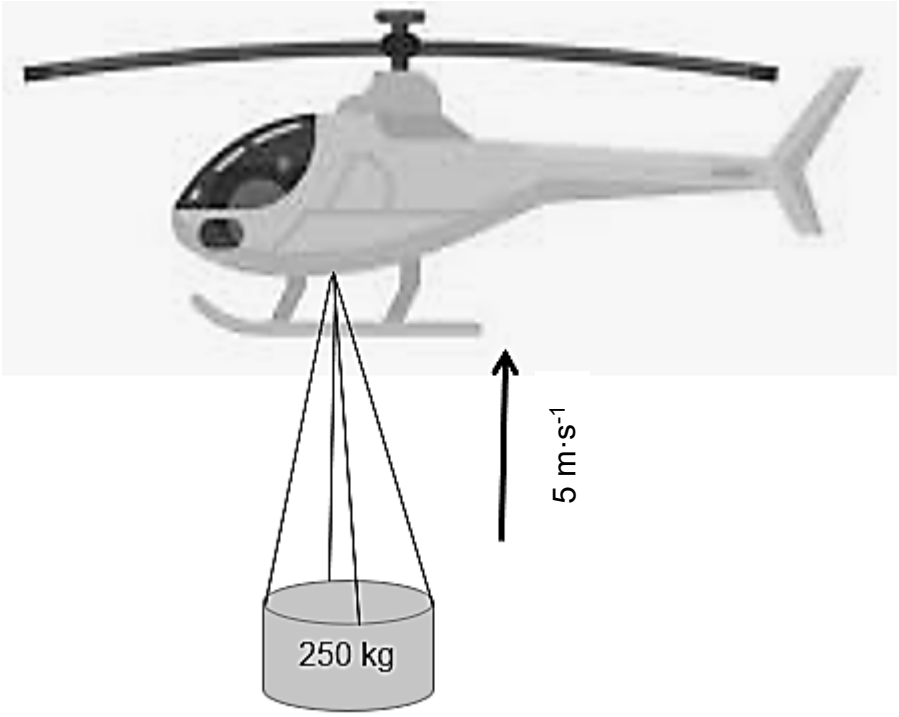
4.2.4 The car is equipped with airbags. Explain, using physics principles, how this would reduce the extent of the driver's injuries. (3)

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

[18]

QUESTION 5 (Start on a new page.)

A helicopter airlifted a 250 kg container filled with water vertically upwards from a river, as shown in the diagram below. The container is lifted by an inextensible cable to a height of 30 m above the river at a constant speed of 5 $m \cdot s^{-1}$. (Ignore air friction and assume that there is NO sideways motion.)

