Province of the EASTERN CAPE EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

TECHNICAL SCIENCES P1 (DEAF)

MARKS: 150

TIME: 3 hours

This question paper has 18 pages, including 3 data sheets.

INSTRUCTIONS AND INFORMATION

1.   This **question paper** has **TEN questions**.
       Answer ALL the **questions** in the **ANSWER BOOK**.

2.   Start **EACH question** on a **NEW page** in the ANSWER BOOK.

3.   **Number** the **answers** the **same** as the **numbers** in the **question paper**.

4.   **Use** a **non-programmable calculator**.

5.   Leave **ONE line between questions**, e.g. between QUESTION 2.1 and
       QUESTION 2.2.

6.   **Use** the attached **DATA SHEETS**.

7.   **Show** ALL **formulae** and **substitutions** in ALL calculations.

8.   **Round off** your **answers** to a minimum of **TWO decimal places**.

9.   Some **questions** will **ask** you to **explain** your **answer**.
       Write **short explanations**.

10.   Write **neatly**.
       Your **work** must be **easy** to **read**.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Choose the **answer**.
Write only the **letter** (A–D) **next** to the **question numbers** (1.1 to 1.10), e.g.
1.11 D.

1.1   An **object continues** in a **state** of **uniform velocity** or **rest until** …

        A   it is influenced by inertia.

        B   it is acted upon by tension.

        C   it is acted upon by a net force.

        D   it is influenced by gravity.   (2)

1.2   A **girl catches** a **cricket ball**.
        Consider the **action force** to be the **contact** of the **ball** against the
        girl's hand.
        What is the **reaction** to this **force**?

        A   The impact felt in the girl's shoulder.

        B   The force her hand exerts on the ball.

        C   The friction caused by the ground on the girl's shoes.

        D   None of the above.   (2)

1.3   The **SI-unit** of **impulse** is …

        A $N \cdot s^{-1}$.

        B $N \cdot s$.

        C $J \cdot s^{-1}$.

        D $J \cdot s$.   (2)
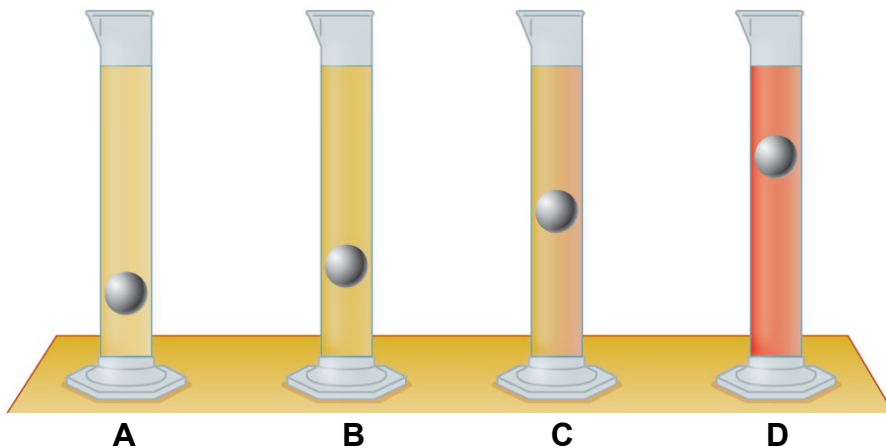
1.4   **Powe**r is **defined** as the …

A   rate at which work is done.

B   product of mass and velocity.

C   rate at which velocity changes.
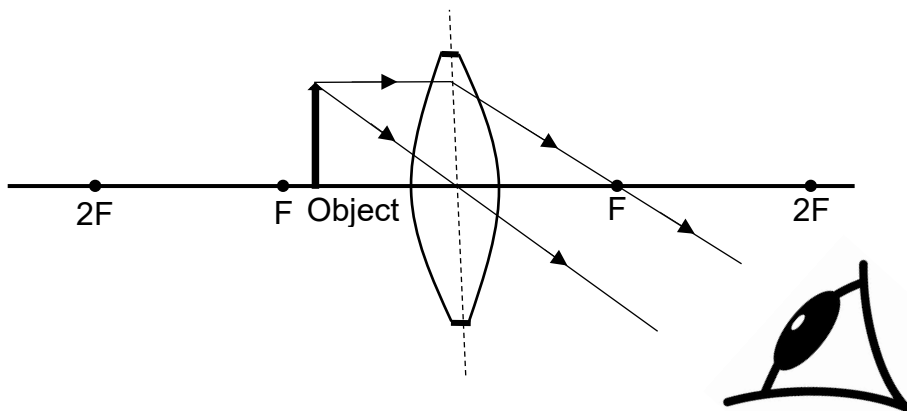
D   product of mass and acceleration.   (2)

1.5   **Steel balls** are **dropped** at the **same time**.
It is **dropped into four different liquids**.
It **takes different times** to **drop** to the **bottom** of **each test tube**.

