basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 14 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.

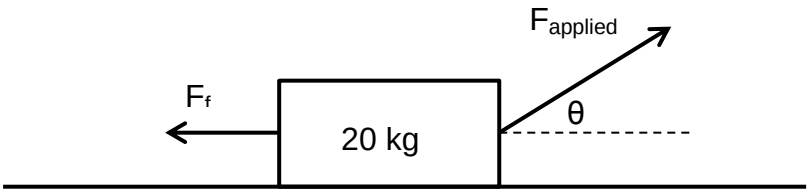
11. Give brief motivations, discussions, etc. where required.

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 A block with a mass of 20 kg moves towards the east at a constant velocity across a rough horizontal surface, as shown in the diagram below.



The velocity is constant because …

A $F_f = F_{applied}$ and $a = 9{,}8\ m{\cdot}s^{-2}$.

B $F_{applied} < F_f$ and $a = 0\ m{\cdot}s^{-2}$.

C $F_{applied} \sin\theta = F_f$ and $a = 9{,}8\ m{\cdot}s^{-2}$.

D $F_{applied} \cos\theta = F_f$ and $a = 0\ m{\cdot}s^{-2}$. (2)

1.2 Newton's Third Law of Motion refers to action-reaction pairs of forces. Which ONE of the following statements is INCORRECT for the action-reaction pairs in the picture?

A They act along the same line.

B Both forces act on the hammer simultaneously.

C These forces act on the hammer and the nail simultaneously.

D These forces act in opposite directions. (2)

1.3 Impulse is equal to the …

A change in momentum.

B rate of change in momentum.

C product of mass and velocity.

D work done by an object. (2)

1.4 The work done to move an object over a distance by a force **F**, which is applied at 30° to the horizontal, is **W**.

The work done to move the object through the same distance by the force **F** acting HORIZONTALLY to the surface is …

A $2\mathbf{W}$

B $\frac{1}{2}\mathbf{W}$

C $\frac{\sqrt{3}}{2}\mathbf{W}$

D $\frac{2}{\sqrt{3}}\mathbf{W}$ (2)

1.5 Which ONE of the following statements defines strain in a material? Strain is the ratio between the …

A change in diameter and the original length.

B total length and the original length.

C change in length and the original length.

D change in stress and the original stress. (2)

1.6 Force $\mathbf{F_1}$ is applied to a piston, with area $\mathbf{A_1}$, in a hydraulic system. Another piston in the same system has area $\mathbf{A_2}$ and this piston can exert a force, $\mathbf{F_2}$.

Which ONE of the following equations is INCORRECT according to Pascal's law?

A $F_2 A_2 = F_1 A_1$

B $F_1 A_2 = F_2 A_1$

C $\frac{F_1}{F_2} = \frac{A_1}{A_2}$

D $\frac{A_2}{F_2} = \frac{A_1}{F_1}$ (2)

1.7 When a light ray moves from a less optically dense medium to a more optically dense medium, the speed of the light will …

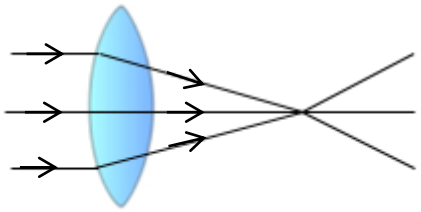
A increase.

B decrease.

C stay the same.

D None of the above-mentioned (2)

1.8 The point where the light rays meet is known as the …



A focal length.

B focal point.

C optic axis.

D principal axis. (2)

1.9 Which ONE of the following combinations indicates the relationship between capacitance and electric charge?

	CAPACITANCE	ELECTRICAL CHARGE
A	increases	decreases
B	decreases	remains the same
C	increases	increases
D	remains the same	increases

(2)

1.10 The function of a step-up transformer is to …

A increase voltage.

B decrease voltage.

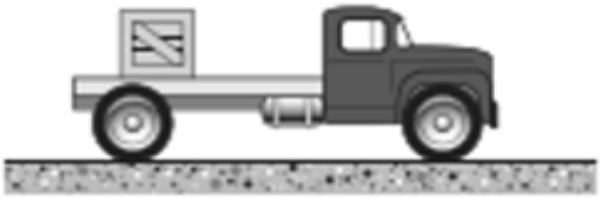
C increase magnetic flux.

