VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2023

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | Letter |

PHYSICS
Written examination

Thursday 9 November 2023

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 11.45 am (2 hours 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	17	17	110
			Total 130

- 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 book of 44 pages
- Formula sheet
- Answer sheet for multiple-choice questions

Instructions
- Write your student number in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book 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 book.
- 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.

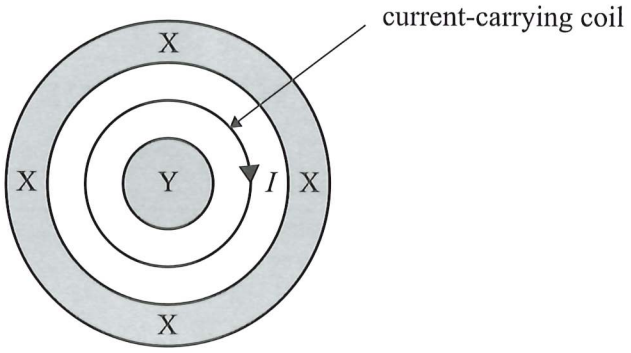
SECTION A – Multiple-choice questions

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 book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

Question 1

One type of loudspeaker consists of a current-carrying coil within a radial magnetic field, as shown in the diagram below. X and Y are magnetic poles, and the direction of the current, I, in the coil is clockwise as shown.

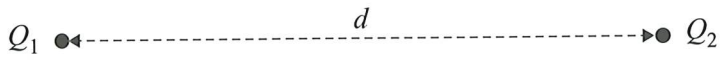


The force, F, acting on the current-carrying coil is directed into the page.
Which one of the following statements correctly identifies the magnetic polarities of X and Y?

A. X is a north pole and Y is a south pole.
B. X is a south pole and Y is a north pole.
C. Both X and Y are north poles.
D. Both X and Y are south poles.

Question 2

The diagram below shows two charges, Q_1 and Q_2, separated by a distance, d.



There is a force, F, acting between the two charges.

Which one of the following is closest to the magnitude of the force acting between the two charges if both d and the charge on Q_1 are halved?

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

B. F

C. $2F$

D. $4F$

Question 3

Space scientists want to place a satellite into a circular orbit where the gravitational field strength of Earth is half of its value at Earth's surface.

Which one of the following expressions best represents the altitude of this orbit above Earth's surface, where R is the radius of Earth?

A. $\frac{\sqrt{2}R}{2} - R$

B. $\sqrt{2}R$

C. $\left(\sqrt{2}R\right) - R$

D. $2R - \sqrt{2}R$

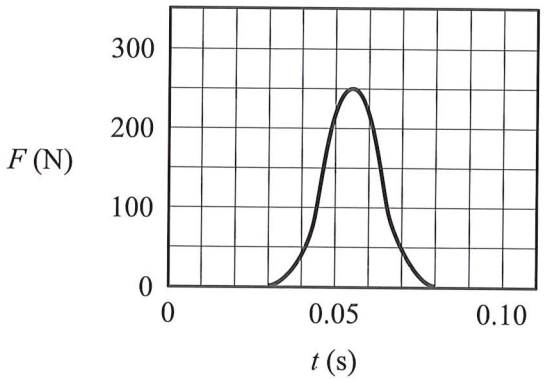
$g = G\frac{M}{R^2}$

$g \div 2 \longrightarrow R \times \sqrt{2}$

$h = \sqrt{2}R - R = R(\sqrt{2} - 1)$

Question 4

The diagram below shows the force versus time graph of the force on a tennis ball when it is hit by a tennis racquet. The tennis ball is stationary when the tennis racquet first comes into contact with the ball.



Which one of the following is closest to the impulse experienced by the tennis ball as it is hit by the tennis racquet?

A. 0.50 N s

B. 5.0 N s

C. 10 N s

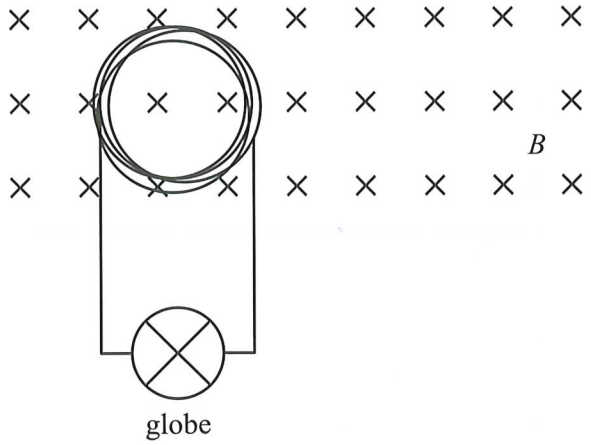
D. 50 N s

1 sq. $50 \times 0.01 = 0.5$ Ns

0.5×9

Use the following information to answer Questions 5 and 6.

