KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES P1

FINAL EXAMINATION

NOVEMBER 2023

MARKS: 100

DURATION: 2 hours

This question paper consists of 11 pages and a data sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT 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 SHEET.
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 (1.1–1.5) in the ANSWER BOOK, for example 1.6 E.

1.1 If the distance between two consecutive compressions in a wave is decreased, which ONE of the following will INCREASE when the wave speed is kept constant?

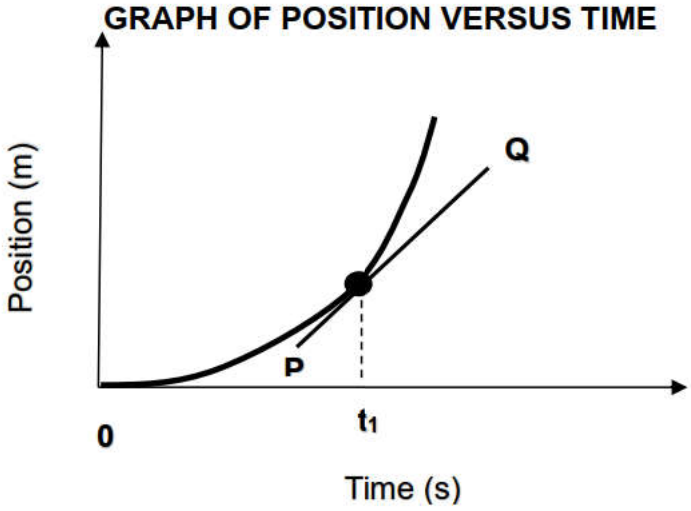
A Amplitude

B Period

C Frequency

D Wavelength (2)

1.2 The position-time graph for a car travelling along a straight horizontal surface is shown below.



Line PQ is a tangent to the curve at time t_1.
Which ONE of the following is equal to the gradient of **PQ**?

A Average velocity over the period 0 to t_1

B Instantaneous velocity at t_1

C Average acceleration over the period 0 to t_1

D Instantaneous acceleration at t_1 (2)

1.3 The kinetic energy of a trolley is E. What will the kinetic energy of the trolley be if its velocity is tripled?

A 3 E

B ⅓ E

C 6 E

D 9 E (2)

1.4 The table below shows the changes in the velocity of a car in intervals of 4 seconds.

Time (s)	0	4	8	12	16	20	24	28	32
Velocity ($m.s^{-1}$)	0	7	14	21	28	28	28	28	28

Which ONE of the following is CORRECT for the acceleration of the car?
The acceleration of the car …

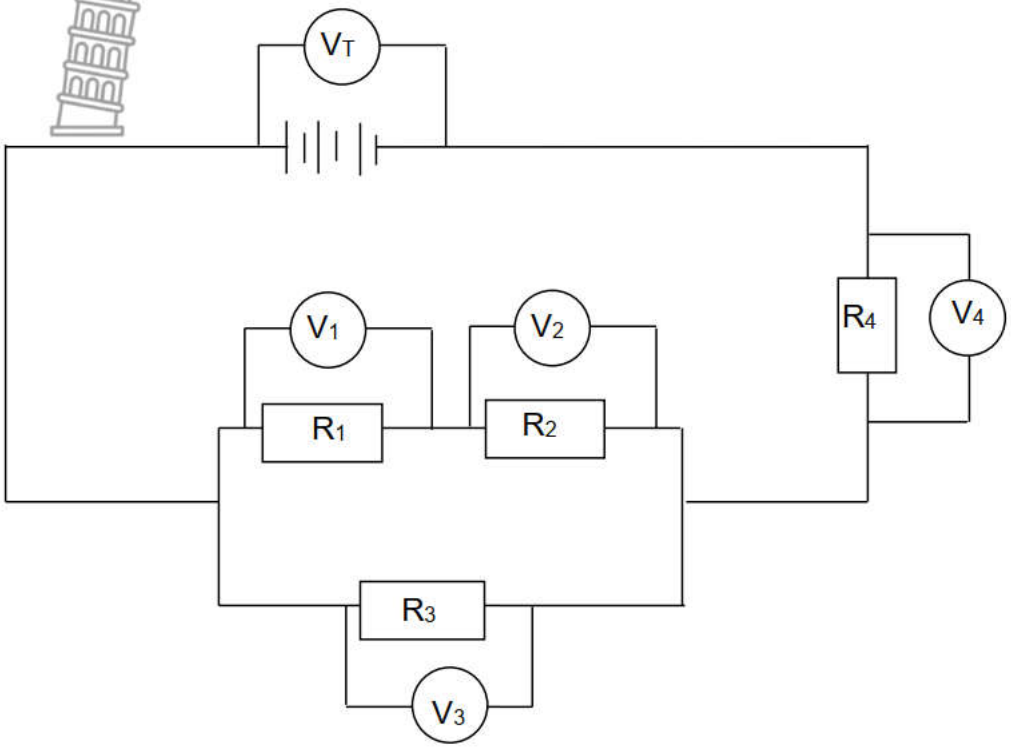
A increases initially for 16 s then remains constant.

