KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES
COMMON TEST
SEPTEMBER 2023

MARKS: 100

DURATION: 2 hours

This question paper consists of 9 pages and 2 data sheets.

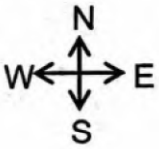
INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN questions. Answer ALL the questions in the 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

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

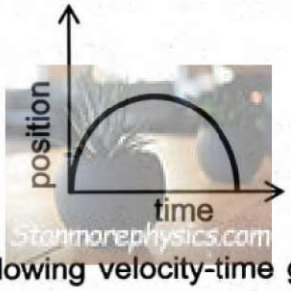
1.1 Two forces act simultaneously on a box so that the resultant force is 120 N East. One of the forces is 70 N West.
What will be the other force?



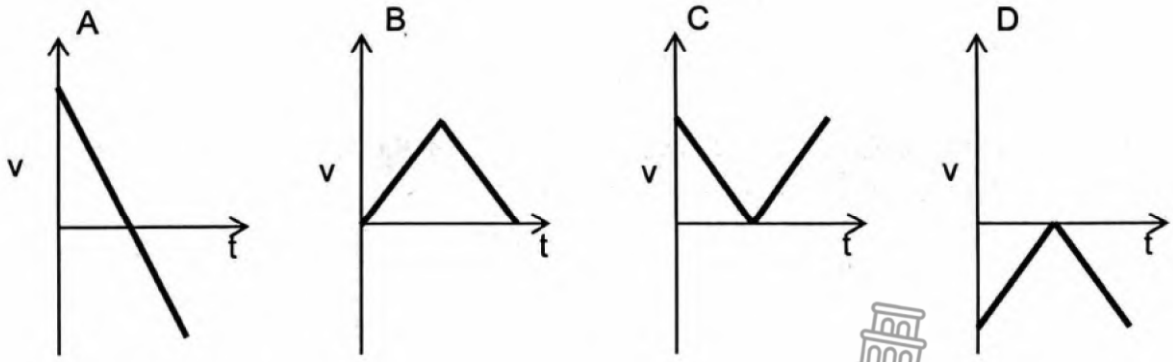
A 190 N West
B 190 N East
C 50 N East
D 50 N West

(2)

1.2 The position – time graph of an object is shown below:



Which ONE of the following velocity-time graphs is correct for the motion of the object?



(2)

1.3 The instantaneous velocity of a car can be defined as…

A the total distance covered by the car, divided by the total time.
B the total displacement of the car divided by the total time.
C the rate of change of displacement of the car at a particular time.
D the rate of change of distance of the car at a particular time. (2)

1.4 Which of the following combinations consists of TWO VECTOR quantities and ONE SCALAR quantity?

A Speed, Distance, Mass
B Force, Acceleration, Distance
C Speed, Acceleration, Distance
D Force, Displacement, Velocity (2)

1.5 Which ONE of the following statements is TRUE?
An object experiences positive acceleration when it is moving in the …

A positive direction at a constant speed.
B negative direction, experiencing a constant decrease in speed.
C positive direction, experiencing a constant decrease in speed.
D negative direction, experiencing a constant increase in speed. (2)

1.6 For which ONE of the following quantities of substances will the TOTAL number of ATOMS be equal to the Avogadro constant?

A 1 mole of CO_2
B 1 mole of N_2
C 2 moles of N_2
D 0,5 mole of H_2 (2)

1.7 Which ONE of the following is correct for the number of oxygen (O) atoms in 3 moles of carbon dioxide (CO_2)?

A $6,02 \times 10^{23}$
B $2 \times 6,02 \times 10^{23}$
C $3 \times 6,02 \times 10^{23}$
D $6 \times 6,02 \times 10^{23}$ (2)

1.8 Which ONE of the following expressions gives the percentage nitrogen (N) in calcium nitrate, $Ca(NO_3)_2$?

A $\frac{14}{164} \times 100$

B $\frac{28}{164} \times 100$

C $\frac{14}{102} \times 100$

D $\frac{28}{102} \times 100$ (2)

1.9 Consider the balanced chemical equation below:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

What volume of $NH_3(g)$ will be produced when 2 dm^3 of $N_2(g)$ reacts completely with excess $H_2(g)$ at STP?