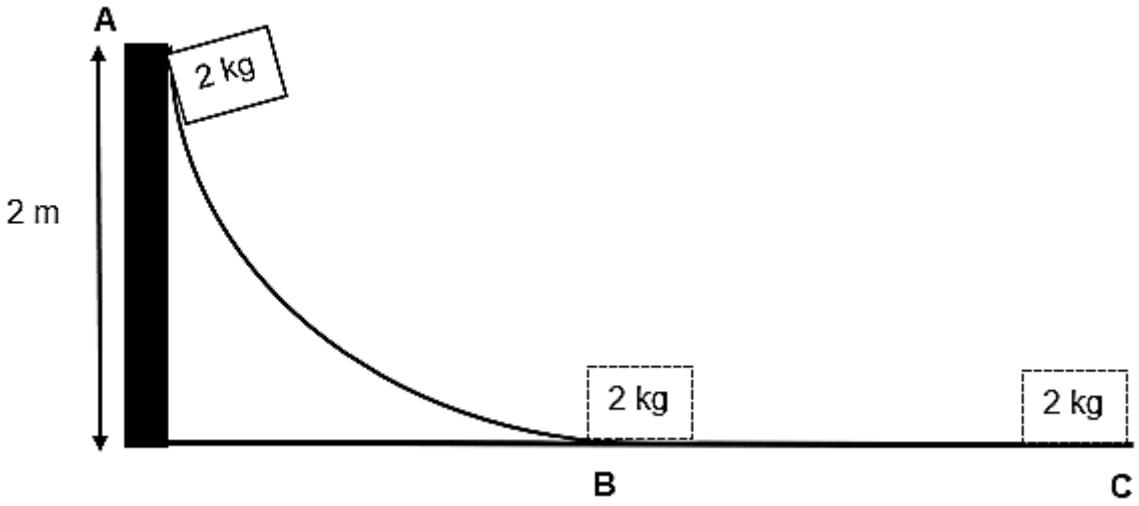


5.1 State the principle of conservation of mechanical energy in words. (2)

5.2 Calculate the potential energy gained by the container 30 metres above the river. (3)

5.3 Calculate the kinetic energy of the container as it was lifted. (3)

A box of mass 2 kg slides down a frictionless track **ABC**. The box starts from rest at point **A**, which is 2 m above the ground. It then passes point **B**, which is at ground level. The box reaches point **C** on the ground with an unknown speed v, as shown in the diagram below.



5.4 Define the term *mechanical energy*. (2)

5.5 Determine the mechanical energy of the box at point **A**. (3)

5.6 Calculate the speed of the box at point **B**. (4)
[17]

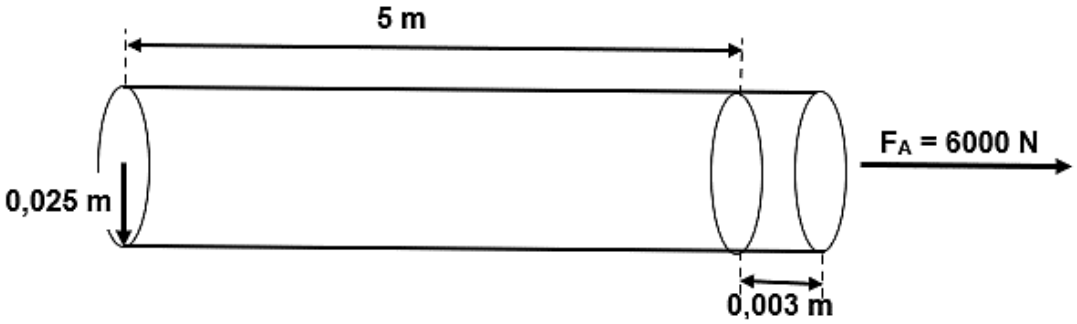
QUESTION 6 (Start on a new page.)

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

6.2 Give TWO examples of perfect elastic substances. (2)

6.3 State TWO applications of hydraulic systems. (2)

6.4 A force (F_A) of 6 000 N is applied to a 5 m long metal wire. The wire stretches by 0,003 m. The radius of the metal wire is 0,025 m.



Calculate the:

6.4.1 Stress in the wire (4)

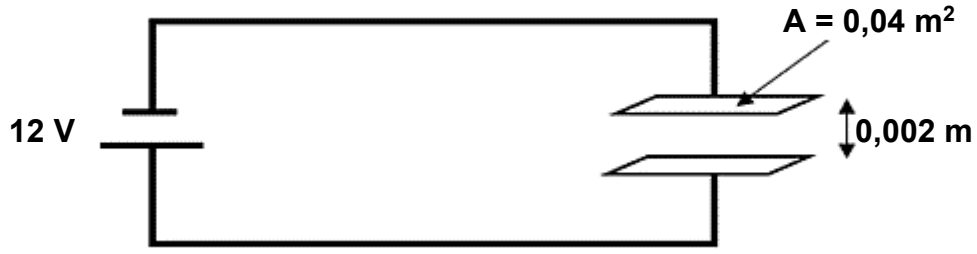
6.4.2 Strain in the wire (3)

6.4.3 Young's modulus of the wire (2)

[15]

QUESTION 7 (Start on a new page.)

