HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- Physics

JUNE 2022

TIME: 2 HRS
TOTAL 100

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (10)
   SECTION B (90)

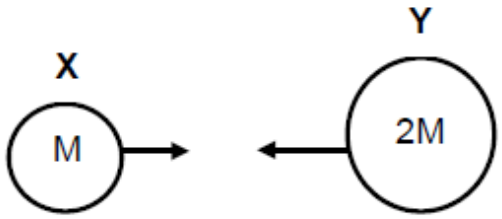
   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and periodic tables are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A

QUESTION 1: MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only one correct answer. Write only the letter (A-D) next to the question number (1.1-1.10) in the answer book.

1.1 Two fairly large asteroids, **X** and **Y**, have masses M and 2M respectively. They move towards each.



If the magnitude of the acceleration of asteroid **X** is **a**, then magnitude of the acceleration of asteroid **Y** would be …

A ¼ **a**

B **a**

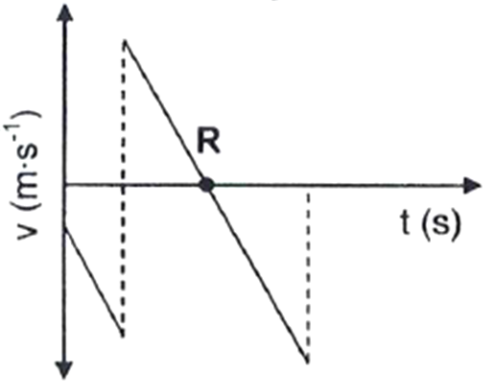
C ½ **a**

D 2 **a**

1.2 A satellite experiences a gravitational force of magnitude **F** on the surface of the earth. The radius of the earth is **R**. The satellite now circles the earth at an unknown height above the surface of the earth and experiences a gravitational force of magnitude ¼ **F**. This unknown height is ….

A **R**
B 2 **R**
C 3 **R**
D 4 **R**

1.3 A ball is projected vertically downwards from a height above the ground. It strikes the ground and bounces up. The velocity-time-graph below represents the motion of the bouncing ball.

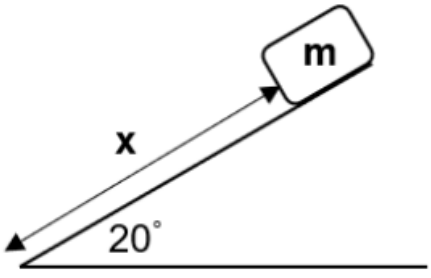


Which ONE of the combinations of the position and magnitude of the acceleration of the ball at point **R** on the graph, is CORRECT?

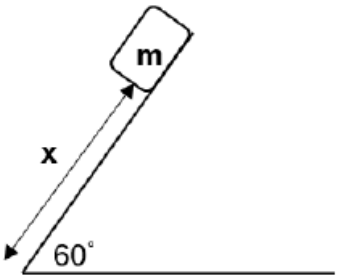
	POSITION	MAGNITUDE OF ACCELERATION ($m \cdot s^{-2}$)
A	On the ground	0
B	Maximum height after bounce	9,8
C	Maximum height after bounce	0
D	On the ground	9,8

1.4 Block **m** moves down the slope for a distance **x** in all the diagrams below. The magnitude of **m** and **x** are the same in each diagram. None of the diagrams are drawn to scale. Ignore all effects of friction.
In which ONE of the diagrams below will W_{net} be the greatest?

