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**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

SEPTEMBER 2023

TECHNICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages, including 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. You may use a non-programmable calculator.
5. LEAVE ONE line between subsections, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as answers to the following questions. Choose the answer and write only the correct letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 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 $\text{N}\cdot\text{s}^{-1}$.
 - B $\text{N}\cdot\text{s}$.
 - C $\text{J}\cdot\text{s}^{-1}$.
 - D $\text{J}\cdot\text{s}$. (2)

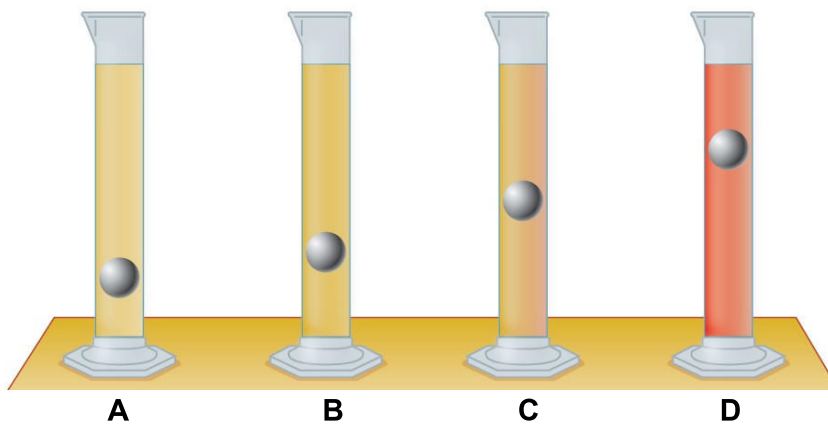
1.4 Power is defined as the ...

- 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)

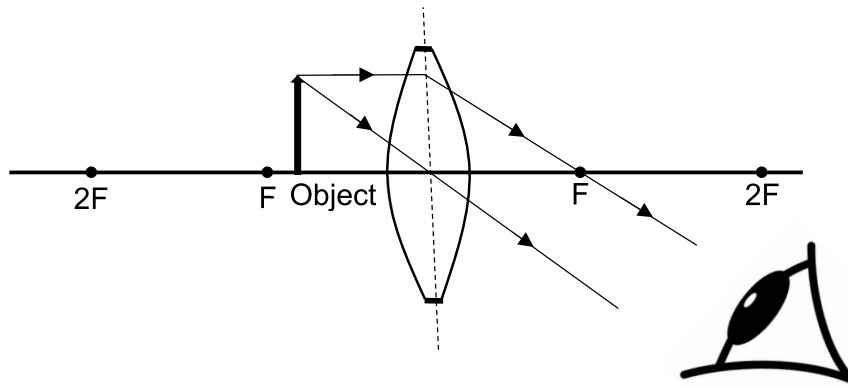
1.5 Steel balls are dropped at the same time, into four different liquids and take different times to drop to the bottom of each test tube.

Which substance has the highest viscosity?



(2)

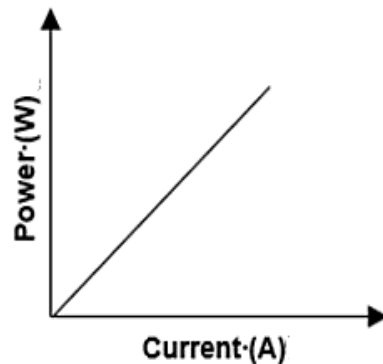
1.6 In the diagram below, an object is placed in front of a converging lens at a distance less than F . The image produced by the lens is ...



- 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 below.



The gradient of this graph represents the ...

- A potential difference.
- B EMF.
- C work done.
- D resistance. (2)

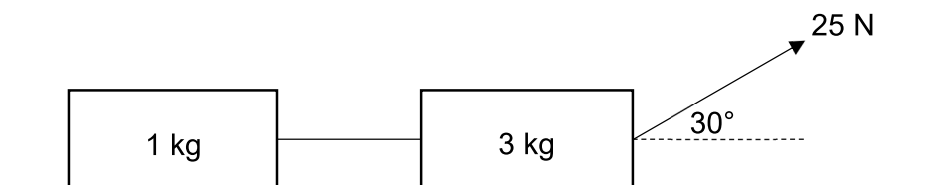
1.10 Which ONE of the following statements does the value of the voltage or current generated by an AC generator NOT depend on?

