



Pymble Ladies' College

Student Number

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2020
TRIAL EXAMINATION

Physics

General Instructions

Reading time - 5 minutes

Working time - 3 hours

Write using black pen

Draw diagrams using pencil

Board-approved calculators may be used

A data sheet, formulae sheets and Periodic Table are provided

Write your Student Number at the top of this page and the multiple choice answer sheet

Total marks – 100

This paper has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1–20
- Allow about 40 minutes for this part

Part B – 80 marks

- Attempt Questions 21–36
- Allow about 2 hours and 20 minutes for this part

PART A

Multiple choice 20 marks

Attempt Questions 1–20.

Allow about 40 minutes for this part

Use the multiple-choice answer sheet attached at the end of this exam paper.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A ☐ B ☒ C ☐ D ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☒ B ☒ C ☐ D ☐

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A ☒ B ☒ C ☐ D ☐
correct
↓

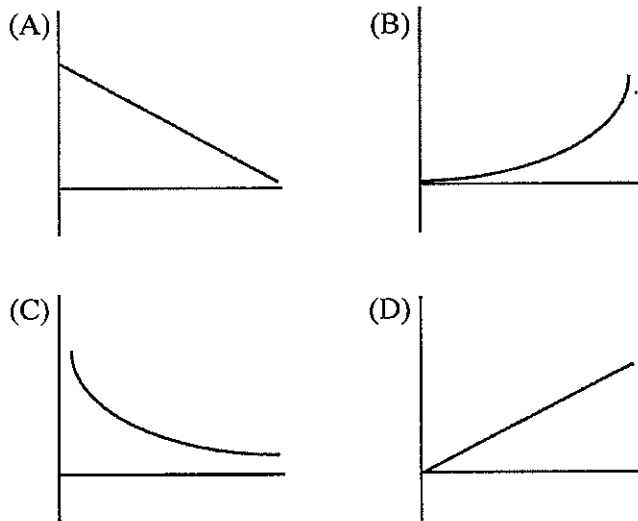
Question 1

Which variable(s) determine the maximum height of a projectile?

- A. Launch elevation angle of 45° only
- B. Launch speed only
- C. Launch speed and launch elevation angle
- D. Launch speed and range

Question 2

Which graph shows the relationship between the mass and surface gravitational field of planets with the same radius.

**Question 3**

Which statement best accounts for the difference between projectile and uniform circular motion?

- A. In projectile motion, linear motion is in a constant direction relative to the frame of reference, while in circular motion, it is always changing.
- B. In projectile motion, the force is in a constant direction relative to the frame of reference, while in circular motion it is always perpendicular to the velocity of the object undergoing circular motion.
- C. In projectile motion, the acceleration is in the same direction as the motion, while in circular motion it is always perpendicular to the motion.
- D. In projectile motion, the horizontal velocity is constant, while in circular motion the vertical motion is constant.

Question 4

The diagram shows a worker who is having trouble lifting a heavy box using a lever.



How could she use her strength more effectively?

- A. By pushing perpendicularly to the lever at the end of the bar
- B. By pushing vertically at the end of the bar
- C. By pushing perpendicular to the lever closer to the box
- D. By pushing vertically closer to the box

Question 5

The escape velocity of Earth is 11200 ms^{-1} and yet a space craft, moving at much lower speed, can travel away from the Earth and towards distant planets.

Which statement about this is correct?

- A. If a space craft turns off its engines, it will slow down and be pulled back to Earth.
- B. To escape the Earth's gravitational field, a space craft will have to accelerate to 11200 ms^{-1} at some stage during the trip.
- C. A space craft in orbit around the Earth could use engines to accelerate and escape Earth's gravity at a speed lower than 11200 ms^{-1} .
- D. The escape velocity depends on the mass of the space craft.

Question 6

Which statement about an induction motor is correct?

- A. It has no moving parts.
- B. It utilises a rotating magnetic field.
- C. It is the only type of motor using AC current.
- D. It does not have a current-carrying conductor.

Question 7

What happens to the electric field strength between two parallel plates if the voltage between them is doubled and the distance between them is halved?

- A. Electric field strength stays the same.
- B. Electric field strength halves.
- C. Electric field strength doubles.
- D. Electric field strength becomes four times greater.

