KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES

COMMON TEST

SEPTEMBER 2024

MARKS: 100

DURATION: 2 hours

This question paper consists of 10 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 (1.1–1.8) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following is a scalar quantity?

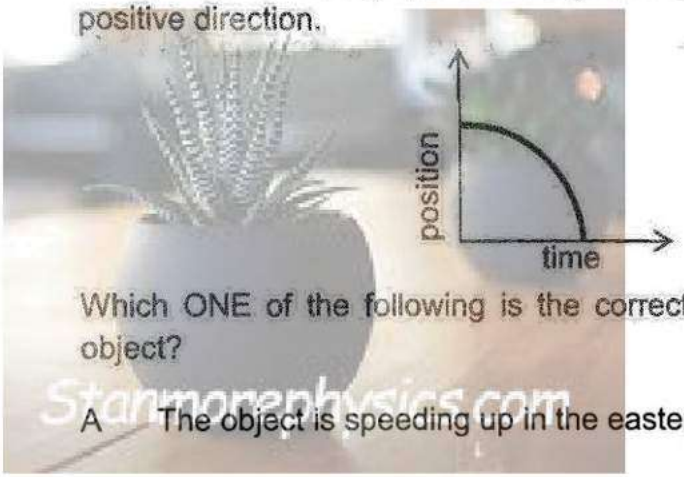
A Displacement

B Force

C Speed

D Acceleration (2)

1.2 The position – time graph of an object is shown below. East is taken as the positive direction.



Which ONE of the following is the correct description of the motion of the object?

A The object is speeding up in the easterly direction.

B The object is slowing down in the easterly direction.

C The object is speeding up in the westerly direction.

D The object is slowing down in the westerly direction. (2)

1.3 An object, starting from rest, experiences a constant acceleration **a** when increasing its velocity to V.
The acceleration when increasing the velocity from V to 2V in the same time will be...

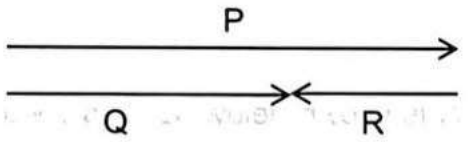
A a

B 2a

C ½ a

D 4a (2)

1.4 Consider the vector diagram below:



Which ONE of the following is the correct relationship between vectors P, Q and R?

A $P = Q + R$

B $R = P + Q$

C $Q = P + R$

D $P + Q + R = 0$ (2)

1.5 Consider the balanced chemical equation for the reaction below:

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

What is the minimum volume of Hydrogen (H_2) required to form 22,4 dm^3 of ammonia (NH_3) at STP?

A 22,4 dm^3

B 3 x 22,4 dm^3

C 1.5 x 22,4 dm^3

D $\frac{2}{3} \times 22,4\ dm^3$

(2)

1.6 Which ONE of the following contains $6,02 \times 10^{23}$ ATOMS?

A 1 mole of CO_2

B 16 g of O_2 gas

C 22,4 dm^3 of N_2 gas at STP

D 18 g of H_2O (2)

1.7 Which ONE of the following expressions is correct for the percentage composition of water (H_2O) in $Na_2SO_4 \cdot 10H_2O$?

A $\frac{18}{142} \times 100$

B $\frac{18}{322} \times 100$

C $\frac{180}{322} \times 100$

D $\frac{180}{142} \times 100$ (2)

1.8 Which is the correct statement of Avogadro's Law?

A One mole of any gas occupies the same volume at the same temperature and pressure.

B One mole of any gas occupies the same volume at standard temperature and pressure.

C One mole is the amount of substance having the same number of particles as there are atoms in 12 g carbon-12.