D decrease magnetic flux. (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 A 360 kg crate rests on the back of a truck with a rough surface. The mass of the truck is 4 550 kg and it is travelling at a speed of 105 $km \cdot h^{-1}$ to the right. The driver applies brakes and the truck slows down to a speed of 62 $km \cdot h^{-1}$ in 7 s.



2.1.1 If the crate is not secured with ropes, explain what will happen to it when the driver applies the brakes. (2)

2.1.2 NAME and STATE in words Newton's law of motion used to answer QUESTION 2.1.1. (3)

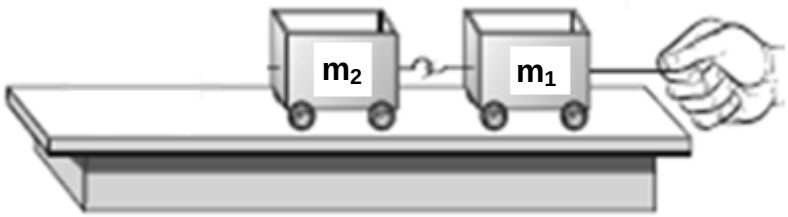
2.1.3 Draw a labelled free-body diagram of ALL the forces acting on the crate as the driver applies the brakes. (3)

2.1.4 Calculate the acceleration of the truck as the driver applies the brakes. (4)

2.1.5 Calculate the force applied by the brakes on the truck. (4)

2.2 Two toy cars with frictionless rollers are tied together and pulled, as shown in the diagram below.

The mass of each car is as follows: $\mathbf{m_1}$ = 0,75 kg and $\mathbf{m_2}$ = 0,8 kg
The cars are pulled to the right with a horizontal force of 6,5 N.



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

2.2.2 Calculate the acceleration of the system. (4)

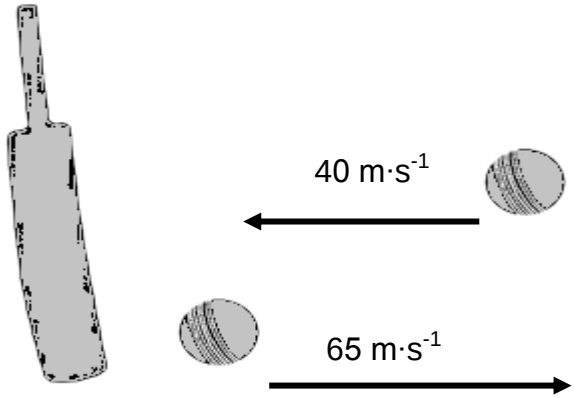
2.2.3 Calculate the force exerted by car $\mathbf{m_1}$ on car $\mathbf{m_2}$. (3)

[25]

QUESTION 3 (Start on a new page.)

3.1 A 160 g ball, bowled with a velocity of 40 $m \cdot s^{-1}$, is struck by a cricket bat. The ball leaves the cricket bat with a velocity of 65 $m \cdot s^{-1}$ in the opposite direction in a straight line, as shown in the diagram below.

The contact time between the cricket bat and the cricket ball is 4×10^{-3} s.

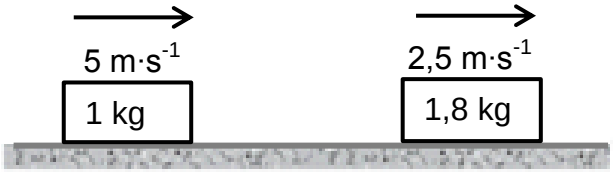


3.1.1 Define the term *impulse*. (2)

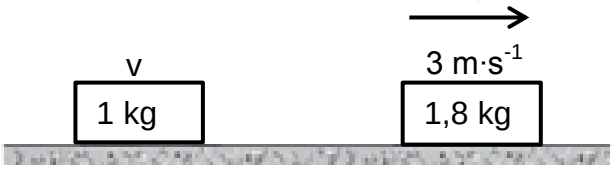
3.1.2 Calculate the impulse of the cricket bat on the ball. (4)