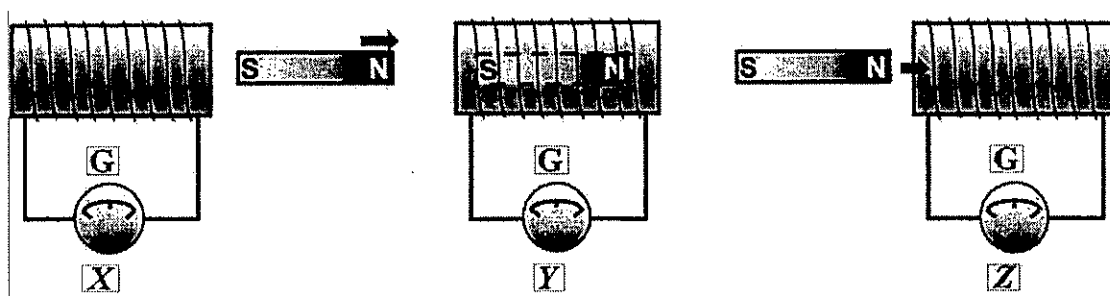
Question 8

When a charge is accelerated through a potential difference of 500 V, its kinetic energy increases from 2.0×10^{-5} J to 6.0×10^{-5} J. What is the magnitude of the electric charge?

- A. 4.0×10^{-8} C
- B. 8.0×10^{-8} C
- C. 1.2×10^{-7} C
- D. 1.6×10^{-7} C

Question 9

A single magnet moves from left to right at a constant speed through three identical coils – X, Y and Z. Each coil has a corresponding galvanometer to detect the current. Three instances of its journey are shown in the diagram.

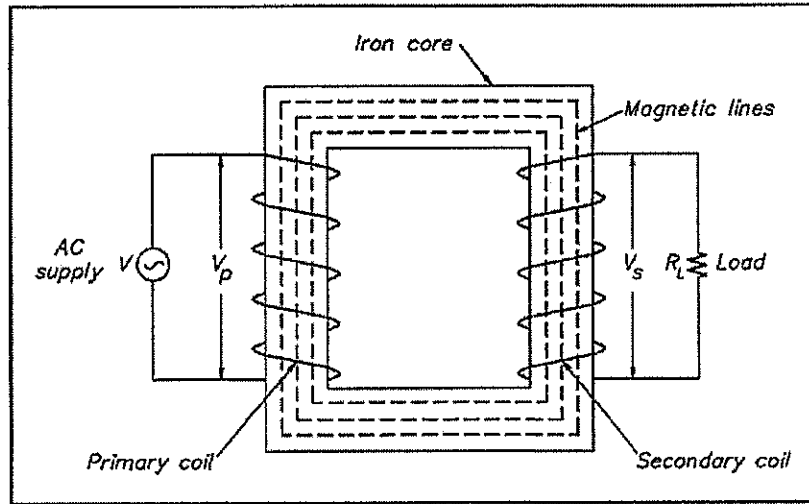


Which choice correctly shows the relationship between the needle position on each galvanometer?

	Galvanometer X (coil moving away)	Galvanometer Y (coil within)	Galvanometer Z (coil moving towards)
A.			
B.			
C.			
D.			

Question 10

A student designed and built a step-up transformer as part of her practical work and included the diagram below of her design in the written report.



Which statement is a correct evaluation of her experimental design?

- A. The design is correct because the output voltage will be larger than the input voltage.
- B. The design is incorrect because the windings of the coils are drawn in opposite directions.
- C. The design is incorrect because it represents a step-down transformer.
- D. The design is incorrect because it has equal numbers of turns in both coils.

Question 11

Friction braking on cars obeys the law of Conservation of Energy by generating heat energy from the car's kinetic energy.

Which of the following is generated with magnetic braking to ensure the same law is obeyed?

- A. Elastic potential energy
- B. Magnetic fields
- C. Eddy currents and heat energy
- D. Gravitational potential energy

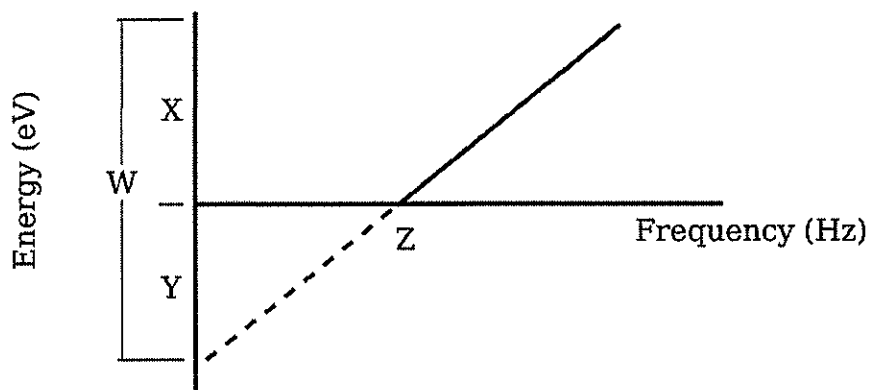
Question 12

How did Newton's particle theory of light explain refraction?

