VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2022

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

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

PHYSICS
Written examination

Wednesday 25 May 2022

Reading time: 10.00 am to 10.15 am (15 minutes)
Writing time: 10.15 am to 12.45 pm (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	20	20	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 37 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.

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

Question 1

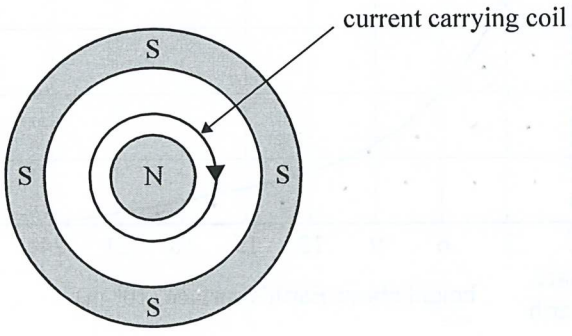
Two parallel plates that are 10 mm apart have a potential difference of 5.0 kV between them.
Which one of the following best gives the strength of the electric field between the plates?

A. 5.0×10^{-1} V m^{-1}
B. 5.0×10^{1} V m^{-1}
C. 5.0×10^{2} V m^{-1}
D. 5.0×10^{5} V m^{-1}

$E = \frac{V}{d} = \frac{5000}{0.01}$

Question 2

A loudspeaker consists of a current carrying coil within a radial magnetic field, as shown in the diagram below. The direction of the current in the coil is also shown.



Which one of the following best describes the direction of the force on the coil?

A. out of the page
B. down the page
C. into the page
D. up the page

RHSR

Question 3

The gravitational field strength at the surface of a uniform spherical planet of radius R is g N kg^{-1}.

At a distance of $3R$ above the planet's surface, the strength of gravity will be closest to

A. 0

B. $\frac{g}{3}$

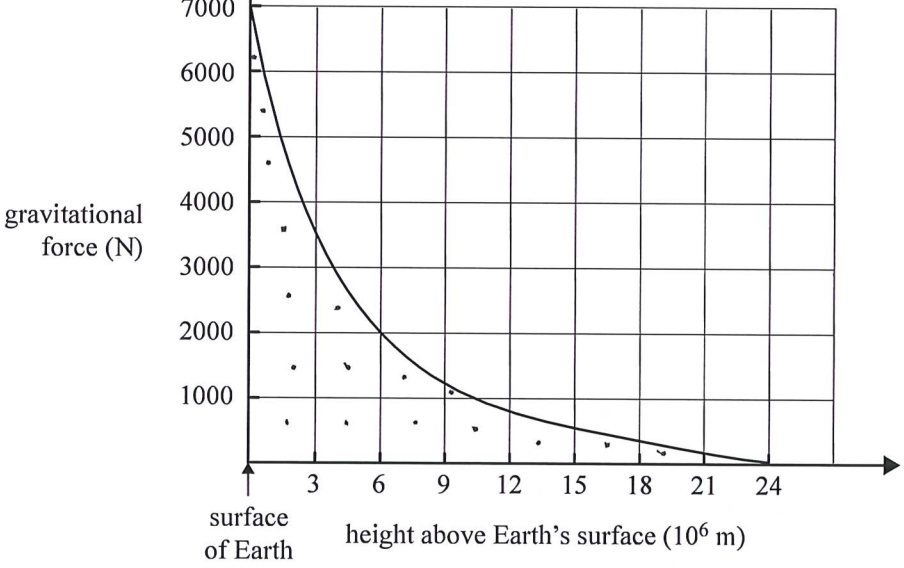
C. $\frac{g}{9}$

D. $\frac{g}{16}$

$g = \frac{GM}{R^2}$ $g_1 = \frac{GM}{(4R)^2}$

Question 4

The Mars *Odyssey* spacecraft was launched from Earth to explore Mars. The graph below shows the gravitational force acting on the 700 kg Mars *Odyssey* spacecraft plotted against its height above Earth's surface.



Which one of the following is closest to the minimum launch energy needed for the Mars *Odyssey* spacecraft to 'escape' Earth's gravitational attraction?