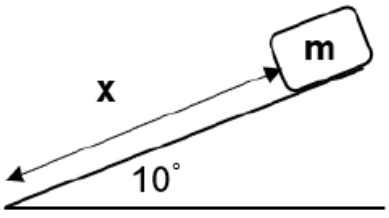
A



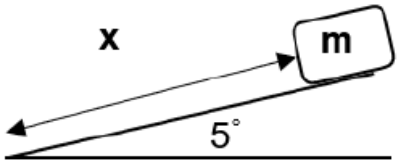
B



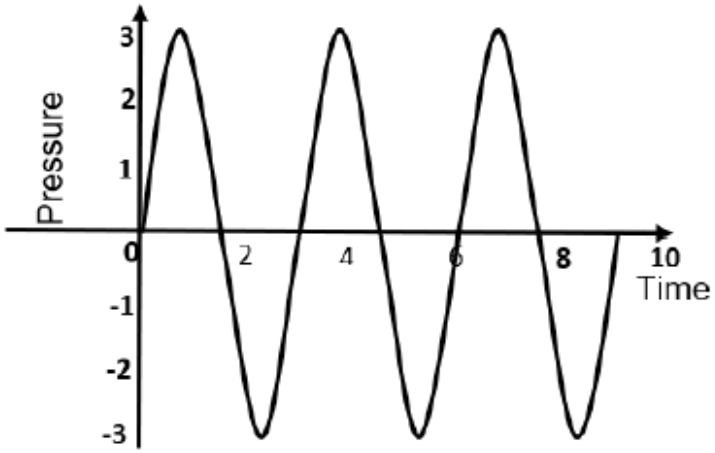
C



D

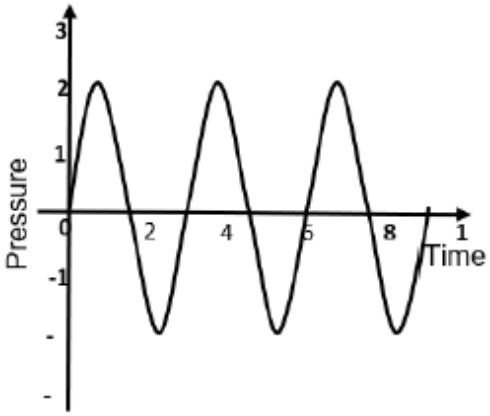


1.5 The pressure vs time graph for a stationary source, relative to the observer, is shown below.

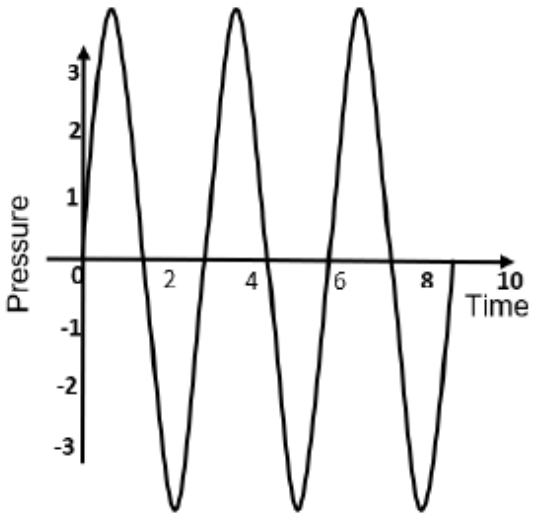


Which of the following sound waves best represents the sound wave if the source is moving towards the observer?