B is initially constant for 16 s then becomes zero.

C is initially constant for 16 s and then decreases.

D increases initially for 16 s and then becomes zero. (2)

1.5 Four identical resistors are connected as shown in the circuit diagram below. Which ONE of the following relationships is correct for the readings on the voltmeters?



A $V_1 = V_2 = V_3$

B $V_T = V_1 + V_2 + V_3 + V_4$

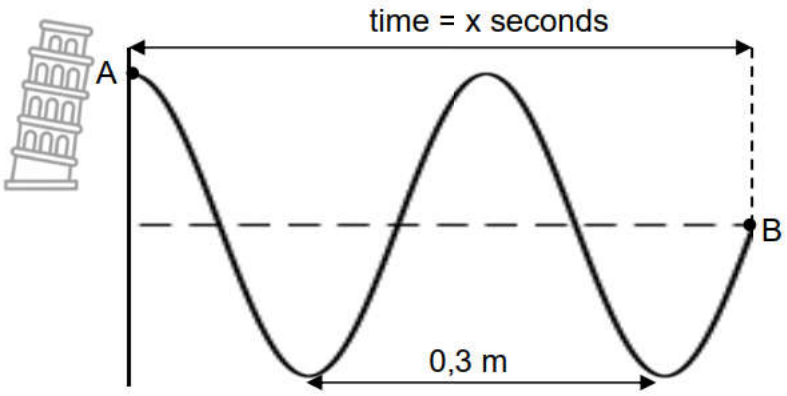
C $V_T = V_3 + V_4$

D $V_1 = V_3$ (2)

[2 X 5 = 10]

QUESTION 2 (Start on a new page.)

2.1 A section of a wave is represented below.



The frequency of the wave is 2,5 Hz.

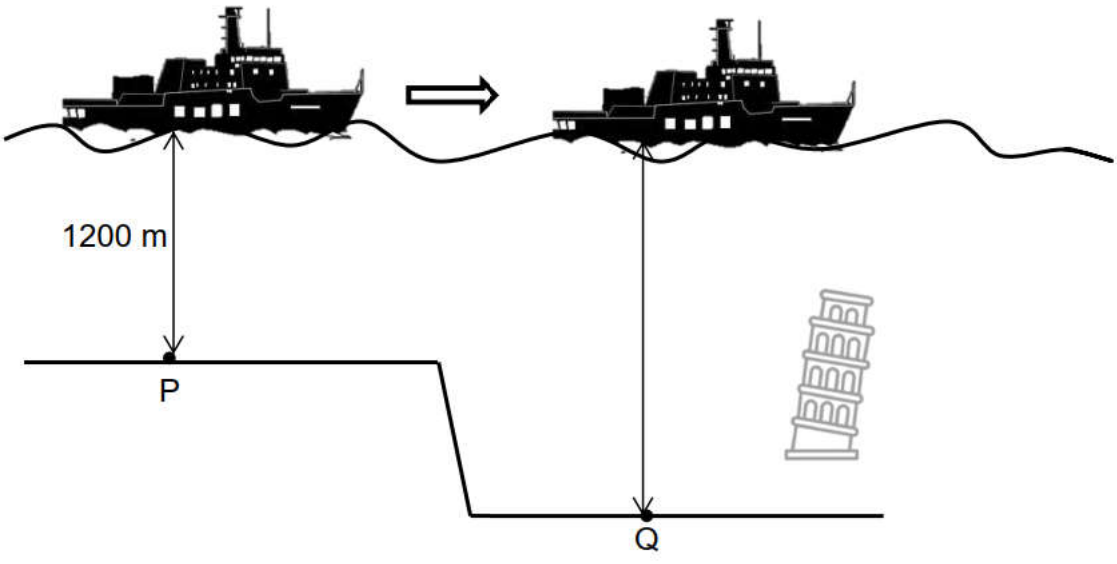
2.1.1 Is the above wave TRANSVERSE or LONGITUDINAL? (1)

2.1.2 Calculate the speed of the wave. (3)

2.1.3 Determine the **time, "x"**, between point A and point B on the graph. (3)

2.2 Ships use Sonar (Sound Navigation and Ranging) to map and measure the depth of the ocean at different points. This is achieved by emitting sound waves into the sea and detecting the reflected sound.

