Neap

Trial Examination 2020

VCE Physics Unit 3

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	10	10	10
B	14	14	80
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, pre-written notes (one folded A3 sheet or two A4 sheets bound together by tape) and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

Question and answer booklet of 22 pages

Formula sheet

Answer sheet for multiple-choice questions

Instructions

Please ensure that you write your **name** and your **teacher's name** in the space provided on this booklet and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

You may keep the formula sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

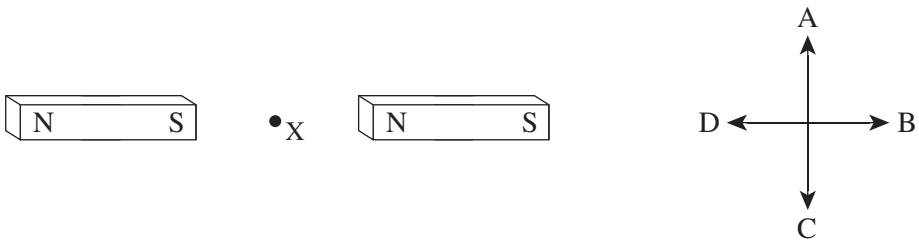
No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1

Two identical bar magnets are placed end to end, as shown below. Point X is midway between the bar magnets.

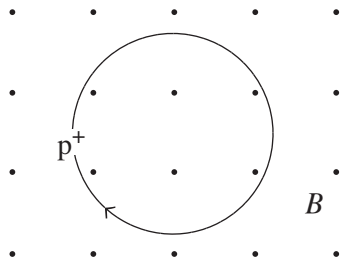


What is the direction of the magnetic field at point X?

A. A
B. B
C. C
D. D

Question 2

A proton moves in a circular path with radius r in magnetic field B as shown below.



The speed of the proton is then decreased.

Which row of the following table correctly shows the effects of this change in the radius of the path (r) and the force on the proton (F)?

	Effect on r	Effect on F
A.	increase	increase
B.	decrease	decrease
C.	increase	decrease
D.	decrease	increase

Question 3

Two electric charges are separated by a certain distance and experience a force of repulsion, F.

What is the new force if the distance between the two electric charges is decreased by a factor of 2 and both of the charges are doubled?

A. F
B. $2F$
C. $8F$
D. $16F$

Question 4

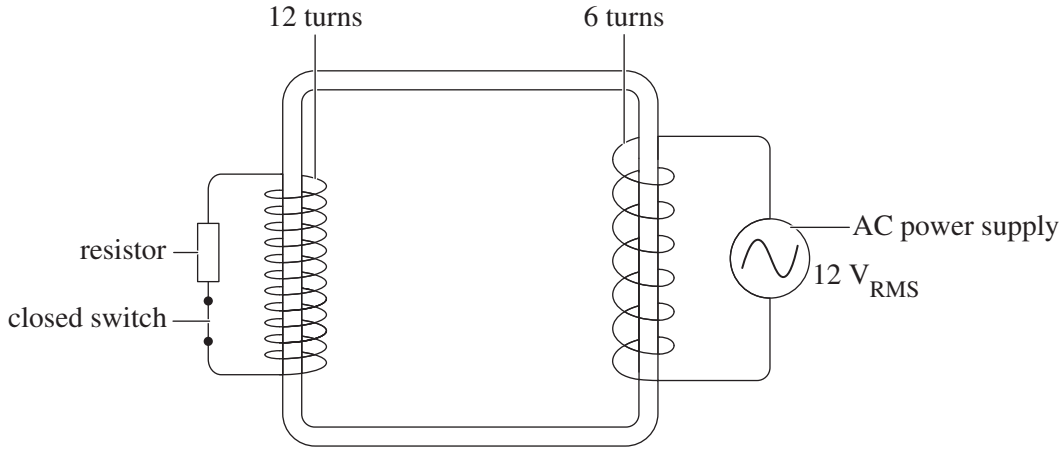
Saturn has many natural satellites, two of which are Helene and Rhea. Rhea, Saturn's second largest moon, has a mass of 2.3×10^{21} kg, an average orbital radius of 527 100 km and an orbital period of 4.5 days. Helene is smaller and has an average orbital radius of 377 400 km.

