education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

GERT SIBANDE DISTRICT

PHYSICAL SCIENCES TOPIC TEST

TOPIC: MOMENTUM & IMPULSE

JANUARY 2023

MARKS: 50

TIME: 1:00 HOUR

This question paper consists of 7 pages including the data sheet

INSTRUCTIONS

1. Attempt ALL questions.
2. Round off your final answers to a minimum of TWO decimal places.
3. Write neatly and legibly.
4. You are advised to use the attached data sheet.

QUESTION 1 Multiple-choice questions

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1- 1.4) in the answer sheet, eg. 1. 5 A.

1.1 Which one of the following best describes an inelastic collision?

A Both momentum and kinetic energy are conserved.

B Total kinetic energy is not conserved but total linear momentum is Conserved.

C Neither kinetic energy nor momentum are conserved.

D Kinetic energy is conserved but total linear momentum is not conserved. (2)

1.2 In the equation $F_{net}\,\Delta t = \Delta p$, the product of $F_{net}\,\Delta t$ represents the ...

A force per unit time.

B rate of change in momentum.

C impulse.

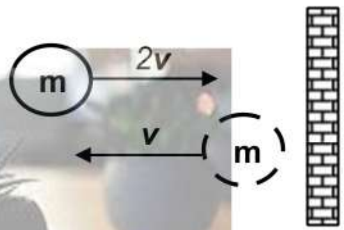
D inertia of the body. (2)

1.3 A body moving at a constant velocity has kinetic energy **E** and momentum **p**. The velocity of the body is doubled. Which ONE of the following correctly gives the magnitudes of both the kinetic energy and momentum?

	Kinetic Energy	Momentum
A	2 E	2 p
B	4 E	4 p
C	4 E	2 p
D	2 E	4 p

(2)

1.4 A ball of mass **m** strikes a wall perpendicularly at a speed 2***v***. Immediately after the collision the ball moves in the opposite direction at a speed ***v***, as shown in the diagram below.



The magnitude of the impulse of the ball is …

A 0

B MV

C 2MV

D 3MV (2)

[8]

QUESTION 2

The diagram below shows a 65,4Kg gymnastic dancer who jumped in the air and landed her left foot on the floor at 7 m.s^{-1}. She slid and came to a complete stop in 0, 5 seconds**.**

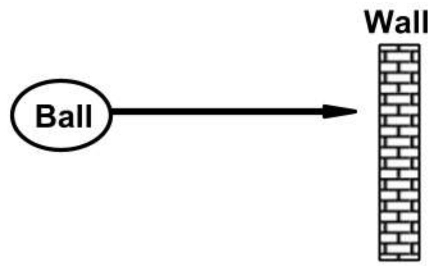
2.1 Define the term impulse in words. (2)

2.2 Calculate:

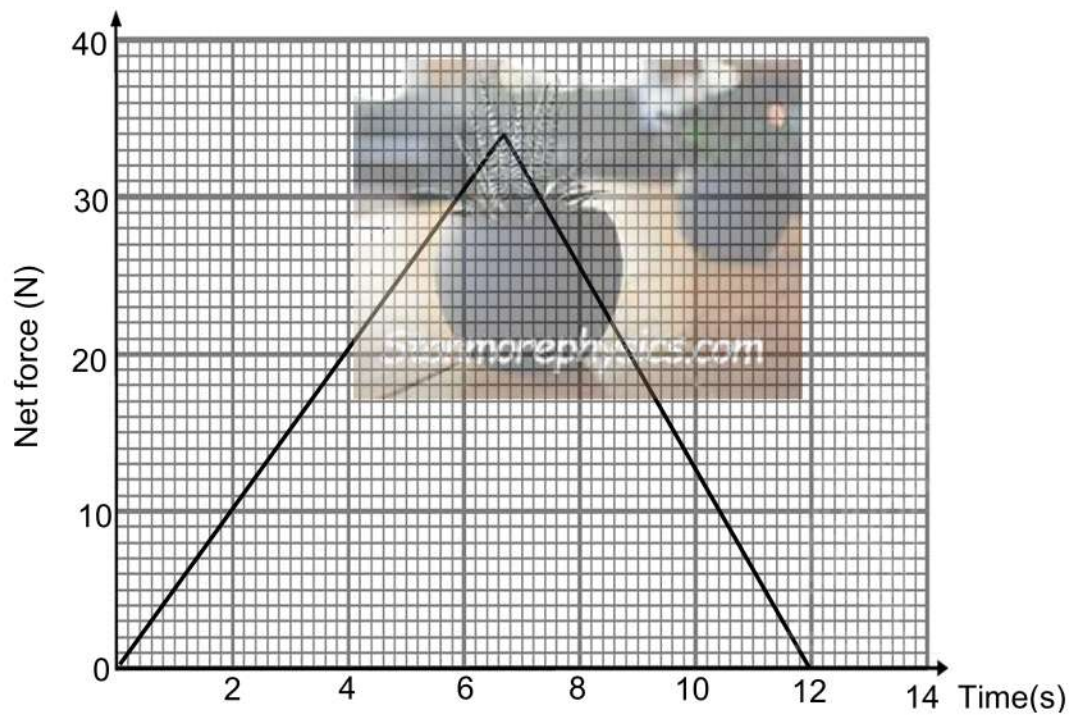
2.2.1 The impulse of the dancer. (3)

2.2.2 The magnitude of the force which the floor exerted on the dancer's foot. (3)

2.3 In the diagram below, a 600 g football which is initially at rest is thrown at the wall.



The following graph shows the change in the applied net force over a period of time.