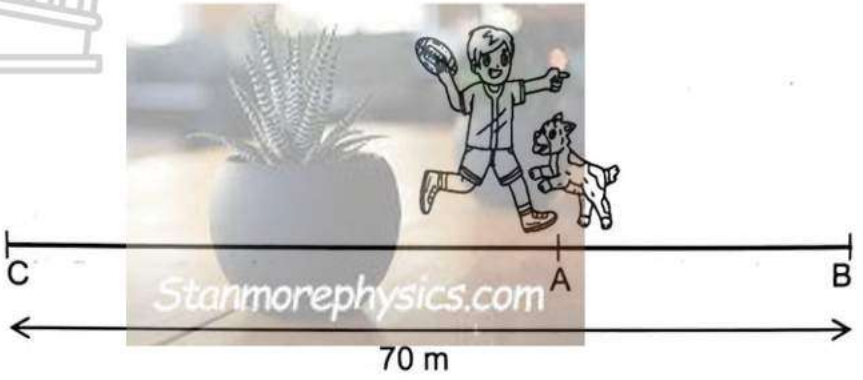
D Avagadro's number is the number of particles present in one mole. (2)

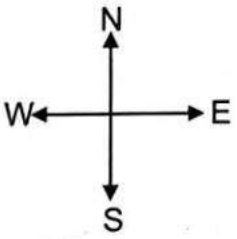
[16]

SECTION A: PHYSICS

QUESTION 2 (Start on a new page.)

2.1 Jack and his dog, Rex, are initially standing at point A. Jack throws a ball in an easterly direction so that it comes to rest at point B.





Jack thereafter runs at an average velocity of 5 $m \cdot s^{-1}$ due west, reaching point C in 10 seconds. The distance between point B and point C is 70 m

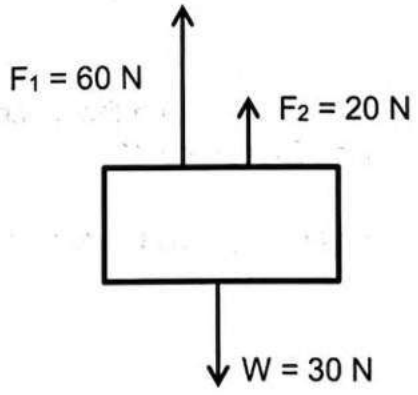
2.1.1 Calculate Jacks displacement. (3)

Rex leaves point A at the same time as Jack and runs due east to fetch the ball at point B. He immediately turns around and runs due west, meeting Jack at point C.
Rex takes 2 seconds more than Jack to reach point C.

2.1.2 Define the term *average speed* in words. (2)

2.1.3 Calculate Rex's average speed for his motion from A to B to C. (4)

2.2 Two forces, F_1 and F_2 of magnitude 60 N and 20 N respectively act on a suspended box of weight 30 N as shown in the diagram below.

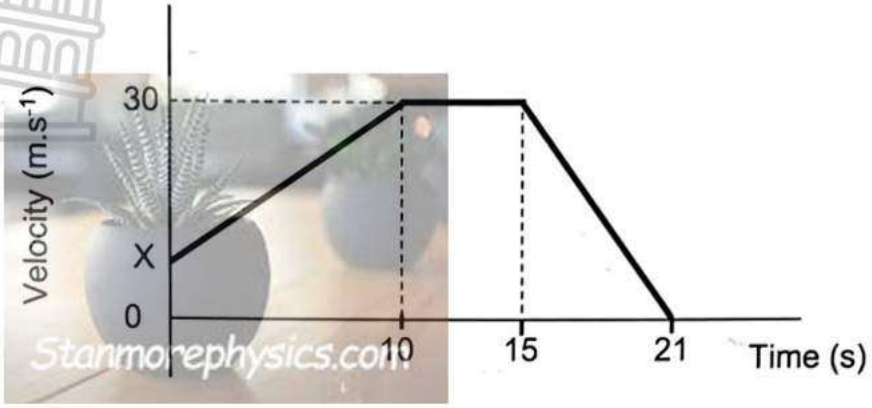


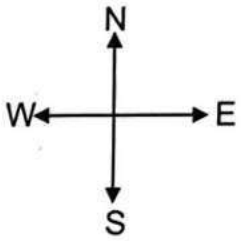
Using the tail-to-head method and a scale of 1 cm represents 10 N, draw an accurate vector diagram to determine the magnitude of the resultant force acting on the box. (4)

[13]

QUESTION 3 (Start on a new page.)

