HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- Physics

JUNE 2021
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 are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

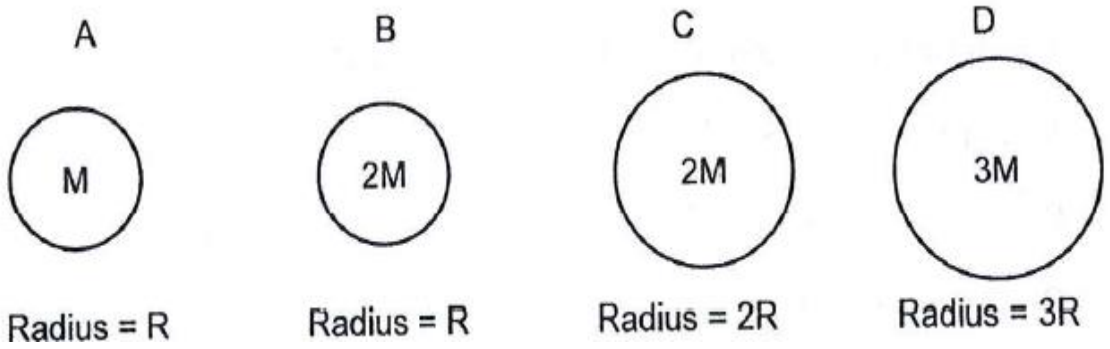
QUESTION 1 (Multiple-choice)

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) on your ANSWER BOOK.

1.1 The net force acting on the moving object is zero. The object will continue its motion with…

A Constant acceleration
B Constant velocity
C Increasing velocity
D Decreasing acceleration

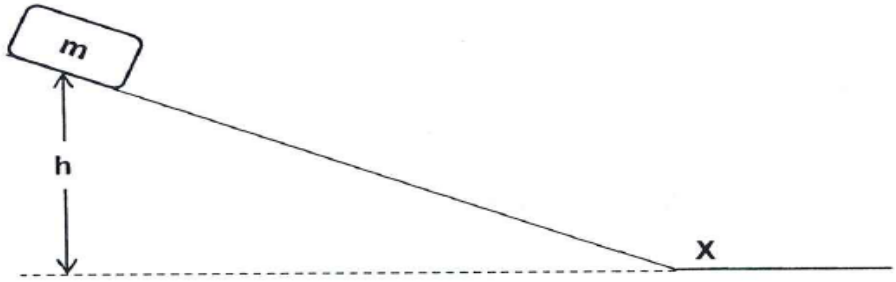
1.2 An object is dropped from a certain height above the surface of different planets. The mass and radius of each planet is shown in the options below. Which ONE of the following planets will cause the greatest gravitational acceleration on the object? Ignore any effects of air friction.



1.3 Two identical billiard balls, moving towards each other, collide head-on. The first ball hits the second ball with a speed of v, and the second ball hits the first ball with a speed of 3v. After the collision, the first ball moves off in the opposite direction with a speed 1,5v. Which ONE of the following expressions correctly gives speed of the second ball after the collision?

A 0.5 v
B 1.5 v
C 2 v
D 3 v

1.4 A block with a mass **m** moves from rest from a height **h** down a frictionless tract and reaches point **X** with speed **v**.

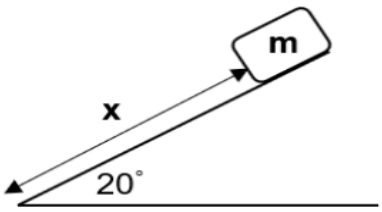


Which ONE of the following changes will produce a speed of 2**v** at point **X**?

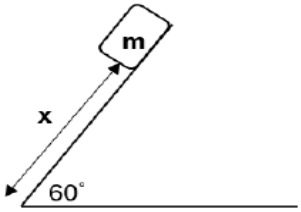
A Double the mass of the block.
B Double the gradient of the track from the same height **h**.
C Increase the height to 4**h**.
D Use a track with a rough surface.

1.5 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 will W_{net} be the greatest?