- A. Stronger forces within the refracting medium changed the direction of travel of the light particles as they entered the medium.
- B. Because the refracting medium was so dense compared to air, the light particles were forced to slow down.
- C. The light particles scattered in the medium because the medium particles were closer together than air particles.
- D. Newton's particle theory of light could not explain refraction.

Question 13

The graph shows information about the emission of photoelectrons from a metal.

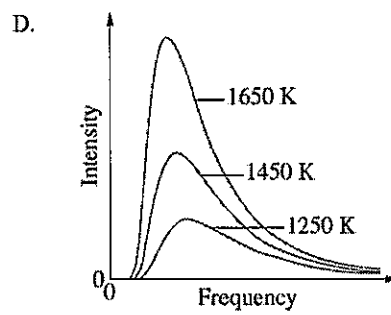
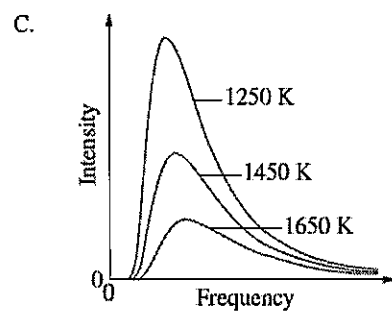
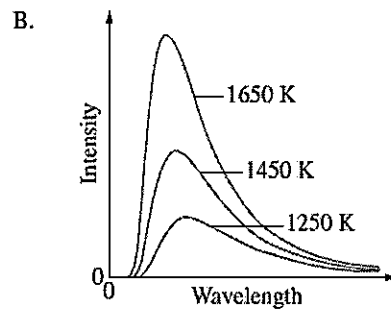
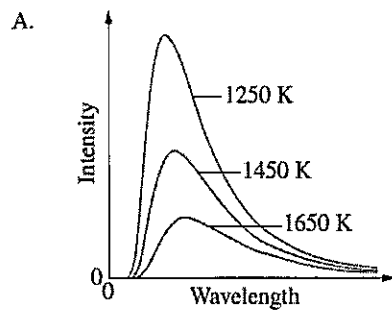


Which choice correctly identifies the sections labelled W, X, Y and Z?

	W	X	Y	Z
A.	Energy of incident photon	Work function of emitter	Kinetic energy of emitted photoelectron	Threshold frequency
B.	Kinetic energy of emitted photoelectron	Energy of incident photon	Threshold frequency	Work function of emitter
C.	Threshold energy	Kinetic energy of emitted photoelectron	Energy of incident photon	Work function of emitter
D.	Energy of incident photon	Kinetic energy of emitted photoelectron	Work function of emitter	Threshold frequency

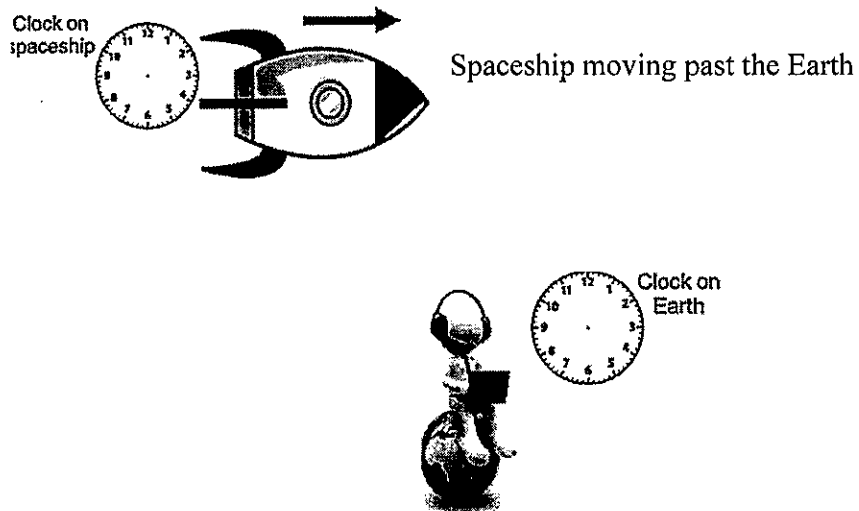
Question 14

Which graph is consistent with predictions resulting from Planck's hypothesis regarding radiation from black bodies?



Question 15

The diagram below shows a spaceship moving past the Earth close to the speed of light. An observer on Earth observes time on his clock and on the clock of the spaceship.