The diagram below shows a stationary circular coil of conducting wire connected to a low-resistance globe in a uniform, constant magnetic field, *B*.



Question 5

The magnetic field is switched off.

Which one of the following best describes the globe in the circuit **before** the magnetic field is switched off, **during** the time the magnetic field is being switched off and **after** the magnetic field is switched off?

	Before	During	After
A.	Off	On	Off
B.	On	On	Off
C.	On	Off	Off
D.	Off	On	On

Question 6

The radius of the coil is 5 cm and the magnetic field strength is 0.2 T. The coil has 100 loops. Assume that the magnetic field is perpendicular to the area of the coil.

Which one of the following is closest to the magnitude of the magnetic flux through the coil of wire when the magnetic field is switched on?

A. 0.0016 Wb

B. 0.16 Wb

C. 16 Wb

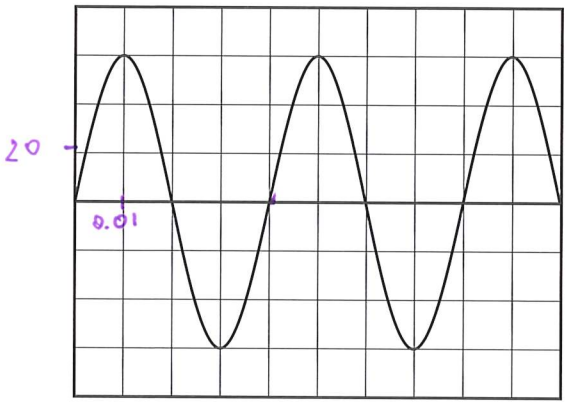
D. 1600 Wb

$\pi r^2 \times B$

$\pi \times 0.2 \times 0.05^2$

Question 7

An oscilloscope is connected to a sinusoidal AC voltage source. The resulting trace on the oscilloscope screen is shown below. One vertical division on the oscilloscope screen represents a potential difference of 20 V, and one horizontal division represents a time interval of 10 ms.



Which one of the following is closest to both the peak-to-peak voltage and the frequency of the signal shown in the diagram?

A. 42 V and 10 Hz

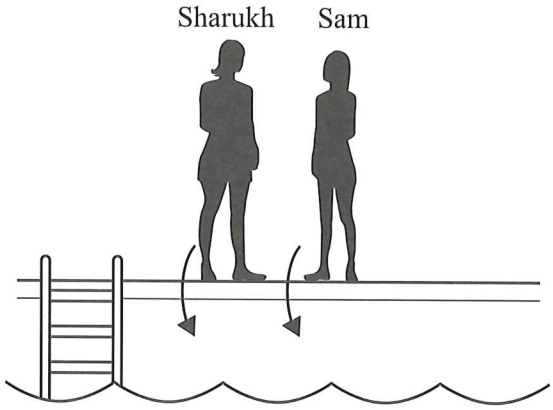
B. 60 V and 25 Hz

C. 120 V and 10 Hz

D. 120 V and 25 Hz

Question 8

At a swimming pool, Sharukh and Sam, shown below, step off the low diving board at the same time. Over the small distance they fall, air resistance may be ignored. Sharukh and Sam have masses of 80 kg and 60 kg respectively.



Which one of the following best explains what happens to Sharukh and Sam as they drop straight down into the water?

A. Sharukh reaches the surface first because she has a larger mass.

B. The net force on Sharukh is larger than that on Sam, so Sharukh reaches the surface first.

C. They both reach the surface together because they both experience the same downward force.

D. They both reach the surface together because they both experience the same downward acceleration.

Question 9

An engineer is designing a banked circular curve of radius 25 m in a new bicycle velodrome.

Diagram A shows the bicycle approaching the banked section, and diagram B shows the front view of a bicycle moving out of the page as it rounds the banked bend.