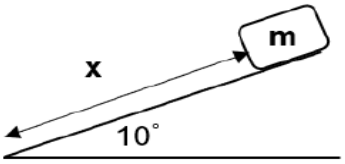
A



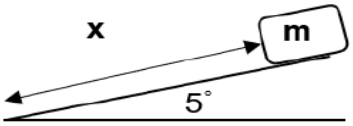
B



C



D



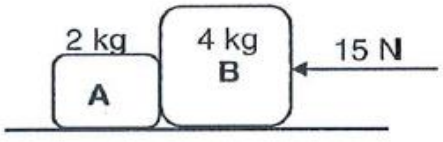
[2 x 5 = 10]

Question 2

Block **A**, of mass 2 kg, is placed against block **B**, of mass 4 kg, on a rough horizontal surface. The following table supplies the frictional forces that are experienced on each block:

	MAXIMUM STATIC FRICTIONAL FORCE ($f_{s(max)}$)	**KINETIC FRICTIONAL FORCE (f_k)**
Block A	5,88 N	2,35 N
Block B	11,76 N	4,70 N

A force of 15 N is applied horizontally on block **B** as shown in the diagram below.



2.1 State Newton's Second Law in words. (2)

2.2 Block **B** exerts a force **F** on block A.

Write down the magnitude and direction of the force that block A exerts on block B. (1)

2.3 State whether block B will ACCELERATE TO THE LEFT or REMAIN STATIONARY. (1)

The 15 N force is removed and replaced with an unknown horizontal force $\mathbf{F_T}$.

The blocks accelerate at 4,5 $m.s^{-2}$ to the left.

2.4 Draw a labelled free-body diagram for block **B**. (5)

2.5 Apply Newton's Second Law on EACH of the blocks to calculate the force $\mathbf{F_T}$. (5)

2.6 A 400 kg research satellite is orbiting the Earth at a certain average height above the Earth's surface. The Earth exerts a force of 2 x 10^3 N on the satellite to keep it in orbit.

2.6.1 State Newton's law of universal gravitation (2)

2.6.2 What magnitude of force does the satellite exert on the Earth? (1)

2.6.3 Calculate how many kilometres **above** the Earth's surface the satellite is moving. (5)

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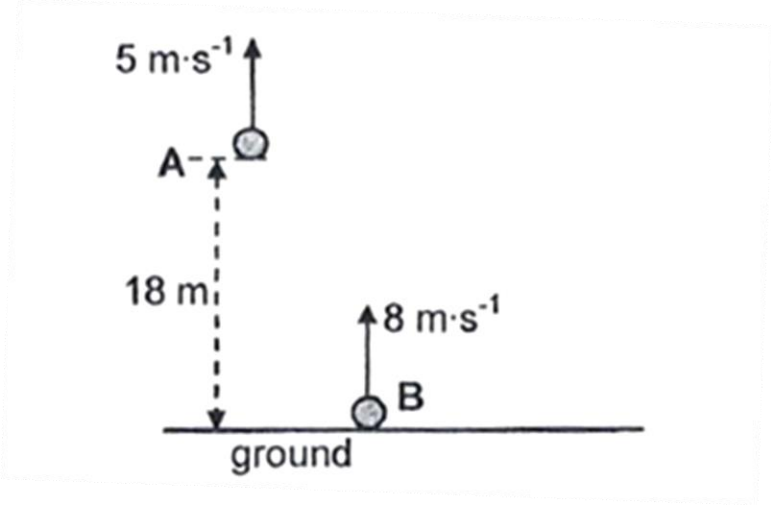
Question 3

Ball A is projected vertically upwards at a speed of 5 $m.s^{-1}$ from the top of a 18 m high building. Ignore air resistance.

3.1 Calculate the time taken for ball A to reach its maximum height. (3)



At the same instant that ball **A** is projected, ball **B** is projected vertically upwards from the ground at a speed of 8 $m.s^{-1}$.

3.2 Calculate the magnitude of the velocity of ball **B** the moment that ball **A** is at its maximum height. (3)

3.3 Calculate the time, from the moment the balls were projected, for the speed of the two balls to be **EQUAL**. (4)

3.4 Sketch velocity-time graphs for the COMPLETE motions of ball **A** and ball **B** ON THE SAME SET OF AXES. Label the respective graphs for ball **A** and **B** clearly.