3.1.3 Calculate the magnitude of the net force exerted on the ball. (3)

3.2 Two blocks are sliding on a frictionless ice surface, as shown in the diagram below.



Before collision



After collision

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

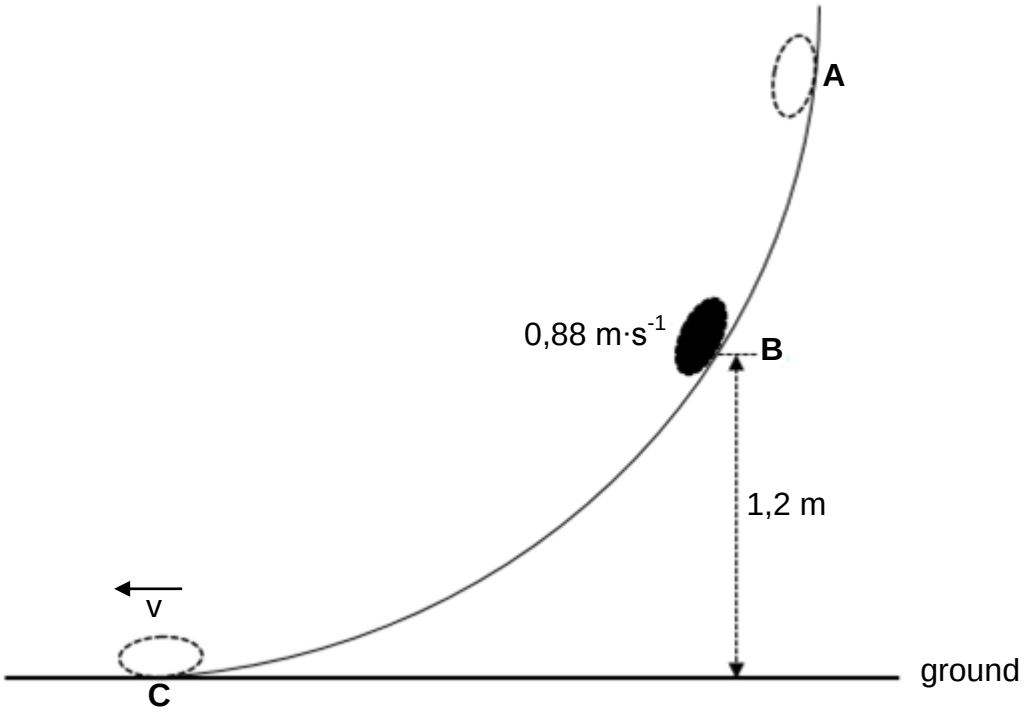
3.2.2 Calculate the velocity of the 1 kg block after the collision. (4)

3.2.3 Determine, by means of calculations, if the above collision is elastic or inelastic. (5)

[20]

QUESTION 4 (Start on a new page.)

An object of mass 2 kg slides down a frictionless track **ABC**. The object starts from rest at point **A**. It then passes point **B**, which is 1,2 m above the ground, with a speed of 0,88 $m \cdot s^{-1}$. The object reaches point **C**, on the ground, with an unknown speed v, as shown in the diagram below.



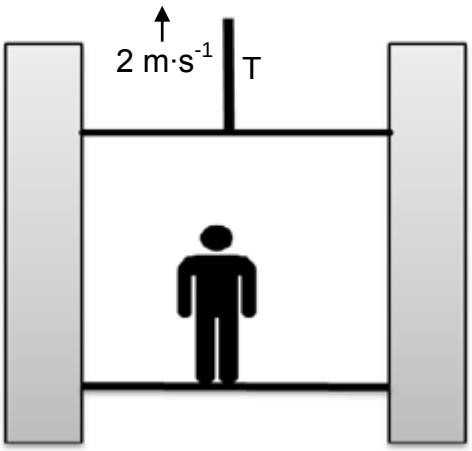
4.1 State the principle of conservation of mechanical energy in words. (2)

4.2 Determine the gravitational potential energy of the object at point **B**. (3)

4.3 Calculate the mechanical energy of the object at point **B**. (4)

4.4 Calculate the speed, v, with which the object reaches point **C**. (4)

The diagram below shows an elevator that is moving upwards with a person. A motor delivers 43 kW to lift the elevator with the person at a constant speed of 2 $m \cdot s^{-1}$. Ignore air friction.