The average orbital period of Helene is

A. unable to be calculated because Helene's mass is not known.
B. 2.7 days.
C. 3.2 days.
D. 7.4 days.

Question 5

The following diagram shows a simple transformer circuit.

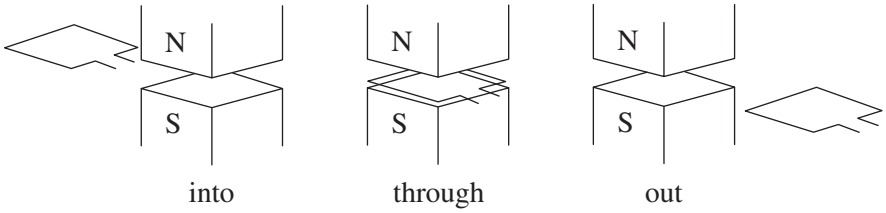


Which one of the following statements about the transformer circuit above is correct?

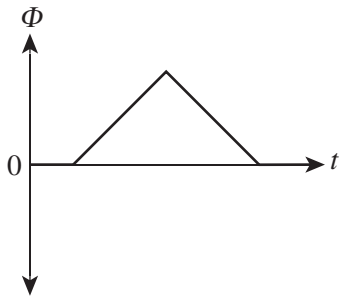
A. The transformer is a step-up transformer and the voltage on the secondary side is 6.0 V.
B. The transformer is a step-up transformer and the voltage on the secondary side is 24.0 V.
C. The transformer is a step-down transformer and the voltage on the secondary side is 6.0 V.
D. The transformer is a step-down transformer and the voltage on the secondary side is 24.0 V.

Question 6

Michaela and Amelia pass a square coil into, through and out of a magnetic field at a constant speed, as shown in the diagram below.

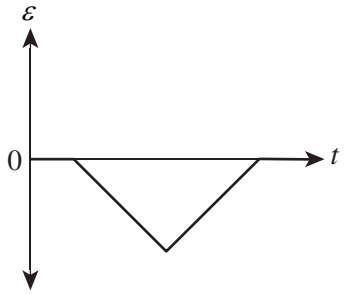


The graph below shows the change in magnetic flux (Φ) through the square coil as it passes into, through and out of the magnetic field as a function of time (t).

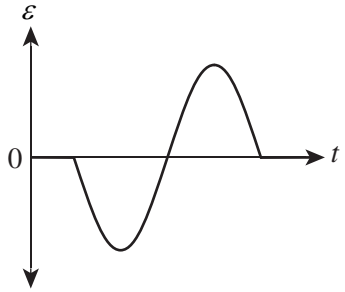


Which one of the following graphs best represents the induced EMF (ε) in the coil as it passes into, through and out of the magnetic field as a function of time (t)?

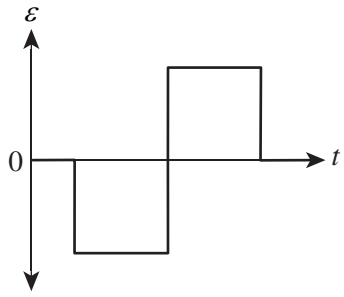
A.



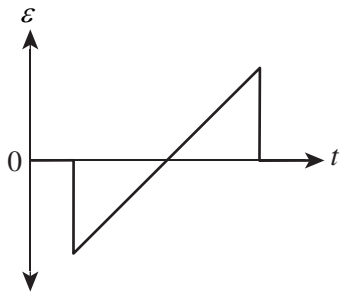
B.



C.

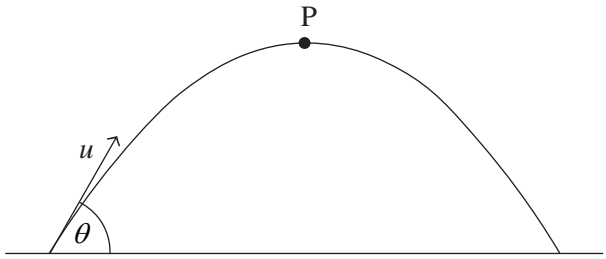


D.