A potential difference of 12 V is applied across two parallel plates of a capacitor. The plates are 0,002 m apart. Each plate of the capacitor has an area of 0,04 m^2.



7.1 Write down TWO factors that affect the capacitance of capacitor. (2)

7.2 Calculate the:

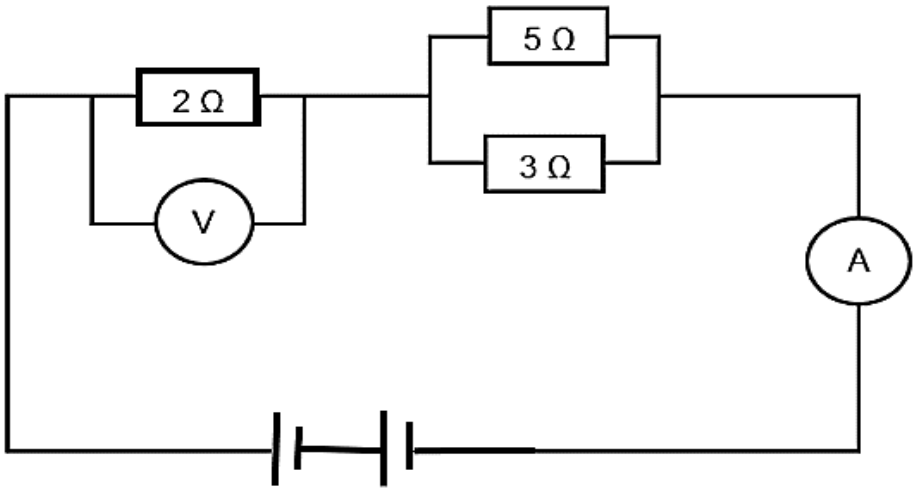
7.2.1 Capacitance of the capacitor (3)

7.2.2 Charge on each plate (3)

[8]

QUESTION 8 (Start on a new page.)

The diagram below shows a circuit that consists of two cells connected in series. Each cell has a potential difference of 1,5 V. Two resistors with resistances of 3 Ω and 5 Ω are connected in parallel, and one resistor with a resistance of 2 Ω is connected in series with the two parallel resistors.



8.1 State Ohm's law in words. (2)

8.2 Calculate the:

8.2.1 Total resistance in the circuit (4)

8.2.2 Potential difference across the 2 Ω resistor (4)

8.3 A heater with a single element has a resistance of 18 Ω and a potential difference of 220 V.

8.3.1 Define the term *power*. (2)

8.3.2 Calculate the power of the heater. (3)

8.3.3 Name TWO appliances in which the heating effect of electric current is used. (2)

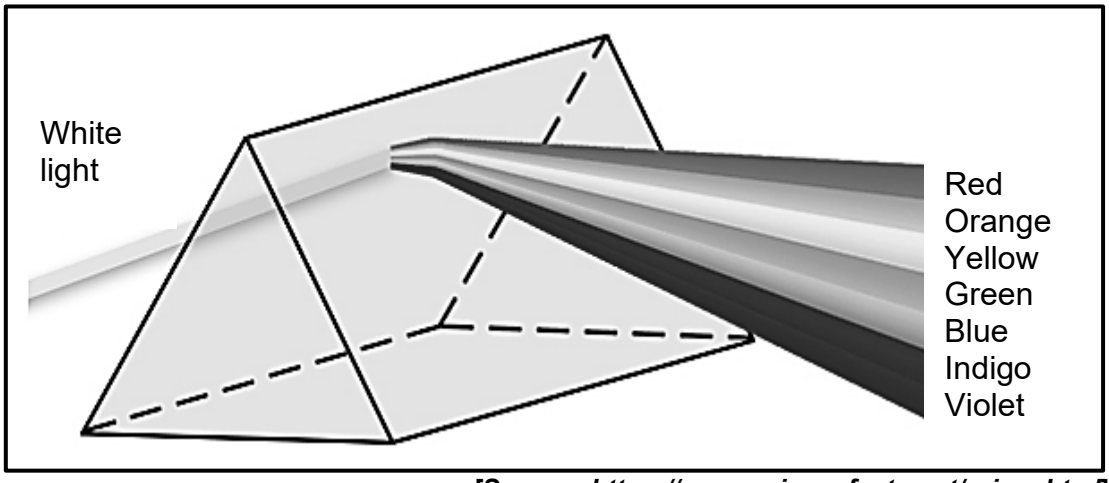
[17]

