Neap

Trial Examination 2021

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 23 pages

Formula sheet

Answer sheet for multiple-choice questions

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in the 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.

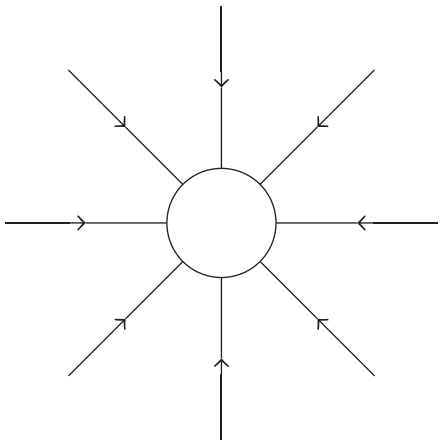
SECTION A – MULTIPLE-CHOICE QUESTIONS

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

The diagram below represents a field.



Which one of the following statements about the diagram is correct?

A. It could only represent an electric field.

B. It could only represent a gravitational field.

C. It could represent an electric field or a gravitational field.

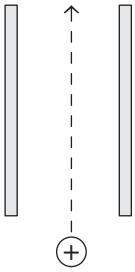
D. It could not represent an electric field or a gravitational field.

Question 2

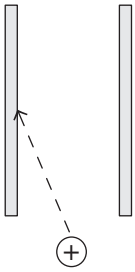
A positively charged particle is moving upwards when it enters a region between two parallel plates. This region has a uniform electric field pointing to the left.

Which one of the following diagrams could correctly represent the particle's path?

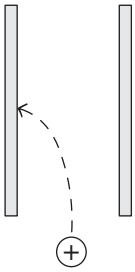
A.



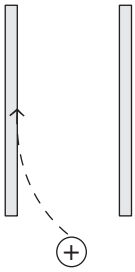
B.



C.

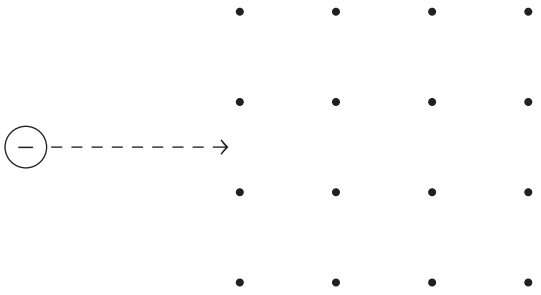


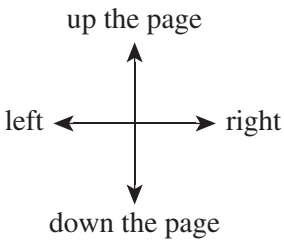
D.



Question 3

A negative charge moving with a constant velocity, *v,* enters a region of uniform magnetic field directed out of the page. This is shown in the diagram below.





What is the direction on the charge as it first enters the field?

A. up the page

B. down the page

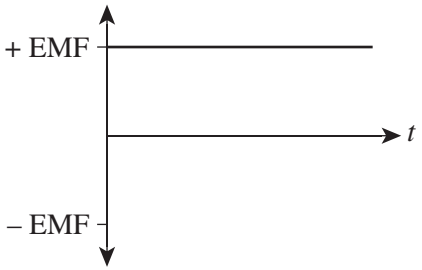
C. right

D. left

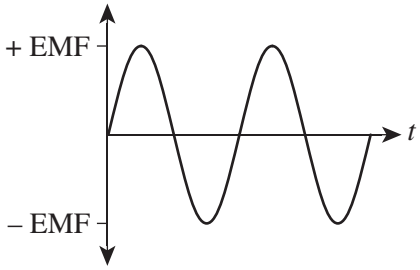
Question 4

Four EMF output graphs from an oscilloscope are shown in the diagram below.