Which **substance** has the **highest viscosity**?

          A   B   C   D   (2)

1.6   An **object** is **placed** in front of a **converging lens** at a **distance less** than
F. The **image produced** by the **lens** is …

A   real, inverted and smaller.

B   real, inverted and larger.

C   virtual, upright and larger.

D   virtual, upright and smaller.   (2)

1.7 **Fibre optics cable used** in **communication works** on the **principle** of …

    A   regular reflection of light.

    B   diffuse reflection of light.

    C   refraction of light.

    D   total internal reflection of light.   (2)

1.8 **Which** of the **following** is the **correct order** of **electromagnetic waves** in **ORDER** OF **DECREASING WAVELENGTH**?

    A   Gamma rays → X-rays → Infrared wave → Radio wave

    B   Radio wave → Infrared wave → X-rays → Gamma rays

    C   X-rays → Radio wave → Gamma rays → Infrared wave

    D   Infrared wave → Radio wave → X-rays → Gamma rays   (2)

1.9 A **graph** of **power versus current** is shown.
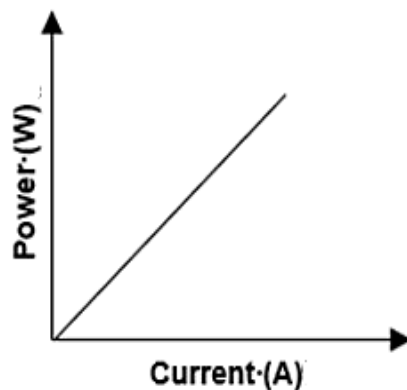
The gradient of this graph represents the …

    A   potential difference.

    B   EMF.

    C   work done.

    D   resistance.   (2)

1.10 **Which ONE** of the **following statements** does the **value** of the **voltage** or **current generated** by an **AC generator NOT depend on**?

     A   Speed at which the coil or magnetic field rotates.

     B   The poles of the permanent magnet.

     C   Strength of the magnetic field.

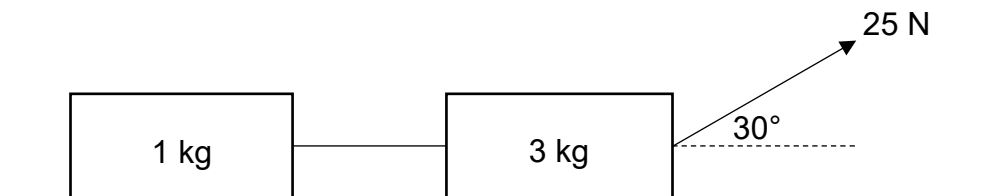   D   Number of turns in the coil. (2)
[20]

QUESTION 2 (Start on a new page.)

DIAGRAM:
A **block** of **mass 3 kg** is **pulled across** a rough **horizontal surface** with a **force** of **25 N**.
It is at **30°** to the **horizontal,** and a **1 kg block** is **connected** to it by a **light inextensible**(cannot stretch) **string**.
The **frictional force** between the **surface** and the **1 kg block** is **0,8 N**.

| 2.1	**Define** *Newton's Second Law of Motion* in **words**.	(2)
2.2	**Draw** a **labelled free body diagram** of the **3 kg block**.	(5)
2.3	**Calculate** the **normal force** on the **3 kg block**.	(4)
2.4	**What type** of **frictional force** is **working in** on the **system**?	(1)
2.5	The **frictional force** on the **3 kg block** is **3,38 N**. **Calculate** the **acceleration** of the **system** as **result** of the **net force**.	(5)
2.6	**Which force** is **present** in the **string**?	(1)
2.7	If the **angle** that the **30 N force makes** with the **horizontal** is **decreased** to **20°**, what **would happen** to the **frictional force**? Write only **INCREASE, DECREASE** or **REMAINS THE SAME**. **Explain** your **answer**.	(3)

[21]

QUESTION 3 (Start on a new page.)