A. 4.0×10^4 J

B. 1.5×10^5 J

C. 4.0×10^{10} J

D. 1.5×10^{11} J

1 sq = $1000 \times 10^6 \times 3 = 3 \times 10^9$ J

11.5 sq = 3.45×10^{10}

~~3.45×10^{10}~~

Question 5

The ratio of the number of turns in an ideal step-up transformer is 350:1. An alternating RMS current of 30.0 mA is supplied to the primary coil.

The RMS current in the output will be closest to

A. 0 mA

B. 0.086 mA

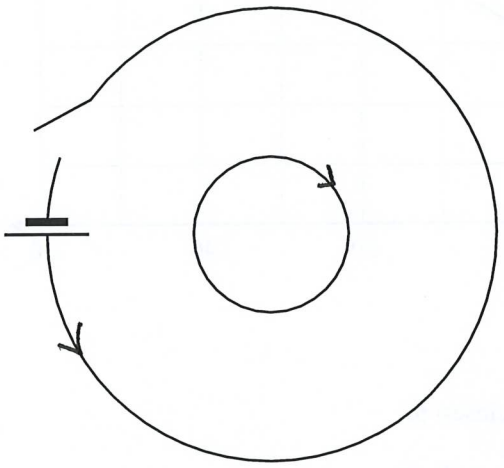
C. 30.0 mA

D. 1.1×10^4 mA

$\frac{30}{350}$

Question 6

Two concentric loops of conducting wire are placed on a flat horizontal surface. The outer loop contains an open switch and a battery cell. The inner loop consists of a single closed loop of wire. The diagram below shows the arrangement of the two loops, as viewed from above.



I ↻ → B ⊙ and ↑ →

Induced ⊗

Which one of the following best describes the induced current in the inner loop once the switch is closed in the outer loop, as viewed from above?

A. a steady clockwise current

B. a steady anticlockwise current

C. a momentary clockwise current

D. a momentary anticlockwise current

Question 7

A car travelling at 60 km h^{-1} brakes to a complete stop over a distance of 18 m under a constant braking force.

Which one of the following is closest to the braking distance required for the same car to come to a complete stop when travelling at 40 km h^{-1} and braking with the same constant braking force?

A. 8 m

B. 9 m

C. 12 m

D. 15 m

$u_1^2 = 2as \times 18$

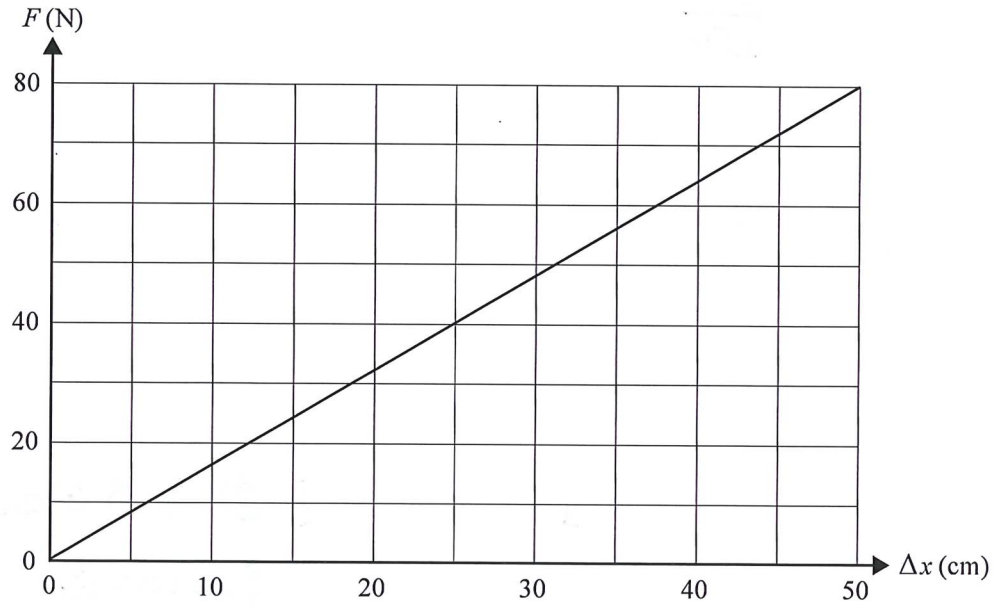
$u_2^2 = 2as$

$\frac{s}{18} = \left(\frac{2}{3}\right)^2$

$\frac{s}{18} = \frac{4}{9}$ $s = 8$ m

Use the following information to answer Questions 8 and 9.