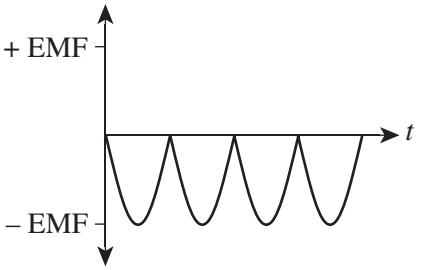
graph I



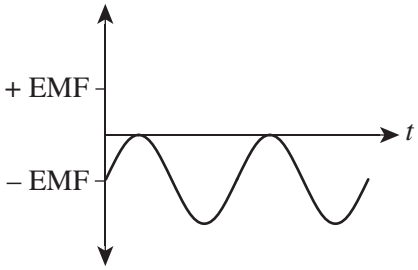
graph II



graph III



graph IV



Which of the following do **not** represent direct current (DC)?

A. graph I only

B. graph II only

C. graphs II and IV only

D. graphs II, III and IV only

Question 5

A satellite in circular orbit, at distance r from the centre of Earth, has an orbital velocity of v.

What is the satellite's orbital velocity if r was increased to $4r$?

A. $\frac{v}{4}$

B. $\frac{v}{2}$

C. $2v$

D. $4v$

Question 6

A curve of radius 45.0 m is banked so that a car can safely navigate the corner at 36.0 km h^{-1}. Without the need of friction, the angle of the slope of the banked curve to the nearest degree is

A. 2°

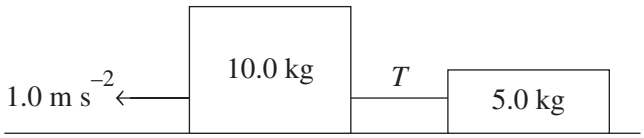
B. 5°

C. 13°

D. 71°

Question 7

Blocks of 10.0 kg and 5.0 kg are connected with a rope as shown in the diagram below. The system is accelerating at 1.0 m s^{-2} on a smooth surface.



The magnitude of the tension, *T*, in the rope connecting the blocks is

A. 0.0 N

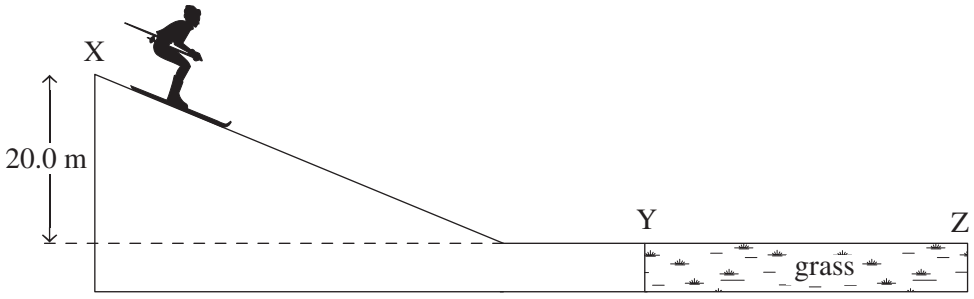
B. 5.0 N

C. 10.0 N

D. 15.0 N

Question 8

Rory and his ski equipment have a total mass of 80.0 kg. Starting from rest, Rory skis down a slope from point X to point Y, as shown in the diagram below. The vertical height of the slope is 20.0 m. There are no frictional forces from point X to point Y.



At point Y, Rory skis onto the grass. There is now a frictional force, and he slows down to stop at point Z after a time of 10.0 s.

The magnitude of the frictional force acting on Rory between points Y and Z is closest to

A. 32 N

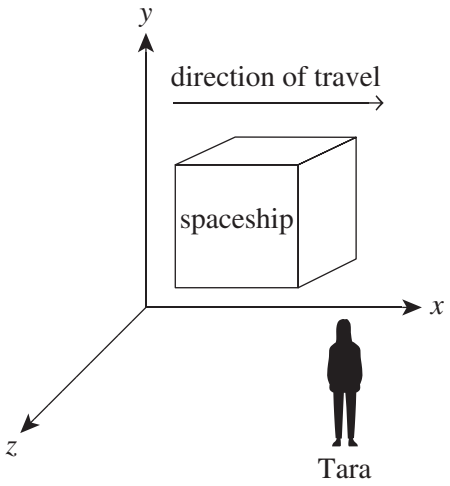
B. 160 N

C. 784 N

D. 1584 N

Question 9

The dimensions (x, y, z) of a cube-shaped spaceship are 50.0 m × 50.0 m × 50.0 m when measured by an observer at rest on the spaceship. Tara stands outside the spaceship and observes it travelling past her at $0.87c$ ($\gamma = 2.00$).