3.1 The velocity-time graph below represents the motion of a car travelling EAST over a period of 21 seconds.



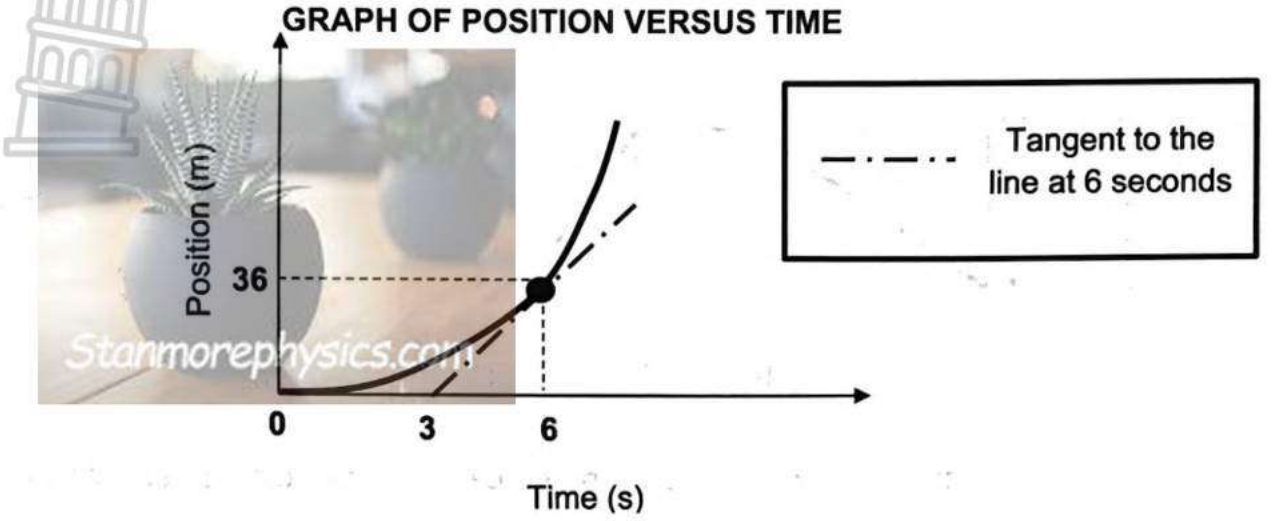


3.1.1 Describe how the velocity of the car changes from 15 seconds to 21 seconds. (2)

3.1.2 Calculate the acceleration of the car from 15 seconds to 21 seconds. (3)

3.1.3 The displacement of the car in the 21 seconds interval is 415 m. Calculate the magnitude of the cars initial velocity, X. (4)

3.2 The position-time graph for a quad bike travelling NORTH along a straight horizontal surface is shown below.
The quad bike starts from rest and moves at a constant acceleration



3.2.1 Define the term *instantaneous velocity* in words. (2)

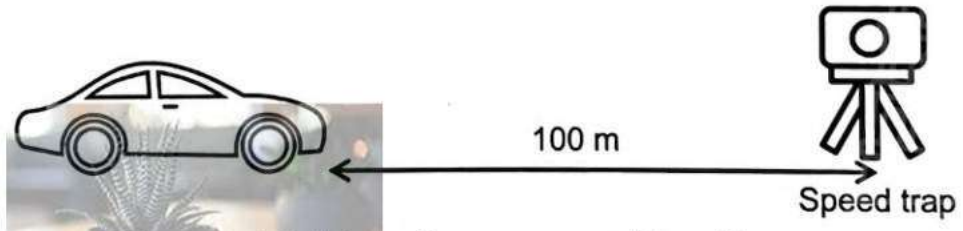
3.2.2 Calculate the instantaneous velocity of the quad bike at 6 seconds. (3)

3.2.3 Determine the magnitude of the quad bikes acceleration during the first 6 seconds. (3)

[17]

QUESTION 4 (Start on a new page.)

In the diagram below, the driver of a car travelling east, at a constant velocity of 45 $m \cdot s^{-1}$, notices a speed trap 100 m away. The speed limit is 120 $km \cdot h^{-1}$.
The driver takes 0,5 seconds to react before applying brakes. The car slows down uniformly at 6 $m \cdot s^{-2}$.



4.1 Convert the speed limit to metres per second ($m \cdot s^{-1}$) (2)

4.2 Use relevant calculations to determine if the car will exceed the speed limit at the speed trap. (6)

4.3 Determine the time taken for the car to reach the speed trap after applying brakes. (4)

[12]

SECTION B: CHEMISTRY

QUESTION 5 (Start on a new page.)