A 2 dm^3

B 4 dm^3

C 22,4 dm^3

D 44,8 dm^3 (2)

1.10 Which ONE of the samples of gases below will have the largest number of molecules if the mass of each of the samples is the same?

A H_2O

B N_2

C CO_2

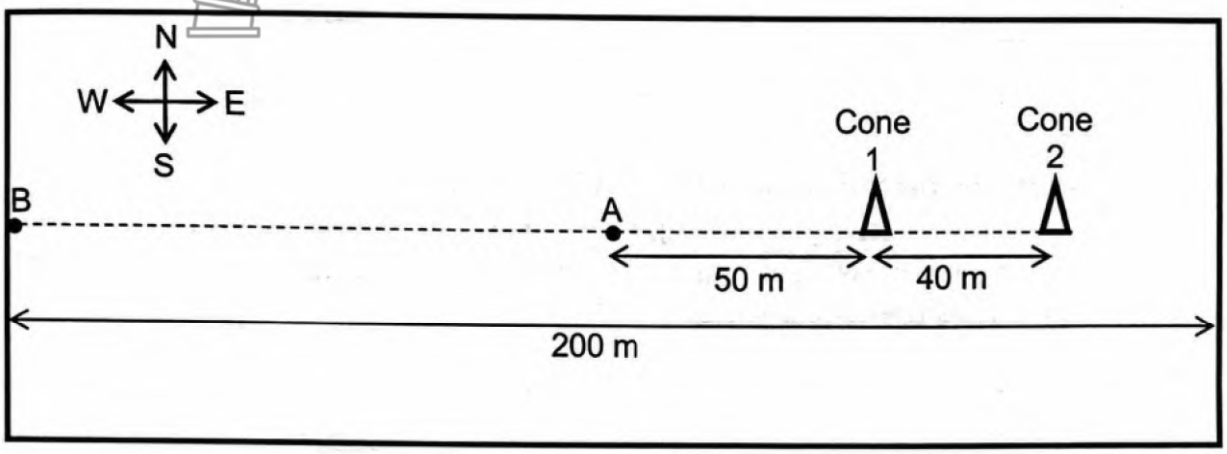
D Cl_2 (2)

[20]

SECTION A: PHYSICS

QUESTION 2 (Start on a new page.)

Two friends, Tom and James are training for an athletics meeting on a sports field of length 200 m. **Both friends start from the middle of the field at Point A.**



Tom runs using two cones. The first cone is placed 50 m east of the starting point (point A), while the second cone is placed 40 m east of cone 1.

Tom runs along the following route:

- From the starting point (point A) due east to Cone 1, and then turns around and returns to the starting point running due west.
- From Point A due east to Cone 2. He then turns around and runs due west ending at Cone 1.

2.1 Define the term *displacement* in words. (2)

2.2 Write down the final position of Tom, relative to the starting point. (2)

2.3 The complete route described above took Tom 30 seconds to complete. Determine his average speed in $m \cdot s^{-1}$. (4)

2.4 James runs from the starting point (point A), due east to Cone 2. He immediately turns around and runs in a westerly direction until he reaches Point B.
Point B lies on the boundary of the field, due west from the starting point.

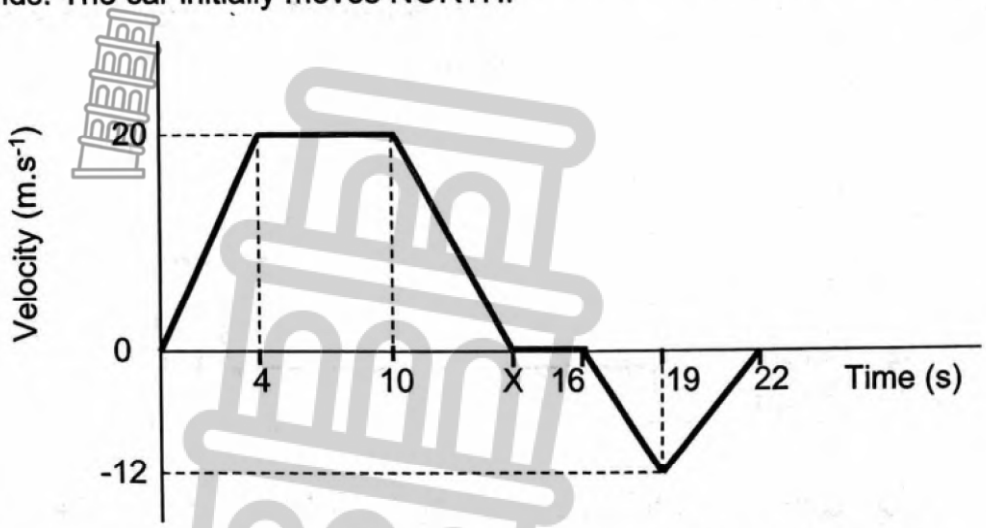
2.4.1 Determine the total time taken by James if his average speed is 1 $m \cdot s^{-1}$ SLOWER THAN that of Tom's. (3)

