YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME	

CG		INDEX NUMBER	

PHYSICS **8867/02**

Paper 2 Structured Questions **2 September 2020**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer **one** question.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Paper 2	
Section A	
1	**/8**
2	**/6**
3	**/10**
4	**/9**
5	**/11**
6	**/16**
Section B	
7	**/20**
Penalty	
Paper 2 Total	
	/80

This document consists of **18** printed pages and **2** blank pages.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
the Avogadro constant	N_A	=	6.02×10^{23} mol^{-1}
gravitational constant	G	=	6.67×10^{-11} N m^{2} kg^{-2}
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
resistors in series	R	=	$R_1 + R_2 + \ldots\ldots\ldots$
resistors in parallel	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$

Section A

Answer **all** the questions in this section.

1 A uniform plank AB of length 5.0 m and weight 200 N is placed across a stream, as shown in Fig. 1.1.

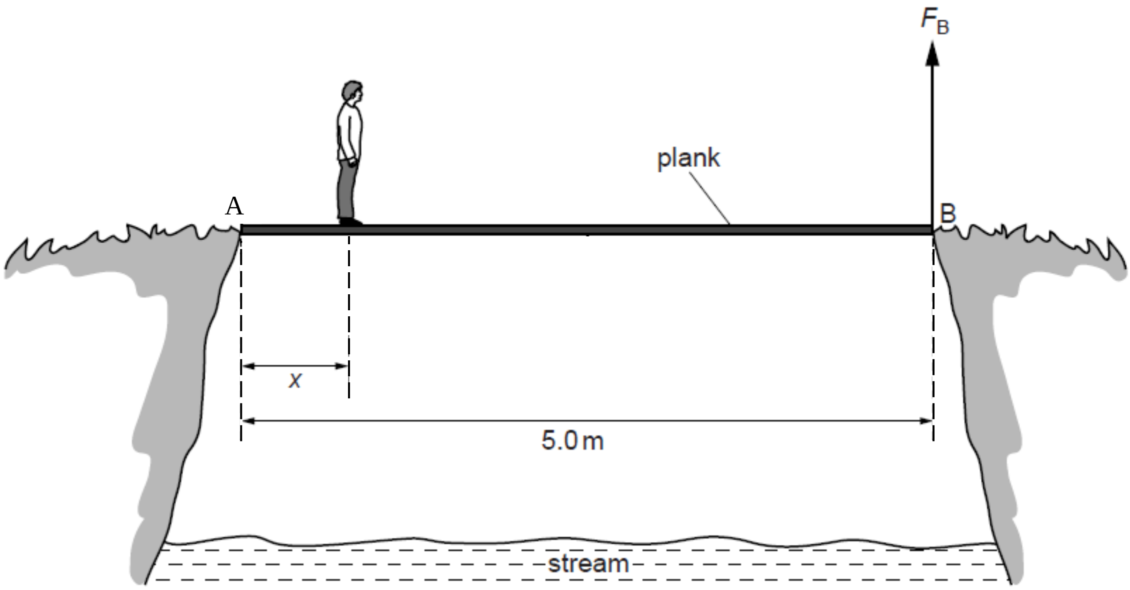

Fig. 1.1

A man of weight 880 N stands at a distance x from end A. The ground exerts a vertical force F_B on the plank at end B. As the man moves along the plank, the plank is always in equilibrium.

(a) **(i)** Draw all other forces on the plank and label them clearly. [3]

(ii) Define *moment of a force*.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(iii) The man stands at a distance x = 0.50 m from end A. Calculate the magnitude of F_B.

F_B = ………………….. N [2]

(b) If the plank is not uniform and the centre of gravity is nearer to point B, explain why the magnitude of F_B will increase.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

[Total: 8]

2 Fig. 2.1 shows an archer with a bow.

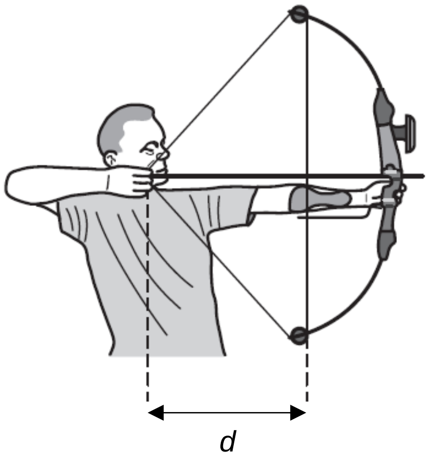

Fig. 2.1

The force *F* required to bend the bow and the corresponding displacement *d* of the arrow are measured. A plot of *F* against *d* is shown in Fig. 2.2.