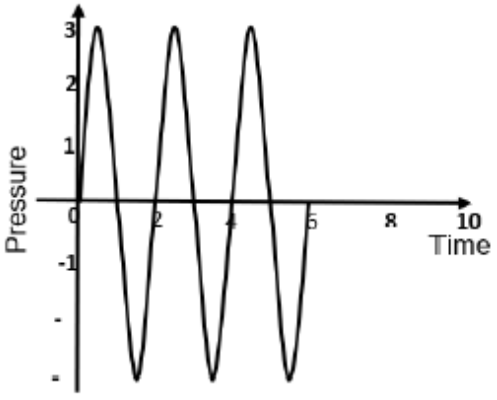
A



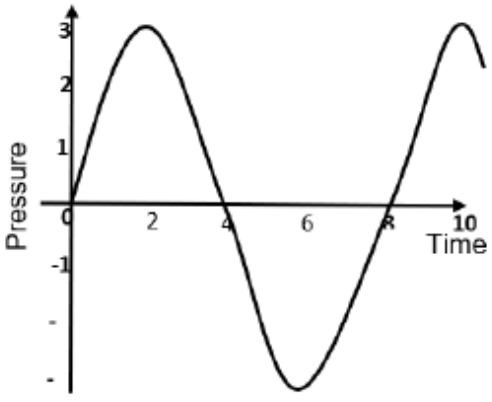
B



C



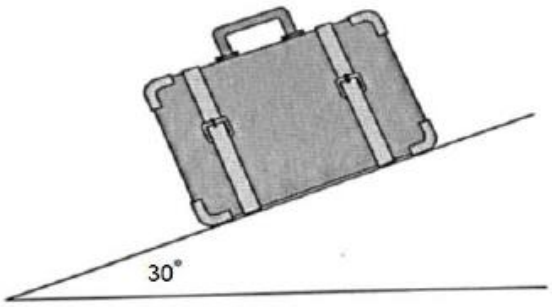
D



[2x5 = 10]

SECTION B: QUESTION 2:

2.1 The sketch below shows a large suitcase with a mass of 32 kg resting on a rough incline at an angle of 30° to the ground.



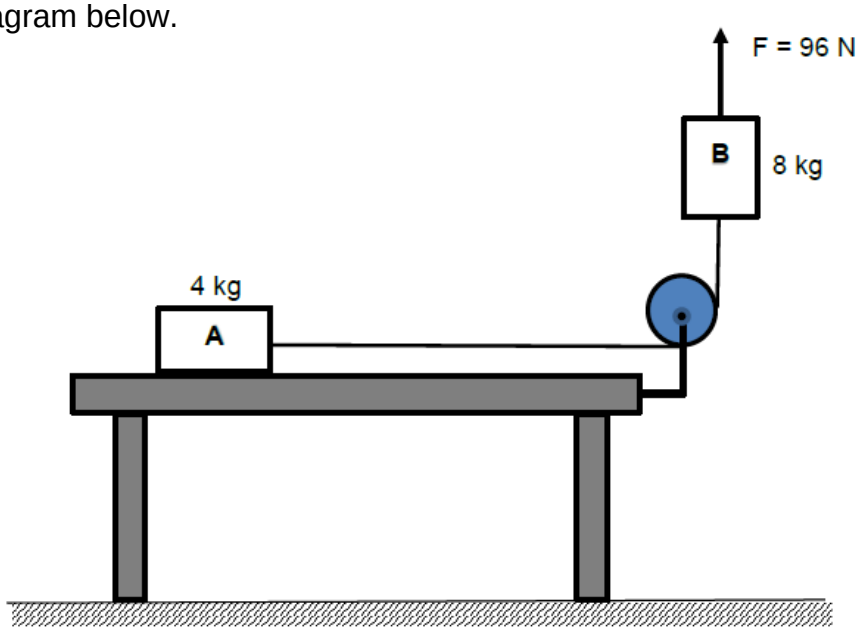
2.1.1 Define *normal force* in words. (2)

2.1.2 Draw a labelled free-body diagram of all the forces acting on the suitcase. (3)

2.1.3 Calculate the magnitude of the force of friction that keeps the suitcase stationary on the incline. (3)

2.1.4 Calculate the coefficient of static friction between the suitcase and the incline if the suitcase is just about to move on the incline. (3)

2.2 A block **A** of mass 4 kg, resting on a rough horizontal table, is connected to another block **B** of mass 8 kg by a light inextensible string which passes over a light frictionless pulley. A force of magnitude 96 N is applied vertically upwards on block **B** as shown in the diagram below.



The coefficient of kinetic friction of block **A** is 0,3. Ignore the effects of air friction.