The sound wave emitted by the Sonar on a ship takes 0,8 seconds to reach point P, which is on the seabed 1200 m below the ship. Q is a second point on the seabed, as shown in the diagram below.



2.2.1 Calculate the speed of sound in seawater at point P. (3)

It is estimated that the speed of sound in seawater increases by 4,5 $m.s^{-1}$ for every 1°C increase in temperature.

2.2.2 The temperature of the seawater at point Q is 2°C higher than at point P. When a sound wave is emitted directly above point Q, the reflected sound wave is detected 2,5 seconds later.

Determine the depth of the sea at point Q. (4)

[14]

QUESTION 3 (Start on a new page.)

A photon of wavelength 2 x 10^{-7} m is located within the x-ray range of the electromagnetic spectrum.

3.1 Write down the speed of this photon in a vacuum. (1)

3.2 Calculate:

3.2.1 The frequency of the photon. (3)

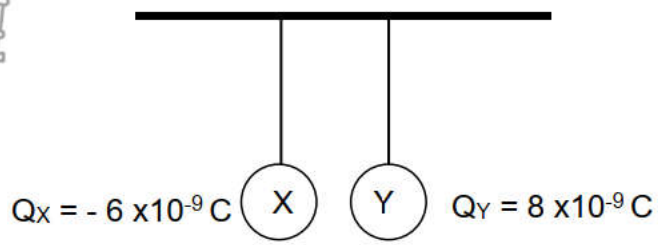
5.3.2 The energy of the photon. (3)

3.3 The wavelength of the photon is doubled. Will the penetrating ability of this photon INCREASE, DECREASE or REMAIN THE SAME?
Explain the answer. (3)

[10]

QUESTION 4 (Start on a new page.)

Two small identical Spheres, X and Y, carrying charges of **– 6 x 10 $^{-9}$ C** and **8 x 10 $^{-9}$ C** respectively, are suspended from a ceiling by means of light, insulated strings.



4.1 State the *principle of quantization of charge*. (2)

4.2 Calculate the difference between the number of protons and electrons in Sphere X. (3)

The spheres are brought into contact and are then separated.

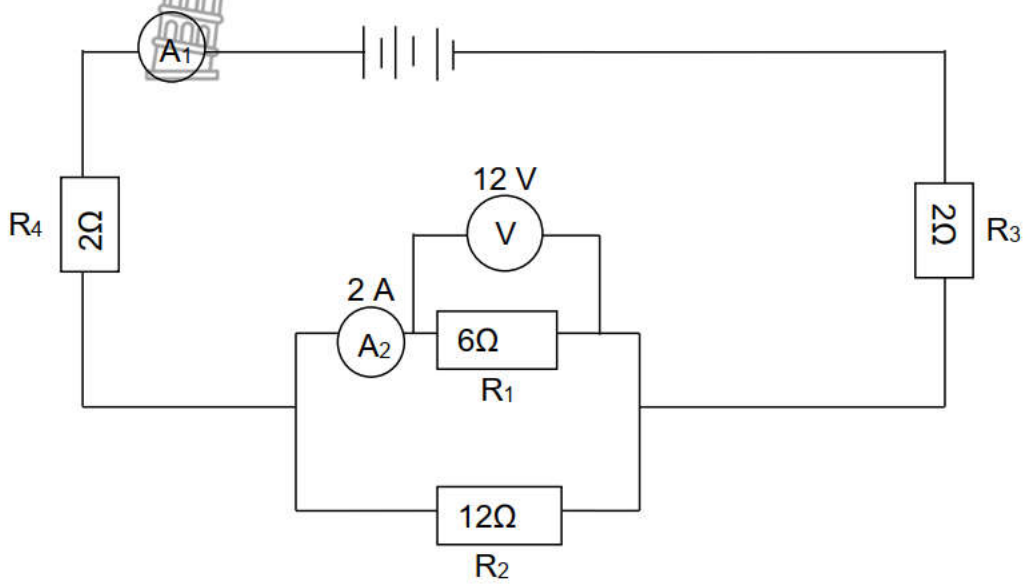
4.3 State the *principle of conservation of charge*. (2)

4.4 Calculate the new charge on Sphere Y. (3)

[10]

QUESTION 5 (Start on a new page)

A battery consisting of 3 identical cells of unknown emf is connected to four resistors, as shown in the circuit diagram below.



