P Σ Λ K
PHYSICS & CHEMISTRY

2019

HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

Name: .....

Class: .....

Section I	/20
Section II	/80
Total	/100

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
  Black pen is preferred
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet is provided at the back of this paper
- Write your name and class at the top of this page

Total marks – 100

Section I Pages 2 – 8

20 marks
- Attempt Questions 1 – 20
- Allow about 35 minutes for this part

Section II Pages 9 – 20

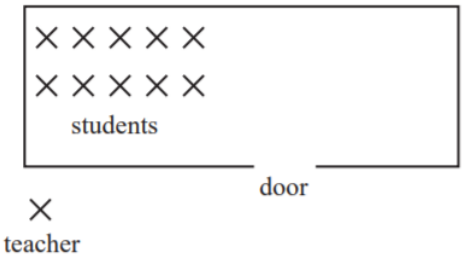
80 marks
- Attempt Questions 21 – 33
- Allow about 2 hours and 25 minutes for this part

Part A: Multiple Choice Questions (20 marks)
Attempt Questions 1 – 20
Allow about 35 minutes for this part

Use the multiple choice answer sheet for Questions 1 – 20.

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)
11.	(A)	(B)	(C)	(D)
12.	(A)	(B)	(C)	(D)
13.	(A)	(B)	(C)	(D)
14.	(A)	(B)	(C)	(D)
15.	(A)	(B)	(C)	(D)
16.	(A)	(B)	(C)	(D)
17.	(A)	(B)	(C)	(D)
18.	(A)	(B)	(C)	(D)
19.	(A)	(B)	(C)	(D)
20.	(A)	(B)	(C)	(D)

1. A teacher stands in the corridor at a short distance from the open door of her classroom. This is shown in the diagram below. She can hear her students but cannot see them.



Which one of the following best explains why the teacher can hear her students?

(A) The speed of sound is much greater than the speed of light.
(B) The speed of sound is comparable with the speed of light.
(C) Sound diffracts because the wavelength of sound is much smaller than the width of the door.
(D) Sound diffracts because the wavelength of sound is comparable with the width of the door.

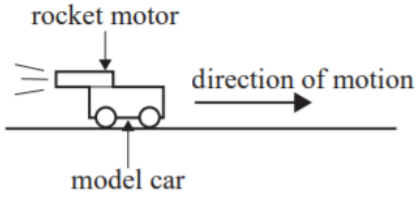
2. Millikan, a famous scientist, measured the size of the electron charge by balancing an upwards electric force with a gravitational force on a small oil drop. In a repeat of this experiment, an oil drop with a charge of 9.6×10^{-19} C was placed in an electric field of $104\ \text{V m}^{-1}$.

Which one of the following is closest to the electrical force on the oil drop?

(A) 9.6×10^{-14} N
(B) 9.6×10^{-15} N
(C) 9.6×10^{-22} N
(D) 9.6×10^{-23} N

Use the following information to answer Questions 3–5.

A model car of mass 2.0 kg is propelled from rest by a rocket motor that applies a constant horizontal force of 4.0 N, as shown below. Assume that friction is negligible.



3. Which one of the following best gives the magnitude of the acceleration of the model car?

(A) $0.50\ \text{m s}^{-2}$
(B) $1.0\ \text{m s}^{-2}$
(C) $2.0\ \text{m s}^{-2}$
(D) $4.0\ \text{m s}^{-2}$

4. Which one of the following best gives the magnitude of the impulse given to the car by the rocket motor in the first 5.0 s?

   (A) 4.0 Ns
   (B) 8.0 Ns
   (C) 20 Ns
   (D) 40 Ns

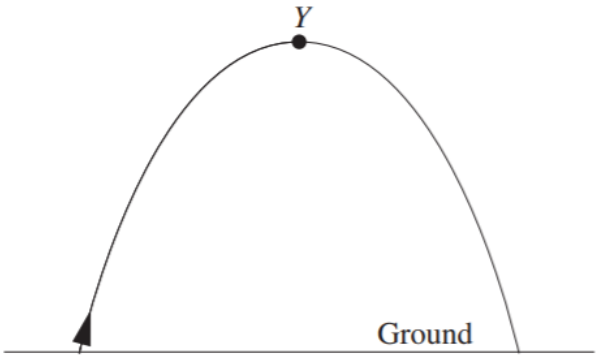
5. With the same rocket motor, the car accelerates from rest for 10 s. Which one of the following best gives the final speed?