A **truck** with **mass 12 000 kg**, **travels** at a **velocity** of **20 m•s^{-1} east**.
It **collides** with a **stationary(not moving) motor vehicle** with a mass of **2 000 kg**.
After the **collision**, the **truck** and the **car get stuck together**.
It **then moves** as a **single isolated system**, **as shown**.

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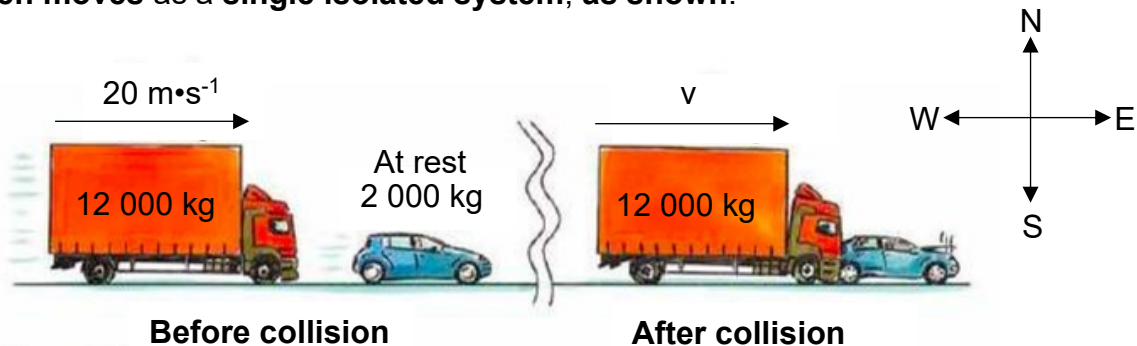
3.1   **State** the **principle** of **conservation** of **linear momentum in words**.   (2)

3.2   **Calculate** the **final velocity** of the **system after** the **collision**.   (5)

3.3   **Is** the **collision ELASTIC** or **INELASTIC**?

        Use a **calculation**.
        Give a **reason** for **your answer**.   (5)

3.4   It is **an industrial requirement** for **modern cars** to have **crumple zones**.

        Explain how this **safety feature protects passengers** in a **vehicle** in the **event** of a **collision**.   (3)

3.5   A **soccer ball**, with a **mass** of **450 g**, **moves across** a **horizontal floor in** a **straight line** at a **speed** of **6 m·s^{-1}**.
        It **hits** a **wall** and then **it moves** in the **opposite direction** at **4,5 m·s^{-1} directly** after the **collision**.
        The **ball** is in **contact** with the **wall** for **0,16 s**.

        3.5.1   **Calculate** the **magnitude** of **force** that the **wall exerts(applies)** on the **ball.**   (4)

        3.5.2   **If** the **ball** is in **contact** with the **wall** for **0,2 s**, **will** the **net force** be **GREATER THAN**, **SMALLER THAN** or **EQUAL TO** the **answer** in **QUESTION 3.5.1**.

                Explain your **answer.**   (2)

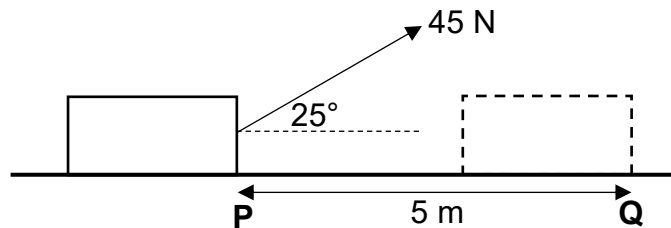   **[21]**

QUESTION 4 (Start on a new page.)

DIAGRAM:
A **learner moves** a **crate across** a **rough horizontal surface**.
It is with **a pulling force** of **45 N** at **25°** to the **horizontal across** a **5 m path** from **P** to **Q**.
The **frictional force** from **P** to **Q** is **1,6 N**.

4.1   **Define** the **term** *work done* in **words**.   (2)

4.2   **Calculate** the:

     4.2.1   **Net work done** in **moving** the **crate** from **P** to **Q**   (4)

     4.2.2   **Power** the **learner uses** in **moving** the **block** from **P** to **Q** if it
            takes 7 s   (3)

4.3   **If** the **crate** is **moved over** a **longer distance**, how will **this affect** the
magnitude(size) of the **net work done**?

     Write only **INCREASE**, **DECREASE** or **REMAINS THE SAME**.