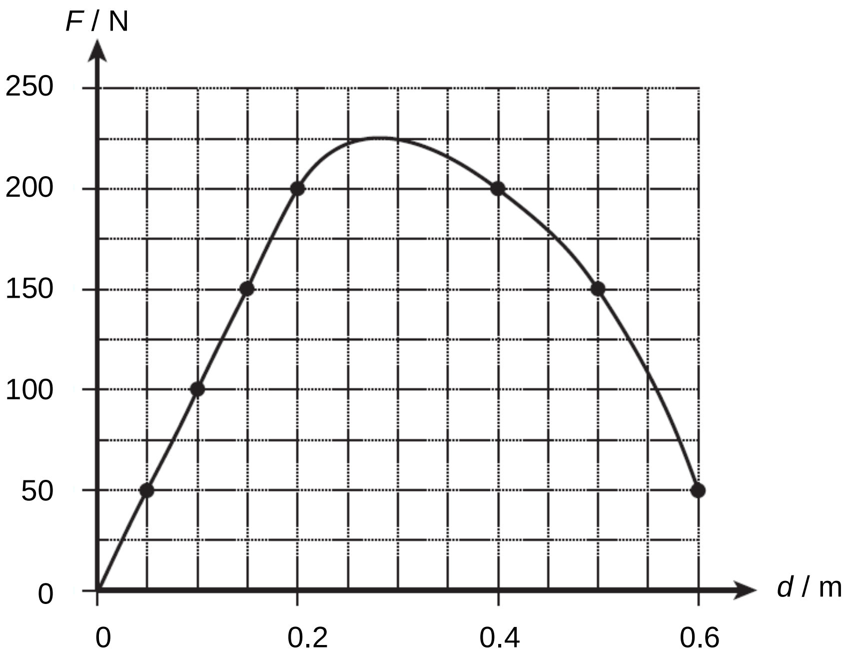

Fig. 2.2

(a) An experienced archer is able to draw an arrow further back, resulting in a greater displacement of arrow, *d*, as compared to a novice archer.

Using Fig. 2.2 and the principle of conservation of energy, suggest an advantage that this extra displacement provides.

……

……

……

……

………………………………………………………………………………………………… [2]

(b) **(i)** Using Fig. 2.2, estimate the elastic potential energy stored in the bow when an arrow is displaced by 0.50 m.

elastic potential energy = ………………………… J [2]

(ii) The arrow in **(b) (i)** is then released by the archer from the bow.

Determine the maximum speed of the arrow which has a mass of 3.5×10^{-2} kg.

maximum speed = ………………………… m s^{-1} [2]

[Total: 6]

3 **(a)** Explain qualitatively why a body which is travelling in circle with constant speed experiences an acceleration towards the centre of the circle.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) A toy plane has a mass of 0.40 kg as shown in Fig. 3.1, and a taut wire of length 5.0 m attached to it when it flies in a horizontal circle. The taut wire is inclined 60° to the horizontal and fixed to a point O. The wings of the toy plane are horizontal, creating a vertical upward lift on the plane.

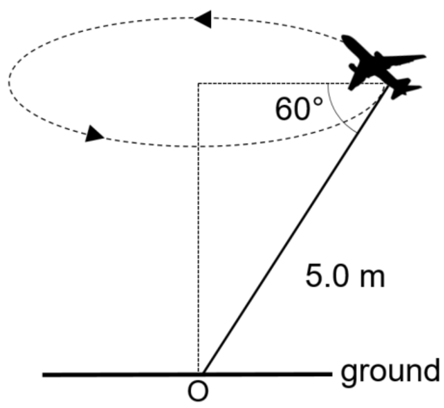

Fig. 3.1

(i) If each revolution takes 3.5 s, determine the centripetal acceleration of the toy plane.

centripetal acceleration = ………………………… m s^{-2} [2]

(ii) Calculate the tension T in the taut wire.

T = ………………………… N [2]

(iii) Hence calculate the upward lift L on the toy plane due to the air.

L = ………………………… N [2]

(iv) In another arrangement, the taut wire is now fixed to a point O attached to the ceiling with the toy plane flying in a horizontal circle as shown in Fig. 3.2.