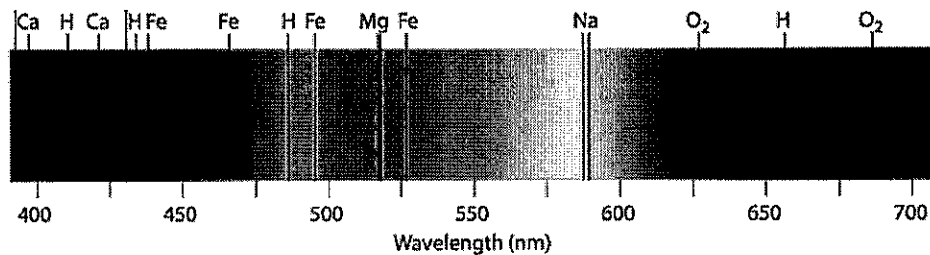


Which statement about this situation is correct?

- A. The clock on the ship will run slower.
- B. The clock on the ship will run faster.
- C. The clock on Earth will run faster.
- D. The clock on Earth will run slower.

Question 16

An absorption spectrum from a star is shown.

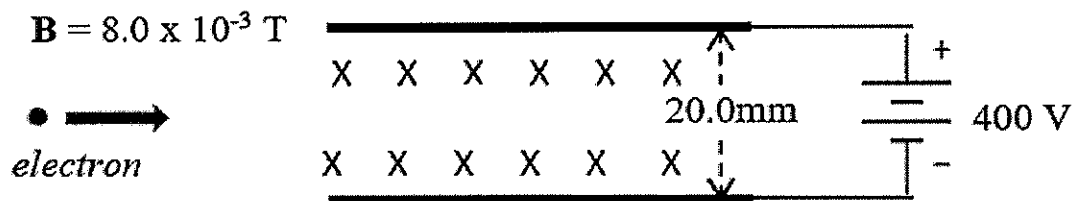


What is indicated by the existence of the dark lines in the spectrum?

- A. the star is moving away from us.
- B. atoms in the star's atmosphere are absorbing light and not re-emitting it.
- C. several elements are present in the star's atmosphere.
- D. only some atoms in the star's atmosphere are contributing to the spectrum.

Question 17

An electron enters a region where a uniform magnetic field is perpendicular to an electric field between two charged plates, as shown.



The electron passes through the crossed fields without being deflected.

The electron's speed is:

- A. $8.0 \times 10^{-15} \text{ m s}^{-1}$
- B. $1.6 \times 10^3 \text{ m s}^{-1}$
- C. $5.0 \times 10^4 \text{ m s}^{-1}$
- D. $2.5 \times 10^6 \text{ m s}^{-1}$

Question 18

Step-down transformers are used in the distribution of energy.

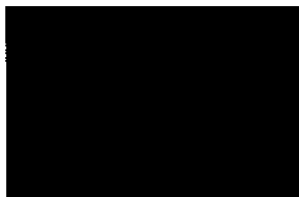
Which statement about their use is correct?

- A. They ensure low power loss in transmission lines.
- B. They have laminated cores to ensure complete flux linkage.
- C. They enable safe voltages to be delivered to consumers.
- D. They reduce the current flowing in transmission lines.

Question 19

Laser light with a wavelength of 621 nm was passed through a double slit. The two slits are 100 μm apart.

The resulting interference pattern is reproduced below. The screen is placed 1.50 m from the slits.



NOT TO
SCALE

What is the distance from the central maximum to the 2nd bright spot on the screen?

- A. 19 mm
- B. 15 mm
- C. 12 mm
- D. 3.0 mm

Question 20

In 2012 scientists at the European Organisation for Nuclear Research (CERN) in Switzerland claimed to have found the Higgs boson. They measured its rest energy as 126 GeV. If this measurement is correct, the mass of the Higgs boson is closest to:

- A. 1.40×10^{-9} kg.
- B. 2.24×10^{-24} kg.
- C. 2.24×10^{-25} kg.
- D. 1.40×10^{-24} kg.

Part B Extended Answers – 80 marks

Attempt Questions 21 – 36

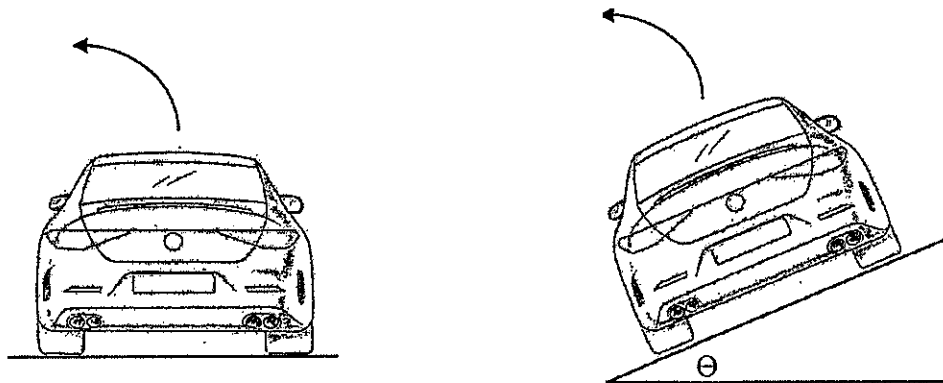
Allow about 2 hours and 20 minutes for this part

Answer the questions in the spaces provided. Extra Space is provided at the end of the exam if required.