The voltmeter reads 12 V, while ammeter A_2 reads 2 A.

5.1 Define *the emf of a battery* in words. (2)

5.2 Calculate the:

5.2.1 Effective resistance of the parallel combination (3)

5.2.2 The reading on ammeter A_1 (3)

5.2.3 Energy transferred to the resistor R_3 in 2 minutes (5)

5.2.4 EMF of each cell (3)

5.3 A fifth resistor, R_5, is now connected in parallel to R_4.

5.3.1 Will the emf of the battery INCREASE, DECREASE OR REMAIN THE SAME? (1)

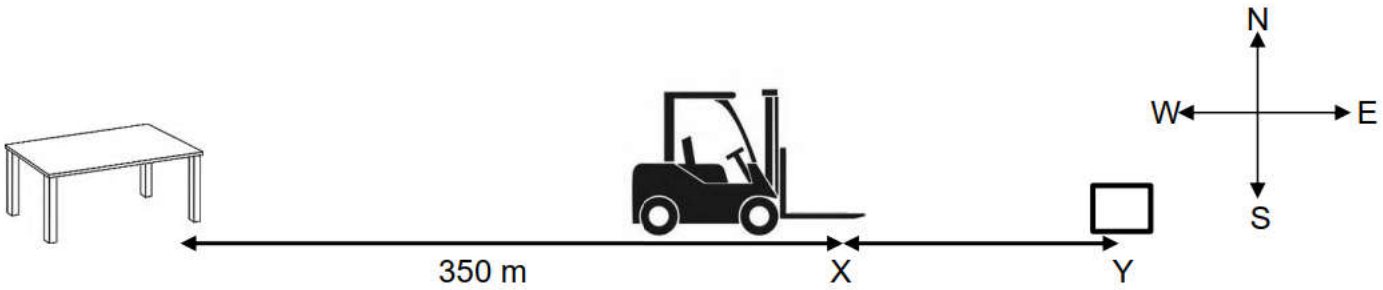
5.3.2 Will the reading on A_1 INCREASE, DECREASE OR REMAIN THE SAME?
Give a reason for the answer. (2)

[19]

QUESTION 6 (Start on a new page)

A forklift starting from Point X needs to pick up a package from Point Y, which is due east from Point X.

The package is thereafter transported to a table, which lies 350 metres due west of Point X. The entire trip takes the driver 2 minutes to complete.



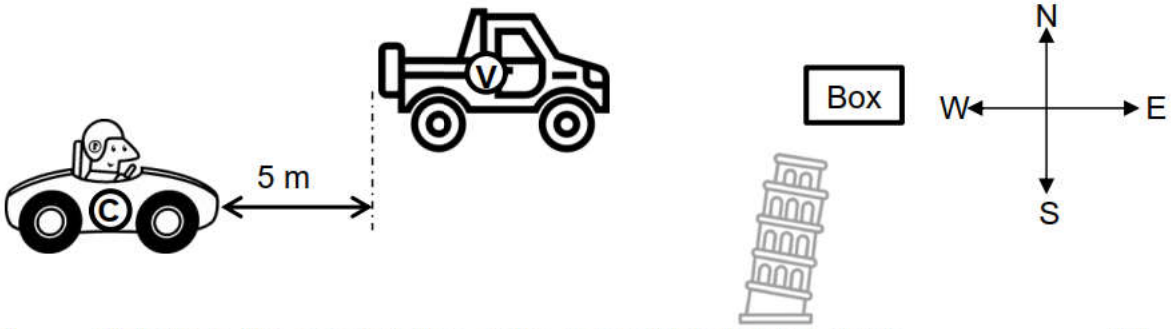
6.1 Define the term *average velocity* in words. (2)

6.2 Calculate the average velocity of the forklift for the entire motion. (3)

6.3 The average speed of the forklift is 3,75 $m \cdot s^{-1}$.
Determine the position of Point Y relative to Point X. (4)
[9]

