Neap:

Trial Examination 2017

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	13	13	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 of 4 pages.

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 and hand them in.

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2017 VCE Physics Units 3 Written Examination.

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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 10 m s^{-2}.

Question 1

Figure 1 shows the electric field pattern due to two point charges P and Q. P is a negative charge.

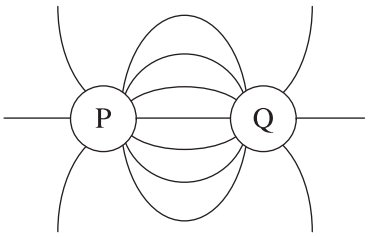

Figure 1

Which of the following correctly identifies charge Q and describes the direction of the electric field between charge P to charge Q?

A. Sign of Q is negative and the direction of the electric field between P and Q is to the left.

B. Sign of Q is positive and the direction of the electric field between P and Q is to the left.

C. Sign of Q is negative and the direction of the electric field between P and Q is to the right.

D. Sign of Q is positive and the direction of the electric field between P and Q is to the right.

Question 2

The relationship between the gravitational field strength at the surface of Mars, g_{Mars}, and the gravitational field strength at the surface of the Earth, g_{Earth}, is given by $g_{Mars} = 0.4 \times g_{Earth}$.

The relationship between the radius of Mars, r_{Mars}, and the radius of the Earth, r_{Earth}, is given by $r_{Mars} = 0.5 \times r_{Earth}$.

If the relationship between the mass of Mars, M_{Mars}, and the mass of the Earth, M_{Earth}, is given by $M_{Mars} = X \times M_{Earth}$ what is the value of X?

A. 0.1

B. 0.2

C. 0.8

D. 1.6

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Question 3

A cathode ray beam strikes in the middle screen at point M, producing a bright spot where the electrons hit. The south end of a magnet is brought towards the beam along the axial line as shown in Figure 2.

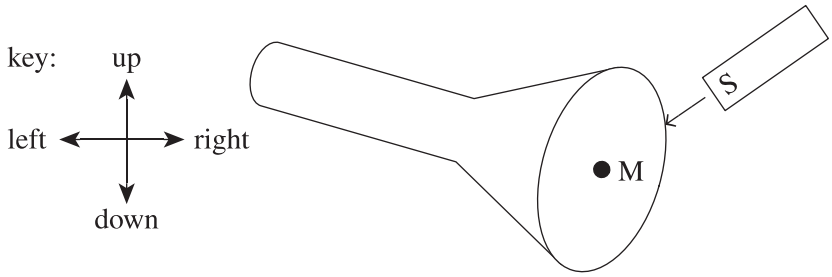

Figure 2

Using the key given, in which direction does the bright spot move?

A. up
B. left
C. down
D. right

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Question 4

Figure 3 shows two parallel metal plates with opposite charges. X, Y and Z represent distances from the positive plate.

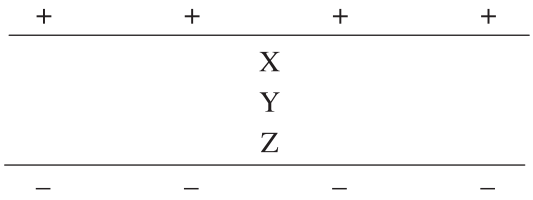
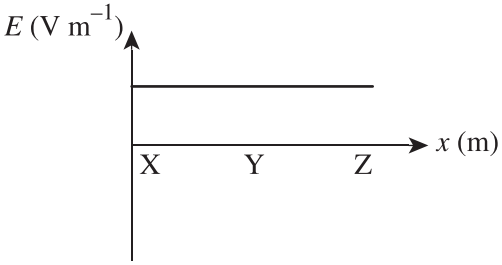


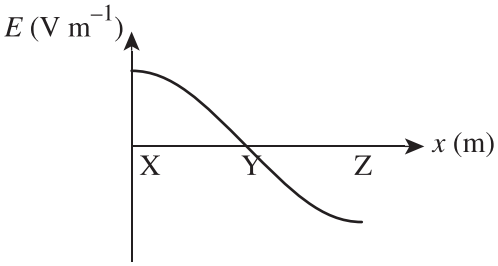
Figure 3

Which of the following graphs describes the electric field strength, E, versus the position, x, between the plates?