   (A) 6.3 $\mathrm{m\,s^{-1}}$
   (B) 10 $\mathrm{m\,s^{-1}}$
   (C) 20 $\mathrm{m\,s^{-1}}$
   (D) 40 $\mathrm{m\,s^{-1}}$

6. Which one of the following best describes a hypothesis?

   (A) A possible explanation that needs to be rigorously tested by experimental evidence.
   (B) An explanation that has been supported by rigorous experimental evidence.
   (C) A statement that is widely accepted by scientists.
   (D) An explanation that is mathematically correct.

7. An object is projected upwards from the ground and follows a path as represented in the diagram.



   Which of the following describes the projectile's horizontal and vertical acceleration at point Y?

   (A) Both the horizontal and vertical acceleration are zero.
   (B) Both the horizontal and vertical acceleration are 9.8 $\mathrm{m\,s^{-2}}$.
   (C) The horizontal acceleration is 9.8 $\mathrm{m\,s^{-2}}$ and the vertical acceleration is zero.
   (D) The horizontal acceleration is zero and the vertical acceleration is 9.8 $\mathrm{m\,s^{-2}}$.

8. Which of the following statements regarding the development of the atomic model is correct?

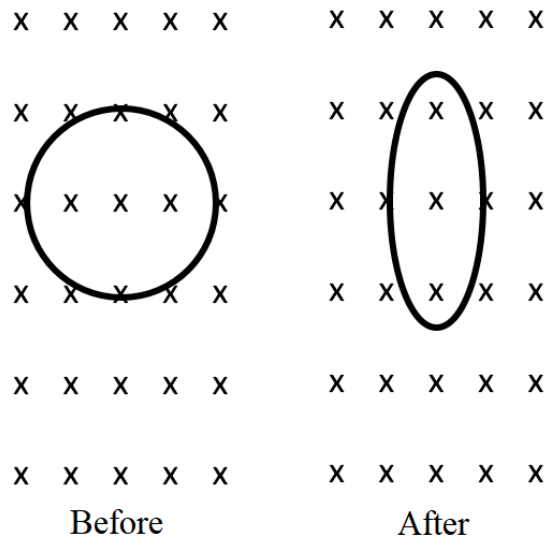
   (A) Rutherford proposed a model where a negative sphere was embedded with positive charges.

   (B) The Bohr atomic model correctly explains how electrons continuously emit energy as they orbit the nucleus.

   (C) De Broglie's matter wave model explains how electrons can remain at a certain radius by setting up standing waves.

   (D) J.J. Thompson's plum pudding model was devised before John Dalton's billiard ball model.

9. A circular loop of wire is stationary in a magnetic field. The sides are then pushed together to change the shape as show in the diagram.



   As the loop is compressed, a current is induced. Which row of the table shows the direction of the current and explains why it is induced?

	Direction	**Explanation**
(A)	Clockwise	Change in magnetic flux leads to an induced current
(B)	Anticlockwise	Change in magnetic flux leads to an induced current
(C)	Clockwise	Change in magnetic flux density leads to an induced current
(D)	Anticlockwise	Change in magnetic flux density leads to an induced current

10. The rest length of a train is 200 m and the rest length of a railway platform is 160 m. When the train rushes past the platform, a stationary observer notices the train and platform are the same length.

    If the observer is in the same frame of reference as the platform, how fast is the train moving?

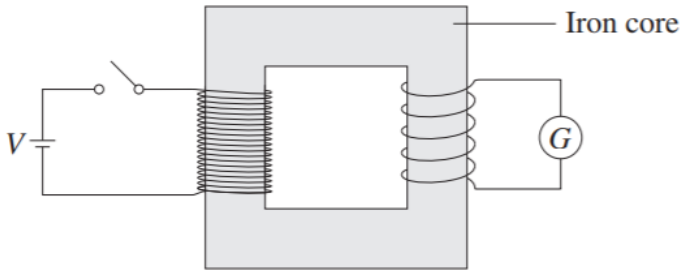
    (A) 0.60c

    (B) 0.75c

    (C) 0.80c

    (D) 1.25c

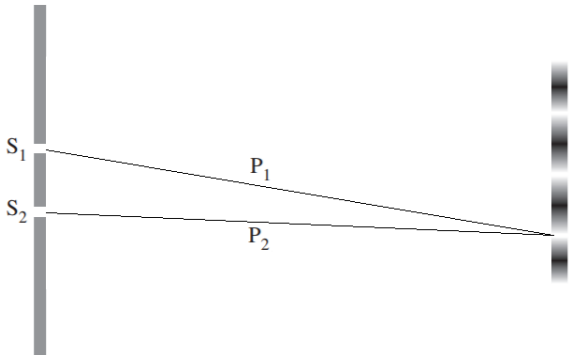
11. The below diagram shows an ideal transformer.