Question 7

A golf ball is launched at a speed of 70.0 m s^{-1} at an angle of 30.0° to the horizontal, as shown in the diagram below. Point P is the highest point reached by the golf ball.



What is the speed of the ball at point P if air resistance is ignored?

A. 0.0 m s^{-1}

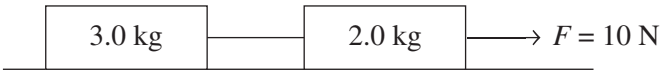
B. 35.0 m s^{-1}

C. 60.6 m s^{-1}

D. 70.0 m s^{-1}

Question 8

Two blocks joined by a string are pulled along a horizontal, frictionless bench by a force of 10 N, as shown in the diagram below.



What is the tension in the string joining the blocks?

A. 2.0 N

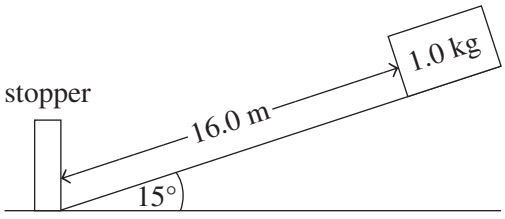
B. 4.0 N

C. 6.0 N

D. 10.0 N

Question 9

Ben and Bodie set up an inclined plane surface angled at 15° to the horizontal, as shown below.



They release a 1.0 kg block of wood at a distance of 16.0 m from the stopper. When the block is sliding down the incline, there is a constant frictional force between it and the surface. The block takes 16.0 s to reach the stopper at the bottom.

The magnitude of the frictional force of the plane surface acting on the block is closest to

A. 0.0 N

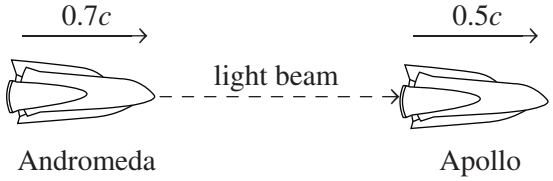
B. 0.5 N

C. 2.0 N

D. 2.4 N

Question 10

Two spaceships are travelling at relativistic speeds, as shown below. Spaceship Andromeda is travelling $0.7c$, where c is the speed of light. Spaceship Andromeda shines a light beam toward spaceship Apollo, which is travelling at $0.5c$.



What is the speed of the light beam according to an observer on spaceship Apollo?

A. c

B. $0.2c$

C. $0.5c$

D. $1.2c$

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Where an answer box is provided, write your final answer in the box.

If an answer box has a unit printed in it, give your answer in that unit.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1 (2 marks)

Figure 1 shows two equal negative stationary point charges placed near each other.

Figure 1

Sketch on Figure 1 the shape and direction of the electric field lines around the charges. Use at least **eight** field lines.

Question 2 (7 marks)

A single charged particle of magnitude 1.6×10^{-19} C moving North at 1.0×10^{6} m s^{-1} enters a region in which there is a 0.30 T field acting vertically downward into the page, as shown in Figure 2. The charged particle undergoes circular motion in a clockwise direction, as viewed from above.

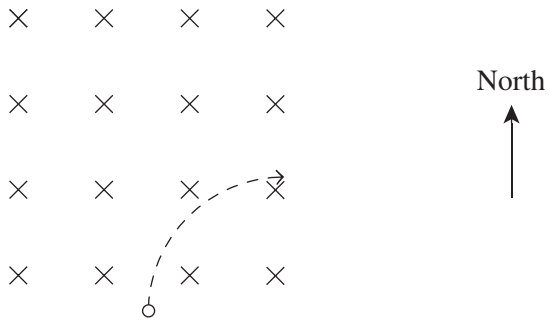


Figure 2

a. Explain why the path is circular in shape. 2 marks

_____

_____

_____

_____

b. Circle the word that best describes the nature of the particle and explain your reasoning. 3 marks

proton electron

_____

_____

_____

_____

_____

c. Calculate the force on the charge. 2 marks

_____

_____

_____

_____

N

Question 3 (7 marks)

Figure 3 shows two parallel metal plates separated by a distance of 5.00 mm. The voltage between the plates is 2.00×10^2 V and the top plate is positive.