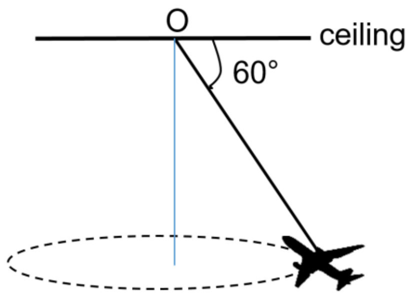

Fig. 3.2

Given that the magnitude of tension in wire remains unchanged, discuss how your answer to **(b) (iii)** will change if the wings of the toy plane are horizontal and the wire remaining at 60° to the horizontal.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

[Total: 10]

4 A battery of electromotive force (e.m.f.) E and internal resistance 1.5 Ω is connected to a network of resistors, as shown in Fig. 4.1.

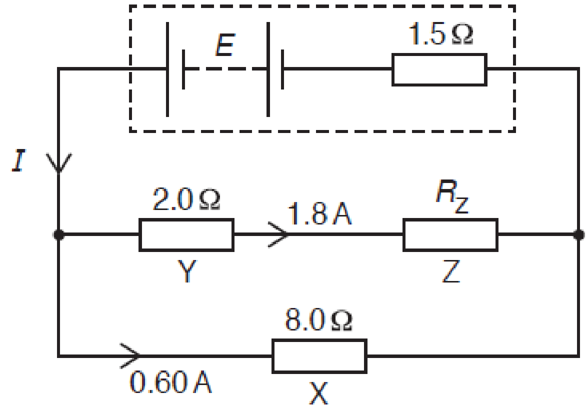

Fig. 4.1

Resistor X has a resistance of 8.0 Ω. Resistor Y has a resistance of 2.0 Ω. Resistor Z has a resistance of R_Z. The current in X is 0.60 A and the current in Y is 1.8 A.

(a) Calculate

(i) the current I in the battery,

I = ... A [1]

(ii) resistance R_Z and

R_Z = ... Ω [2]

(iii) e.m.f. *E*.

E = ………………………… V [2]

(b) Resistors X and Y are each made of wire. The two wires have the same length and are made of the same metal.

Determine the ratio $\dfrac{\text{cross-sectional area of wire X}}{\text{cross-sectional area of wire Y}}$.

ratio = ………………………… [2]

(c) Determine the efficiency of the battery.

efficiency = ………………. [2]

[Total: 9]

5 An electron having charge $-q$ and mass m is accelerated from rest in a vacuum through a potential difference V. The electron then enters a region of uniform magnetic field of magnetic flux density B, as shown in Fig. 5.1.

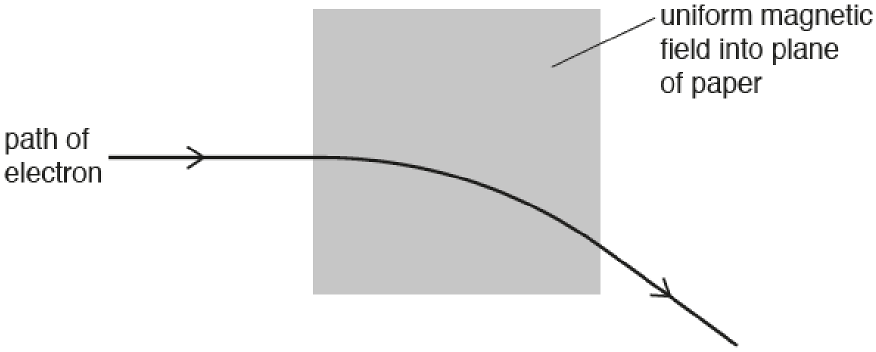

Fig. 5.1

The direction of the uniform magnetic field is into the plane of the paper.

The velocity of the electron as it enters the magnetic field is normal to the magnetic field.

The radius of the circular path of the electron in the magnetic field is r.

(a) Explain why the path of the electron in the magnetic field is the arc of a circle.

………

………

………

………

…………………………………………………………………………………………………… [2]

(b) Show that the magnitude p of the momentum of the electron as it enters the magnetic field is given by

$$p = \sqrt{(2mqV)}$$

[2]

(c) The potential difference V is 120 V. The radius r of the circular arc is 7.4 cm.

Determine the magnitude B of the magnetic flux density. Explain your working.

B = ………………………… T [4]

(d) The potential difference V in **(c)** is increased. The magnetic flux density B remains unchanged.

Explain the effect of this increase on the radius r of the path of the electron in the magnetic field.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [3]

[Total: 11]

6 While investigating projectile motion, a student used stroboscopic photography to determine the position of a steel ball at regular intervals as it fell under gravity. With the stroboscope flashing 20 times per second, the ball was released from rest at the top of an inclined track, and left the foot of the track at P, as shown in Fig. 6.1.