The dimensions (x, y, z) of the spaceship as measured by Tara when it travels past her are

A. 50.0 m × 50.0 m × 50.0 m.

B. 25.0 m × 50.0 m × 50.0 m.

C. 50.0 m × 25.0 m × 50.0 m.

D. 25.0 m × 25.0 m × 25.0 m.

Question 10

Matter is converted into energy by nuclear fusion in stars. The Sun generates power at a rate of 3.8×10^{26} W.

The rate at which the Sun converts mass to energy per second is closest to

A. 4.2×10^{9} kg s^{-1}

B. 2.5×10^{11} kg s^{-1}

C. 1.5×10^{13} kg s^{-1}

D. 1.3×10^{18} kg s^{-1}

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.
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)
A coil of wire is placed around an iron rod. The coil is connected to a DC battery, as shown in Figure 1.

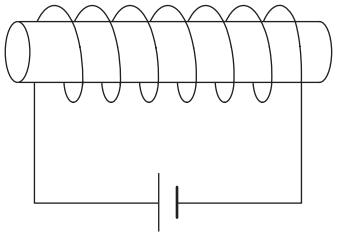


Figure 1

Sketch the shape and direction of **at least four** magnetic field lines in the region around the iron rod shown in Figure 1.

Question 2 (6 marks)

Two charges of +200 μC and –500 μC are situated 20.0 cm apart in a vacuum, as seen in Figure 2. Point X is midway between the two charges.

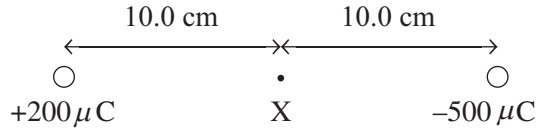


Figure 2

Calculate the magnitude and indicate the direction of the electric field at point X. Show your working.

N C^{-1}	direction =

Question 3 (3 marks)

An object with a net charge of 25.0 μC is placed in a uniform electric field of 500 N C^{-1} directed vertically upwards, as shown in Figure 3.

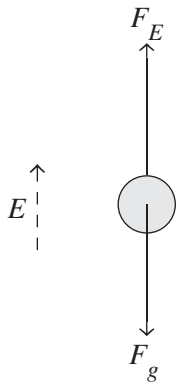


Figure 3

What is the mass of this object if it is stationary in the field? Show your working.

kg

Question 4 (7 marks)

NROL-44, one of the largest military satellites, was launched in December 2020. NROL-44 sits at an average altitude of 250 km above Earth's surface.

a. Calculate the orbital radius of NROL-44. Show your working. 1 mark

m

b. Calculate the period of NROL-44 correct to 3 significant figures. Show your working. 4 marks

s

c. Explain how satellites maintain a stable circular orbit without the use of propulsion engines. 2 marks

Question 5 (8 marks)

Figure 4 shows a simple DC motor consisting of a square loop of 75 turns, side lengths of 4.0 cm and a split-ring commutator. The DC motor is entirely within a uniform magnetic field of 2.5×10^{-2} T and a current of 4.0 A.

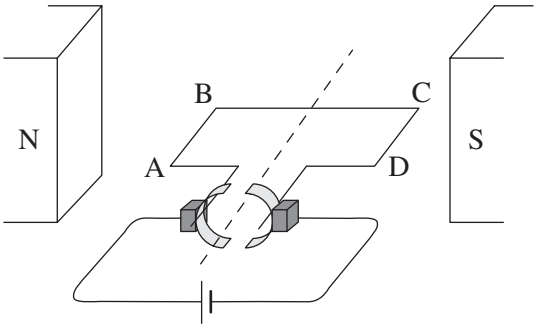


Figure 4

a. What is the magnitude of the force on side AB when the loop is in the position shown in Figure 4? Show your working. 2 marks