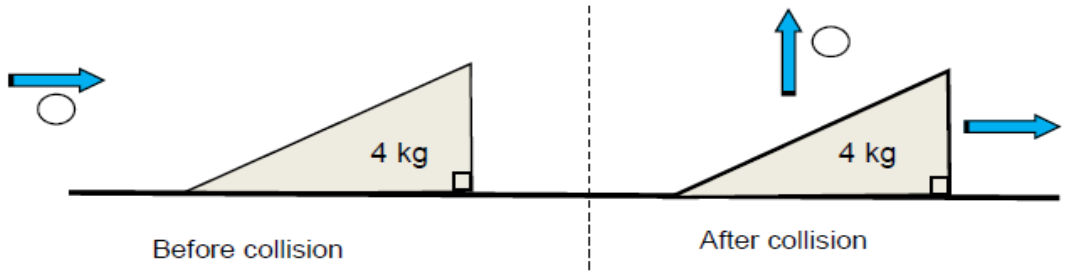
Show the following on the graphs:

- The initial velocity of ball **A**
- The time taken for ball **A** to reach its maximum height.
- The initial velocity of ball **B** (4)

[14]

QUESTION 4

A 4 kg wooden triangle is at rest on a horizontal frictionless surface. A ball of mass 0.1 kg, thrown horizontally at 10 $m.s^{-1}$, collides **ELASTICALLY** with the wooden triangle. As a result of the collision the ball rebounds vertically upwards as shown below. Ignore air friction.



4.1 State the *law (principle) of conservation of linear momentum* in words. (2)

4.2 Explain when a collision is said to be elastic. (2)

4.3 Calculate the speed of the wooden triangle immediately after the collision. (4)

4.4 Use ONLY energy considerations to calculate the maximum height reached by the ball after colliding **ELASTICALLY** with the wooden triangle. (6)

After the collision, the wooden triangle continues to move on the horizontal frictionless surface and then strikes a ROUGH surface. It experiences frictional force of 4.8 N when sliding across the rough surface until it comes to rest.

4.5 Use ONLY energy principles to calculate the distance covered by the wooden triangle on the ROUGH surface. (4)

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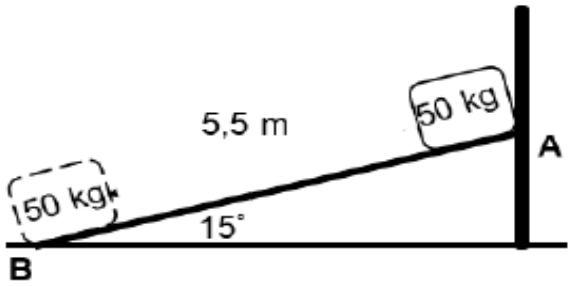
QUESTION 5

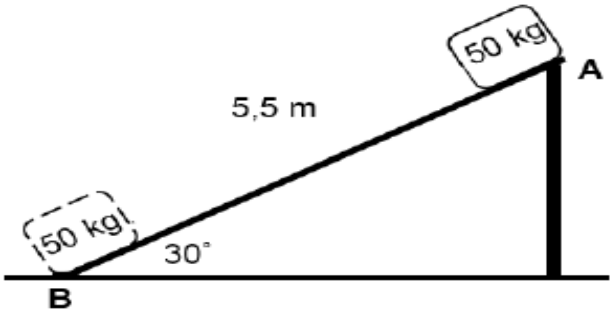
In Diagram 1 below, a slide of length **AB** equal to 5.5 m is inclined at an angle of 15º. In a test, a 50 kg mass, travels the length of **AB** at **CONSTANT** speed. The kinetic friction of the slide is unknown.

Diagram 1



In Diagram 2 below the inclined angle of the same slide of length 5.5 m is increased to 30 º. The mass of 50 kg starts from rest at **A** and slides down the slide to point **B**.

Diagram 2



The kinetic coefficient of friction for the slope in Diagram 1 and Diagram 2 are identical.