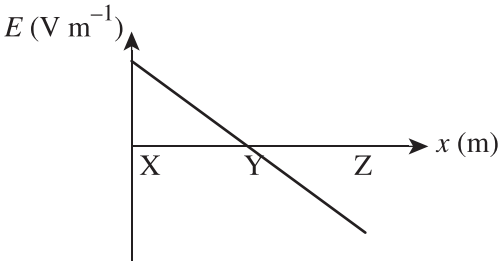
A.



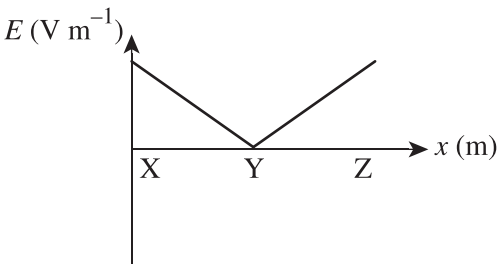
B.



C.



D.



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Question 5

A rectangular coil of wire is placed in a uniform magnetic field B. This is shown in Figure 4. At the instant shown, the plane of coil is parallel to the page.

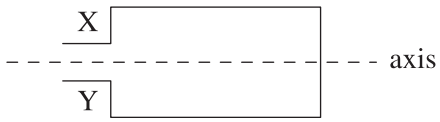


Figure 4

The coil rotates about the axis. The time variation of the electromotive force (EMF) induced in the coil is shown in Figure 5.

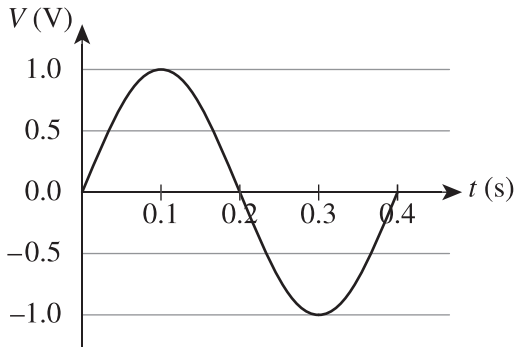
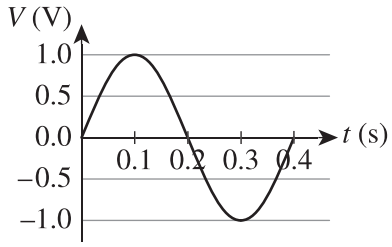


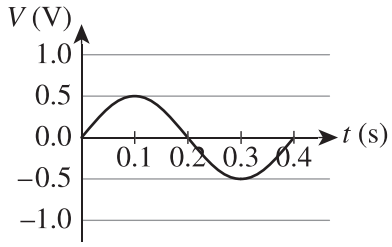
Figure 5

Which of the graphs below shows the EMF versus time if the coil is rotated at half the original speed?

A.



B.



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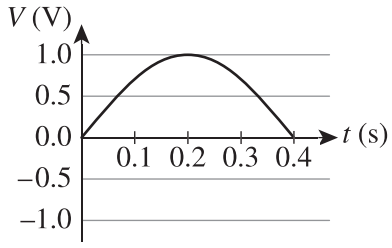
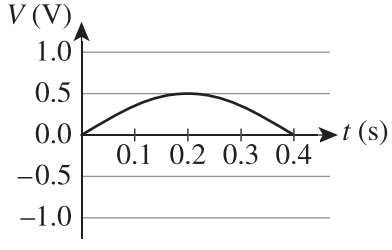


D.



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Question 6

An oscilloscope is connected to a sinusoidal AC source whose frequency and voltage output can be varied. At a certain frequency, the AC signal has an RMS output of 28.3 V. Figure 6 shows the trace obtained on the screen of the oscilloscope when one horizontal division corresponds to a time of 10 ms.