2.4.2 Calculate the average velocity of James for the entire motion. (4)

[15]

QUESTION 3 (Start on a new page.)

The velocity-time graph below represents the motion of a car over a period of 22 seconds. The car initially moves NORTH.



3.1 Describe how the velocity of the car changes in the time interval:

3.1.1 0 seconds to 4 seconds (2)

3.1.2 19 seconds to 22 seconds (2)

3.2 Determine the displacement of the car during the first 10 seconds of its motion. (4)

3.3 The acceleration of the car from the 16th second to the 19th second is equal to the acceleration from the 10th second to X seconds.

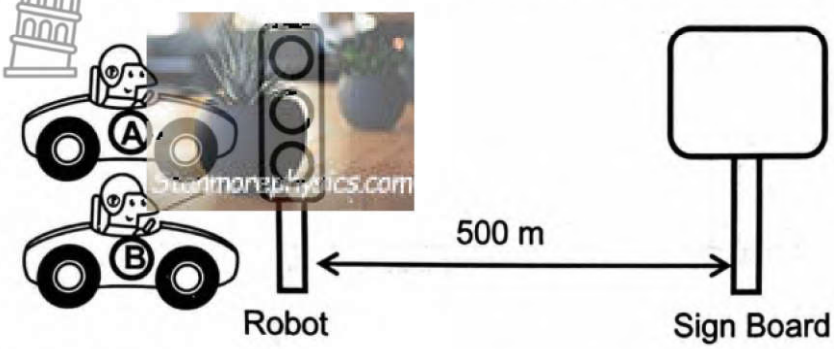
3.3.1 Define the term *acceleration* in words. (2)

3.3.2 Determine the value of X on the graph. (5)

[15]

QUESTION 4 (Start on a new page.)

In the diagram below, a robot (traffic light) and a sign board are 500m apart. Two cars, Car A and Car B, both pass the robot at the same time.
Car A takes off from rest (at the Robot) and accelerates at 1,2m·s^{-2}. Car B travels at a constant velocity of 27,78 m.s^{-1}. Both vehicles are travelling in an easterly direction.



4.1 Use suitable calculations to determine which vehicle, Car A or Car B, will reach the sign board first. (6)

4.2 Determine the velocity of Car A when it reaches the sign board. (4)

[10]

SECTION B: CHEMISTRY

QUESTION 5 (Start on a new page.)

The reaction between zinc and phosphoric acid (H_3PO_4) is represented by the balanced equation below:

$$3Zn(s) + 2H_3PO_4(aq) \rightarrow Zn_3(PO_4)_2(aq) + 3H_2(g)$$

12,8 grams of zinc reacts completely with excess phosphoric acid.

5.1 Define the term *one mole of a substance* in words. (2)

5.2 Determine the number of moles of zinc used. (3)

5.3 Calculate the number of moles of phosphoric acid that reacts with the zinc. (2)

5.4 Determine the number of hydrogen (H_2) molecules that form. (4)

[11]

QUESTION 6 (Start on a new page)

6.1 A compound is made up of the elements sodium (Na), carbon (C) and oxygen (O) only. A sample of this compound is found to contain 43,4% sodium and 11,32% carbon by mass.
Calculate the:

6.1.1 Percentage of oxygen in the compound (2)

6.1.2 Empirical formula of this compound (5)

6.2 The molar mass of hydrated zinc sulphate ($ZnSO_4 \cdot xH_2O$) is found to be 287 $g \cdot mol^{-1}$.
Determine the value of x (the number of moles of water of crystallization). (4)

6.3 A learner needs to prepare 250 cm^3 of a solution of sodium sulphate (Na_2SO_4) of concentration 1,5 $mol \cdot dm^{-3}$.