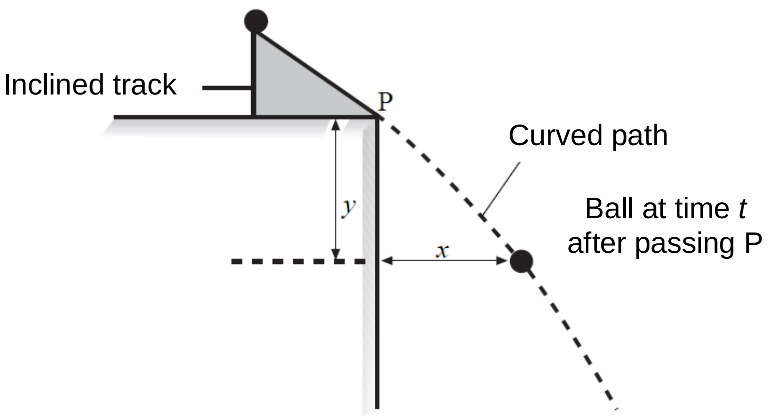

Fig. 6.1

For each of the images on the photograph, the student calculated the horizontal distance x, and the vertical distance y, covered by the ball at time t after passing P. Both distances were measure from point P. He recorded his results for the distances x and y in Table 6.2 below.

Image	x/ cm	y/ cm	t/ s	$\frac{y}{t}$ / cm s^{-1}
1	11.6	9.3	0.05	
2	22.0	21.0	0.10	
3	32.4	35.0	0.15	
4	44.2	51.8	0.20	
5	54.8	71.0	0.25	
6	66.0	92.2	0.30	

Table 6.2

(a) Using two sets of measurements from the table, calculate the horizontal component of the velocity of the ball. Give a reason for your choice of measurements.

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) The student suggested that the variables y and t in the experiment could be represented by

$$\frac{y}{t} = u + kt$$

where *u* and *k* are constants

(i) Complete Table 6.2. [2]

(ii) Use the data in Table 6.2 to plot a graph of $\frac{y}{t}$ against *t* in Fig. 6.3. [2]