2.3.1 State Newton's second law in terms of momentum. (2)

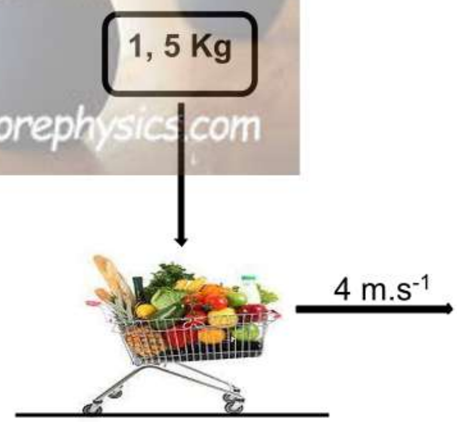
2.3.2 Calculate the magnitude of the impulse exerted to the football. (3)

2.3.3 Use a calculation to show that the velocity at which the football hits the wall is 340 $m.s^{-1}$ (3)

[16]

QUESTION 3

In the diagram below, a trolley of mass 5 kg, moves at 4 $m \cdot s^{-1}$ east across a frictionless horizontal surface. A box of mass 1, 5 kg is dropped onto the trolley, then the trolley and the box continue to move in the same east ward direction. Take eastward direction as positive.



3.1 Define in words the Law of Conservation of linear momentum. (2)

3.2 Calculate:

3.2.1 The velocity of the trolley-box system after the box is dropped on to the trolley. (3)

3.2.2 The change in momentum of the trolley. (2)

3.3 State the condition for an elastic collision. (1)

3.4 Use a calculation to show that the collision above between the box and the trolley is ELASTIC or INELASTIC. (5)

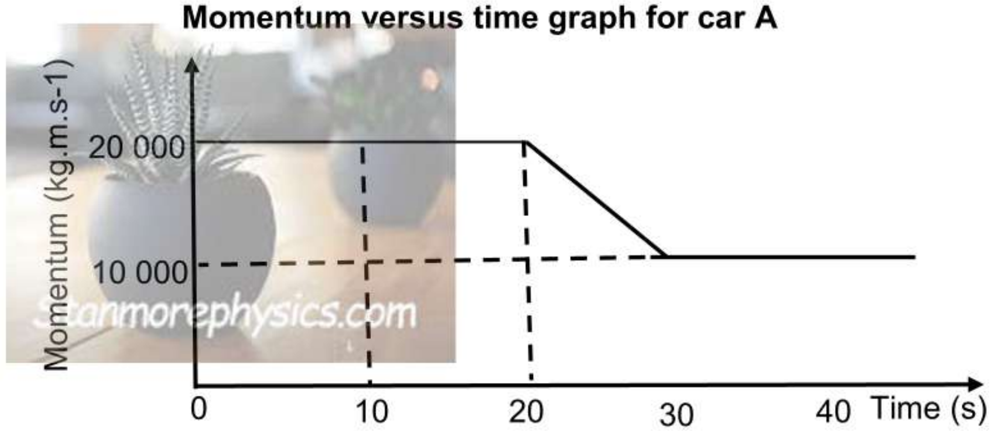
[13]

QUESTION 4

The diagram below shows car **A** of mass 800 kg, travelling slowly near the traffic light. Car **A** is hit from behind by Car **B** of mass 950 kg, travelling at 10 $m \cdot s^{-1}$ in eastward direction.

The change in momentum with time of car **A** just **before** and just **after** collision is represented on the graph below. Consider the system to be isolated.

Momentum versus time graph for car A



4.1 Define the term momentum in words. (1)

4.2 Use the information in the graph and a relevant equation to explain why the net force acting on car **A** is *zero between t = 10 s and t = 20 s.* (2)

4.3 Use the information in the graph to calculate:

4.3.1 The magnitude of the velocity of car **A** just before the collision. (3)

4.3.2 The velocity of car **B** just after the collision. (4)

4.4 To improve passenger safety, modern cars are designed to crumple partially on impact, in addition of the presence of seat belts. Explain how seat belts in cars can improve passenger safety during an accident. Include a relevant physics equation in the explanation. (3)

[13]

TOTAL: 50

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1:

PHYSICAL CONSTATNTS

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$

TABLE 2:

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

TABLE 3:

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* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

TABLE 4:

ENERGY

$W = F\Delta x\cos\theta$	$U = mgh$ or/of $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/of $E_k = \frac{1}{2}mv^2$	

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MARKING GUIDELINES

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This memorandum consists of 4 pages

