KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES

COMMON TEST

MARCH 2024

MARKS : 100

TIME : 2 Hours

This question paper consists of 10 pages and 3 data sheets.

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INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN questions. Answer ALL the questions in your 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. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. 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 number (1.1-1.6) in the ANSWER BOOK, for example 1.11 D.

1.1 In which of the following cases is the net force on the object zero? An object which...

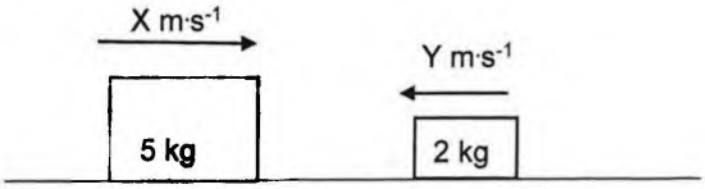
A moves with constant speed around a corner.

B moves under the influence of a force gravity only.

C moves with constant acceleration in a straight line.

D moves with equal displacements in equal time intervals.

1.2 A 5 kg block traveling at X $m \cdot s^{-1}$ to the right collides ELASTICALLY with a 2 kg block travelling at Y $m \cdot s^{-1}$ to the left as shown in the diagram below. The blocks remain coupled together after the collision and move to the right.



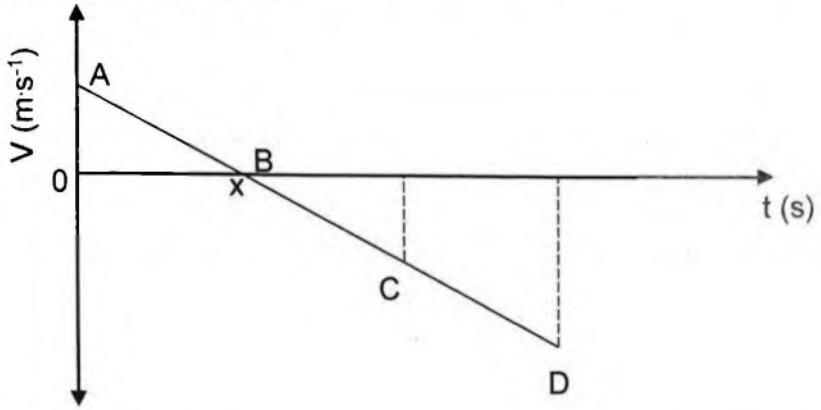
What change in TOTAL MOMENTUM and TOTAL KINETIC ENERGY takes place in the above collision?

	Total momentum	**Total kinetic energy**
A	Remains constant	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Remains constant	Remains constant

(2)

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1.3 The velocity time-graph below represents an object that has been projected vertically upwards from the edge of a cliff. It takes x seconds to reach the highest point above the ground, after which it falls past the edge of the cliff and strikes the ground. Ignore the effects of friction.



Which one of the following represent the height of the cliff?

A A - B

B B - C

C C - D

D A - D (2)

1.4 Which ONE of the following organic compounds has a formyl group as a functional group?

A Butane

B Butanal

C butan-2-ol

D butan-2-one (2)

1.5 Which ONE of the following compounds has the HIGHEST vapour pressure at room temperature?

A Ethane

B Ethanol

C Propane

D Fluoroethane (2)

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1.6 Which ONE of the following organic reactions will take place only when exposed to light?

A $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$

B $CH_3CH_3 \rightarrow CH_2CH_2 + H_2$

C $CH_2CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$

D $CH_3CH_3 + Br_2 \rightarrow CH_3CH_2Br + HBr$

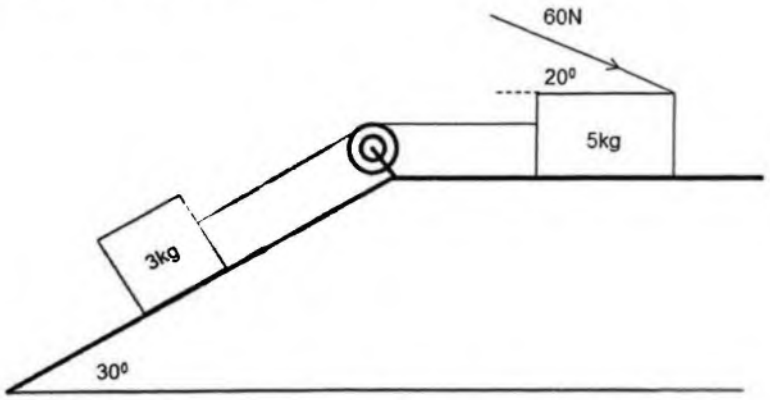
(2)

6 x 2 =**[12]**

QUESTION 2 (Start on a new page.)

A learner constructs a push toy using two blocks with masses 3 kg and 5 kg respectively. The blocks are connected by means of a light inextensible string. The string moves over a frictionless pulley.