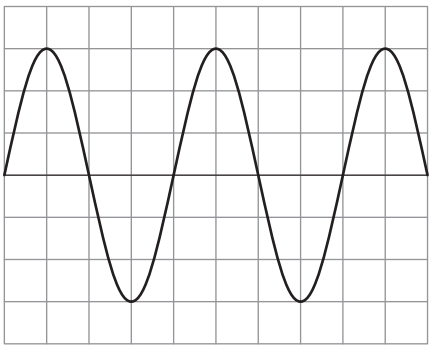


Figure 6

Which of the following gives the correct peak voltage and frequency of this trace?

A. $V_P = 40$ V $f = 25$ Hz

B. $V_P = 40$ V $f = 40$ Hz

C. $V_P = 20$ V $f = 25$ Hz

D. $V_P = 20$ V $f = 40$ Hz

Question 7

Which of the following best represents an example of an inertial frame of reference?

A. a man running on a curved path

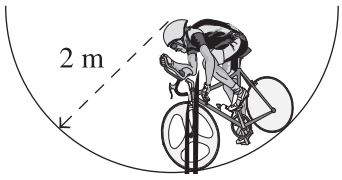
B. a man running on a curved path at constant speed

C. a man running on a straight path at constant speed

D. a man running on a straight path at constant acceleration

Question 8

Liam rides his bike down a ditch of circular radius 2 m. He and his bike's mass is 120 kg. At the bottom of the ditch his speed is 2 m s^{-1}.



The size of the normal reaction force the ground exerts on Liam when he is at the bottom of the ditch is closest to

A. 240 N

B. 960 N

C. 1296 N

D. 1440 N

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Question 9

In Figure 7, a car of mass 1.0 tonne is being towed on a level road by a truck of mass 2 tonne. There is a constant retarding force due to air resistance and friction of 800 N on the truck and 500 N on the car. The vehicles are accelerating at 0.5 m s^{-2}.

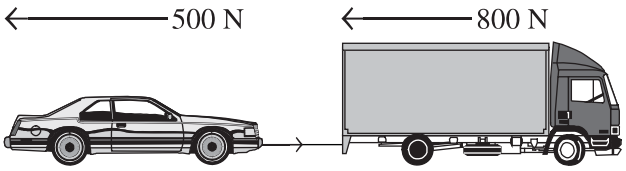

Figure 7

What is the magnitude of the tension, *T*, in the tow bar?

A. 500 N
B. 1000 N
C. 1500 N
D. 2800 N

Question 10

Jeff and Rhondo are conducting an experiment using a mass attached to a spring. The spring has an unstretched length of 80 cm. The spring constant is equal to 10 N m^{-1}. The situation is shown in **i.** on Figure 8.

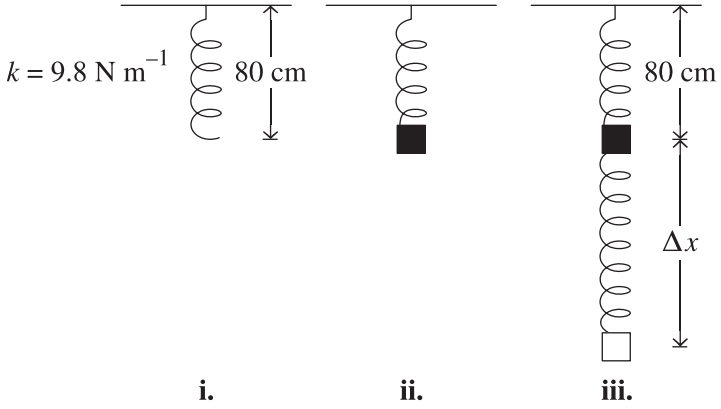

Figure 8

Jeff and Rondo attach 200 g mass to the spring as shown in **ii.** They then release it from its unstretched position as shown in **iii.** They allow the mass to oscillate freely as shown.