Maya is given a light spring with an unstretched length of 20 cm. The force versus extension graph for the spring is shown below. Maya hangs the spring vertically and attaches a mass to it so that the new length of the spring is 30 cm.



Question 8

The spring constant, k, of Maya's spring is closest to

A. 1.6 N m^{-1}

B. 40 N m^{-1}

C. 160 N m^{-1}

D. 4000 N m^{-1}

$k = \frac{F}{\Delta x} = \frac{80}{0.5} = 160$

Question 9

Assuming that the spring has no mass, the value of the mass Maya attached to it is closest to

A. 1.6 kg

B. 4.9 kg

C. 6.6 kg

D. 8.2 kg

$mg = kx$

$m = \frac{160 \times 0.1}{9.8}$

Question 10

Ning travels at $0.67c$ from Earth to the star Proxima Centauri, which is a distance of 4.25 light-years away, as measured by an observer on Earth.

Which one of the following statements is correct?

A. In Ning's frame of reference, the distance to Proxima Centauri is less than 4.25 light-years.

B. In Ning's frame of reference, the distance to Proxima Centauri is more than 4.25 light-years.

C. According to Ning's clock, the trip takes longer than the time measured by Earth-based clocks.

D. In Ning's frame of reference, the distance to Proxima Centauri is exactly equal to 4.25 light-years.

Question 11

The star Betelgeuse is classified as a red supergiant. At the core of this star, three stationary helium nuclei fuse to form one carbon nucleus and two gamma-ray photons, as represented by the equation below.

$$^4\text{He} + {}^4\text{He} + {}^4\text{He} \rightarrow {}^{12}\text{C} + \gamma + \gamma$$

The mass of one helium nucleus is 6.645×10^{-27} kg.

The mass of one carbon nucleus is 1.993×10^{-26} kg.

The energy released from the fusion of three helium nuclei is closest to

A. 5.0×10^{-30} J

B. 1.5×10^{-21} J

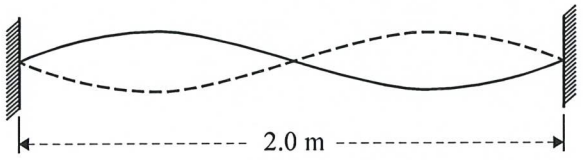
C. 4.5×10^{-13} J

D. 1.2×10^{-9} J

$(6.645 \times 3 - 19.93) \times 10^{-27} \times 9 \times 10^{16} = 4.5 \times 10^{-4}$

Question 12

The diagram below represents a standing wave on a string fixed at both ends, with a node at the centre. The wave has a frequency of 5.0 Hz and the distance between the two fixed ends is 2.0 m.



Which one of the following would be closest to the speed of a transverse wave travelling on the string?

A. 0.40 m s^{-1}

B. 2.5 m s^{-1}

C. 5.0 m s^{-1}

D. 10 m s^{-1}

$v = f\lambda = 10$

Question 13

The refractive index of a diamond is 2.42 and the refractive index of water is 1.33

Which one of the following is closest to the critical angle for a diamond fully submerged in water?