     Explain your **answer**.   (3)

4.4   A **15 kg pendulum attached**(fitted) to the **roof** by **inextensible**(cannot stretch) **string**, **swings** from **REST** at **point A**, which is **at** a **height** of **h above** the **ground**.
At **point B** the **pendulum** is **half** the **distance above** the **ground** than it is at **point A** and **moves** at a **velocity** of **14 m•s⁻¹**.
Ignore the **effects** of **air friction**.
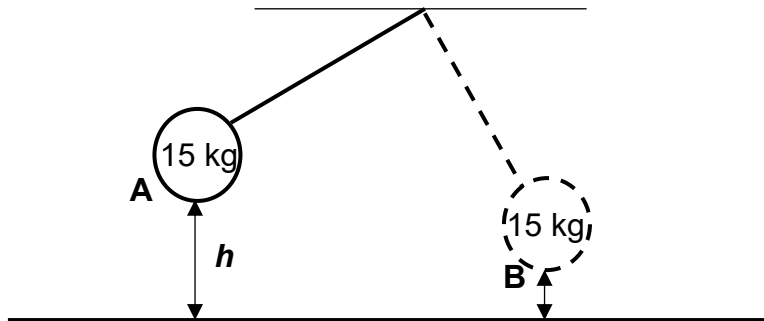
4.4.1   **State** the **principle** of **conservation** of **mechanical energy** in **words**.   (2)

4.4.2   **Calculate h** the **height** of the **pendulum** at **point A**.   (4)
                                                                                [18]

QUESTION 5 (Start on a new page.)

A **metal wire** with **diameter 1,8 mm** is **stretched** when a **12 N force** is **applie**d.
The **wire X** is **initially(at first) 2 m long** and **stretches** by **Y** until it is **2,006 m long**.
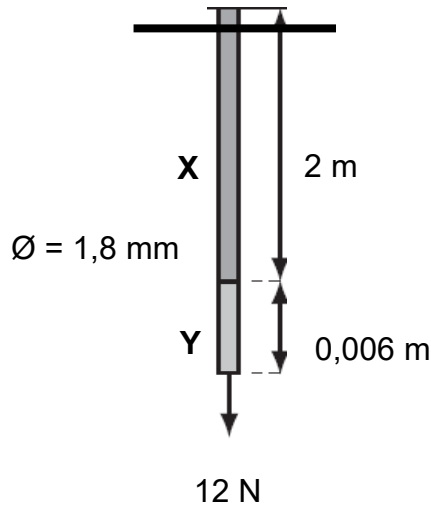
5.1   **Define** the **term** *strain.* (2)

5.2   **Calculate** the:

    5.2.1   **Stress** in the **wire** (4)

    5.2.2   **Strain** in the **wire** (3)

    5.2.3   **Wire's modulus** of **elasticity** (3)

5.3   A **hydraulic jack** is **used** to **lift** a **small truck** with **a mass 3 500 kg**.
      The **piston** at A_2 is **used** to **lift** the **truck** and **has** a **cross-sectional area**
      of **7,49 m^2**.
      The **cross-sectional area** of the **input piston** at A_1 is given as **0,54 m^2**.
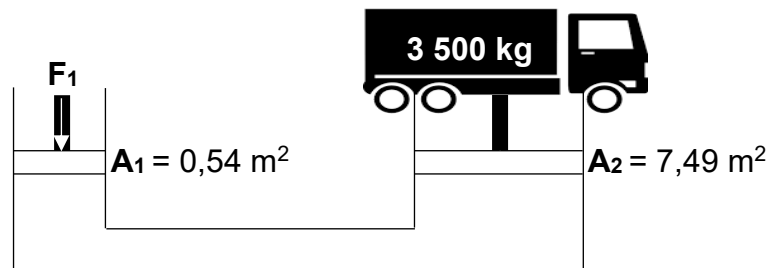
    5.3.1   **State Pascal's law** in **words**. (2)

    5.3.2   **Calculate** the **pressure** in the **fluid** of this **hydraulic system**. (3)

    5.3.3   **Calculate** the **force** that **needs** to be **applied** at A_1 to **lift** the
         truck. (3)

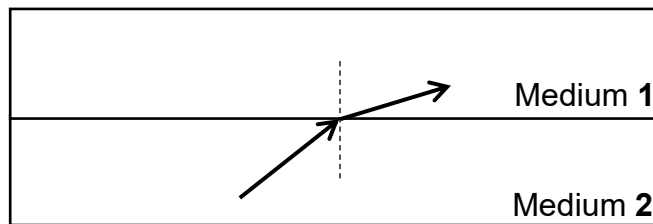   **[20]**

QUESTION 6 (Start on a new page.)