Iron(III) oxide (Fe_2O_3) reacts with carbon monoxide (CO) as represented in the balanced equation below:

$$3Fe_2O_3(s) + CO(g) \rightarrow 2Fe_3O_4(s) + CO_2(g)$$

In one such reaction, 1,2 kg iron(III) oxide reacts with excess carbon monoxide at standard temperature and standard pressure (STP)

5.1 Define the term *molar mass* in words. (2)

5.2 Calculate the:

5.2.1 Number of moles of Fe_2O_3 reacted (3)

5.2.2 Number of Fe_3O_4 formula units formed (4)

5.2.3 Volume of CO (in dm^3) required to completely react with the 1,2 kg Fe_2O_3 (4)

[13]

QUESTION 6 (Start on a new page)

6.1 An organic acid made up of carbon (C), hydrogen (H) and oxygen (O) only has the following percentage composition by mass:

Element	Percentage Composition
Carbon (C)	48,65%
Hydrogen (H)	8,11%
Oxygen (O)	43,24%

6.1.1 Define the term *empirical formula* in words. (2)

6.1.2 Determine the empirical formula of this compound. (6)

6.2 An unknown metal Y reacts completely with sulphuric acid (H_2SO_4) according to the following balanced equation:

$$2Y + H_2SO_4 \rightarrow Y_2SO_4 + H_2$$

13,8 grams of metal Y is required to completely react with 0,4 dm^3 H_2SO_4 of concentration 0,75 $mol.dm^{-3}$.

Use relevant calculations to determine the NAME of metal Y. (6)

[14]

QUESTION 7 (Start on a new page.)

7.1 Propane(C_3H_8) reacts with oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O), as indicated in the balanced equation below.

$$C_3H_8\ (g) + 5O_2\ (g) \rightarrow 3CO_2\ (g) + 4H_2O\ (g)$$

In one such reaction 5 dm^3 propane(C_3H_8) reacts with excess oxygen at standard temperature and standard pressure (STP).

7.1.1 Calculate the TOTAL volume of gas (in dm^3) formed at the end of the reaction. (4)

The graph below shows the **volume of CO_2 formed** as the reaction above progresses. The reaction has not reached completion.

7.1.2 Determine the mass of C_3H_8 (in grams) that reacted after 6 minutes (5)

7.2 Hydrochloric acid (HCl) reacts with magnesium (Mg), as represented in the balanced equation below:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

18 grams of magnesium (Mg) reacts completely with excess hydrochloric acid (HCl). The percentage yield of hydrogen (H_2) in the reaction is 80%.

Calculate the mass of H_2 formed (in grams). (6)

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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 He 4
2,1 H 1												2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
1,0 Li 7	1,5 Be 9											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,9 Na 23	1,2 Mg 24											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
1,9 Cu
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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GRADE 10

PHYSICAL SCIENCES
COMMON TEST
MARKING GUIDELINES
SEPTEMBER 2024

MARKS: 100

DURATION: 2 hours

This marking guideline consists of 8 pages.

QUESTION 1

1.1 C ✓✓ (2)

1.2 C✓✓ (2)

1.3 A ✓✓ (2)

1.4 C ✓✓ (2)

1.5 C ✓✓ (2)

1.6 B ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

[16]

QUESTION 2

2.1

2.1.1 $v = \frac{\Delta x}{\Delta t}$ ✓

$5 = \frac{\Delta x}{10}$ ✓

= 50 m west ✓ (3)

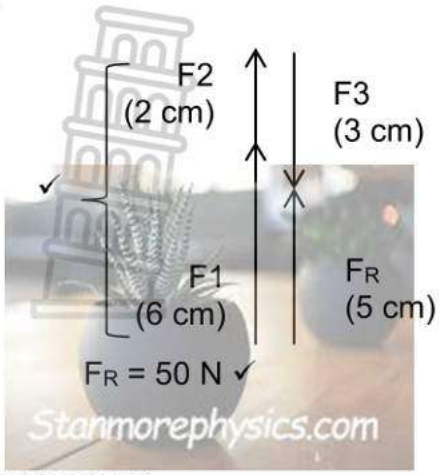
2.1.2 The total distance travelled per total time ✓✓ (2)

2.1.3 $\text{speed} = \frac{\text{distance}}{\text{time}}$ ✓

$= \frac{20+70}{12}$ ✓✓

$= 7{,}5\ \text{m·s}^{-1}$ ✓ (4)