5.1 State the *work-energy theorem* in words. (2)

5.2 Use energy principles to calculate the…

5.2.1 Kinetic coefficient of the surface. (6)

5.2.2 Speed of the mass at point **B** in Diagram2. (5)

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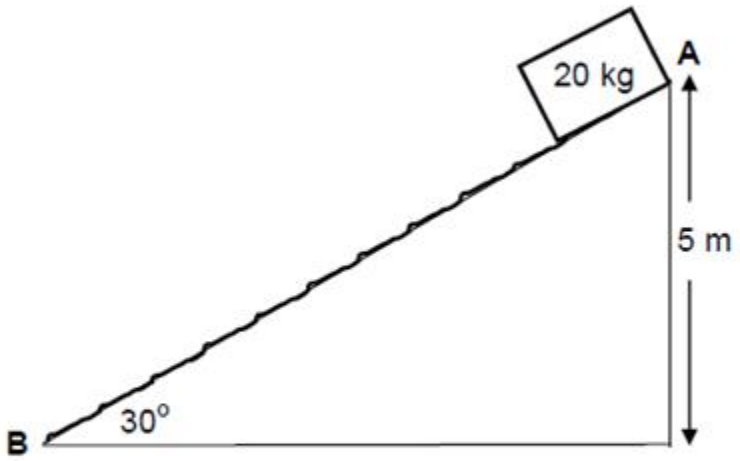
Question 6

A 20 kg block is released from rest from the top of a ramp at point **A** at a construction site as shown in the diagram below.

The ramp is inclined at an angle of 30° to the horizontal and its top is at a height of 5 m above the ground.



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

6.2 The kinetic frictional force between the 20 kg block and the surface of the ramp is 30 N.

Use *energy principles* to calculate the:

6.2.1 Speed of the block at point **B** at the bottom of the ramp (7)

6.3 A 100 kg object is pulled up the SAME RAMP at a constant speed of 2 $m \cdot s^{-1}$ by a small motor. The kinetic frictional force between the 100 kg object and the surface of the ramp is 25 N.

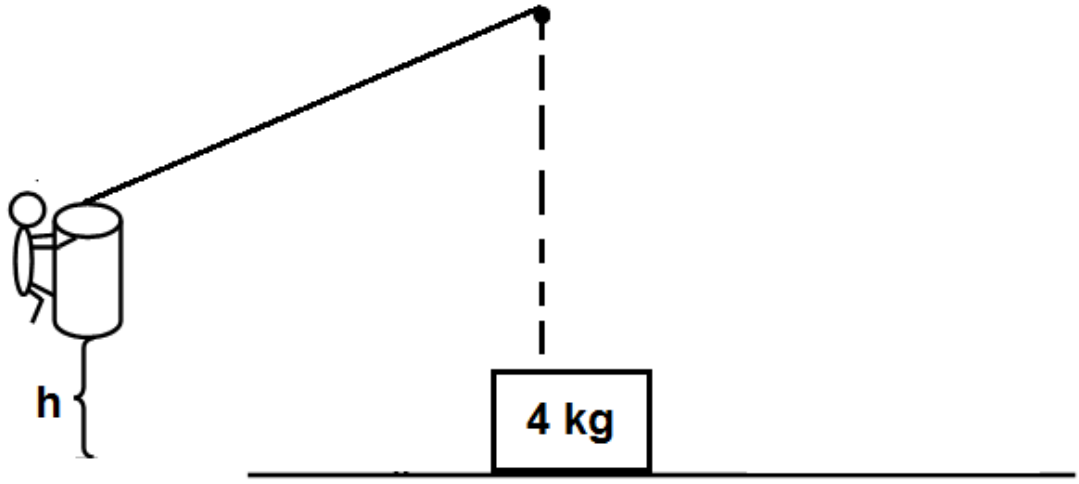
Calculate the average power delivered by the small motor in the pulling of the object up the incline. (4)

[13]

Question 7

Alex, while holding onto a punching bag, is released from a maximum height, h. He swings towards a stationary crate of mass 4 kg while holding onto the punching bag. When he and the punching bag collide with the crate, the crate travels to the right for 1,2 s and then comes to rest after covering a distance of 1 m. After the collision with the crate, Alex and the punching bag continue to move forward at a speed of 1,93 $m.s^{-1}$.

Calculate the original height that Alex was released from if the work done by air friction during the swing is 1250 J. (The combined mass of Alex and the punching bag is 100 kg).



[10]

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 gravitasiekonstant*	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6{,}38 \times 10^{6}\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5{,}98 \times 10^{24}\ kg$
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	$9{,}11 \times 10^{-31}\ kg$

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*

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

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$	
$P_{ave} = Fv_{ave}$		

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

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