6.1   **Use** the **diagram** of **light reflecting** off a **flat mirror**.
        Answer the **questions**.
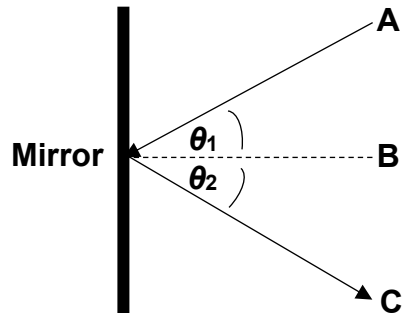
      6.1.1   **State** the **law** of the **reflection of light**.   (2)

      6.1.2   **Identify B** and **C in** the **diagram**.   (2)

6.2   **DIAGRAM:**
        Study the **diagram** of **refraction of light** in **different media**.
        Answer the **questions**.

      6.2.1   **Define** the **term** *refraction of light*.   (2)

      6.2.2   **Which optical medium** in the **diagram** has the **highest optical density**?
             Write only **MEDIUM 1** or **MEDIUM 2**.
             Explain your **answer**.   (2)

      6.2.3   **Name TWO conditions** of **total internal reflection**.   (2)
                                                                   [10]
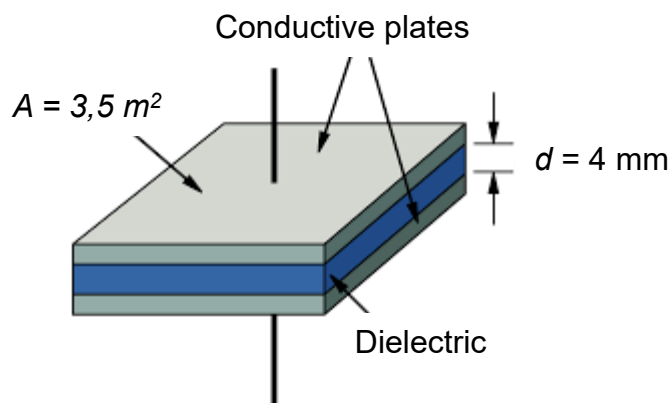
QUESTION 7 (Start on a new page.)

Electromagnetic waves can be **transmitted through** a **vacuum**.

7.1　**Define *electromagnetic waves*.**　　　　　　　　　　　　　　　　(2)

7.2　**Briefly explain** how the **police make use** of **ultraviolet radiation** in
　　　forensic science to **investigate crime scenes**.　　　　　　　　　(3)

7.3　**Calculate** the **wavelength** of a **photon** of **light rays** that has
　　　$2,49 \times 10^{-19}$ J of energy.　　　　　　　　　　　　　　　　(5)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[10]

QUESTION 8 (Start on a new page.)

A **capacitor** has a **potential difference** of **240 V applied** across its **two parallel plates**.
The **plates** have an **area** of **3,5 m²** and are **4 mm apart**.

Conductive plates

$A = 3,5\ m^2$

$d = 4$ mm

Dielectric

8.1　**Define** the **term *capacitance*.**　　　　　　　　　　　　　　　(2)

8.2　**Calculate** the **capacitance** of the **capacitor**.　　　　　　　　(4)

8.3　**Calculate** the **charge** on **each plate**.　　　　　　　　　　　(3)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[9]

QUESTION 9 (Start on a new page.)