What is the extension of the spring, Δx, at the lowest point of its oscillation when it is momentarily stationary? (Ignore any loss due to frictional forces.)

A. 6.32 cm
B. 40 cm
C. 80 cm
D. 120 cm

END OF SECTION A

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SECTION B – SHORT-ANSWER QUESTIONS

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 10 m s^{-2}.

Question 1 (3 marks)

Figure 1 shows the paths taken by two moving, charged particles when they enter a region of uniform magnetic field, B, directed out of the page.

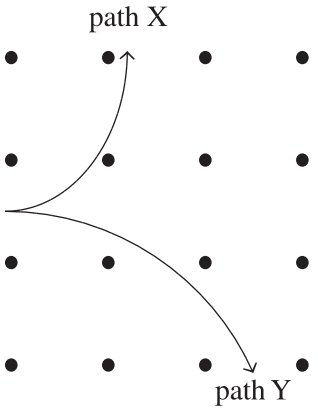

Figure 1

a. Why do the paths curve in different directions? 1 mark

_____

_____

_____

_____

b. Why are the paths circular and have different radii? 2 marks

_____

_____

_____

_____

_____

_____

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Question 2 (4 marks)

A neodymium magnet is placed on the top of a styrofoam box, which is then placed on an electronic balance as shown in Figure 2. A copper rod lies freely on the box and is placed such that 2 cm of the rod passes at right angles to the horizontal magnetic field of the neodymium magnet. The weight of the rod is factored out by zeroing the balance as the rod sits on the box

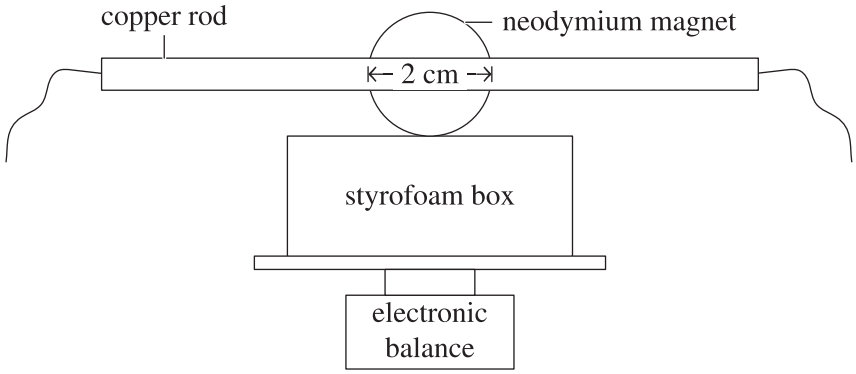

Figure 2

When a positive current of 1.5 A is passed through the rod, the rod experiences a force downwards and the reading on the electronic balance increases by 2.02 g.

a. What is the strength of the magnetic field? 2 marks

_____

_____

_____

_____

_____

T

b. If the current is passing through the rod from left to right as shown, what pole is facing the rod? Explain. 2 mark

_____

_____

_____

_____

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Question 3 (5 marks)

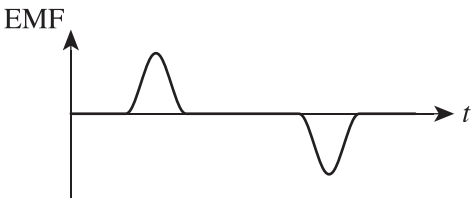
A magnet is passed through a long copper tube at a constant velocity as shown in Figure 3.

Figure 3

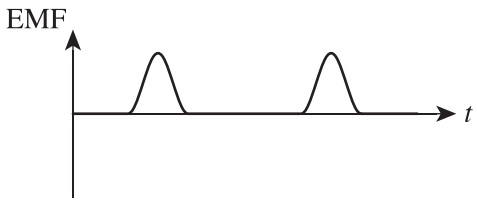
a. Explain why an EMF is generated in the copper tube. 4 marks

b. Which graph best represents the measured EMF during the time that the magnet moves into, through and then out of the pipe? 1 mark

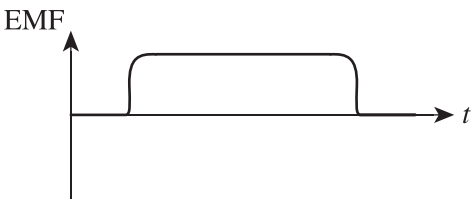
A.