N

b. If the coil is rotated 45° from the position shown in Figure 4, how is the magnitude of the force on side AB affected? Circle the correct response and explain your reasoning. 2 marks

less than the force calculated in **part a.** | equal to the force calculated in **part a.** | greater than the force calculated in **part a.**

c. Explain the role and operation of the split-ring commutator in the DC motor shown in Figure 4. 2 marks

d. Determine if the direction of rotation of the coil as viewed from the split-ring commutator is clockwise or anticlockwise. Justify your choice. 2 marks

Question 6 (8 marks)

A flexible coil with 10 turns and a diameter of 30.0 cm is placed in a magnetic field of 0.20 T into the page, as shown in Figure 5.

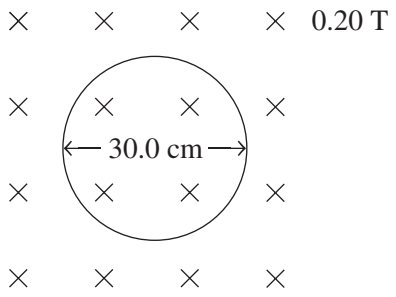


Figure 5

a. What is the magnetic flux through the coil? Show your working. 2 marks

Wb

The coil is grasped at points P and Q, as shown in Figure 6a, and it is stretched apart until the area of the loop is zero, as seen in Figure 6b.

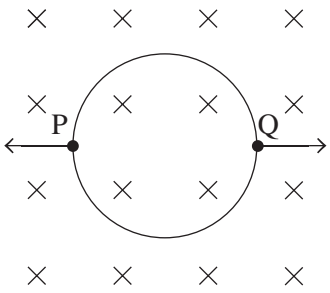


Figure 6a

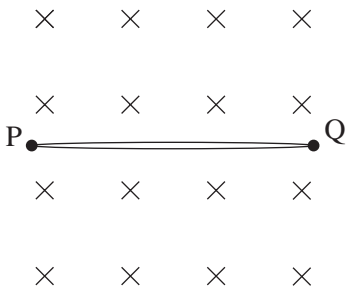


Figure 6b

b. What is the magnetic flux through the coil in the position shown in Figure 6b? 1 mark

Wb

It takes 0.5 s to stretch the loop from Figure 6a to Figure 6b.

c. What is the EMF induced in the coil as it is stretched? Show your working. 2 marks

Wb

d. What is the direction, clockwise or anticlockwise, of the induced current in the loop as it is stretched, as viewed from above? Explain your reasoning. 3 marks

Question 7 (11 marks)

Loy Yang B Power Station is located in the Latrobe Valley. Power from the Loy Yang B Power Station (0.50 GW, 20 kV) passes into a transformer and the voltage is increased to 275 kV for transmission to Melbourne. The transmission lines have a total resistance of 5.00 Ω.

a. Will either a step-up or step-down transformer increase the voltage for transmission? Explain your answer. 3 marks

b. Why are transformer coils of wire wrapped around an iron core? 2 marks

c. Determine the value of $\frac{\text{number of turns in the secondary coil}}{\text{number of turns in the primary coil}}$. Give your answer correct to two significant figures. Show your working.

2 marks

d. How much current is flowing at the beginning of the transmission lines (at the Loy Yang B Power Station)? Show your working. 2 marks

A

e. Calculate the power loss in the transmission lines. Show your working. 2 marks

W

Question 8 (2 marks)

A box is pushed to the right along a smooth, frictionless surface. Figure 7 shows the applied force versus distance graph for the box**.**

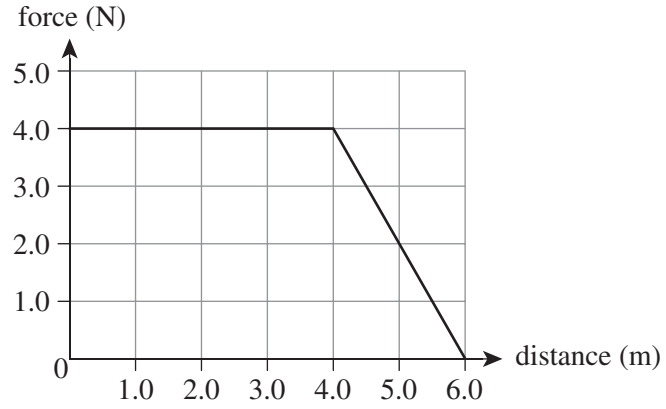


Figure 7

What is the total work done on the box to move it 6.0 m?