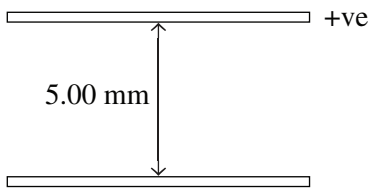


Figure 3

a. Calculate the electric field strength. 2 marks

_____

_____

_____

_____

	V m^{-1}

b. A charge of +1.50 μC is placed midway between the plates.
Calculate the force on the charge. Include a direction in your answer. 3 marks

_____

_____

_____

_____

N	

c. Calculate the work done by the field on the charge as it moves from the midpoint to the negative plate. 2 marks

_____

_____

_____

_____

	J

Question 4 (3 marks)

A charge of +10 μC is placed at point X between two +5 μC charges, as shown in Figure 4.

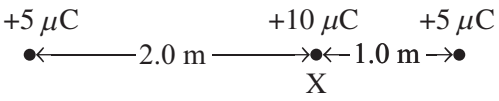


Figure 4

Find the magnitude and direction of the net force acting on the +10 μC charge at point X.

N	

Question 5 (9 marks)

a. What is the gravitational field strength at the centre of Mars? Explain your answer. 3 marks

N kg^{-1}

_____

_____

_____

_____

_____

b. A 'Mars day' is 37 minutes longer than an earth day.
Calculate the time in seconds for **one** Mars day. 1 mark

_____

_____

_____

s

In the year 2071 Ziqi is aboard the Mars International Space Station (MISS). MISS is in a geostationary orbit above Mars. The mass of Mars is 6.4×10^{23} kg.

c. What is the orbital radius of MISS? 3 marks

_____

_____

_____

_____

_____

_____

m

d. What is the origin of the net force acting on Ziqi while in orbit? 1 mark

_____

e. What is the direction of the net force acting on Ziqi while in orbit? 1 mark

_____

Question 6 (5 marks)

A DC motor of square coil ABCD with sides 10.0 cm consists of 100 turns. It is rotated in the field of a uniform permanent magnet of field strength 20 mT, as shown in Figure 5. The current in the square coil is 500 mA.

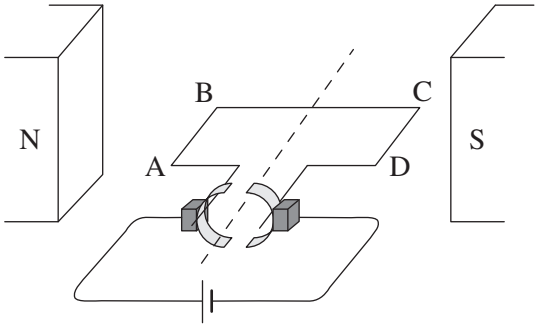


Figure 5

a. In the position shown, what is the magnitude of the net force on the arms AB? 2 marks

_____

_____

_____

_____

N

b. In the position shown, what is the magnitude of the net force on the arm BC? 1 mark

_____

_____

N

c. With reference to the external magnetic field and the effect of current in the coil, explain why there is a force on the side AB in the position shown. You may provide a diagram to support your answer. 2 marks

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_____

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Question 7 (8 marks)

A bar magnet is positioned near a coil of wire, which is wrapped around a tube of cardboard. The coil is connected to a resistor, as seen in Figure 6.

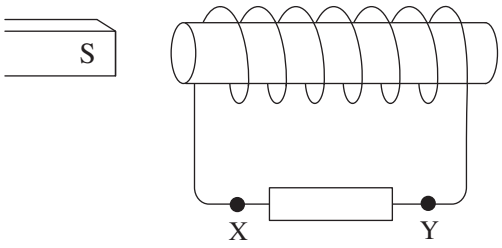

Figure 6

a. In which direction (X to Y, or Y to X) will a current flow through the resistor when the magnet moves towards the coil from the position shown? Justify your answer. 4 marks

b. What is the current produced when the magnet is held stationary inside the coil? Justify your answer. 2 marks

c. Identify **two** ways to increase the magnitude of the current through the resistor. 2 marks

Question 8 (10 marks)

Electric power from the Yallourn W power station is delivered to consumers in Melbourne as shown in Figure 7. The electric power has different voltages at different stages of transmission. The generator produces energy at a rate of 200 MW_{RMS} and an AC voltage of 20 kV_{RMS}. In the adjacent switchyard transformer, 20 kV_{RMS} is stepped up to 500 kV_{RMS} for transmission. The terminal station is 100 km away.