Show all relevant working in questions involving calculations.

Question 21 (4 marks)

The diagram shows identical cars on rough road surfaces, one on a curved horizontal road and one on a curved road banked at 8° . The cars are viewed from behind. Both roads curve towards the left and have the same radius.



With the help of annotations to the diagram above, explain why the car can safely take the banked curve at a higher speed than the identical car driving on the horizontal curved road. 4

Question 22 (7 marks)

A stroboscopic photograph was taken of an athlete competing in a long jump event. The distance between the athlete in the first and last images is 7.4 m. The camera used to take the pictures took one frame every 0.1 s. The parallax error is **not** significant in making accurate measurements.



Using appropriate equations, calculate the maximum height and launch velocity. Clearly identify any assumptions you have made.

7

Question 22 continues over page

Question 22 (continued)

Question 23 starts over the page

Question 23 (3 marks)

A 2500 kg satellite is launched from a place on the Earth's surface where it has a rotational speed of 370 m/s.

It is then launched into a circular orbit with a radius of 2.0×10^7 m.

What amount of work is required to place this satellite into its orbit?

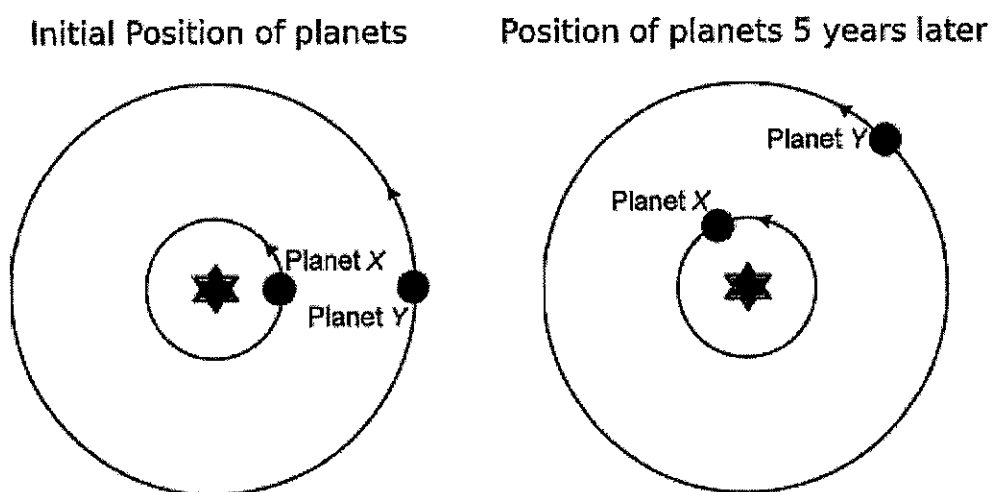
4

Question 24 starts over the page

Question 24 (3 marks)

Two planets, X and Y, travel anticlockwise in circular orbits about a star, as seen in the diagram. The radii of the orbits X and Y are in the ratio 2:5.

The planets are shown below at a time interval of 5 years. Initially they were aligned, making a straight line with the star. Five Earth years later, planet X has rotated through 120° ($1/3$ of a revolution) as shown.

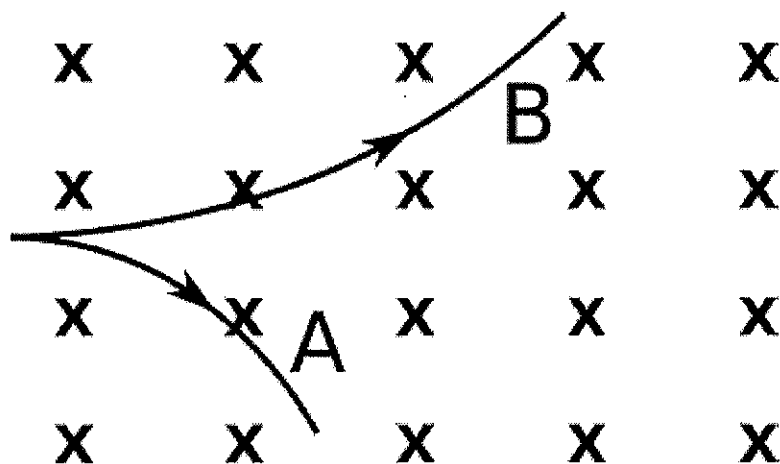


Determine how long it takes (in Earth years) for planet Y to orbit the star.