B.



C.



D.

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Question 4 (7 marks)

Figure 4 shows a DC motor. A square coil, PQRS, of side length 15.0 cm and consisting of 100 turns is rotated in the field of a uniform permanent magnet of field strength 50 mT. The current through the arm PQ is measured as 3.0 A.

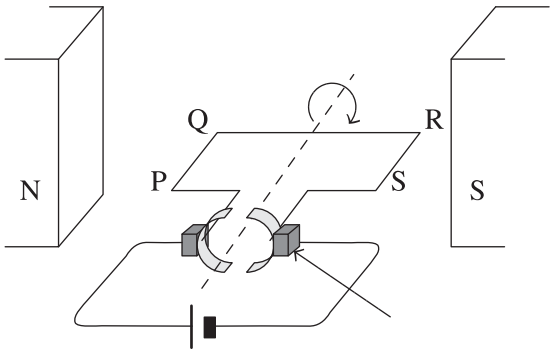

Figure 4

a. Explain, referring to magnetic fields, the principle reason why the current-carrying wire (side PQ) experiences the magnetic force when placed in the magnetic field, as shown in Figure 4. 2 marks

_____

_____

_____

_____

b. What is the name and function of the structure the arrow is pointing to in Figure 4? 3 marks

_____

_____

_____

_____

_____

_____

c. The coil has rotated 30° from the position shown.

Which one of the following describes the magnitude of the force on the side PQ compared with the magnitude of the force on PQ referred to in part **a.**? 2 marks

A. The magnitude of the force on side PQ is greater.

B. The magnitude of the force on side PQ is equal.

C. The magnitude of the force on side PQ is less.

D. The magnitude of the force on side PQ is zero.

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Question 5 (11 marks)

A particular power station generates 120 MW of electrical power. Transformers are located near the power station and step up the voltage from 24 kV to 240 kV. From the transformers, electricity passes through transmission cables that carry power over long distances to step-down transformers, as shown in Figure 5.

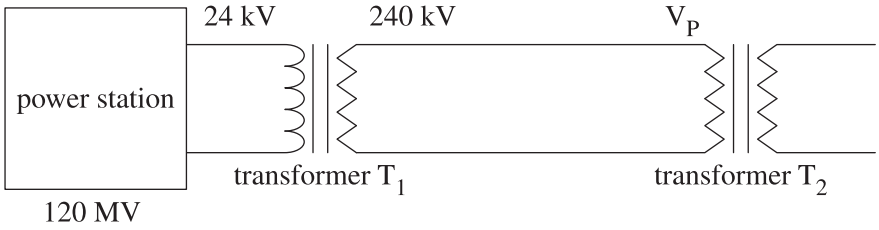

Figure 5

a. Calculate the magnitude of the generated current by the power station. 2 marks

A

b. Calculate the current in the secondary coil of transformer T_1. 2 marks

A

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The total resistance of the transmission cables between the two transformers is 2.0 Ω.

c. Calculate the voltage, V_P, of the primary coil of transformer T_2. 3 marks

kV

d. Explain why transformers do not work with a constant DC input voltage. 4 marks

Question 6 (7 marks)

A metal ball of mass 1.5 kg hangs from a string and moves with a constant speed in a horizontal circle as shown. The 1.0 m string makes an angle of 30° with the vertical as shown in Figure 6.