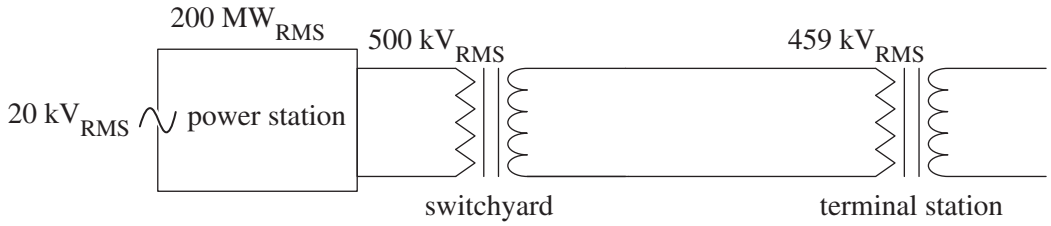

Figure 7

a. Calculate the value of $\frac{\text{number of turns on the secondary}}{\text{number of turns on the primary}}$ for the switchyard transformer. 2 marks

_____

_____

_____

_____

b. Show that the RMS current flowing in the transmission lines is 400 A. 2 marks

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_____

The voltage at the input to the terminal station is 495 kV_{RMS}.

c. What is the total resistance of the transmission lines? 3 marks

Ω

d. Why is the voltage stepped up from 20 kV_{RMS} to 500 kV_{RMS} before transmission to Melbourne? 3 marks

Question 9 (5 marks)

A golf ball is projected horizontally off a cliff into the sea below. The golf ball lands in the sea at a speed of 34.7 m s^{-1} at an angle of 81.7° to the horizontal, as shown in Figure 8.

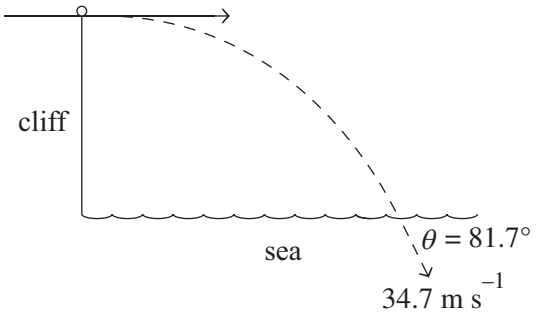

Figure 8

a. Calculate the total time of flight for the golf ball. 3 marks

s

b. Calculate the horizontal distance between the base of the cliff and the position where the golf ball hits the water. 2 marks

m

Question 10 (6 marks)

Lacrosse is a team sport played with a lacrosse stick and a lacrosse ball. The lacrosse stick is strung with loose netting that allows the ball to be caught. During a particular game, Lucas catches a 200 g ball travelling at 20.0 m s^{-1} with his stationary lacrosse stick, as shown in Figure 9.

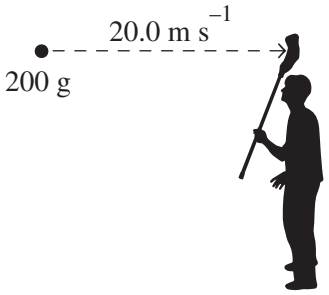

Figure 9

Immediately after the collision, the ball and stick move off together with a common velocity of 5.0 m s^{-1}.

a. Show that the mass of the lacrosse stick is 600 g. 3 marks

_____

_____

_____

_____

_____

_____

b. Is this an elastic or inelastic collision? Use appropriate calculations to support your answer. 3 marks

_____

_____

_____

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_____

_____

Question 11 (7 marks)

A 2.0 kg ball is held at rest on a compressed spring of length 1.50 m, as shown in Figure 10. When uncompressed, the spring is 2.00 m. The spring constant of the spring is 200.0 N kg^{-1}.