J

Question 9 (5 marks)

On a loop-the-loop roller coaster, a loop in the track has a radius of 8.0 m, as shown in Figure 8. A cart rolls from rest at point B.

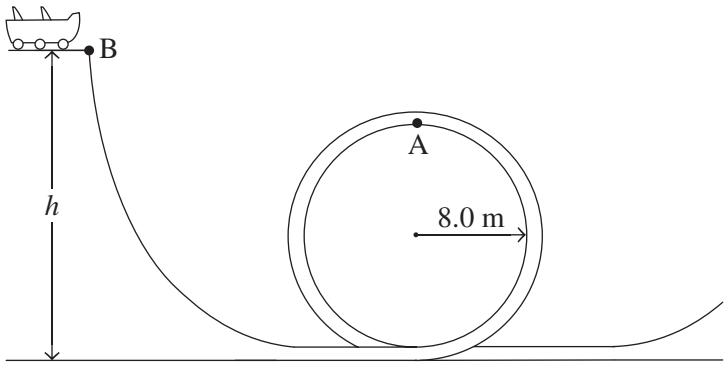


Figure 8

a. What is the minimum speed the cart must have at point A such that it does not leave the roller coaster track? 2 marks

m s^{-1}

b. What is the minimum value of height *h* such that the cart does not leave the track? 3 marks

m

Question 10 (5 marks)

In the game of cricket, six 'runs' are scored when a batter hits the ball and it crosses the boundary line **before** coming into contact with the ground.

A batter hits a ball with a speed of 30.0 m s^{-1} at an angle of 45° above the horizontal toward the boundary line, which is 70.0 m away. The ball is 1.0 m above the ground when the batter hits it, as shown in Figure 9.

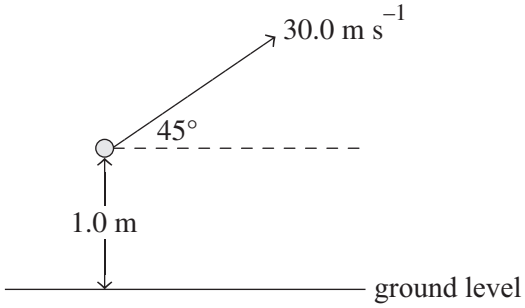


Figure 9

Did the batter score six runs? Support your answer with calculations.

Question 11 (8 marks)
Block A, of mass 8.0 kg, is moving to the right at a speed of 16 m s^{-1}, as shown in Figure 10.

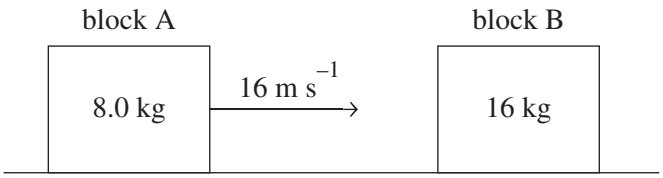


Figure 10

Block A collides with block B, a stationary block of mass 16 kg, and rebounds to the left. Block A has a speed of 4.0 m s^{-1} after the collision.

a. Calculate the speed of block B immediately after the collision. 2 marks

m s^{-1}

b. What is the magnitude and direction, left or right, of the impulse by block B on block A? Show your working. 3 marks

I =	direction =

c. State whether the collision is elastic or inelastic. Use calculations to support your answer. 3 marks

Question 12 (9 marks)

A mass of 5.0 kg is suspended from a vertical spring attached to the ceiling, with spring constant $k = 100.0 \text{ N m}^{-1}$, as shown in Figure 11. The spring is initially unstretched as the mass is released.