A. 2°

B. 24°

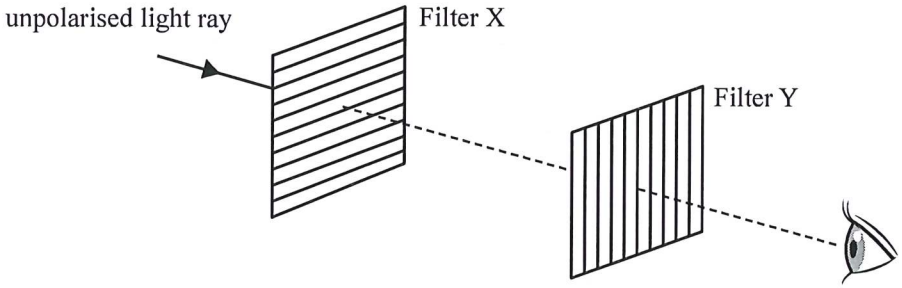
C. 33°

D. 49°

$\theta = \sin^{-1}\left(\frac{1.33}{2.42}\right) = 33°$

Question 14

An unpolarised light ray is directed towards two polarising filters, X and Y, which are placed so that their planes of polarisation are at right angles to one another, as shown in the diagram below.



Which of the following correctly describes the direction of the electric field vibrations of the light emerging from the two filters?

	Electric field vibrations of light emerging from Filter X	Electric field vibrations of light emerging from Filter Y
A.	vibrate in every direction	vibrate in one direction
B.	vibrate in every direction	no vibration
C.	vibrate in one direction	vibrate in one direction
D.	vibrate in one direction	no vibration

Question 15

The Doppler effect can be observed

A. only in sound waves.

B. in all mechanical waves.

C. only in electromagnetic waves.

D. in water waves and sound waves but not in electromagnetic waves.

Question 16

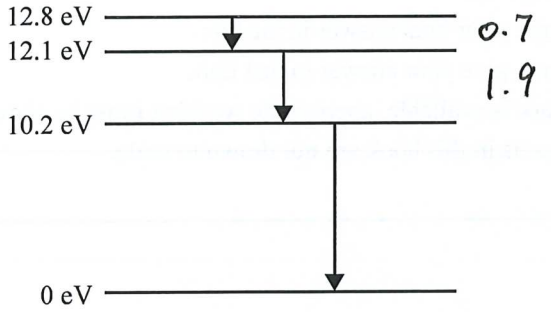
When light of a specific frequency strikes a metal surface, photoelectrons are emitted.

If the light intensity is increased but the frequency of the light remains the same, which of the following would be correct?

	Number of photoelectrons emitted	Maximum kinetic energy of photoelectrons
A.	increases	remains the same
B.	remains the same	increases
C.	increases	decreases
D.	remains the same	remains the same

Question 17

Some of the energy levels of the hydrogen atom are shown in the diagram below. A hydrogen atom has been excited to the 12.8 eV energy level. It returns to the ground state via the three transitions shown.



Which of the following indicates the energies of the emitted photons?

A. 0.7 eV, 2.6 eV, 10.2 eV
B. 0.7 eV, 1.9 eV, 10.2 eV
C. 1.9 eV, 2.6 eV, 10.2 eV
D. 10.2 eV, 12.1 eV, 12.8 eV

Question 18

Which one of the following best describes how laser light is produced?

A. by focusing solar radiation
B. by stimulating the emission of radiation
C. by accelerating positively charged particles
D. by heating a tungsten filament in an evacuated glass tube

Question 19

Diffraction is a property of waves. Electrons display wave-like properties when producing diffraction patterns.

This is because electrons

A. always carry an electric charge.
B. can move around nuclei in fixed orbits.
C. have a wavelength related to their momentum.
D. can jump between energy levels within an atom.

Question 20

The position and the momentum of an object cannot be measured precisely at exactly the same time, no matter how carefully the measurements are made.

This is explained by

A. Newton's laws of motion.
B. Young's double-slit experiment.
C. de Broglie's matter-wave equation.
D. Heisenberg's uncertainty principle.

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 (4 marks)

A particle with mass m and charge q is accelerated from rest by a potential difference, V. The only force acting on the particle is due to the electric field associated with this potential difference.

a. Show that the speed of the particle is given by $v = \sqrt{\frac{2qV}{m}}$ and state the principle of physics used in your answer. 2 marks

Conservation of energy

$qV = \frac{mv^2}{2}$

$v = \sqrt{\frac{2qV}{m}}$

b. Calculate the speed of an electron accelerated from rest by a potential difference of 200 V. 2 marks

$v = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 200}{9.1 \times 10^{-31}}} =$

8.4×10^{6} m s^{-1}