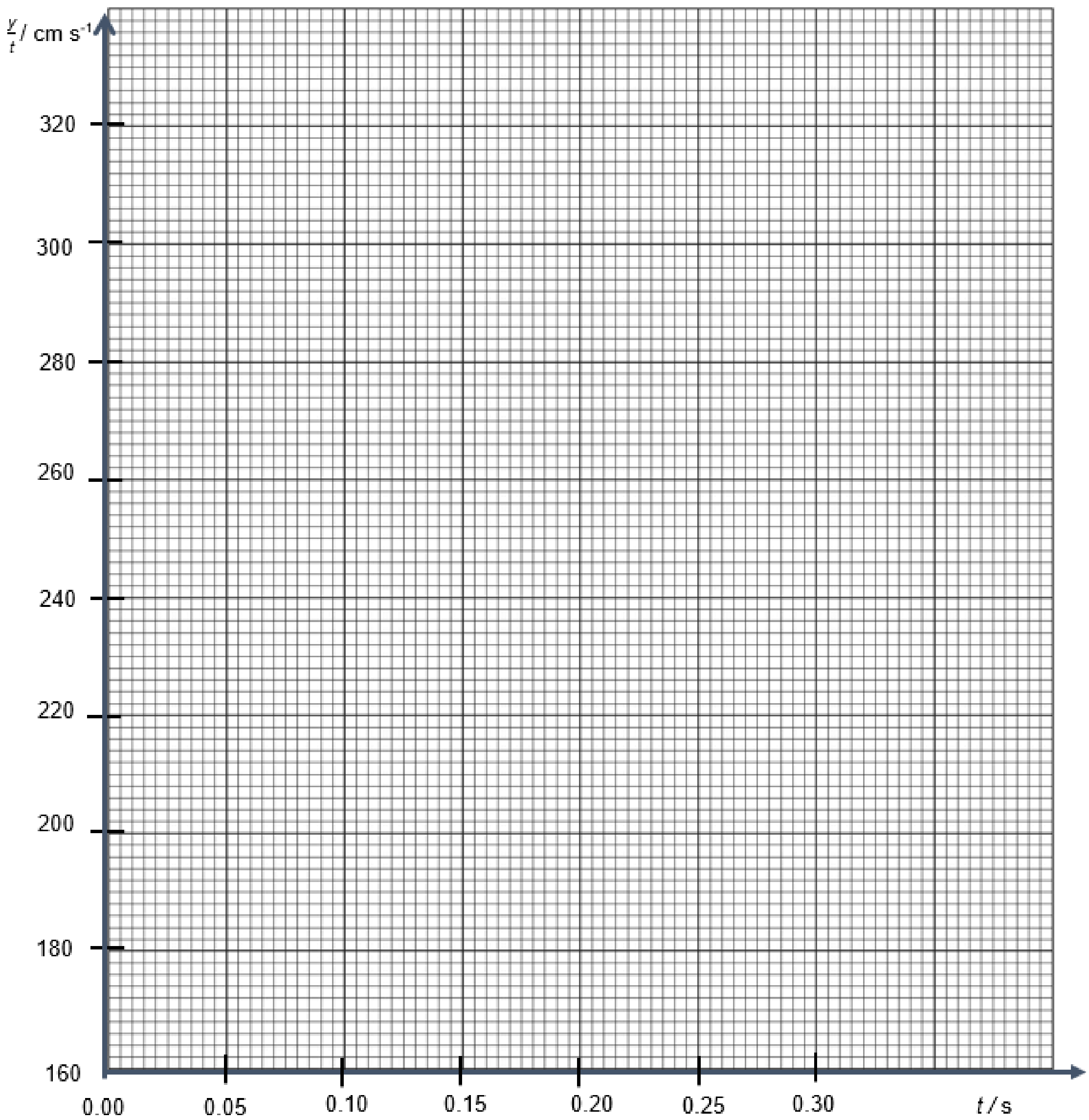

Fig. 6.3

(iii) Use your graph in Fig. 6.3 to find the values of *u* and *k*.
Include suitable units for your values.

u = ………………………… unit ………………………… [2]

k = ………………………… unit ………………………… [2]

(c) State the physical significance of

(i) u: …………………………………………………………………………… [1]

(ii) k: …………………………………………………………………………… [1]

(d) Calculate the magnitude of the velocity of the ball at point P.

velocity = ………………………… m s^{-1} [2]

(e) The student have different choices for the type of ball for the experiment.
Suggest why a steel ball is prefered for this experiment.

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

[Total: 16]

Section B
Answer **one** question from this section.

7 **(a)** **(i)** State the *principle of conservation of linear momentum*.

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) State the relationship between the change in linear momentum of an object, the constant force acting on the object, and the time for which the force acts.

[1]

(b) In a collision between two bodies A and B, the force that A exerts on B varies with time in the way as shown in Fig. 7.1.

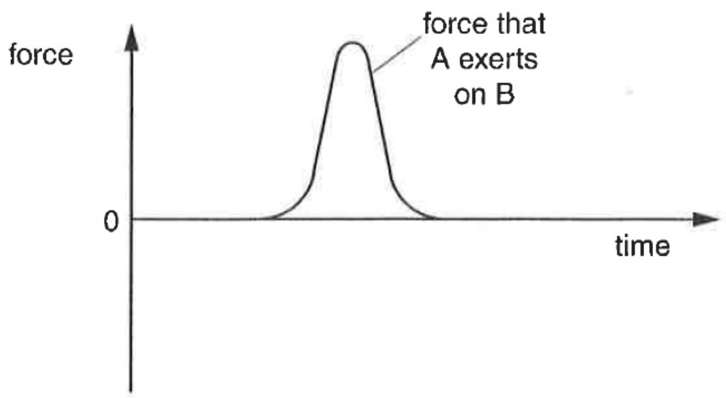

Fig. 7.1

(i) On Fig 7.1, sketch a graph of the force that B exerts on A. [2]

(ii) Explain your answer to **(b) (i)** and how it is consistent with the principle of conservation of momentum.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(c) In a head-on collision, a cargo truck of mass 12 000 kg runs into the back of a car of mass 1200 kg. A constant force of 72 000 N acts for 0.25 s.

(i) Explain what is meant by the term "*head-on collision*".

………………………………………………………………………………………….

……………………………………………………………………………………… [1]

(ii) Calculate the change in velocity of the vehicles and state whether it gains or loses momentum.

1. The car

change in velocity of car = ... m s^{-1} [2]

The car .... momentum. [1]

2. The truck

change in velocity of truck = ... m s^{-1} [1]

The truck .... momentum. [1]

(d) Suggest one way in which the conditions in **(c)** are unrealistic.

…………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

(e) Discuss how seat belts and air bags in a car ensure greater safety.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(f) In order to reduce the number of road traffic accidents, many countries conduct research into improving road safety.

(i) One area of research concerns braking distances. State two factors that may affect braking distances which might be investigated by the researchers.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

(ii) Suggest one other aspect of car safety that could be researched.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

[Total: 20]

- Blank Page -

- Blank Page -