- 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.)

A block of mass 3 kg is pulled across a rough horizontal surface with a force of 25 N at 30° to the horizontal, and a 1 kg block is connected to it by a light inextensible 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 If 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? (3)

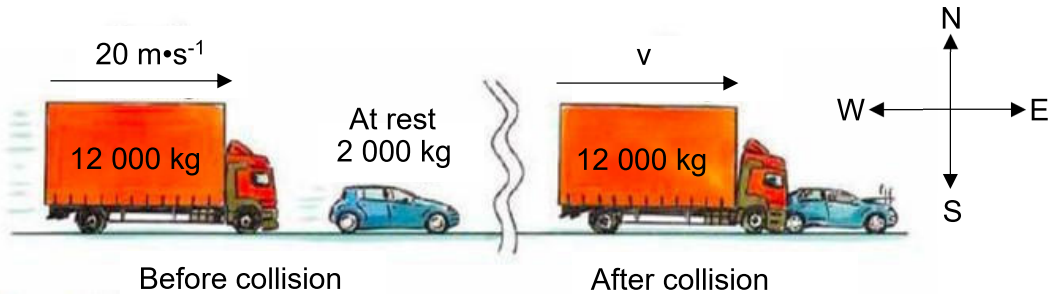
Write only INCREASE, DECREASE or REMAINS THE SAME.

Explain your answer.

(3)
[21]

QUESTION 3 (Start on a new page.)

A truck with mass 12 000 kg, travels at a velocity of $20 \text{ m}\cdot\text{s}^{-1}$ east, and collides with a stationary motor vehicle with a mass of 2 000 kg. After the collision, the truck and the car get stuck together and move as a single isolated system, as shown in the diagram below.

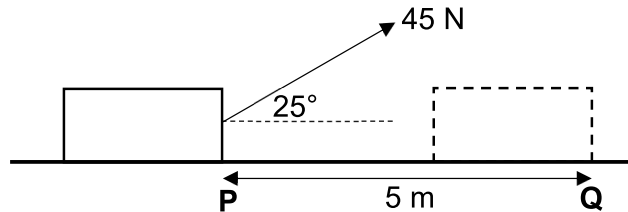


- 3.1 State the principle of conservation of linear momentum in words. (2)
- 3.2 Calculate the final velocity of the system after the collision. (5)
- 3.3 Is the collision ELASTIC or INELASTIC?
Use a calculation to justify your answer. (5)
- 3.4 It is an industrial requirement for modern cars to have 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 $6 \text{ m}\cdot\text{s}^{-1}$. It hits a wall and then it moves in the opposite direction at $4,5 \text{ m}\cdot\text{s}^{-1}$ 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 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.)

A learner moves a crate across a rough horizontal surface 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)

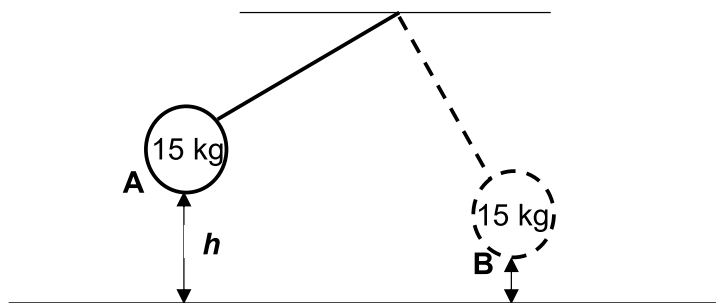
4.2.2 Power the learner uses in moving the block from **P** to **Q** if it takes 7 s (3)

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

Write only INCREASE, DECREASE or REMAINS THE SAME.

Explain your answer. (3)

4.4 A 15 kg pendulum attached to the roof by inextensible 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 $14 \text{ m}\cdot\text{s}^{-1}$. Ignore the effects of air friction.