3

Question 25 (5 marks)

Charged particles A and B move into a magnetic field and move along different circular paths as shown in the diagram.



a) What **must** be different about particles A and B? Justify your answer.

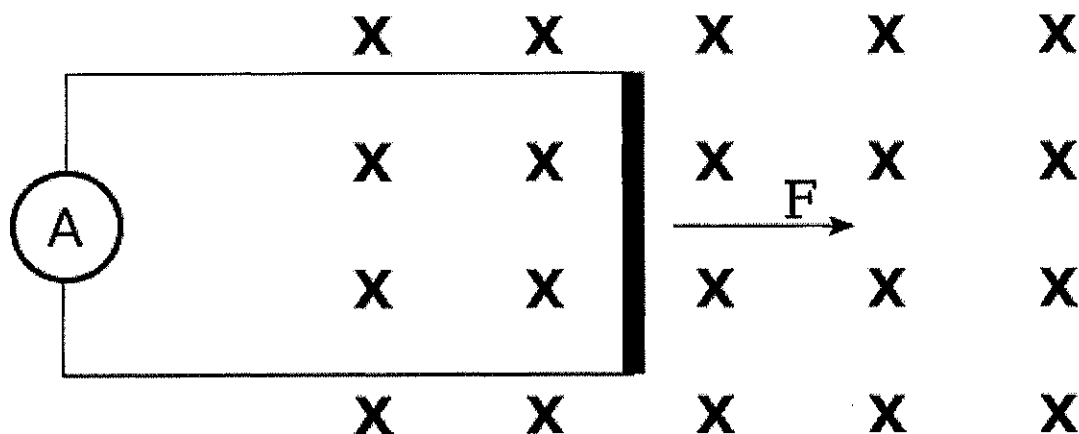
2

b) What **might** be different about particles A and B? Justify your answer.

3

Question 26 (4 marks)

A conductor which is connected to a galvanometer is moved by a force F through a magnetic field, as shown below.



In terms of the principles of physics involved, show on the diagram the direction of the induced current in the conductor and explain why it must be in this direction.

4

Question 27 (4 marks)

One definition of the ampere states:

The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed one metre apart in vacuum, would produce a force equal to 2×10^{-7} newtons per metre of length between these conductors.

Explain how this definition of the ampere relates to Newton's Third Law and calculate the size of the force between two parallel current carrying wires, each 0.65 metres long, carrying 0.375 amperes each, and separated by a distance of 13.5 mm. 4

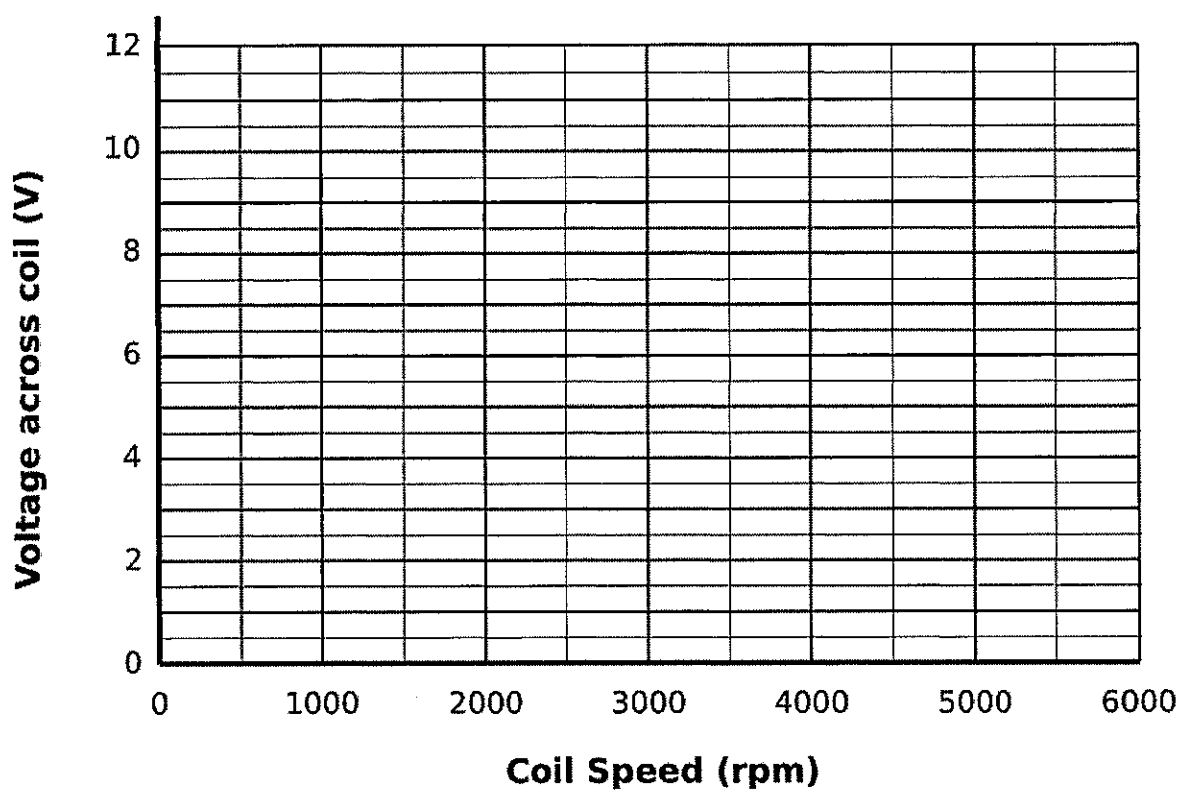
Question 28 (8 marks)