2.2.1 State *Newton's second law of motion* in words. (2)

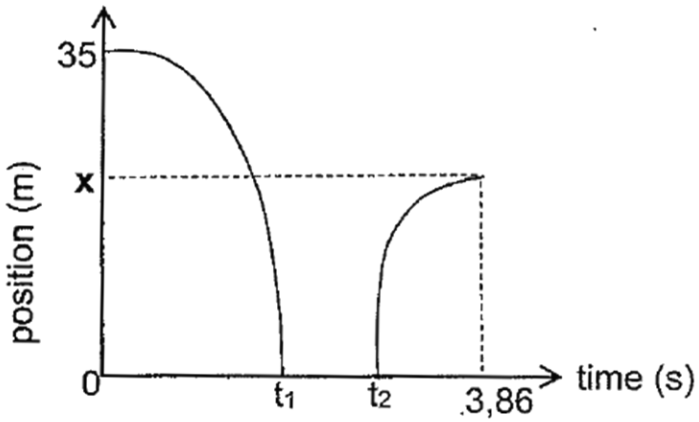
2.2.2 Calculate the magnitude of the tension force acting on block **A**. (6)

[19]

QUESTION 3:

The position-time graph below, not according to scale, represents the motion of a ball thrown vertically downwards with a speed of 3,28 $m.s^{-1}$ from the edge of the roof of a 35 m high building. The ball hits the ground and is in contact with the ground for 0,1 s. The ball then bounces off to a maximum height **x** above the ground.

Ignore the effects of air resistance.



3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Speed of the ball at time t_1 (3)

3.2.2 Time, t_1, it takes the ball to hit the ground (3)

3.2.3 Height, **x**, reached by the ball after it bounces off the ground (7)

3.3 Draw the velocity-time graph for the ball from the moment it is thrown until it reaches the the maximum height **x** after the first bounce.

Indicate:

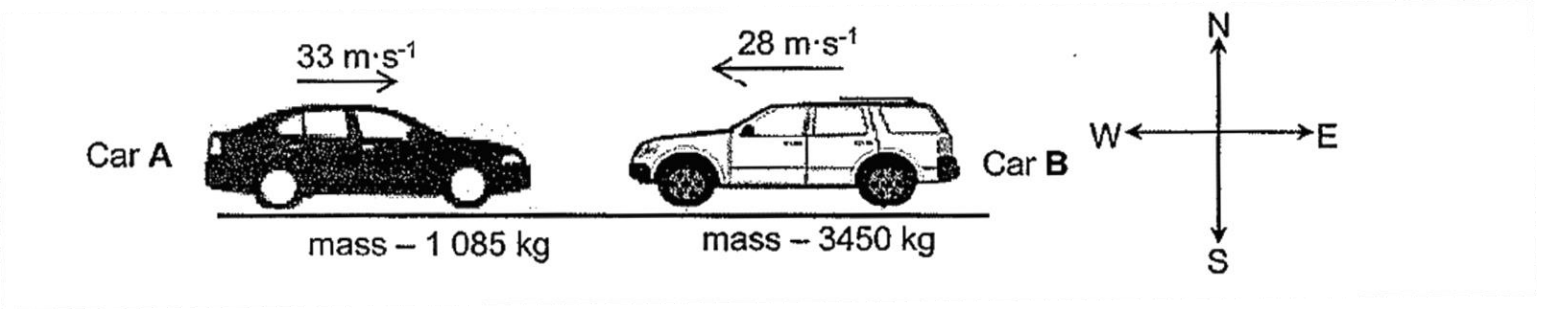
(i) The values of time t_1 and t_2

(ii) The velocities of the ball at time t_1 and t_2 (3)

[18]

QUESTION 4:

Car **A** of mass 1 085 kg travelling east at a speed of 33 $m.s^{-1}$, collides head-on with car **B** of mass 3 450 kg travelling west at a speed of 28 $m.s^{-1}$. Immediately after the collision, car **A** moves west at a speed of 5 $m.s^{-1}$. Ignore friction.