The learner places the 3 kg block on a plane that is inclined at an angle of 30^0 to the horizontal. He then applies a force of 60 N at an angle of 20^0 to the 5 kg block by means of a light rigid rod, causing the toy to move across a flat, rough, horizontal surface, as shown in the diagram below.



The coefficient of kinetic friction between the surface and each block is 0,15.

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

2.2 Draw a labelled free-body diagram indicating all the forces acting on the 3 kg block. (4)

2.3 Calculate the magnitude of the:

2.3.1 Normal force acting on the 3 kg block (2)

2.3.2 Kinetic frictional force acting on the 5 kg block (3)

2.3.3 Tension in the string connecting the blocks (5)

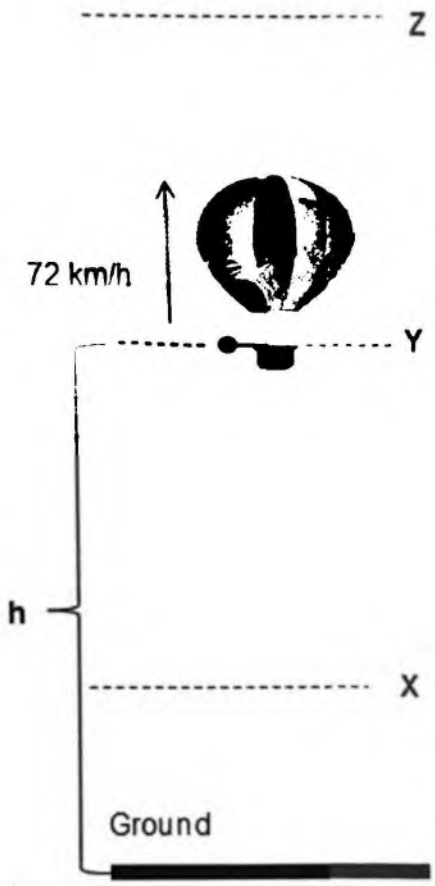
[16]

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QUESTION 3 (Start on a new page.)

A hot-air balloon moves vertically upwards at a CONSTANT VELOCITY of 72 km/h. When it is **h** meters above the ground, a ball is dropped from the balloon. The ball reaches its MAXIMUM HEIGHT above the ground at point **Z**. Refer to the diagram below.

Assume that the dropping of the ball has no effect on the speed of the hot-air balloon. Ignore air friction for the motion of the ball.



3.1 Give a reason why the ball keeps moving upwards after it is dropped. (1)

3.2 What is the acceleration of the ball at:

3.2.1 Point **X** (1)

3.2.2 Point **Z** (1)

3.3 Calculate the time it takes for the ball to reach its maximum height. (3)

3.4 Calculate the distance between the hot-air balloon and the ball, when the ball is at its maximum height. (6)

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3.5 Sketch a velocity-time graph in the ANSWER BOOK for the motion of the ball from the time it is dropped until it hits the ground.

Clearly show the following on your graph:

- The initial velocity
- The time it takes to reach its maximum height
- The time it passes point **Y** on its way downward

(4)

[16]

QUESTION 4 (Start on a new page.)

A minibus taxi with an unknown number of passengers travels at 30 $m \cdot s^{-1}$ when it collides head-on with a car of mass of 1 100 kg, travelling at 20 $m \cdot s^{-1}$, as shown in the diagram below. During the collision the vehicles stick together and travel at 10 $m \cdot s^{-1}$ immediately after the collision in the direction of the original motion of the taxi.



The average mass of a minibus taxi on South African roads is 1 500 kg. The law states that the combined mass of all the passengers in a minibus taxi and the taxi itself should not exceed 3 500 kg.

4.1 What is meant by the term *isolated system* in Physics? (2)

4.2 Was the minibus taxi overloaded? Support your answer with an appropriate calculation. (5)

The surface exerts a constant frictional force of 2500 N on the minibus taxi-car system as it comes to rest.

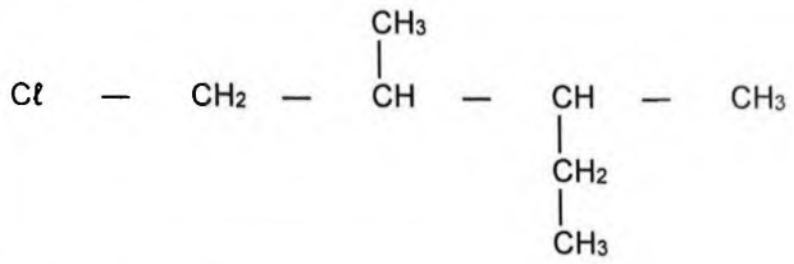
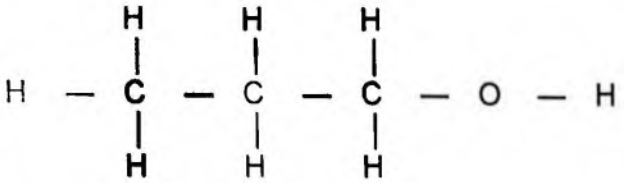
4.3 Calculate the distance that the minibus taxi-car system moves after the collision. (5)

[12]

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QUESTION 5 (Start on a new page.)