2.2



CRITERIA
1 mark – F1 and F2 drawn head-to-tail with correct scale and direction
1 mark – F3 drawn downwards from F2 with the correct scale.
1 mark – F_R drawn with correct direction and scale.
1 mark – Final answer (50 N)

(4)
[13]

QUESTION 3

3.1

3.1.1 The velocity uniformly decreased from 30 m·s^{-1} east ✓ to 0 m·s^{-1} / stop/ rest in 6 seconds ✓ (2)

3.1.2 $a = \frac{\Delta v}{\Delta t}$ OR $a = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{0 - 30}{21 - 15}$ ✓✓

= - 5 m·s^{-2}

= 5 m·s^{-2} West ✓ (3)

3.1.3 OPTION 1

415 ✓ $= \underline{10x + \frac{1}{2} \times 10 \times (30 - x)}$ ✓ $+ \underline{5 \times 30 + \frac{1}{2} \times 6 \times 30}$ ✓

X = 5 m·s^{-1} ✓

OPTION 2

415 ✓ $= \underline{\frac{1}{2} \times 10 \times (x + 30)}$ ✓ $+ \underline{5 \times 30 + \frac{1}{2} \times 6 \times 30}$ ✓

X = 5 m·s^{-1} ✓

OPTION 3

Δx (10 – 21 seconds) = $5 \times 30 + \frac{1}{2} \times 6 \times 30$ ✓

= 240 m

Δx (0 – 10 seconds) = 415 - 240

= 175 m

$\Delta x = \frac{v_f + v_i}{2} \Delta t$

175 ✓ $= \frac{30 + X}{2} \times 10$ ✓

X = 5 m·s^{-1} ✓ (4)

3.2

3.2.1 The rate of change in position. ✓✓ (2)

3.2.2 $v = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{36 - 0}{6 - 3}$ ✓

= 12 m·s^{-1} North ✓ (3)

3.2.3 POSITIVE MARKING FROM 3.2.2

OPTION 1

$a = \frac{\Delta v}{\Delta t}$ ✓

$= \frac{12 - 0}{6}$ ✓

= 2 m·s^{-2} ✓

OPTION 2

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

$36 = 0(6) + \frac{1}{2} a(6)^2$ ✓

a = 2 m·s^{-2} ✓

OPTION 3

$v_f^2 = v_i^2 + 2a\Delta x$ ✓

$(12)^2 = 0^2 + 2a(36)$ ✓

a = 2 m·s^{-2} ✓

(3)

[17]

QUESTION 4

4.1 120 ÷ 3,6 ✓ = 33,33 m·s^{-1} ✓ (2)

4.2 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$

$= 45(0,5) + \frac{1}{2}(0)\Delta t^2$ ✓

Δx = 22,5 m

Distance to speed trap = 100 – 22,5 ✓

= 77,5 m

$v_f^2 = v_i^2 + 2a\Delta x$ ✓

$= (45)^2 + 2(-6)(77,5)$ ✓

= 33,09 m·s^{-1} ✓

OR

$\Delta x = v_i \Delta t$

$= 45(0,5)$ ✓

Δx = 22,5 m

The vehicle will not exceed the speed limit. ✓ (6)

4.3 POSITIVE MARKING FROM 4.2

OPTION 1

$v_f = v_i + a\Delta t$ ✓

33,09 ✓= 45 + (-6)Δt ✓

Δt = 1,99 s ✓

OPTION 2

$\Delta x = \frac{v_f + v_i}{2}\Delta t$✓

77,5 ✓= $\frac{33,09 + 45}{2}\Delta t$✓

Δt = 1,98 s ✓

OPTION 3

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

77,5 ✓ = 45Δt + $\frac{1}{2}$(-6)Δt^2✓

Δt = 1,98 s ✓ (4)

[12]

QUESTION 5

5.1 The mass of one mole of substance. ✓✓ (2)

5.2

5.2.1 $n(Fe_2O_3) = \frac{m}{M}$ ✓

$n(Fe_2O_3) = \frac{1200}{160}$ ✓

= 7,5 mol ✓ (3)