When the switch is closed, the pointer on the galvanometer deflects. How could the size of this deflection be increased?

(A) Decrease the number of primary coils.
(B) Decrease the number of secondary coils.
(C) Replace the iron core with a copper core.
(D) Place a resistor in series with the galvanometer.

12. Monochromatic light of wavelength λ strikes a double slit and produces bright and dark fringes on a screen. Light from slit S_1 travels along path P_1 and light from slit S_2 travels along path P_2 to produce the light fringe shown.



What is the difference in length between P_1 and P_2?

(A) $\frac{\lambda}{2}$
(B) λ
(C) $\frac{3\lambda}{2}$
(D) 2λ

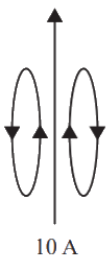
13. What is the magnitude of the momentum (in $\mathrm{kgm\,s^{-1}}$) of an electron travelling at 0.8c?

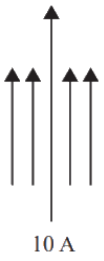
(A) 2.19×10^{-22}
(B) 3.64×10^{-22}
(C) 4.89×10^{-22}
(D) 5.99×10^{-22}

14. A straight wire carries a current of 10 A. Which one of the following diagrams best shows the magnetic field associated with this current?

(A) 

(B) 

(C) 

(D) 

15. A student sits inside a windowless box that has been placed on a smooth-riding train carriage. He conducts a series of motion experiments to investigate frames of reference.

Which one of the following observations is correct?

(A) The results when the train accelerates are identical to the results when the train is at rest.
(B) The results when the train accelerates differ from the results when the train is in uniform motion in a straight line.
(C) The results when the train is at rest differ from the results when the train is in uniform motion in a straight line.
(D) The results when the train accelerates are identical to the results when the train is in uniform motion in a straight line.

16. In the late 1800s, scientists were experimenting with cathode ray tubes to deduce the properties of cathode rays. Which of the following statement regarding their findings were not true?

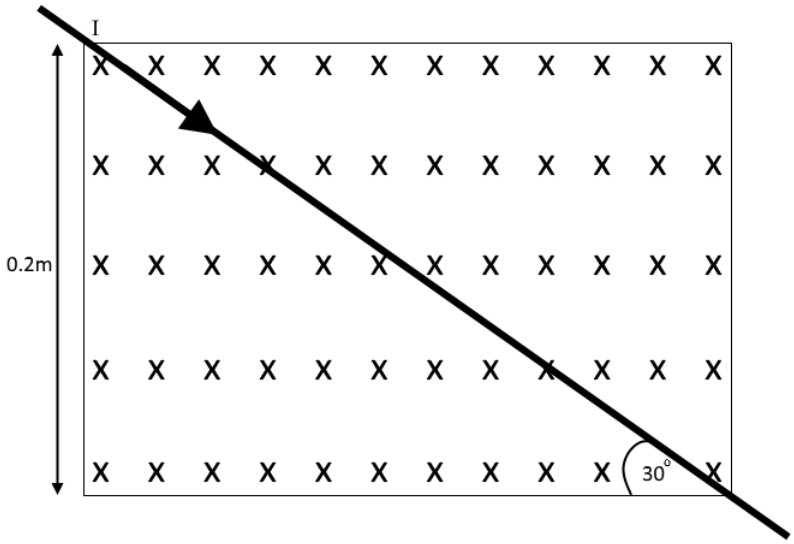
(A) Cathode ray tubes identified that cathode rays were deflected by magnetic fields.
(B) Cathode ray tubes helped show that cathode rays travelled in straight lines.
(C) Cathode ray tubes were used to confirm the mass of the particles that formed a cathode ray.
(D) Cathode ray tubes helped demonstrate that cathode rays had momentum.

17. A truck drives with a constant linear speed v_i down a road with two curves. The first curve has a radius R and the second curve has a radius $3R$.

How does the magnitude of the truck's centripetal acceleration change after the radius increases?