6.3.1 Define the term *concentration* in words. (2)

6.3.2 Calculate the mass of sodium sulphate required. (4)
[17]

QUESTION 7 (Start on a new page.)

A sample of sodium carbonate (Na_2CO_3) of mass 20 grams reacts completely with excess nitric acid (HNO_3) of concentration 1,5 $mol \cdot dm^{-3}$.

The reaction is represented by the following balanced equation:

$$Na_2CO_3(s) + 2HNO_3(aq) \rightarrow 2NaNO_3(s) + CO_2(g) + H_2O(\ell)$$

7.1 Calculate the :

7.1.1 Number of moles of Na_2CO_3 that reacted. (3)

7.1.2 Volume of HNO_3 (in dm^3) required to completely react with the 20 g Na_2CO_3. (4)

7.2 The percentage yield of CO_2 in the reaction is 85%.
Calculate the actual volume (in dm^3) of CO_2 that formed at STP. (5)
[12]

TOTAL: 100

DATA FOR PHYSICAL SCIENCES GRADE 10

PHYSICS

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^{8}$ $m \cdot s^{-1}$
Planck's constant	h	$6,63 \times 10^{-34}$ $J \cdot s$
Charge on electron	q_e	$-1,6 \times 10^{-19}$ C
Electron mass	m_e	$9,11 \times 10^{-31}$ kg

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

CHEMISTRY

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1,013 \times 10^{5}$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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	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	La 139	1,6 Hf 179	Ta 181	W 184	Re 186	Os 190	Ir 192	Pt 195	Au 197	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	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 Cu 1,9 63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

KWAZULU-NATAL PROVINCE
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NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES
COMMON TEST
MARKING MEMORANDUM
SEPTEMBER 2023

MARKS: 100

DURATION: 2 hours

QUESTION 1

1.1 B ✓✓ (2)

1.2 A ✓✓ (2)

1.3 C ✓✓ (2)

1.4 B ✓✓ (2)

1.5 B ✓✓ (2)

1.6 D ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

1.9 B ✓✓ (2)

1.10 A ✓✓ (2)

[20]

QUESTION 2

2.1 The difference / change in position in space ✓✓ (2)

2.2 50 m ✓ east✓ (2)

2.3 Distance = 50 + 50 + 90 + 40 = 230 m

$$\text{speed} = \frac{\text{distance}}{\text{time}} \checkmark$$

$$= \frac{230}{30} \quad \checkmark \checkmark$$

$$= 7{,}67 \text{ m·s}^{-1} \checkmark$$ (4)

2.4 POSITIVE MARKING FROM QUESTION 2.3

2.4.1

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$6{,}67 \checkmark = \frac{90+90+100 \checkmark}{\text{time}}$$

time = 41.98 s ✓ (3)

POSITIVE MARKING FROM QUESTION 2.4.1

2.4.2 $v = \frac{\Delta x}{\Delta t}$ ✓

$v = \frac{100}{41.98}$ ✓ ✓

= 2.38 m·s^{-1} west ✓ (4)

[15]

QUESTION 3

3.1

3.1.1 The velocity uniformly increased from 0 m·s^{-1}/ rest ✓ to 20 m·s^{-1} (North) in 4 seconds ✓ (2)

3.1.2 The velocity uniformly decreased from 12 m·s^{-1} South ✓ to 0 m·s^{-1}/ stop/rest in 3 seconds ✓ (2)

3.2 Displacement $= \frac{1}{2} \times 4 \times 20$ ✓ $+ 6 \times 20$ ✓

Displacement = 160 m ✓ North ✓ (4)

3.3

3.3.2 $a = \frac{\Delta v}{\Delta t}$ ✓ OR $a = \frac{y_2 - y_1}{x_2 - x_1}$ ✓

$= \frac{-12 - 0}{19 - 16}$ ✓

= - 4 m·s^{-2}

$a = \frac{\Delta v}{\Delta t}$

- 4 ✓ $= \frac{20 - 0}{10 - X}$ ✓

X = 15 s ✓ (5)

[15]

QUESTION 4

4.1 Car A

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$500 = 0\Delta t + \frac{1}{2}(1{,}2)\Delta t^2$ ✓

$\Delta t = 28{,}87$ s ✓

Car B

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$500 = 27{,}78\Delta t + \frac{1}{2}(0)\Delta t^2$ ✓