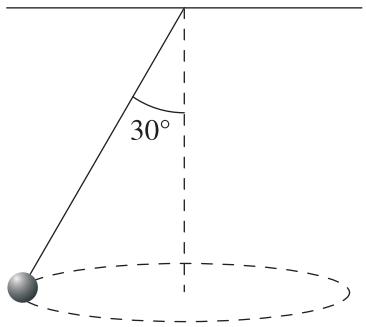

Figure 6

a. Which one of the five vector diagrams in Figure 7 correctly shows the forces that act on the ball in the position shown in Figure 6? Choose the correct option **A.–E.** and provide in the answer box. 1 mark

Figure 7

b. On Figure 6, draw the net force acting on the ball with a dotted arrow and label this force F_{net}. 1 mark

c. Calculate the tension in the string as the ball moves in the horizontal circle. 2 marks

_____

_____

_____

_____

N

d. Calculate the speed of the metal ball. 3 marks

_____

_____

_____

_____

_____

m s^{-1}

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Question 7 (6 marks)

A golf ball is hit from the ground at an angle of 30° to the horizontal. It hits the ground 20.0 m away. The time of flight is 1.53 s. This is shown in Figure 8. (Ignore the effects of friction.)

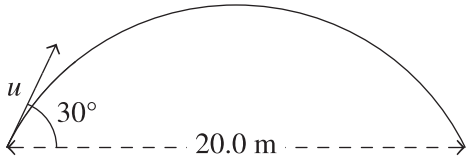

Figure 8

a. Calculate the initial speed of the golf ball. 2 marks

m s^{-1}

b. Calculate the speed of the golf ball at the highest point of the flight. 2 marks

m s^{-1}

c. At the highest point of its flight, what is the acceleration of the golf ball? 1 mark

A. horizontally to the left
B. horizontally to the right
C. vertically up
D. vertically down
E. no direction, the acceleration is zero

d. On page 15, sketch a possible trajectory of the golf ball if air resistance is not ignored. The dashed line is the original trajectory. 1 mark

Figure 9

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Question 8 (8 marks)

Two model cars are travelling towards each other and collide. Model car A weighs 1.2 kg and model car B weighs 1.4 kg. Before the collision, model car A is travelling east at 0.5 m s^{-1} and model car B is travelling west at 0.2 m s^{-1}, as shown in Figure 10. After the collision, model car A rebounds in the opposite direction, now travelling at 0.1 m s^{-1}.

m = 1.2 kg $\qquad$ m = 1.4 kg

Figure 10

a. Calculate the velocity of model car B after the collision. 2 marks

m s^{-1}

b. Is this an example of an elastic or inelastic collision? Use a calculation to justify your answer. 3 marks

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c. The force–time graph below shows the force of car B on car A during the collision. The collision time for the car is 0.05 s. The highest force value on graph F_{peak} is shown in Figure 11.

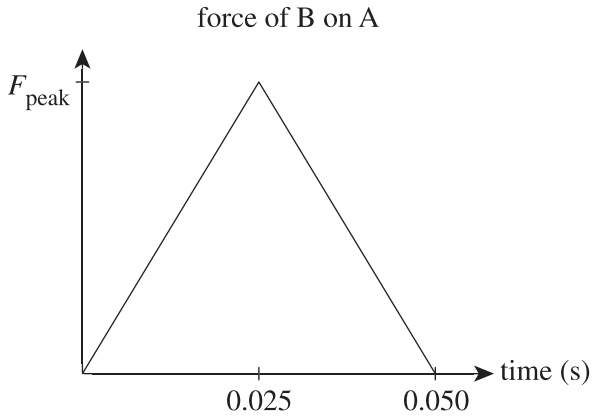

Figure 11

Determine the value of F_{peak}. Include a direction in the second box. 3 marks

N	

Question 9 (6 marks)

Figure 12 shows a bouncing ball of mass 200 g. The ball falls and rebounds vertically. The weight force, F_g, is shown.

a. On **ii.** in Figure 12, draw the normal force F_N while the ball is in contact and decelerating with the ground. (Direction and relative magnitude must be considered.) 2 marks