(A) Increases by a factor of 3
(B) Increases by a factor of 9
(C) Decreases by a factor of 3
(D) Decreases by a factor of 9

18. A current carrying wire passes through a region of uniform magnetic field, magnitude 0.05 T, and as a result experiences a force of magnitude 0.03 N.



What is the current I?

(A) 1.5 A
(B) 1.7 A
(C) 3.0 A
(D) 6.0 A

19. Matter waves are not obvious for a car travelling at highway speeds because the wavelength:

(A) is dependent on the mass of the car.
(B) is too large.
(C) cannot be calculated.
(D) is too small.

20. The expansion of the universe observed by Hubble is best understood to be due to the:

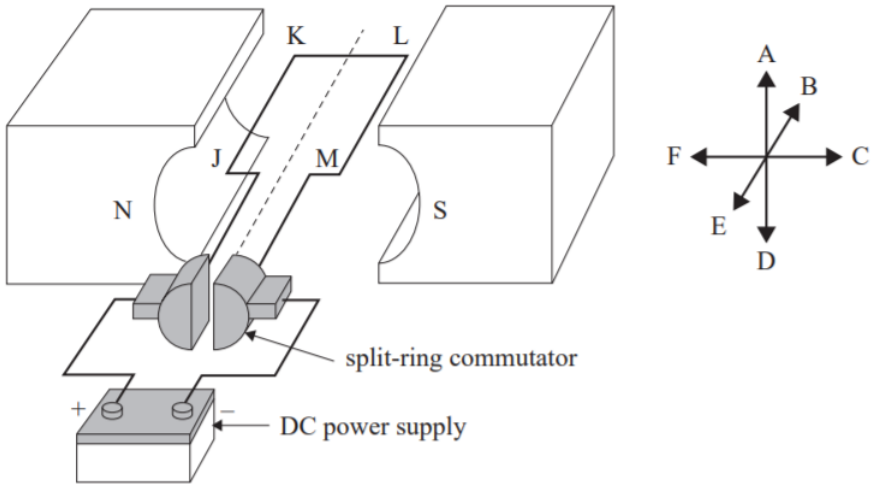
(A) movement of stars into the outer reaches of the Universe.
(B) expansion of space itself.
(C) Doppler effect of photons.
(D) repulsive gravitational forces between the stars and galaxies.

Part B: Short Answer Questions (80 marks)
Attempt Questions 21 – 13
Allow about 2 hour and 25 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (6 marks)
The diagram below shows a schematic diagram of a simple DC motor. It consists of two magnets, a single 9.0 V DC power supply, a split-ring commutator and a rectangular coil of wire consisting of 10 loops. The total resistance of the coil of wire is 6.0 Ω. The length of the side JK is 12 cm and the length of the side KL is 6.0 cm. The strength of the uniform magnetic field is 0.50 T. A compass has also been provided to aid in indicating direction.



(a) Determine the size and direction of the force acting on the side JK. **3**

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(b) To prevent the motor from spinning, a mass is attached to the armature. **3**
Calculate the weight of the mass and its location on the armature that would allow this to happen.

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Question 22 (11 marks)
In a game of tennis tetherball, a 250 g ball is tied by a rope to the top of a pole. The ball swings in a horizontal circle at 2.0 $\mathrm{m\,s^{-1}}$ after being struck. The radius of its circular path is 50 cm.

(a) Construct a labelled diagram that outlines the motion, indicating the centripetal force and any component forces. **3**

(b) Calculate the period of rotation of the ball. **2**

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(c) Calculate the centripetal acceleration of the ball. **2**

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(d) Determine the magnitude and direction of tension in the rope. **4**

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Question 23 (6 marks)
Astronaut Chris travels to Vega, the fifth brightest star in the night sky, leaving his 35 year old twin Pat behind on Earth. Chris travels at a speed of 0.990c and Vega is 25.3 light-years from Earth.