The table shows the results of an experiment on the relationship between the rotational speed in revolutions per minute (rpm) of a motor coil and the net voltage across the coil. The motor was connected to a 12 V power supply. Assume that there is a load attached to the motor.

<i>Speed of coil (rpm)</i>	<i>Voltage across coil (V)</i>
0	12.0
500	10.6
1000	8.2
1500	7.6
2000	6.6

(a) Plot this data on the axes below.

1



Question 28 continues over the page

Question 28 (continued)

- (b) Explain why the net voltage across the coil decreases as the speed of the motor increases, **and** why the voltage across the coil will not reach zero. 5

- (c) **On the same axes where you plotted the data**, draw and extrapolate the curve of best fit to show the relationship between the voltage across the coil and the coil speed for speeds of 0 to 6000 rpm. 2

Question 29 (8 marks)

Outline the contribution of James Maxwell to our understanding of the nature of light and outline the experimental evidence, found soon after his death, that supported Maxwell's theory.

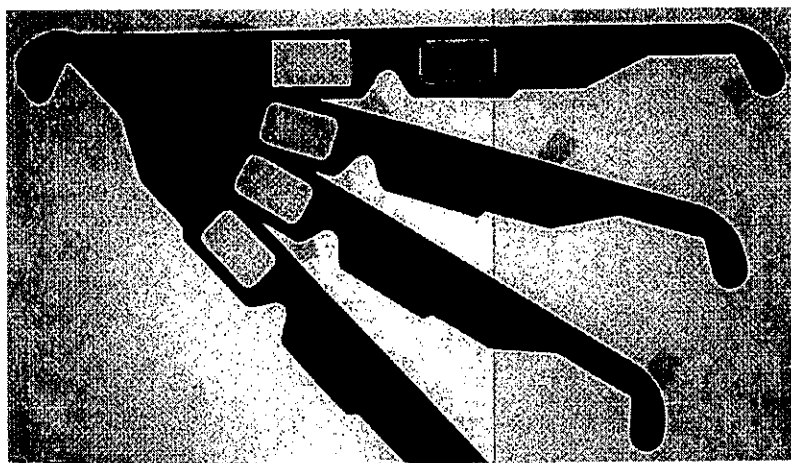
8

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Question 30 (4 marks)

The photograph below shows the two lenses of a pair of cardboard glasses that have been opened flat. Both lenses are in front of the same polarised light source. The arm of the glasses is pivoted on the left-hand side so that the angle of the arm relative to the light source can be changed.

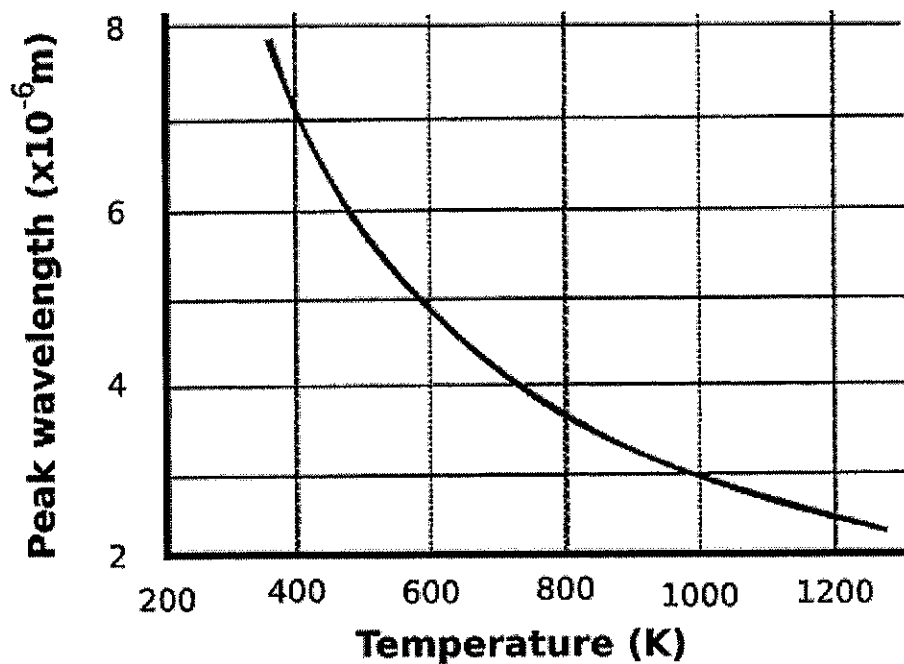
The photograph below shows the two lenses at four different positions.