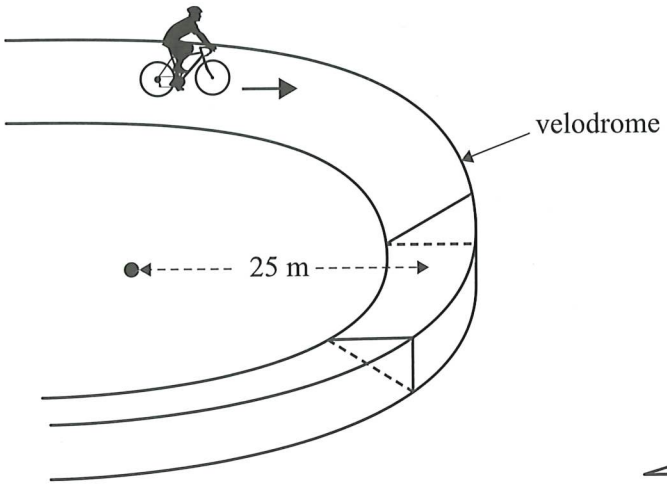


Diagram A

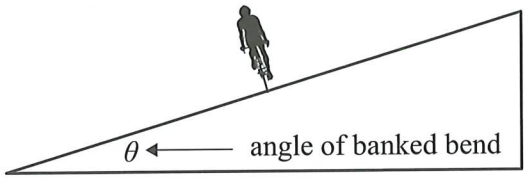


Diagram B

The bicycle is travelling at 11 m s^{-1} on the banked section. At this speed there are no sideways frictional forces between the wheels and the road surface.

Which one of the following is closest to the angle of the banked bend?

A. 2.6°

B. 10°

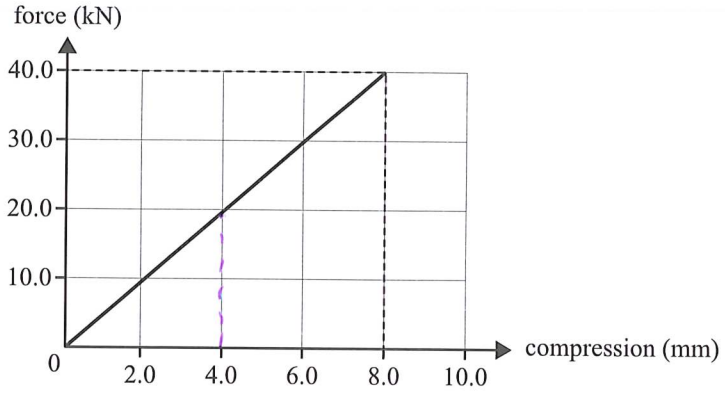
C. 26°

D. 30°

$\theta = \tan^{-1}\left(\frac{v^2}{gr}\right)$

Use the following information to answer Questions 10 and 11.

A force versus compression graph for a car spring is shown below.



Question 10

Which one of the following is closest to the spring constant of the car spring?

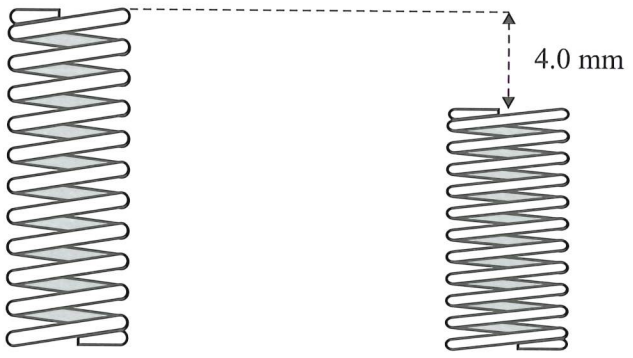
A. $5.0\ \text{N m}^{-1}$

B. $5.0 \times 10^{3}\ \text{N m}^{-1}$

C. $5.0 \times 10^{5}\ \text{N m}^{-1}$

D. $5.0 \times 10^{6}\ \text{N m}^{-1}$

When the car is sitting on a level surface, the car spring is compressed by 4.0 mm from its natural length, as shown below.



natural length of car spring **car spring compressed by 4.0 mm**

As the car goes over a bump in the road, the car spring compresses an additional 4.0 mm from the initial compression of 4.0 mm, to a total compression of 8.0 mm.

Question 11

Which one of the following is closest to the additional potential energy stored in the car spring when the car goes over the bump?