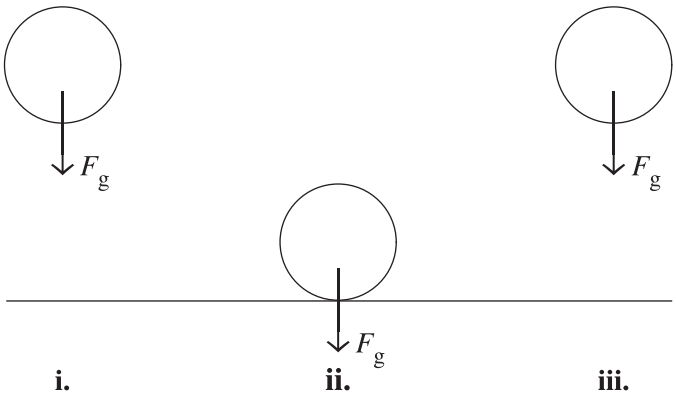

Figure 12

b. If the ball is dropped from 2.5 m, and its rebound height is 1.5 m, calculate the magnitude of the impulse given to the ball by the ground. 4 marks

Ns

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Question 10 (5 marks)

Figure 13 represents a pulley system where M_1 = 2 kg and M_2 = 5 kg are connected by a 10 m massless string over a frictionless pulley. Both masses are 2 m above the ground and the system is initially at rest. The system is then released.

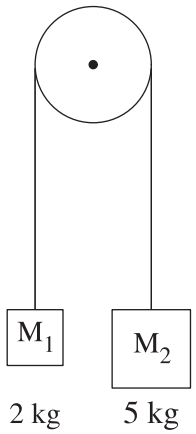

Figure 13

a. Calculate the acceleration of M_2. 3 marks

_____

_____

_____

_____

_____

_____

_____

m s^{-2}

b. How long does it take M_2 to fall 1.0 m? 2 marks

_____

_____

_____

_____

_____

s

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Question 11 (5 marks)

The year is 2060. Humans have colonised Mars. A communication satellite, MARSSAT, is placed in orbit around Mars so that it is stationary (always over the same point on Mars' surface on the equator).

- mass of Mars = 6.4×10^{23} kg
- mass of satellite = 5.0×10^{3} kg
- period of rotation of Mars = 24 hours, 39 minutes and 35 seconds

a. Calculate the period of MARSSAT in seconds. 2 marks

_____

_____

_____

_____

_____

s

b. Calculate the radius of the orbit of MARSSAT. 3 marks

_____

_____

_____

_____

_____

_____

_____

m

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Question 12 (6 marks)

Muons are elementary particles that are produced at about 16 000 m above the ground as cosmic radiation from outer space collides with the atoms of the Earth's atmosphere. Experiments on laboratory muons have found them to be unstable, and decay with a half-life of 2.2 μs (the time for half of a large number of muons to decay) when measured at rest in their frame of reference. Their short half-life suggest they should decay in the outer atmosphere. However, early experimenters found that many more muons reached Earth than they had expected. The experimenters calculated the time that a muon would take to travel from a certain height and found that their calculated time was much longer than the muon half-life.

In a particular experiment, a muon detector counted 100 000 muons per hour travelling at 0.995c at an altitude of 1.000 km above Earth's surface.

a. Show that the Lorentz factor is equal to 10.01. 2 marks

b. Calculate the half-life of the moving muons, as measured from the ground. 2 marks

s

c. From their reference frame, the muons see the ground rushing upwards at a speed of 0.995c.

What would be the height from the top, as measured by the muons, in their reference frame? 2 marks

km

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Question 13 (7 marks)

In a particular particle accelerator, a beam of protons was accelerated.

a. If a proton's rest energy is m_0c^2 = 938.26 MeV and a particular proton has a total energy of 100.00 GeV, what speed, as a percentage of the speed of light c, is the proton moving at? Express the result to five significant figures. 4 marks

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	%c

A famous example of a very high-energy particle was detected on Earth in Utah. It was called the 'Oh-My-God particle', and was detected at travelling at a speed close to 99.99999999999999999951%c.

b. Can a particle ever travel at the speed of light? Explain your answer using Einstein's theory of special relativity. 3 marks

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END OF QUESTION AND ANSWER BOOKLET

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