QUESTION 1

1.1 B ✓✓

1.2 C ✓✓

1.3 C ✓✓

1.4 D ✓✓ **[8]**

QUESTION 2

2.1 The product of the resultant/net force acting on an object and the time the resultant/net force acts on the object ✓✓ **[2 or 0 mark]** (2)

2.2.1

DOWNWARD IS POSITIVE	**UPWARD IS POSITIVE**
$F_{net} \Delta t = \Delta p$ ✓ $= m (V_f – V_i)$ $= 65,4(0-7)$ ✓ $= - 457,8$ N.S $= 457,8$ N.S upward ✓	$F_{net} \Delta t = \Delta p$ ✓ $= m (V_f – V_i)$ $= 65,4(0- (-7))$ ✓ $= 457,8$ N.S upward ✓
[If no direction, max: 2mks]	

(3)

2.2.2 **POSITIVE MARKING FROM 2.2.1**

DOWNWARD IS POSITIVE	**UPWARD IS POSITIVE**
$F_{net} \Delta t = \Delta p$ ✓ $F_{net} (0,5) = - 457,8$ ✓ $F_{net} = -915,6$ N $F_{net} = 915,6$ N ✓ (upward)	$F_{net} \Delta t = \Delta p$ ✓ $F_{net} (0,5) = 457,8$ ✓ $F_{net} = 915,6$ N ✓ (upward)

(3)

2.3.1 The net force acting on an object is equal to the rate of change of its momentum ✓✓ **[2 or 0 mark]** (2)

2.3.2 Impulse = area under the graph
$= \frac{1}{2} \times b \times h$ } Any one ✓

$= \frac{1}{2} \times 12 \times 34$ ✓

$= 204$ N.S ✓

(3)

2.3.3 $F_{net} \Delta t = \Delta p$ ✓

$204 = 0,6\ (V_f - 0)$ ✓

$V_f = 340\ m.s^{-1}$ ✓ (3)

[16]

QUESTION 3

3.1 The total linear momentum of a closed system ✓ remains constant/is conserved ✓ **[2 or 0 mark]** (2)

3.2.1 $\Sigma P_{before} = \Sigma P_{after}$ ✓

$mv + mv = (m+m)V_f$

$(5)(4) + 0 = (6,5)V_f$ ✓

$v_f = 3,077\ m \cdot s^{-1}$ east ✓ **[If no direction, max: 2 mks]** (3)

3.2.2 $\Delta p = m(V_f - V_i)$

$= 5\ (3,077 - 4)$ ✓

$= -4,62\ kg \cdot m \cdot s\text{-}1$

$= 4,62\ kg \cdot m \cdot s\text{-}1$, west ✓ **[If no direction, max: 1 mk]** (2)

3.3 The kinetic energy remains constant. ✓

OR

The kinetic energy before the collision equals kinetic energy after the collision. (1)

3.4 $\Sigma K_i = \frac{1}{2} m{v_i}^2$ ✓ $+ \frac{1}{2} m{v_i}^2$

$= \frac{1}{2} \times 1,5 \times 0 + \frac{1}{2} \times 5 \times (4)^2$ ✓

$= 40\ J$

$\Sigma K_f = \frac{1}{2} m{v_i}^2 + \frac{1}{2} m{v_i}^2$

$\Sigma K_f = \frac{1}{2} \times 1,5 \times (3,077)^2 + \frac{1}{2} \times 5 \times (3,077)^2$ ✓

$\Sigma K_f = 30,77\ J$

ΣK_i is not equal to ΣK_f ✓, inelastic collision. ✓ (5)

[13]

QUESTION 4

4.1 The product of the object's mass and its velocity.✓ **[1 or 0 mk]** (1)

4.2 From the graph Δp is zero/constant.✓

From $F_{net} = \frac{\Delta p}{\Delta t}$, Fnet will be zero✓ (2)

4.3.1 $P_i = mv_i$✓

$20\ 000 = 800v_i$✓

$V_i = 25\ m.s^{-1}$✓ (3)

4.3.2

EAST IS POSITIVE
$\Sigma p_i = \Sigma p_f$ / $(P_{Ai} + mv_{iB} = P_{Ai} + mv_{fB}$ } **Any 1**✓ $(20\ 000) + (950 \times 10)$✓ $= (10\ 000) + (950V_{Fb})$✓ $V_{fB} = 20,53\ m.s^{-1}$ east✓ **[If no direction, max: 3 mks]**
WEST IS POSITIVE
$\Sigma p_i = \Sigma p_f$ / $(P_{Ai} + mv_{iB} = P_{Ai} + mv_{fB}$ } **Any 1**✓ $(20\ 000) + (950 \times -10)$✓ $= (10\ 000) + (950V_{Fb})$✓ $V_{fB} = -20,53\ m.s^{-1}$ $V_{fB} = 20,53\ m.s^{-1}$ east✓ **[If no direction, max: 3 mks]**

(4)

4.4

From; $F_{net} = m\frac{\Delta V}{\Delta t}$ ✓ **OR:** $F_{net} = \frac{\Delta p}{\Delta t}$

As Δt is increased✓ F_{net} (exerted on a passenger) decreases✓ (3)

[13]

TOTAL:50