A. $4.0 \times 10^{1}\ \text{J}$

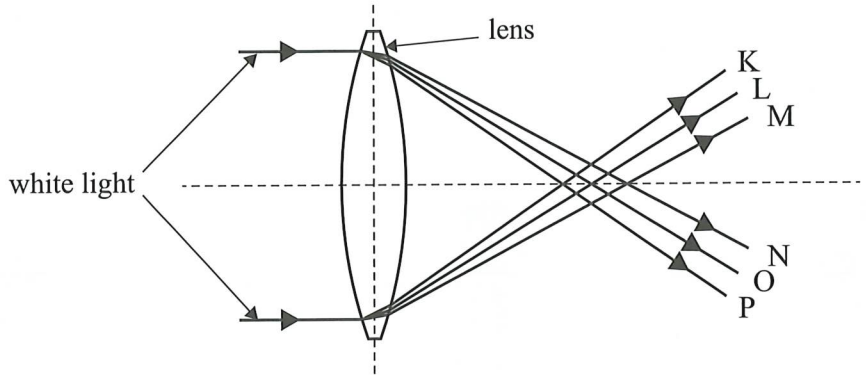
B. $1.2 \times 10^{2}\ \text{J}$

C. $1.6 \times 10^{2}\ \text{J}$

D. $3.2 \times 10^{2}\ \text{J}$

Question 12

A physics class is investigating the dispersion of white light using a lens, as shown in the diagram below.



The students observe the rays K–P that have been refracted by the lens.

Which one of the following correctly identifies the colour, red (R), green (G) or violet (V), of the rays K–P?

	K	L	M	N	O	P
A.	R	G	V	V	G	R
B.	V	G	R	R	G	V
C.	V	G	R	V	G	R
D.	V	R	G	G	R	V

Question 13

A physics student hears a clap of thunder shortly after observing a flash of lightning.

Which one of the following statements best describes the sound associated with the clap of thunder and the visible light associated with the flash of lightning?

A. Both the sound and the visible light are examples of transverse waves.

B. Both the sound and the visible light are examples of longitudinal waves.

C. Sound is an example of a transverse wave and visible light is an example of a longitudinal wave.

D. Sound is an example of a longitudinal wave and visible light is an example of a transverse wave.

Question 14

Polarisation of visible light provides evidence that electromagnetic radiation can be explained using a

A. standing wave model for light.

B. transverse wave model for light.

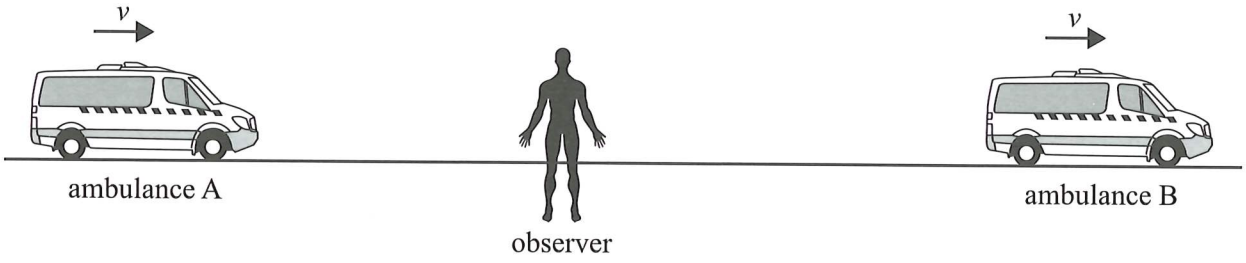
C. mechanical wave model for light.

D. longitudinal wave model for light.

Question 15

Two ambulances, A and B, are travelling along a straight road, both with the same constant velocity, v. Both ambulances have their sirens on and the sounds produced are identical and have a constant frequency.

Ambulance A is travelling directly towards a stationary observer, while ambulance B is travelling directly away from the stationary observer, as shown in the diagram below.



Which one of the following best describes the frequency of each siren as measured by the stationary observer, compared to the frequency the observer would measure if the ambulances were stationary?

A. The observer measures each siren's frequency to be lower.

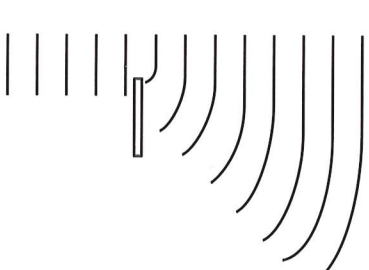
B. The observer measures each siren's frequency to be higher.

C. The observer measures the frequency of ambulance A's siren to be lower and the frequency of ambulance B's siren to be higher.

D. The observer measures the frequency of ambulance A's siren to be higher and the frequency of ambulance B's siren to be lower.