QUESTION 7 (Start on a new page)

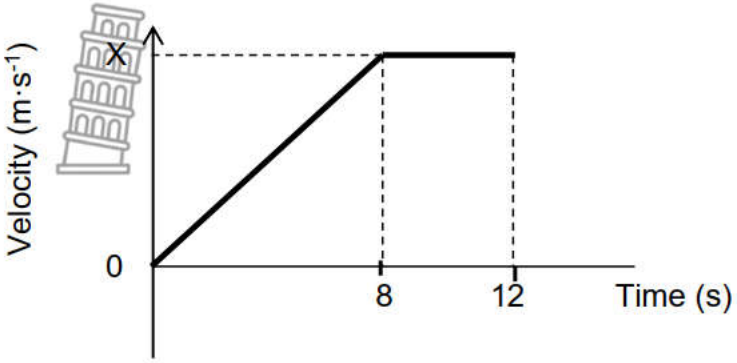
7.1 A car C and a van V are both travelling at a constant velocity of 25 $m.s^{-1}$ east, on different lanes along the same horizontal road. The driver of the car follows the van, keeping a distance of 5 metres between them. Seeing a box on his lane, the driver of the van brakes and slows down uniformly to stop in 5 seconds.



7.1.1 Calculate the acceleration of the van whilst slowing down. (3)

7.1.2 If the car continued at its original motion, how far ahead of the van will the car be when the van stops? (5)

7.2 After passing the box, the van takes off from rest and accelerates uniformly at $4 m \cdot s^{-2}$ for 8 seconds. It thereafter travels at a constant velocity of X $m \cdot s^{-1}$ for a further 4 seconds as shown in the graph below. (3)

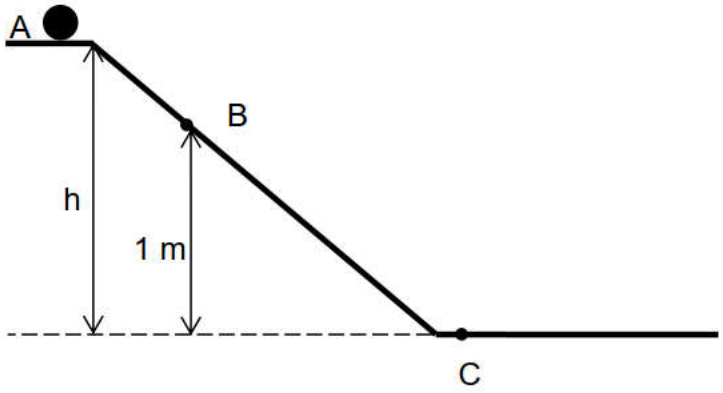


7.2.1 USE THE GRAPH to determine the value of X. (3)

7.2.2 Sketch the acceleration vs time graph for the 12 seconds represented in the graph above.
Indicate the relevant time and acceleration values on the graph. (3)
[17]

QUESTION 8 (Start on a new page)

A 4kg steel ball is pushed from rest from the top of a frictionless ramp of unknown height, **h** at point A. It passes point B, which is 1 metre above the ground at a velocity of 5,422 $m \cdot s^{-1}$. The ball eventually reaches the ground at point C.



8.1 Calculate the mechanical energy of the ball. (4)

The magnitude of the velocity doubles as the ball rolls from Point A to Point C.

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

8.3 Determine the height h of the ramp. (5)
[11]

TOTAL: 100

DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

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

TABLE 2: FORMULAE

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WAVES, SOUND AND LIGHT

$v = f\lambda$ or $c = f\lambda$	$T = \frac{1}{f}$
E = hf	$E = \frac{hc}{\lambda}$

ELECTROSTATICS

$Q = n \times q_e$	$Q = \frac{Q1 + Q2}{2}$

ELECTRIC CIRCUITS

$Q = I \times \Delta t$	$\frac{1}{Rp} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots.$
$R_s = R_1 + R_2 + \cdots$	$V = \frac{W}{Q}$

MOTION

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

WORK, ENERGY AND POWER

U = mgh or E_p = mgh	$K = {}^1/_2\, mv^2$ or $E_k = {}^1/_2\, mv^2$

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QUESTION 1:

1.1 C ✓✓ (2)
1.2 B ✓✓ (2)
1.3 D ✓✓ (2)
1.4 B ✓✓ (2)
1.5 C ✓✓ (2)
[10]

QUESTION 2

2.1 2.1.1 Transverse wave ✓ (1)