4.1 State *Newton's second law of motion in terms of momentum* in words. (2)

4.2 Calculate the:

4.2.1 Velocity of car **B** after the collision (5)

4.2.2 Magnitude of the impulse on car B during the collision (3)

4.3 Airbags serves as a safety feature during collisions.

4.3.1 Use the relevant laws of physics to explain the purpose of airbags in cars. (3)

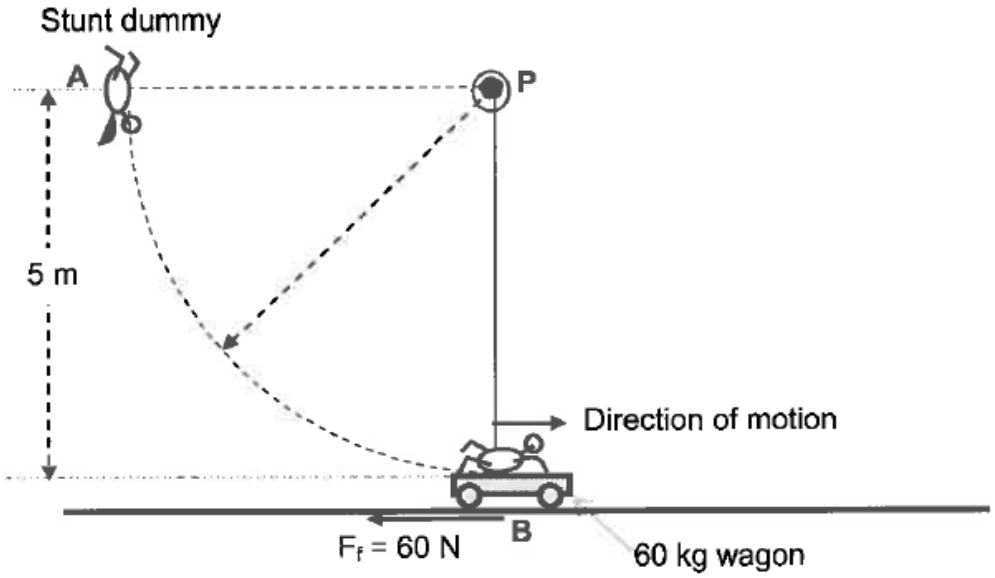
4.3.2 Which driver sustains more injuries during the above collision? Choose from car **A** or car **B**. (1)

[14]

QUESTION 5:

A 50 kg stunt dummy is attached to one end of a 5 m inelastic light rope. The other end is attached to a fixed point P that is 5 m vertically above a stationary wagon. The dummy is then pulled upward to point A such that the rope is fully stretched and held horizontally as shown in the diagram below. When released, the dummy swings downwards along the dotted path. On reaching the stationary wagon, the stunt dummy detaches from the rope, falls flat on the wagon and sticks to it. The wagon has a mass of 60 kg.

The wagon and the stunt dummy move as one unit towards the right.



5.1 Calculate the magnitude of the velocity of the stunt dummy when it reaches its lowest point B. (4)

As the dummy and the wagon move as one unit towards the right, a constant frictional force of 60 N acts on the wheels of the wagon as shown.

5.2 State the *principle of conservation of linear momentum*. (2)

5.3 Calculate the …

5.3.1 initial velocity of the dummy and wagon soon after the dummy lands on the wagon. (3)