(a) How long does the trip take from the point of view of Pat? **2**

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(b) Determine Pat's age when Chris arrives at Vega. **2**

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(c) What distance did Chris travel from his point of view and how old is he at the end of his journey? **2**

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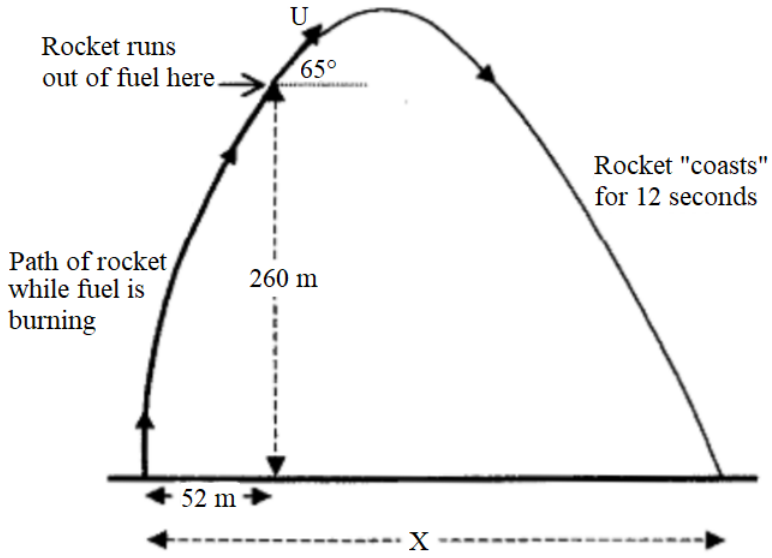
Question 24 (6 marks)

Assess the effectiveness of the Bohr-Rutherford model of the atom in accounting for experimental observations. **6**

Question 25 (6 marks)

A group of students build a small rocket under the guidance of an expert, Mr. Edbert, and take it out to a large testing field. It takes off vertically, but does not go straight due to wind, as shown in the diagram.

At a height of 260 m it runs out of fuel. At that point it is travelling at an angle of 65° to the horizontal, as shown. It then coasts on, following the path as shown, hitting the ground 12 seconds after it ran out of fuel.



For the following parts (a) and (b), assume that air friction on the rocket is not significant.

(a) What was the speed U of the rocket at the point where it ran out of fuel? **2**

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(b) What is the distance X from the launch point to where it hits the ground? **2**

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(c) Explain why the approach that you used to calculate speed and distance could not be used for a rocket that went to a height of 100 km before running out of fuel, even if air friction was negligible. **2**

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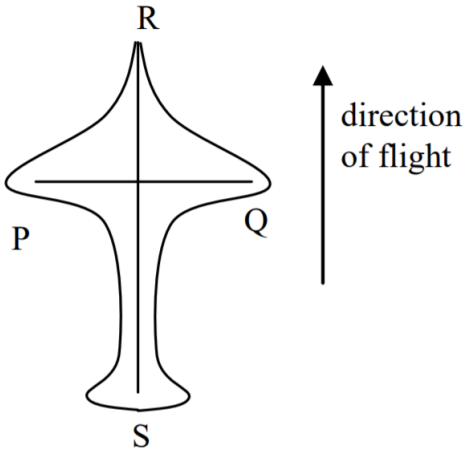
Question 26 (3 marks)

An aeroplane is flying horizontally over the north pole. The diagram shows the plane when viewed from above. **3**



How will the plane be charged? Specify the charge at each of the points P, Q, R and S.

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Question 27 (5 marks)

A planet orbits the star, Pollux, at a distance of 1.64 astronomical units (AU). It takes 590 Earth days to complete one orbit.

(a) Why does the mass of the planet play NO role in determining its orbital speed around Pollux? **2**

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(b) A satellite orbits Pollux with a period of 365 Earth days. How far is the satellite from Pollux in astronomical units (AU)? **3**

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Question 28 (8 marks)

Katrina designs an experiment to help herself understand the concept of torque better. She sets up a thin plywood board to balance on a cylindrical roll (the pivot) and sits two masses on either side of the pivot. Mass A is 23 kg heavy and 25 cm away left of the pivot. Mass B is 12 kg heavy and sits 12.3 cm to the right of the pivot. Assume the weight of the board is negligible.

(a) Construct a clearly labelled diagram displaying this information. **1**

(b) In its current state, determine the overall torque of the system. **3**
Clearly show any assumptions and working out used to do your calculations.

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(c) Suggest two ways to alter mass B such that the board is balanced. **2**

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(d) Katrina decides to try balancing the plywood board in another way. Instead of altering mass A or B she adds a third mass (mass C). **2**

If this third mass is 6 kg heavy, determine where it would have to be situated to achieve equilibrium for the board.

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Question 29 (8 marks)
The primary winding of a transformer contains 2000 turns. The primary AC voltage is 23 000 V and the output voltage is 660 kV.