$\Delta t = 18$ s ✓

OR

Car B

$\Delta x = v_i\Delta t$

$500 = 27{,}78\Delta t$ ✓

$\Delta t = 18$ s ✓

Car B will reach Robot 2 first. ✓ (6)

4.2 POSITIVE MARKING FROM 3.1

OPTION 1

$v_f = v_i + a\Delta t$ ✓

$v_f = 0$ ✓ $+ 1{,}2(28{,}87)$ ✓

$v_f = 34{,}64$ m·s^{-1} East ✓

OPTION 2

$v_f^2 = v_i^2 + 2a\Delta x$ ✓

$v_f^2 = 0^2$ ✓ $+ 2(1{,}2)(500)$ ✓

$v_f = 34{,}64$ m·s^{-1} East ✓ (4)

[10]

QUESTION 5

5.1 The amount of substance having the same number of particles ✓ as there are atoms in 12 g carbon-12 ✓. (2)

5.2 $n(Zn) = \frac{m}{M}$ ✓

$n(Zn) = \frac{12{,}8}{65}$ ✓

$= 0{,}2$ mol ✓ (3)

5.3 $Zn : H_3PO_4$

3 : 2 ✓

$n(H_3PO_4) = 0{,}13$ mol ✓ (2)

5.4 Zn : H_2

3 : 3 ✓

n(H_2) = 0,2 mol

$n(H_2) = \frac{N}{N_A}$ ✓

$0,2 = \frac{N}{6,02 \times 10^{23}}$ ✓

N (H_2) = 1,204 x 10^{23} H_2 molecules ✓ (4)

[11]

QUESTION 6

6.1

6.1.1 % O = 100 – (43,4 + 11,32) ✓ = 45,28% ✓ (2)

6.1.2 Consider 100g

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio	
Na	43,4	$\frac{43,4}{23} = 1,89$ ✓	$\frac{1,89}{0,94} = 2,01 \approx 2$	✓ (Obtaining all simplest ratios)
C	11,32	$\frac{11,32}{12} = 0,94$ ✓	$\frac{0,94}{0,94} = 1$	
O	45,28	$\frac{45,28}{16} = 2,83$ ✓	$\frac{2,83}{0,94} = 3,01 \approx 3$	

Empirical Formula: Na_2CO_3 ✓ (5)

6.2 $M(ZnSO_4.xH_2O) = M(ZnSO_4) + x\ M(H_2O)$

287 ✓ = 65+32+4(16) ✓ + x(2+16) ✓

x= 7 ✓ (4)

6.3

6.3.1 The number of moles of solute ✓ per cubic decimetre of solution ✓ (2)

6.3.2

Option 1	Option 2
$C(H_2SO_4) = \frac{m}{MV}$ ✓	$C(H_2SO_4) = \frac{n}{V}$ ✓
$1,5$ ✓ $= \frac{m}{98 \times 0,25}$ ✓	$1,5 = \frac{n}{0.25}$ ✓
m = 36,75 g ✓	$n(H_2SO_4)$ = 0,375 mol
	$n(H_2SO_4) = \frac{m}{M}$
	$0,375 = \frac{m}{98}$ ✓
	m = 36,75 g ✓

(4)

[17]

QUESTION 7

7.1.1 $n(Na_2CO_3) = \frac{m}{M}$

$n(Na_2CO_3) = \frac{20}{23\times2 + 12 + 16\times3}$ ✓✓

= 0,19 mol ✓ (3)

7.1.2 $Na_2CO_3 : HNO_3$

1 : 2 ✓

$n(HNO_3) = 0,38$ mol

$c(HNO_3) = \frac{n}{V}$ ✓

$1,5 = \frac{0,38}{V}$ ✓

$V(HNO_3) = 0,25\ dm^3$ ✓ (4)

7.2 $Na_2CO_3 : CO_2$

1 : 1 ✓

$n(CO_2) = 0,19$ mol

$n(CO_2) = \frac{V}{V_m}$ ✓

$0,19 = \frac{V}{22,4}$ ✓

$V\ (CO_2) = 4,256\ dm^3$

Actual Volume (CO_2) = 4,256 x 0,85 ✓

Actual Volume $(CO_2) = 3,62\ dm^3$ ✓ (5)

[12]

TOTAL: 100