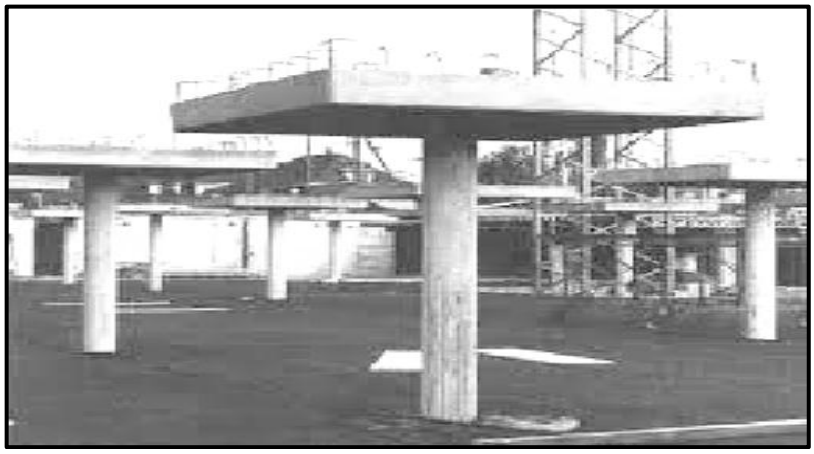


4.5 Define the term *power*. (2)

4.6 Calculate the magnitude of the tension, T, in the cable. (4)
[19]

QUESTION 5 (Start on a new page.)

5.1 A load causes a stress of 5,5 x 10^6 Pa in a round concrete bar, which has a diameter of 50 cm. The concrete bar has an original length of 3,5 m. Young's modulus for concrete is 85 x 10^9 Pa.



5.1.1 Define a *deforming force*. (2)

Calculate the:

5.1.2 Force on the bar (5)

5.1.3 Strain in the bar (3)

5.1.4 Change in length of the bar (3)

5.2 The diagram below shows a man lifting the side of a car with a hydraulic jack. The input and output pistons have areas of 4,8 x 10^{-4} m^2 and 6,2 x 10^{-2} m^2, respectively.

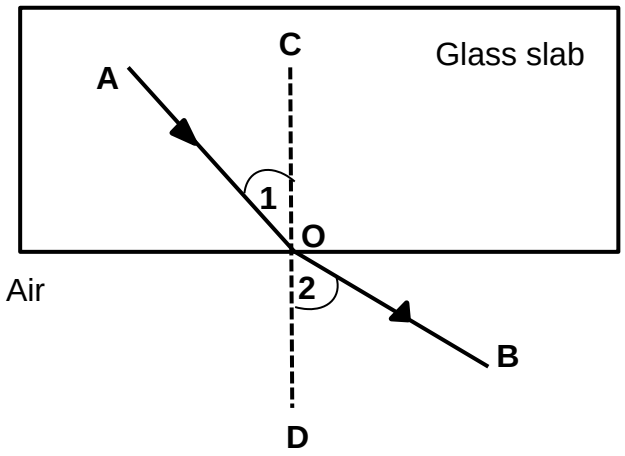
5.2.1 State Pascal's law in words. (2)

5.2.2 If the man applies a force of 40 N to lift the side of the car, calculate the weight of the car experienced by the jack at that point. (4)

[19]

QUESTION 6 (Start on a new page.)

The diagram below shows light ray **AO** moving from a glass slab into air. This phenomenon is known as refraction.



6.1 Define the term *refraction.* (2)

6.2 Write down the names of the following:

6.2.1 Light ray **AO** (1)

6.2.2 Light ray **OB** (1)

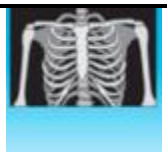
6.2.3 Angle **1** (1)

6.2.4 Angle **2** (1)

6.2.5 Line **CD** (1)
[7]

QUESTION 7 (Start on a new page.)

The table with pictures below represents the electromagnetic spectrum arranged from the lowest frequency to the highest frequency, numbered **1** to **7**.