In terms of the principles of physics involved, account for the lack of change in the light passing through the left-hand lens compared to the changing amount of light passing through the right-hand lens as the angle of rotation of the lenses is increased. 4

Question 31 (4 marks)

The graph below shows the wavelength of the peak intensity radiation emitted by a standard black body at different surface temperatures.

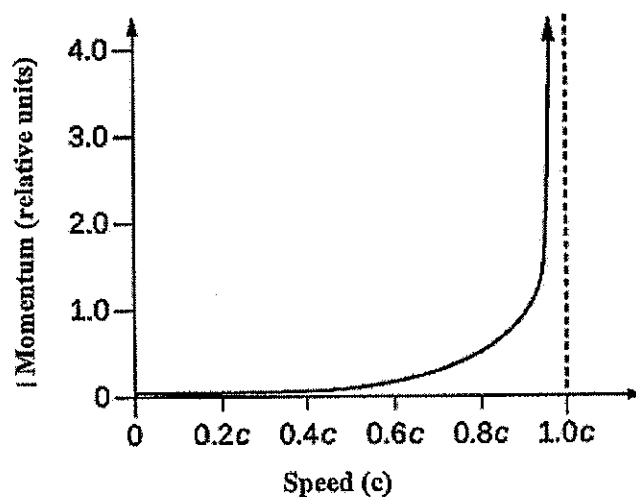


Show that this graph is consistent with Wien's law.

4

Question 32 (5 marks)

The diagram shows how the momentum of an object changes as it approaches light speed.



- a) Explain why this graph is not a straight line as classical theory would predict. 3

- b) Calculate the relativistic momentum of a proton moving at $0.8c$. 2

Question 33 (9 marks)

- a) Outline, with the aid of a diagram a thought experiment that relates to the prediction of length contraction. 3

Muons are created a distance of 10.0 km above the Earth's surface as measured by an observer on Earth's surface. They then travel vertically downwards to the surface where they are detected.

- b) Calculate the distance for this journey as measured by the muons. 3

Question 33 continues over the page

Question 33 (continued)

- c) Explain how investigations involving muons provided experimental validation of length contraction. **3**

Question 34 starts over the page

Question 34 (4 marks)

Compare the effects of electric and magnetic fields on a charged particle if the particle is initially moving perpendicular to the fields. Support your answer with a labelled diagram showing each field.

4

Question 35 starts over the page

Question 35 (7 marks)

Ultraviolet light with a wavelength of 180 nm is shone on a polished nickel plate which has a work function of 5.01 eV.

- a) Determine the maximum kinetic energy of the electrons emitted from the surface of the nickel plate. 3

- b) Describe the interaction of radiation with matter that describes the photoelectric effect. 4

~ END OF EXAM ~

Part B extra writing space

If you use this space, clearly indicate which questions you are answering.

Part B extra writing space

If you use this space, clearly indicate which questions you are answering.

Part B extra writing space

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Pymble Ladies' College

2020

Physics – Multiple Choice Answer Sheet

**Student
Number:**

A B C D

1 ○ ○ ○ ○ ○

2 ○ ○ ○ ○ ○

3 ○ ○ ○ ○ ○

4 ○ ○ ○ ○ ○

■ **5** ○ ○ ○ ○ ○

6 ○ ○ ○ ○ ○

7 ○ ○ ○ ○ ○

8 ○ ○ ○ ○ ○

9 ○ ○ ○ ○ ○

10 ○ ○ ○ ○ ○

A B C D

11 ○ ○ ○ ○ ○

12 ○ ○ ○ ○ ○

13 ○ ○ ○ ○ ○

14 ○ ○ ○ ○ ○

15 ○ ○ ○ ○ ○

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17 ○ ○ ○ ○ ○

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