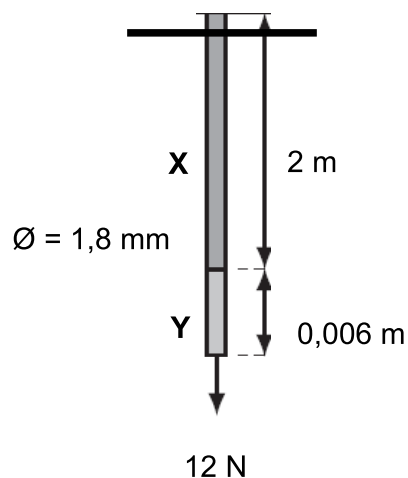
4.4.1 State the principle of conservation of mechanical energy in words. (2)

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 applied. The wire **X** is initially 2 m long and stretches by **Y** until it is 2,006 m long.



5.1 Define the term *strain*. (2)

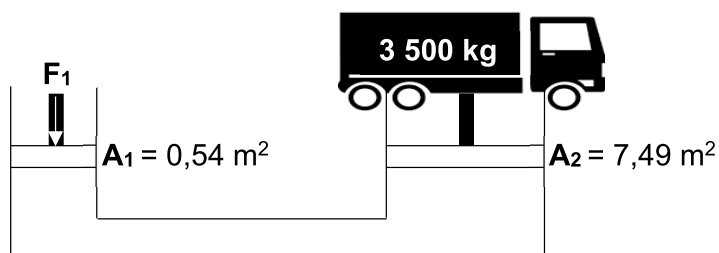
5.2 Calculate the:

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 **A₂** is used to lift the truck and has a cross-sectional area of 7,49 m². The cross-sectional area of the input piston at **A₁** is given as 0,54 m².



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

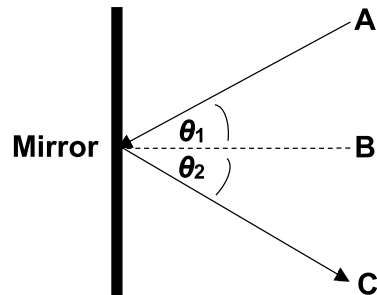
5.3.2 Calculate the pressure in the fluid of this hydraulic system. (3)

5.3.3 Calculate the force that needs to be applied at **A₁** to lift the truck. (3)

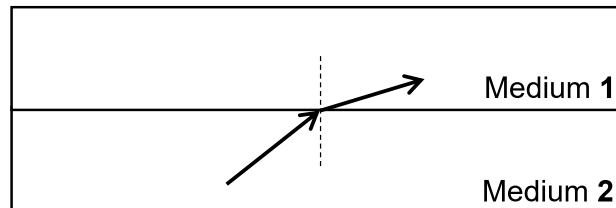
[20]

QUESTION 6 (Start on a new page.)

- 6.1 Use the diagram of light reflecting off a flat mirror to answer the following 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 Study the diagram of refraction of light in different media and answer the following 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 and explain your answer. (2)
- 6.2.3 Name TWO conditions of total internal reflection. (2)

[10]

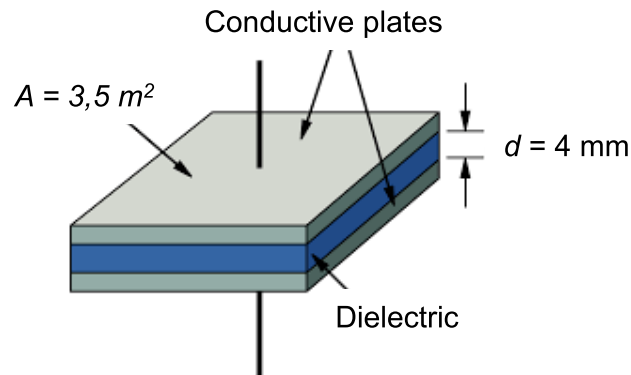
QUESTION 7 (Start on a new page.)

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.)