QUESTION 9 (Start on a new page.)

9.1 Draw a light diagram of an object standing at 2F that passes through a convex lens, and label the diagram. Show the following on your diagram:

- Object
- Image
- Light rays
- Lens (6)

9.2 The following diagram illustrates how Isaac Newton conducted an experiment by allowing light to pass through a triangular prism.



[Source: *https://www.sciencefacts.net/prism.html*]

9.2.1 Which colour has the longest wavelength? (1)

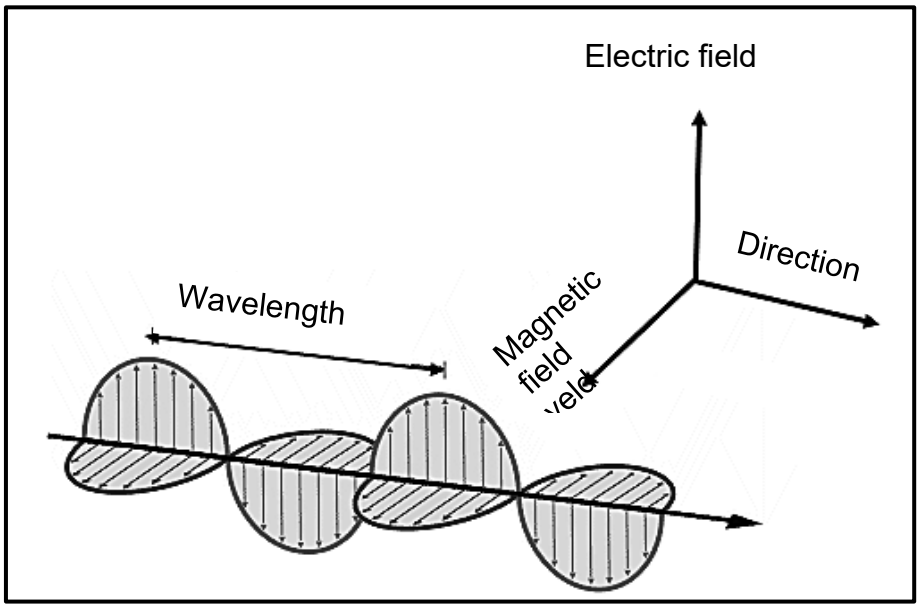
9.2.2 Which colour has the highest frequency? (1)

9.2.3 What do you call this phenomenon? (1)

9.2.4 Define the phenomenon mentioned in QUESTION 9.2.3. (2)
[11]

QUESTION 10 (Start on a new page.)

Study the diagram of electromagnetic waves below and answer the questions that follow.