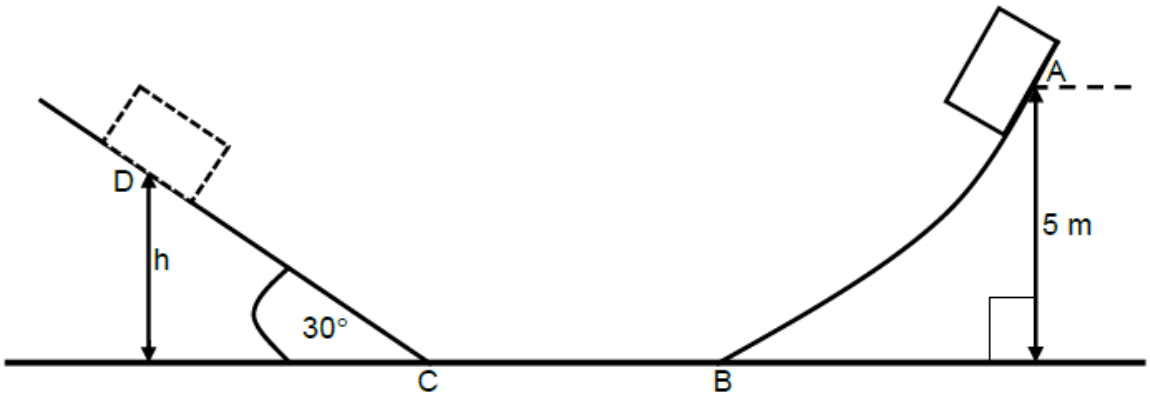
5.3.2 impulse provided to the dummy. (2)

5.3.3 distance moved by the dummy-and-wagon combination before coming to rest (4)

[15]

QUESTION 6:

A block is released from rest at point **A** and slides down a curved frictionless track **AB** and then moves along a frictionless horizontal track **BC**, and finally moves up a ROUGH inclined plane **CD**.



The coefficient of kinetic friction between the block and incline CD is 0,35.

6.1 State, in words, the *principle of conservation of mechanical energy*. (2)

6.2 Use the *principle of conservation of mechanical energy* to calculate the speed of the block at point B. (4)

6.3 Using energy principles, calculate the maximum height h reached by the block. (6)

[12]

QUESTION 7:

A group of Grade 12 learners stand outside a fire station when a fire engine races past them on a call. The siren of the fire engine emits a sound with a frequency of 250 Hz while moving at a speed of 20 $m.s^{-1}$ past the learners with flashing red lights. The group of learners notice that the sound of the siren changes as the fire engine moves away from them. Take the speed of sound in air as 340 $m.s^{-1}$.

7.1 Name the phenomenon described in the underlined sentence above. (1)

7.2 How would each of the following change as the fire engine moves away from the learners? Write only GREATER THAN, LESS THAN or STAYS THE SAME.

7.2.1 Frequency observed by the learners (1)

7.2.2 The speed of the sound in air (1)

7.3 Calculate the apparent frequency of the sound from the siren observed by the learners when the fire engine moves away from the learners at a speed of 20 $m.s^{-1}$. (4)

7.4 Draw a diagram to show the advancing wavefronts that are produced by the sound as the fire engine moves away from the learners. Clearly indicate the learners' position and the direction of the fire engine's velocity in the diagram. (2)

7.5 There is a noticeable change in the frequency of the sound, but no noticeable change in the colour of the flashing red light as the fire engine races past the learners. Explain these observations. (3)

[12]

Total : 100

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasie konstante*	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}\ kg$
Mass of Earth *Massa van Aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6{,}38 \times 10^{3}\ km$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$\mu_k = \frac{f_k}{N}$	$\mu_s = \frac{f_{s(maks)}}{N}$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$	or/*of* $W_{net} = \Delta E_k$
	$\Delta K = K_f - K_i$	or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P_{av} = Fv_{av}$	$P_{gemid} = Fv_{gemid}$
$P = \frac{W}{\Delta t}$		

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$E = W_o + K_{max}$ or/of $E = W_o + E_{k(max)}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv^2_{max}$ ..... or/of $K_{(max)} = \frac{1}{2}mv^2_{max}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$	/	$I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms} I_{rms}$ / $P_{gemiddeld} = V_{wgk} I_{wgk}$	
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$	/	$V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$	
			$P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$	