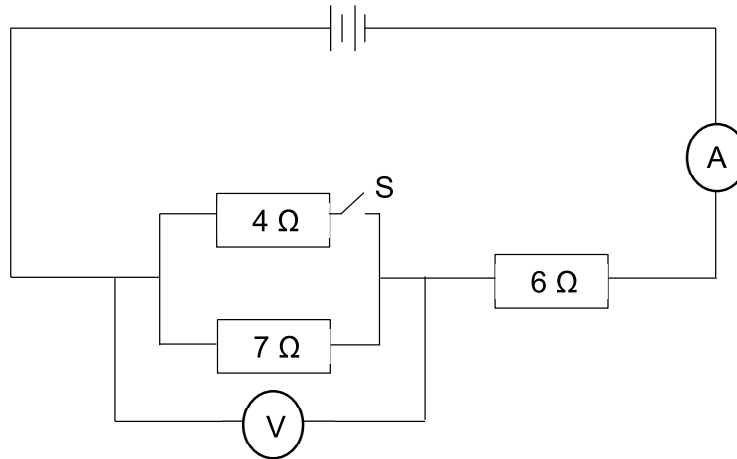
A capacitor has a potential difference of 240 V applied across its two parallel plates. The plates have an area of $3,5 \text{ m}^2$ and are 4 mm apart.



- 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.



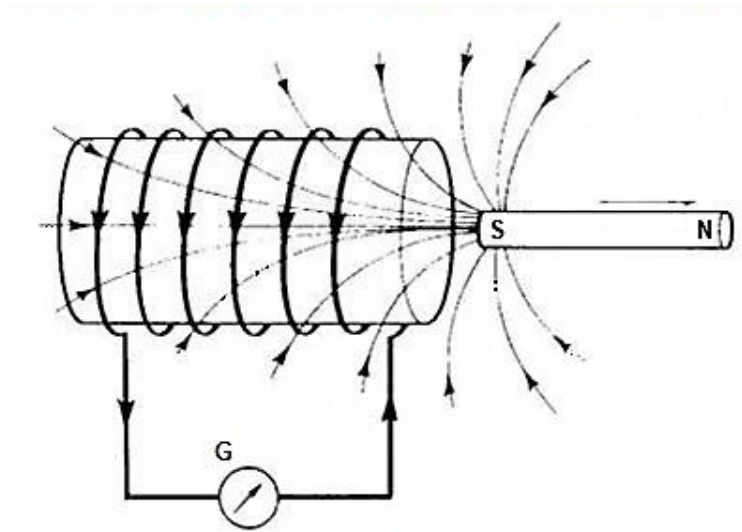
The switch is now closed.

- 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.)

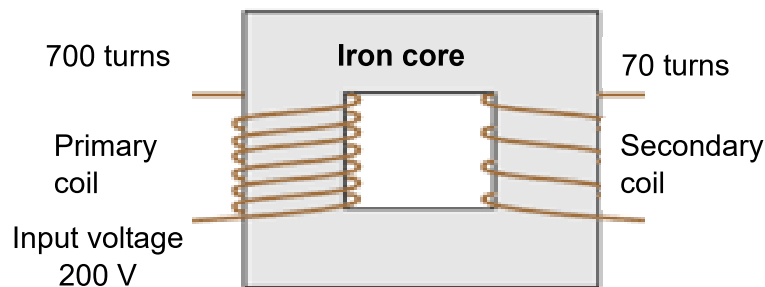
10.1 The sketch below illustrates Faraday's law of electromagnetic induction.



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: FISIIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	3,0 x 10 ⁸ m·s ⁻¹
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 ⁻³⁴ J·s
Electron mass <i>Elektronmassa</i>	m _e	9,11 x 10 ⁻³¹ kg
Permittivity of free space <i>Permittiwiteit van vrye ruimte</i>	ε ₀	8,85 x 10 ⁻¹² F·m ⁻¹

TABLE 2: FORMULAE/TABEL 2: FORMULES

FORCE/KRAG

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

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 $E_k = \frac{1}{2}mv^2$	$W_{\text{net}} = F_{\text{net}}\Delta x \cos\theta$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	$P = \frac{W}{\Delta t}$
	$M_E = E_k + E_p$

ELASTICITY, VISCOSITY AND HYDRAULICS/ELASTISITEIT, VISKOSITEIT EN HIDROULIKA

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

ELECTROSTATICS / ELEKTROSTATIKA

$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$
-------------------	---------------------------------

CURRENT ELECTRICITY/STROOMELEKTRISITEIT

$R = \frac{V}{I}$	$\text{emf/emk } (\mathcal{E}) = I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = VQ$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/ELEKTROMAGNETISME

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

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

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