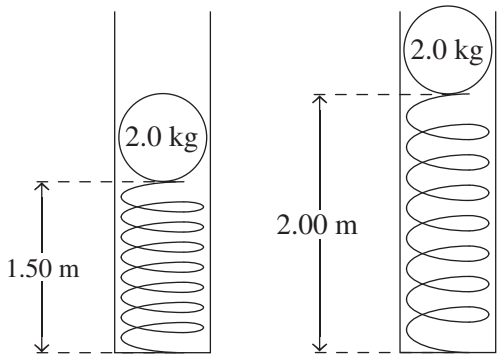

Figure 10

a. Show that the elastic potential energy stored in the compressed spring is 25.0 J. 2 marks

_____

_____

_____

_____

b. The spring is released.
Calculate the compression of the spring when the ball reaches maximum speed. 2 marks

_____

_____

_____

_____

_____

m

c. The ball is launched when the spring has returned to its natural length.

Calculate the speed at which the ball leaves the spring. Ignore any loss of energy due to heat and sound. 3 marks

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	m s^{-1}

Question 12 (5 marks)

A car of total mass 1000 kg is undergoing a loop-the-loop stunt at a carnival, as shown in Figure 11. The diameter of the loop is 12.0 m. Assume the track is frictionless.

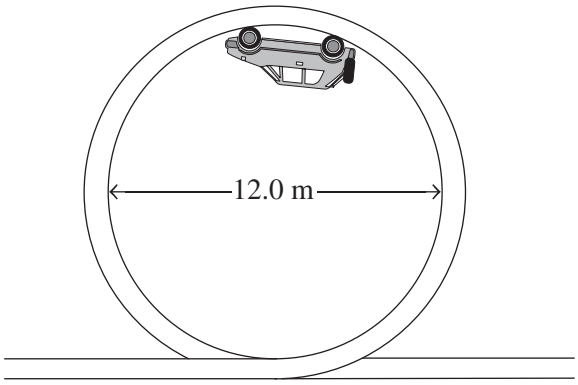

Figure 11

a. State whether or not the car remains in contact with the track if it is travelling at 8.0 m s^{-1} when it reaches the top of the loop. Provide a calculation to support your answer. 3 marks

b. Figure 12 shows the car at the bottom of the loop undergoing motion on the circular track.

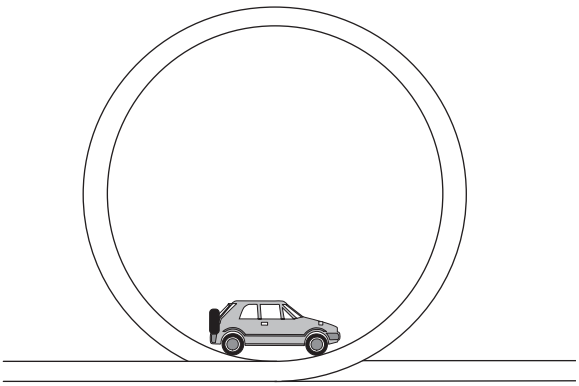

Figure 12

On Figure 12, draw and label the forces acting on the car. The size of the force vectors must be drawn indicating if they are equal or different in size. 2 marks

Question 13 (4 marks)

A beam of muons can be induced by very high-energy particle accelerators. They are created when energetic protons collide with each other. Muons are very short-lived subatomic particles that, at rest, have a lifetime of 2.2 microseconds (μs). Scientists working on a particular particle accelerator measure high-speed muons to have a lifetime of 5.0 μs.

a. Name the effect demonstrated by the scientists' observations of the lifetime of the high-speed muons. 1 mark

_____

b. Calculate the velocity of the muons as they leave this particle accelerator. 3 marks

_____

_____

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_____

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_____

	m s^{-1}

Question 14 (2 marks)

The rest mass of an electron is 9.1×10^{-31} kg.

Calculate the work that must be done on an electron to increase its speed from $0.00c$ to $0.95c$ ($\gamma = 3.2$).

J

END OF QUESTION AND ANSWER BOOKLET