(a) Explain why a transformer can only operate on an alternating current, making references to physics principles and formulas. **3**

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(b) For the above transformer, calculate the number of turns on the secondary winding. **2**

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(c) If the current in the primary winding is 100 A, and the secondary winding has a resistance of 2000 Ω, what is the power loss in the secondary winding? Assume that there is now power loss in the primary winding. **3**

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Question 30 (4 marks)

Rebecca set up a scientific experiment involving a radiation source and a radiation meter (that can detect different radiation). When placing a sheet of aluminium foil in front of the detector the level of radiation on the meter was seen to drop by 50%. **4**

Rebecca then makes the following statements.

"The radioactive source only gives off beta radiation. This experiment is valid as the method can test for different radiation sources."

Assess Rebecca's statement.

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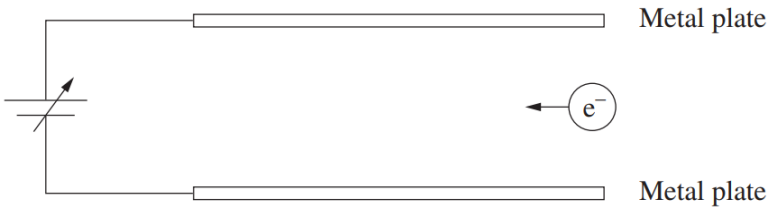
Question 31 (7 marks)

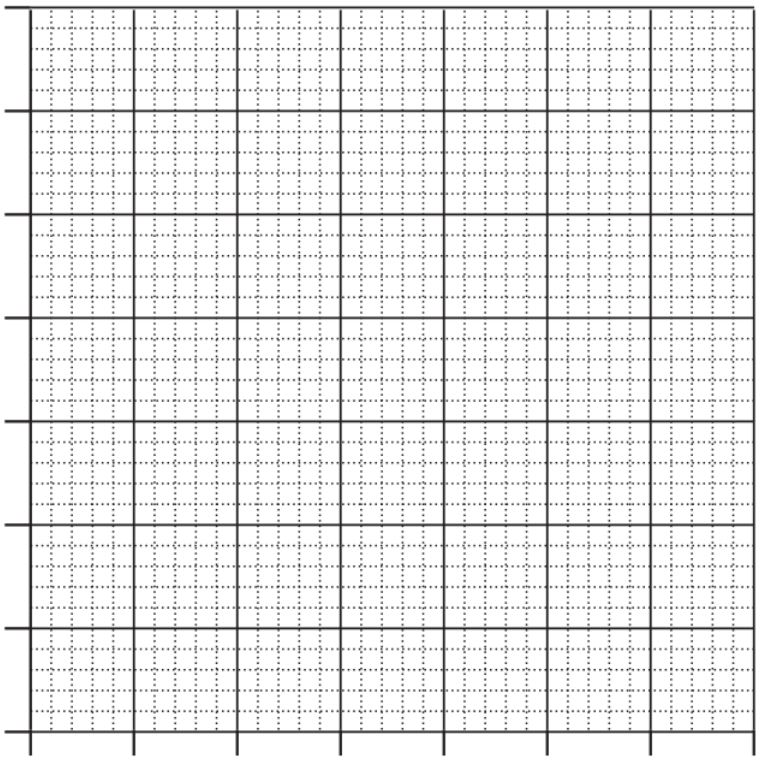
Negatively charged particles were accelerated from rest between a pair of parallel metal plates. The potential difference between the plates was varied, and the final velocity of the particles was measured for each variation.



The data in the table show the potential difference between the plates and the square of the corresponding final velocity of the particles.

Potential difference (V)	v^2 ($\times 10^9$ m^2 s^{-2})
100	0.8
200	2.1
300	3.1
400	4.1
500	5.2

(a) Plot the data on the grid provided and draw a line of best fit. **4**



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(b) A student hypothesised that the charged particles are electrons. Justify whether the student's hypothesis is correct or not. Support your answer using the data provided and relevant calculations. **3**

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Question 32 (4 marks)

Light of wavelength 10 nm is shone with extreme intensity on a copper plate with a work function 4.7 eV.

(a) Determine the maximum kinetic energy that the photons of light can leave the surface with. **3**

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(b) Calculate the threshold frequency for the copper plate. **1**

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Question 33 (6 marks)

Compare and contrast the quantum model of light with the wave nature of light. In your answer refer to the historical development of each model and any key experiments/observations that each model can explain. Planning space has been provided below. **6**

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End of paper

Section II extra writing space

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