The letters A to G in the table below represent six organic compounds.

A	
B	$CH_3COCH_2CH_3$
C	5,6 – dimethylhept – 2 – yne
D	
E	$CH_3CH_2CH_2CHO$
F	2,3 – dimethylpentan – 2 – ol

Use the above table to answer the following questions:

5.1 Write down the:

5.1.1 IUPAC name for compound A. (3)

5.1.2 Letters of the compounds that are FUNCTIONAL ISOMERS of each other. Give a reason for the answer. (3)

5.1.3 Letter of the compound that is classified as a TERTIARY alcohol. Give a reason for the answer. (3)

5.1.4 Structural formula of compound C. (3)

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5.2 Compound **D** is heated with an organic compound **P** in the presence of concentrated sulphuric acid as shown in the equation below:

$$\mathbf{D} + \mathbf{P} \xrightarrow[\text{heat}]{H_2SO_{4(CONC.)}} \mathbf{Q} + H_2O$$

The compound Q that is produced, contains 9,80 % hydrogen (H), 31,38 % oxygen(O) and 58,82 % carbon(C).

Write down the:

5.2.1 Empirical formula of compound Q. Support the answer with a relevant calculation. (6)

5.2.2 Structural formula of compound Q. (3)

5.2.3 Structural formula of the functional group of compound P. (1)

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QUESTION 6 (Start on a new page.)

Two compounds M and P, shown in the table below, were used to investigate one of the factors that influences boiling point.

COMPOUND		MOLECULAR MASS ($g.mol^{-1}$)
M	$C_4H_8O_2$	88
P	$C_5H_{12}O$	88

6.1 Define the term *boiling point*. (2)

6.2 For this investigation write down the:

6.2.1 Dependent variable. (1)

6.2.2 Controlled variable. (1)

6.3 Write down the names of TWO homologous series that compound M can belong to. (2)

The boiling points of compounds M and P, are respectively, 79,8 °C and 138,5 °C.

6.4 Write down the name of the homologous series to which compound P belongs. (1)

6.5 Explain the difference in boiling points of compounds M and P. (4)

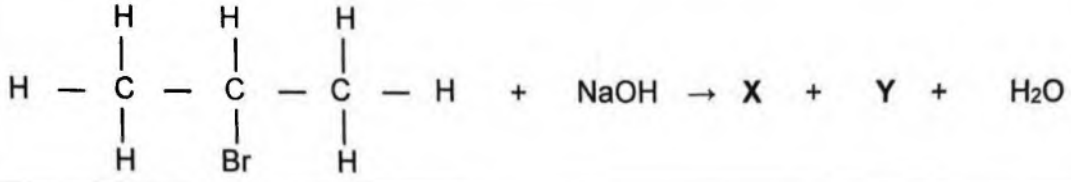
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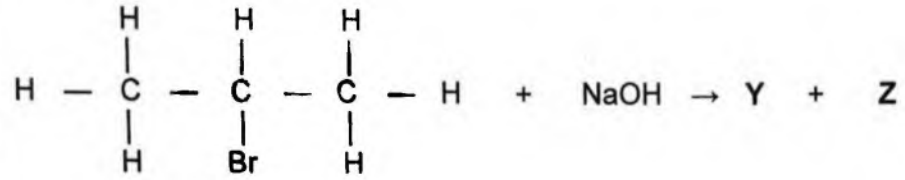
QUESTION 7 (Start on a new page.)

The equations below represent the reactions that takes place when an organic compound reacts with sodium hydroxide under different conditions:

REACTION I



REACTION II



X represents an organic product formed with a general formula C_nH_{2n}

7.1 Write down the:

7.1.1 Structural formula for compound X. (2)

7.1.2 Molecular formula for compound Y. (1)

7.2 For REACTION I, write down:

7.2.1 TWO conditions that must be satisfied for the reaction to take place. (2)

7.2.2 TWO terms that describe the type of reaction represented by REACTION I. (2)

7.3 Consider REACTION II.

Write down:

7.3.1 IUPAC name of compound Z. (1)

7.3.2 The type of reaction represented by REACTION II. Choose from: SUBSTITUTION, ADDITION or ELIMINATION. (1)

7.4 Both REACTIONS I AND II used NaOH as an inorganic reagent. Compare the NaOH used in REACTION I to the one used in REACTION II. (2)

[11]

TOTAL: 100

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

29
1,9 Cu
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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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 gravitasiekonstante*	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 electron*	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	$6,38 \times 10^{6}\ m$

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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

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm1\ m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F \cdot v_{av}$ / $P_{gem} = F \cdot v_{gem}$	

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