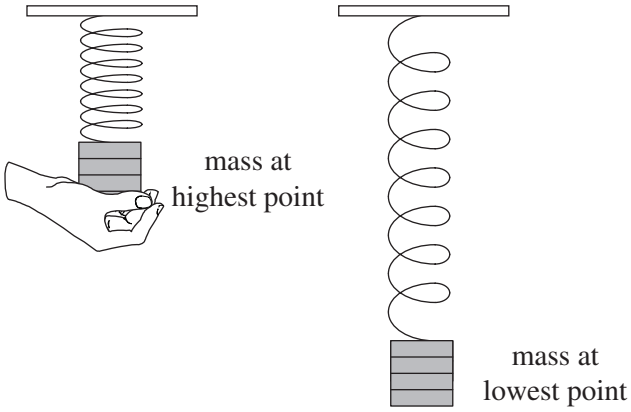


Figure 11

a. Determine how far the spring stretches until the mass comes momentarily to rest at the lowest point. Show your working. 3 marks

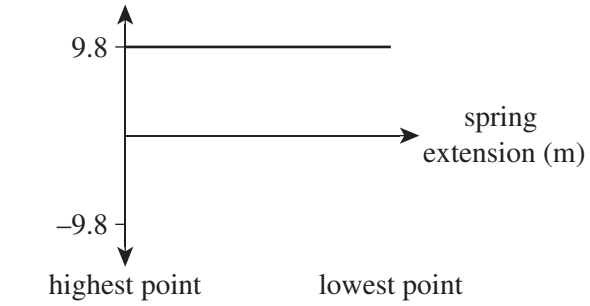
m

b. Calculate the maximum speed of the mass at its midpoint. 3 marks

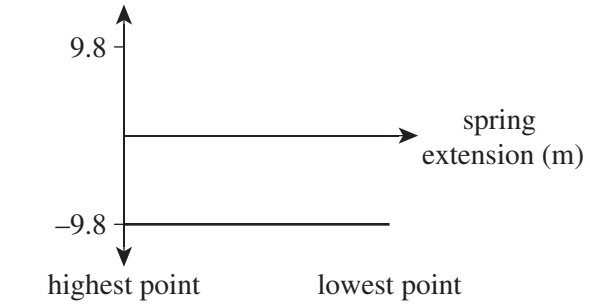
m s^{-1}

c. Consider the graphs shown in Figure 12. Take downwards as positive.

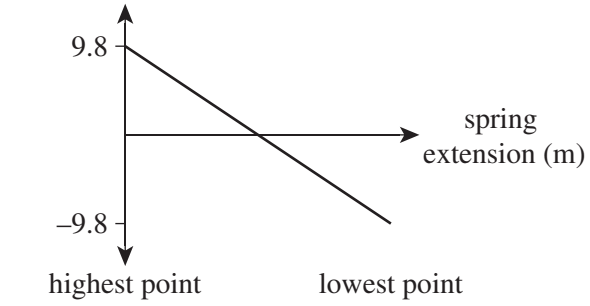
graph I



graph II



graph III



graph IV

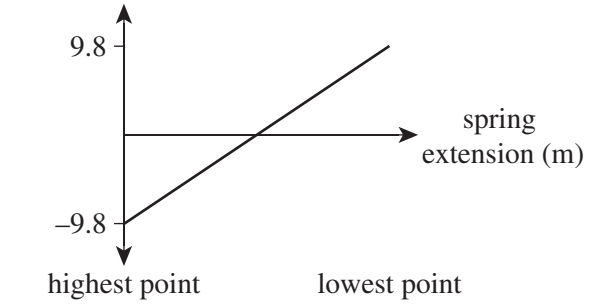


Figure 12

Which one of the graphs (I–IV) best shows the acceleration of the mass as it goes from the highest point to the lowest point? Explain your reasoning. 3 marks

Question 13 (6 marks)

Muons are unstable particles that spontaneously decay into more stable neutrinos. The mean lifetime of a muon in its own inertial reference frame is 2.20 μs.