5.2.2 POSITIVE MARKING FROM 5.2.1

$Fe_2O_3 : Fe_3O_4$

3 : 2 ✓

$n(Fe_3O_4)$ = 5 mol

$n(Fe_3O_4) = \frac{N}{N_A}$ ✓

$5 = \frac{N}{6,02 \times 10^{23}}$ ✓

N (Fe_3O_4) = 3,01 x 10^{24} Fe_3O_4 formula units ✓ (4)

5.2.3 POSITIVE MARKING FROM 5.2.1

Fe_2O_3 : CO

3 : 1 ✓

n(CO) = 2,5 mol

$n(CO) = \frac{V}{V_m}$ ✓

$2.5 = \frac{V}{22.4}$ ✓

V(CO) = 56 dm^3 ✓ (4)

[13]

QUESTION 6

6.1.1 The simplest whole-number ratio✓ of atoms in a compound ✓ (2)

6.1.2

Consider 100g

Element	mass (g)	$n = \frac{m}{M}$		Simplest Ratio		Simplest Ratio (Modified)	
C	48,65	$\frac{48,65}{12} = 4,05$	✓	$\frac{4,05}{2,7} = 1,5$	✓ (all simplest ratios)	1,5 x 2 = 3	✓ (all modified simplest ratios)
H	8,11	$\frac{8,11}{1} = 8.11$	✓	$\frac{8,11}{2,7} = 3$		3 x 2 = 6	
O	43,24	$\frac{43,24}{16} = 2,7$	✓	$\frac{2,7}{2.7} = 1$		1x 2 = 2	

Empirical Formula: $C_3H_6O_2$ ✓ (6)

6.2

$C(H_2SO_4) = \frac{n}{V}$ ✓

$0,75 = \frac{n}{0,4}$ ✓

$n(H_2SO_4)$ = 0,3 mol

Y : H_2SO_4

2 : 1 ✓

n(Y) = 0,6 mol

$n(Y) = \frac{m}{M}$

$0,6 ✓ = \frac{13,8 ✓}{M}$

M(Y) = 23 $g.mol^{-1}$

Y is Sodium ✓ (6)

[14]

QUESTION 7

7.1

7.1.1

<u>OPTION 1</u>

$C_3H_8 : CO_2$

1 : 3 ✓

$V(CO_2) = 15\ dm^3$

$C_3H_8 : H_2O$

1 : 4 ✓

$V(H_2O) = 20\ dm^3$

V (end) = 15 + 20 ✓

= 35 dm^3 ✓

<u>OPTION 2</u>

$n(C_3H_8) = \frac{V}{V_m}$

$n(C_3H_8) = \frac{5}{22,4}$

= 0,22 mol

$C_3H_8 : CO_2$

1 : 3 ✓

$n(CO_2) = 0,66$ mol

$C_3H_8 : H_2O$

1 : 4 ✓

$n(H_2O) = 0,88$ mol

$n(end) = \frac{V}{V_m}$

$(0,66 + 0,88) = \frac{V}{22,4}$ ✓

$V(end) = 34,5\ dm^3$ ✓ (4)

7.1.2 $V(CO_2) = 12\ dm^3$ ✓

$C_3H_8 : CO_2$

1 : 3 ✓

$V(C_3H_8) = 4\ dm^3$

$$n(C_3H_8) = \frac{V}{V_m}$$

$$= \frac{4}{22,4} \checkmark$$

$$= 0,18\ mol$$

$$n(C_3H_8) = \frac{m}{M}$$

$$0,18 = \frac{m}{44} \checkmark$$

$m(C_3H_8) = 7,92\ g$ ✓ (5)

7.2

$$n(Mg) = \frac{m}{M} \checkmark$$

$$= \frac{18}{24} \checkmark$$

$$= 0,75\ mol$$

$Mg : H_2$

1 : 1 ✓

$n(H_2) = 0,75\ mol$

$$n(H_2) = \frac{m}{M}$$

$$0,75 = \frac{m}{2} \checkmark$$

$m(H_2)_{theoretical} = 1,5\ g$

$m(H_2)_{actual} = m(H_2)_{theoretical}$ x percentage yield

$$m(H_2)_{actual} = 1,5 \times \frac{80}{100} \checkmark$$

$m(H_2)_{actual} = 1,2\ g$ ✓ (6)

[15]

TOTAL: 100