[Source: *https://www.noaa.gov/jetstream/satellites/electromagnetic-waves*]

10.1 Name TWO properties of electromagnetic waves. (2)

10.2 Which type of wave is used in:

10.2.1 A remote control (1)

10.2.2 An iron/A heater (1)

10.3 Study the following two types of electromagnetic light:

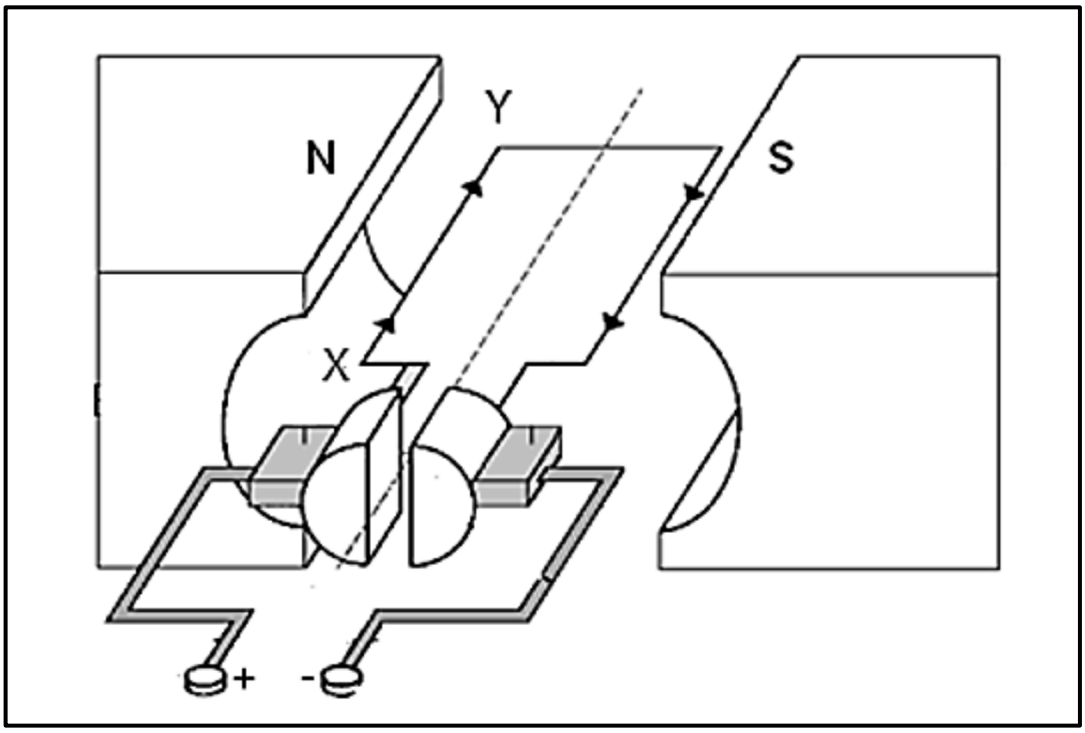
- Light 1 has a frequency of $5,56 \times 10^{14}$ Hz.
- Light 2 has a wavelength of 390 nm.

10.3.1 Calculate the energy of a photon of light 1. (2)

10.3.2 Calculate the energy of a photon of light 2. (3)
[9]

QUESTION 11 (Start on a new page.)

The diagram below is a simplified representation of a DC motor. The current in the coil is in the direction **XY**.



11.1 Name the component that ensures that the coil rotates continuously in ONE DIRECTION. (1)

11.2 In which direction will the coil rotate? Write down only CLOCKWISE or ANTICLOCKWISE. (1)

11.3 Write down the energy conversion which takes place while the motor is working. (2)

11.4 Write down the structural difference between an AC generator and a DC generator. (2)
[6]

TOTAL: 150

END

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	$6,63 \times 10^{-34}$ $J \cdot s$
Permittivity of free space *Permatiwiteit van vrye spasie*	ε_O	$8,85 \times 10^{-12}$ $F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max/maks} = \mu_s N$	$F_s = \mu_s N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$ or/of $F_g = mg$

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* $\Delta E_k = E_{kf} - E_{ki}$
$P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$	
$P = \frac{W}{\Delta t}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{k\varepsilon_o A}{d}$ and/*en* $C = \frac{\varepsilon_o A}{d}$	$E = \frac{V}{d}$
$C = \frac{Q}{V}$	

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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

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

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