Question 16

Water waves travelling at constant speed and hitting a barrier can change direction, as shown in the diagram below.



Which one of the following best identifies this phenomenon?

A. diffraction

B. dispersion

C. refraction

D. resonance

DO NOT WRITE IN THIS AREA

Question 17

Which one of the following statements best explains why it is possible to compare X-ray and electron diffraction patterns?

A. X-rays can exhibit particle-like properties.
B. Electrons can exhibit wave-like properties.
C. Electrons are a form of high-energy X-rays.
D. Both electrons and X-rays can ionise matter.

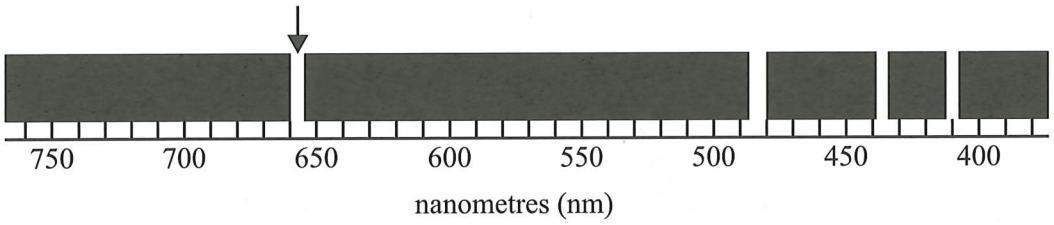
Question 18

Which one of the following statements best describes the type of light produced from different types of light sources?

A. Light from a laser is coherent and has a very narrow range of wavelengths.
B. Light from an incandescent lamp is coherent and has a range of wavelengths.
C. Light from an incandescent lamp is incoherent and has a very narrow range of wavelengths.
D. Light from a single-colour light-emitting diode (LED) is coherent and contains a very wide range of wavelengths.

Question 19

The diagram below shows the spectrum of light emitted by a hydrogen vapour lamp. The spectral line indicated by the arrow on the diagram is in the visible region of the spectrum.



Which one of the following is closest to the frequency of the light corresponding to the spectral line indicated by the arrow?

$\frac{3 \times 10^8}{655 \times 10^{-9}}$

A. 6.5×10^2 Hz
B. 4.6×10^{14} Hz
C. 6.5×10^{14} Hz
D. 4.6×10^{16} Hz

Question 20

Heisenberg's uncertainty principle can be used to explain the results of single-slit diffraction experiments for electrons.

This is because Heisenberg's uncertainty principle

A. fixes the size range of the slit to be used.
B. states that each electron's exact position was predictable after passing through the slit.
C. states that each electron's actual position after passing though the slit was only known within a wide range.
D. states that if the electron's momentum was known, its position after passing through the slit was also known.

END OF SECTION A
TURN OVER

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 book are **not** drawn to scale.

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

Question 1 (7 marks)

Some physics students are conducting an experiment investigating both electrostatic and gravitational forces. They suspend two equally charged balls, each of mass 4.0 g, from light, non-conducting strings suspended from a low ceiling.

The charged balls repel each other with the strings at an angle of 60°, as shown in Figure 1.

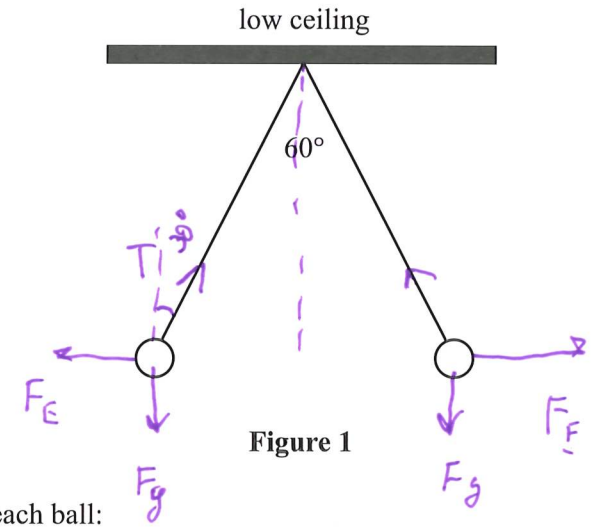


Figure 1

There are three forces acting on each ball:

- a tension force, T
- a gravitational force, F_g
- an electrostatic force, F_E.

a. On Figure 1, using the labels T, F_g and F_E, draw each of the three forces acting on each of the charged balls. 3 marks