A stream of muons passes by a stationary observer at 99.9% the speed of light.

a. What is the mean lifetime of the muons as measured by the stationary observer? 3 marks

μs

b. Is the time measured by the stationary observer the proper time? Explain your reasoning. 3 marks

END OF QUESTION AND ANSWER BOOKLET

Neap

Trial Examination 2021

VCE Physics Unit 3

Written Examination

Formula Sheet

Instructions

This formula sheet is provided for your reference.
A question and answer booklet is provided with this formula sheet.

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

PHYSICS FORMULAS

Motion and related energy transformations

velocity; acceleration	$v = \frac{\Delta s}{\Delta t}; \quad a = \frac{\Delta v}{\Delta t}$
equations for constant acceleration	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $s = vt - \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $s = \frac{1}{2}(v + u)t$
Newton's second law	$\Sigma F = ma$
circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
Hooke's law	$F = -k\Delta x$
elastic potential energy	$\frac{1}{2}k(\Delta x)^2$
gravitational potential energy near the surface of Earth	$mg\Delta h$
kinetic energy	$\frac{1}{2}mv^2$
Newton's law of universal gravitation	$F = G\frac{m_1 m_2}{r^2}$
gravitational field	$g = G\frac{M}{r^2}$
impulse	$F\Delta t$
momentum	mv
Lorentz factor	$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
time dilation	$t = t_o\gamma$
length contraction	$L = \frac{L_o}{\gamma}$
rest energy	$E_{rest} = mc^2$

Fields and application of field concepts

electric field between charged plates	$E = \frac{V}{d}$
energy transformations of charges in an electric field	$\frac{1}{2}mv^2 = qV$
field of a point charge	$E = \frac{kq}{r^2}$
force on an electric charge	$F = qE$
Coulomb's law	$F = \frac{kq_1q_2}{r^2}$
magnetic force on a moving charge	$F = qvB$
magnetic force on a current carrying conductor	$F = nIlB$
radius of a charged particle in a magnetic field	$r = \frac{mv}{qB}$

Generation and transmission of electricity

voltage; power	$V = RI$; $P = VI = I^2R$
resistors in series	$R_T = R_1 + R_2$
resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
ideal transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$
AC voltage and current	$V_{RMS} = \frac{1}{\sqrt{2}}V_{peak}$ $I_{RMS} = \frac{1}{\sqrt{2}}I_{peak}$
electromagnetic induction	EMF: $\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$ flux: $\Phi_B = B_\perp A$
transmission losses	$V_{drop} = I_{line}R_{line}$ $P_{loss} = I^2_{line}R_{line}$

Data

acceleration due to gravity at Earth's surface	$g = 9.8 \text{ m s}^{-2}$
mass of the electron	$m_e = 9.1 \times 10^{-31} \text{ kg}$
magnitude of the charge of the electron	$e = 1.6 \times 10^{-19} \text{ C}$
Planck's constant	$h = 6.63 \times 10^{-34} \text{ J s}$ $h = 4.14 \times 10^{-15} \text{ eV s}$
speed of light in a vacuum	$c = 3.0 \times 10^{8} \text{ m s}^{-1}$
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
mass of Earth	$M_E = 5.98 \times 10^{24} \text{ kg}$
radius of Earth	$R_E = 6.37 \times 10^{6} \text{ m}$

Prefixes/Units

p = pico = 10^{-12}	n = nano = 10^{-9}	μ = micro = 10^{-6}	m = milli = 10^{-3}
k = kilo = 10^{3}	M = mega = 10^{6}	G = giga = 10^{9}	t = tonne = 10^{3} kg

END OF FORMULA SHEET

Neap

Trial Examination 2021

VCE Physics Unit 3

Written Examination

Multiple-choice Answer Sheet

Student's Name: _____

Teacher's Name: _____

Instructions

Use a **pencil** for **all** entries. If you make a mistake, **erase** the incorrect answer – **do not** cross it out. Marks will **not** be deducted for incorrect answers.
No mark will be given if more than **one** answer is completed for any question.

All answers must be completed like this example: **A** B C D

Use pencil only

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

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