2.1.2 $v = f \times \lambda$ ✓
$= 2,5 \times 0,3$ ✓
$= 0,75\ m \cdot s^{-1}$ ✓ (3)

2.1.3

OPTION 1

$T = \frac{1}{f} = \frac{1}{2,5}$

$= 0,4\ s$
time = 0,4 ✓ x 1,75 ✓
time = 0,7 (s) ✓

OPTION 2

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

$0,75 ✓ = \frac{0,525 ✓}{x}$

$x = 0,7\ (s)$ ✓

(3)

2.2

2.2.1 $speed = \frac{distance}{time}$ ✓

$= \frac{1200}{0,8}$ ✓

$= 1500\ m \cdot s^{-1}$ ✓ (3)

2.2.2 **POSITIVE MARKING FROM QUESTION 2.2.1**

speed = 1500 + 2 x 4,5 ✓

speed = 1509 $m.s^{-1}$

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

$1509 ✓ = \frac{distance}{1,25 ✓}$

Distance = 1886,25 m ✓ (4)
[14]

QUESTION 3

3.1 3×10^8 m.s^{-1} ✓ (1)

3.2

3.2.1 $c = f \times \lambda$ ✓.
$3 \times 10^8 = f \times 2 \times 10^{-7}$ ✓.
$f = 1,5 \times 10^{15}$ Hz ✓ (3)

3.2.2

OPTION 1	**OPTION 2**
$E = h \times f$ ✓.	$E = \frac{hc}{\lambda}$ ✓
$= 6,63 \times 10^{-34} \times 1,5 \times 10^{15}$ ✓.	$= \frac{6,63 \times 10^{-34} \times 3 \times 10^8}{2 \times 10^{-7}}$ ✓
$= 9,945 \times 10^{-19}$ J ✓.	$= 9,945 \times 10^{-19}$ J ✓.

(3)

3.3 Decrease. ✓
The energy of the photon will decrease OR Energy of the photon is inversely proportional to the wavelength. ✓
A decrease in the energy of the photon decreases the penetrating ability ✓ (3)
[10]

QUESTION 4

4.1 All charges in the universe consist of an integer multiple ✓ of the charge of one electron ✓ (2)

4.2 $Q = n \times q_e$ ✓
$6 \times 10^{-9} = n \times 1,6 \times 10^{-19}$ ✓
$n = 3,75 \times 10^{10}$ ✓ (3)

4.3 The net charge of an isolated system✓ remains constant✓ (during any physical process). (2)

4.4 $Q = \frac{Q1 + Q2}{2}$ ✓

$Q = \frac{-6 \times 10^{-9} + 8 \times 10^{-9}}{2}$ ✓

$= 1 \times 10^{-9}$ C ✓ (3)
[10]

QUESTION 5

5.1 The work done per unit charge ✓ by the source (battery) ✓ (2)

5.2

5.2.1 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{6} + \frac{1}{12}$ ✓

$R_p = 4\ \Omega$ ✓ (3)

5.2.2

Using Ratio	Using Ohms Law
$I_{12\Omega} = ½\ I_{6\Omega}$	$V = IR$
$= ½\ (2)$ ✓	$12 = I \times 12$ ✓
$= 1A$	$I = 1\ A$
$I_{tot} = 1 + 2$✓	$I_{tot} = 1 + 2$✓
$= 3A$ ✓	$= 3A$ ✓

(3)

5.2.3 **POSITIVE MARKING FROM 5.2.2**

OPTION 1		OPTION 2
$V_{R3} = ½\ (12)$ ✓	**OR** $V = IR$	$W = I^2 R\Delta t$ ✓
$= 6V$	$= 3 \times 2$ ✓	$= 3^2$ ✓$\times 2$ ✓ $\times 120$ ✓
	$= 6V$	$= 2160\ J$ ✓
$Q = I\ \Delta t$		
$= 3 \times 120$ ✓		
$= 360\ C$		
$W = V\ Q$ ✓		
$= 6 \times 360$ ✓		
$= 2160\ J$ ✓		

(5)

5.2.4 EMF of Battery = 12 + 6 + 6 ✓

= 24 V

EMF of ONE CELL = 24 ÷ 3 ✓

= 8 V ✓ (3)

5.3

5.3.1 Remain the same ✓ (1)

5.3.2 Increase ✓

The total resistance decreases. ✓ (2)