						
1 Radio wave	**2**	**3**	**4** Visible light	**5** Ultraviolet	**6**	**7**

7.1 Name the radiation numbered:

7.1.1 **2** (1)

7.1.2 **3** (1)

7.1.3 **7** (1)

7.2 State TWO uses of ultraviolet rays. (2)

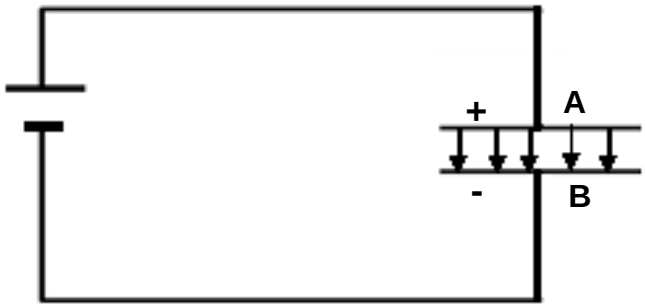
7.3 Define a *photon* of light. (2)

7.4 A radio station broadcasts at a frequency of 102,5 MHz. Calculate the energy of the radio waves. (3)

7.5 Name any THREE colours in visible light. (3)
[13]

QUESTION 8 (Start on a new page.)

Two plates of the parallel plate capacitor shown below are 6 mm apart and have an area of 5 x 10^{-2} m^2. A potential difference of 100 V is applied across the plates of the capacitor.



8.1 Calculate the charge on EACH plate. (5)

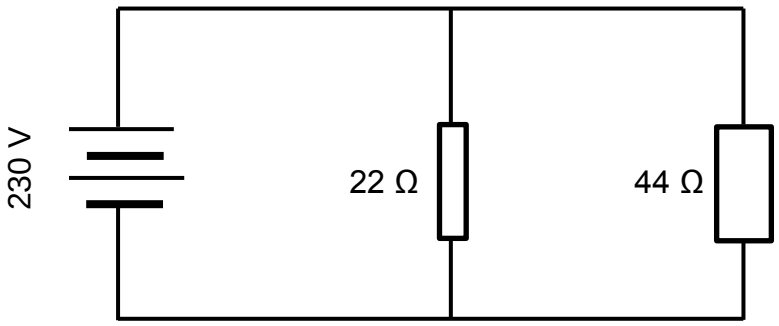
8.2 The distance between the plates is now doubled.

8.2.1 How will this change affect the magnitude of the capacitance? Refer to the RATIO in the answer. (2)

8.2.2 Explain the answer to QUESTION 8.2.1. (2)
[9]

QUESTION 9 (Start on a new page.)

An electric kettle with resistance 22 Ω and a microwave oven with resistance 44 Ω are connected in parallel and the combination is connected across a source of voltage 230 V as shown in the diagram.



Calculate the:

9.1 Total resistance of the circuit (3)

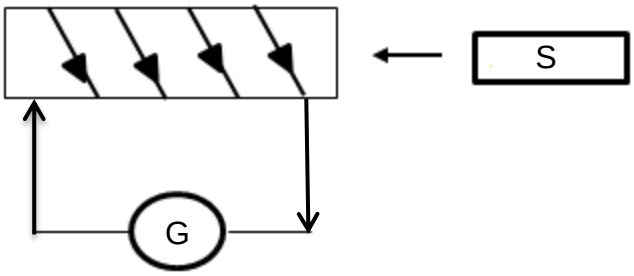
9.2 Power dissipated by the electric kettle (3)

9.3 Heat produced in the electric kettle in 2 minutes (3)
[9]

QUESTION 10 (Start on a new page.)

Learners conducted an experiment to demonstrate electromagnetic induction using a magnet and a galvanometer.

Study the diagram below and answer the questions that follow.



10.1 What is observed on the galvanometer when the magnet is moved into the coil? (1)

10.2 Explain the observation in QUESTION 10.1. (2)

10.3 NAME and STATE in words the law used to explain this observation. (3)

10.4 State THREE ways in which the deflection on the galvanometer can be increased. (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	$9,8\ m\cdot s^{-2}$
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	$6,63 \times 10^{-34}\ J\cdot s$
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*

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

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* $E_k = \frac{1}{2}mv^2$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{Q}{V}$	$E = \frac{V}{d}$
$C = \frac{\varepsilon_o A}{d}$ or/*of* $C = \frac{\kappa \varepsilon_o A}{d}$	

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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

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

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