In the **circuit diagram** below the **battery** has an **emf** of **12 V**.
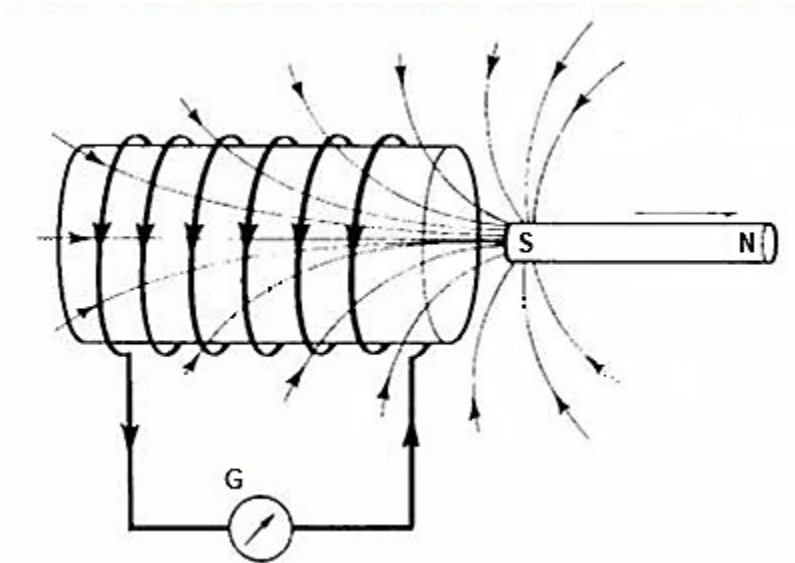**Ignore** the **internal resistance** of the **battery**.
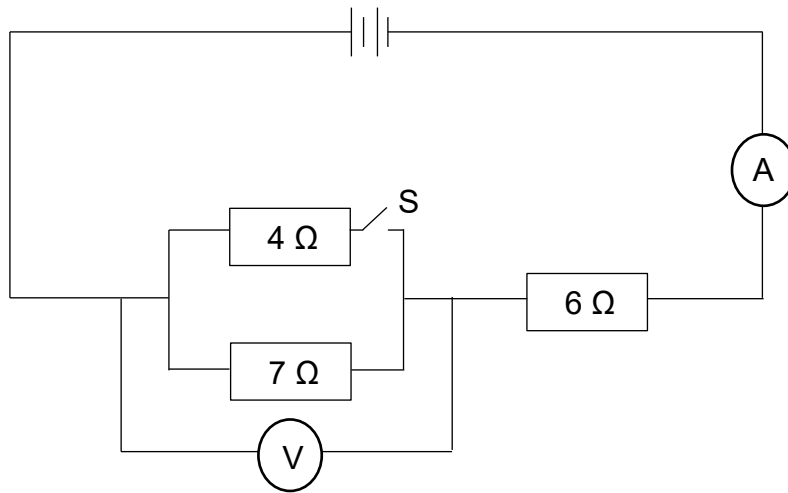
The **switch** is **now closed**.

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

9.2   **Calculate** the:

    9.2.1   **Total resistance** in the **circuit**   (4)

    9.2.2   **Reading** on **ammeter A**   (3)

    9.2.3   **Power** of the **6 Ω resistor**   (3)
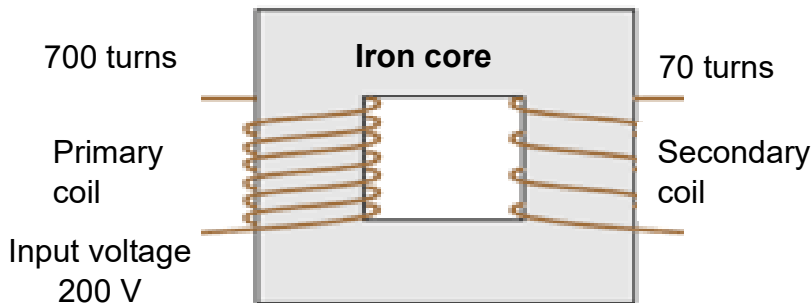
                                                          [12]

QUESTION 10 (Start on a new page.)

10.1   The **sketch** below **illustrates(shows)** Faraday's law of electromagnetic induction.

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

10.1.2   **State TWO ways** in **which** the **deflection** of the **galvanometer needle** could be **increased**.   (2)

10.2

10.2.1   **Define** a **step-down transformer**.   (2)

10.2.2   A **transformer** has **input voltage** of **200 V**.
The **number** of **turns** on the **primary coil** is **700** and on the **secondary coil** is **70**.

Calculate the **output voltage** of **this transformer**.   (3)
[9]

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*	$\varepsilon_\circ$	$8,85 \times 10^{-12} \text{ F.m}^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

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

Please turn over

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

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

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

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

ELECTROSTATICS / *ELEKTROSTATIKA*

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

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$R = \dfrac{V}{I}$	emf/*emk* (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + ...$	$q = I\,\Delta t$
$W = VQ$ $W = VI\Delta t$ $W = I^2 R \Delta t$ $W = \dfrac{V^2 \Delta t}{R}$	$P = \dfrac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \dfrac{V^2}{R}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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

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

$v = f\lambda$	$T = \dfrac{1}{f}$
$E = hf$ or $E = h.\dfrac{c}{\lambda}$	