[19]

QUESTION 6

6.1 The rate of change of position ✓✓ (2)

6.2 $v = \frac{\Delta x}{\Delta t}$ ✓

$v = \frac{350}{120}$ ✓

$v = \underline{2,92 \text{ m.s}^{-1} \text{ west}}$ ✓ (3)

6.3 $\text{speed} = \frac{\text{distance}}{\text{time}}$

$3,75 = \frac{\text{distance}}{120}$ ✓

distance = 450 m

450 = 2XY + 350 ✓

Distance from point X to Point Y = 50 m

Position of Point Y = 50 m ✓ east ✓ (4)

[9]

QUESTION 7

7.1.1

OPTION 1	**OPTION 2**
$a = \frac{\Delta v}{\Delta t}$ ✓	$v_f = v_i + a\Delta t$ ✓
$= \frac{0 - 25}{5}$ ✓	$0 = 25 + a(5)$ ✓
$= -5 \text{ m.s}^{-2}$	$a = -5 \text{ m.s}^{-2}$
$= \underline{5 \text{ m.s}^{-2} \text{ west}}$ ✓	$= \underline{5 \text{ m.s}^{-2} \text{ west}}$ ✓

(3)

7.1.2 Van

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

$\Delta x = \left(\frac{0 + 25}{2}\right) \times 5$ ✓

$\Delta x = 62,5$ m

Car

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

$\Delta x = 25 \times 5 + \frac{1}{2} \times 0 \times 5^2$ ✓

= 125 m

POSITIVE MARKING FROM Q7.1.2

$= 25(5) + \frac{1}{2}(-5)(5)^2$ ✓

= 62,5 m

OR $\Delta x = v_i\Delta t$

$\Delta x = 25 \times 5$ ✓

= 125 m

Distance between vehicles = 125 – 62,5 – 5 ✓

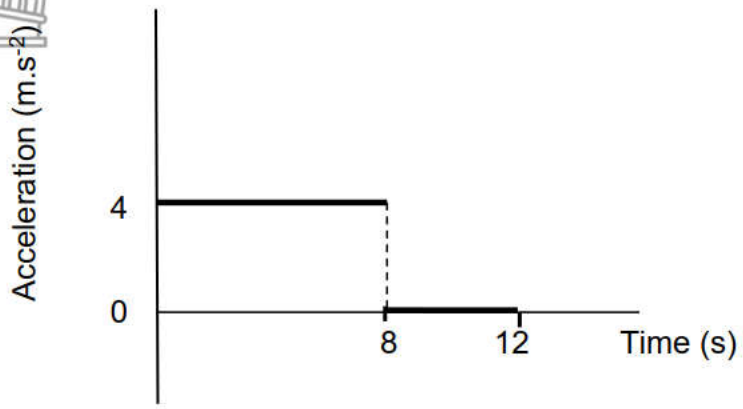
= 57,5 m ✓ (5)

7.2.1 $a = \frac{y_2 - y_1}{x_2 - x_1}$

$4 \checkmark = \frac{X - 0}{8 - 0}$ ✓

$X = 32\ m \cdot s^{-1}$ ✓ (3)

7.2.2 (3)



Marking Criteria
1 Mark – Horizontal line at 4 $m.s^{-2}$ from 0 to 8 seconds
1 Mark – Horizontal line at 0 $m.s^{-2}$ from 8 to 12 seconds
1 Mark – Shape (2 parallel horizontal lines that are disjointed) (3)

[17]

QUESTION 8

8.1 $E_T = mgh + ½mv^2$ ✓
$= \underline{4 \times 9.8 \times 1}$ ✓ + $\underline{½ \times 4 \times (5.422)^2}$ ✓
$= 98$ J ✓ (4)

8.2 The total mechanical energy in an isolated system remains constant. ✓✓ (2)

8.3 **POSITIVE MARKING FROM 8.1**

Point C
$E_T = mgh + ½mv^2$
98 ✓ $= 0 + ½ \times 4 \times v^2$ ✓
$v = 7\ m \cdot s^{-1}$

Point A
$v = 7 \div 2 = 3{,}5\ m \cdot s^{-1}$ ✓
$E_T = mgh + ½mv^2$
$\underline{98 = 4 \times 9{,}8 \times h + ½ \times 4 \times 3{,}5^2}$ ✓
$h = 1{,}875$ m ✓ (5)

[11]

TOTAL: 100