Physics Trial HSC Examination Cranbrook 2002 ERRATA

Page 3 Q 6 option (D) should read: electric currents cause interaction of two magnetic fields.

Page 7 Part B – 85 marks not 75

Page 14 Q 23 (5 marks) part b is 2 marks

Page 16 Q 25 (3 marks) part a is 2 marks

Page 20 Q 28 c Table first row for KE should be 0.80

CRANBROOK SCHOOL

YEAR 12 TRIAL HSC EXAMINATION

2 UNIT HSC COURSE
2002

Physics

General Instructions

- Working time - 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Formulae Sheets are provided at the back of this paper
- Write your Student Number at the top of the pages indicated

Total marks - 100

There are two parts, Part A and Part B

Part A – 15 marks
- Attempt Questions 1 - 15
- Allow about 30 minutes for this part

Part B – 85 marks
- Attempt Questions 16-30
- Allow about 2 hours and 30 minutes for this part

The content and format of this paper do not necessarily reflect the content and format of the HSC examination paper.

Part A – 15 marks
Attempt Questions 1 – 15
Allow about 30 minutes for this part

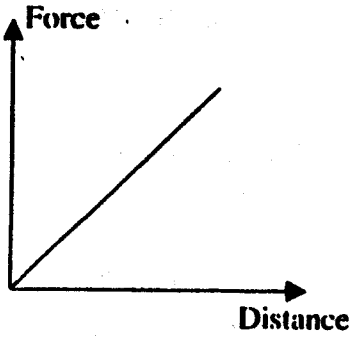
Use the multiple choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response space.

1 The slingshot effect is used to increase the speed of a spacecraft as it approaches, swings around and leaves a planet. Which statement is correct?

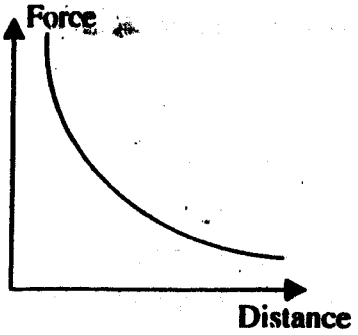
(A) The energy of the planet stays constant.
(B) There is no energy loss or gain for the planet/spacecraft system.
(C) The momentum of the planet is constant.
(D) The gravitational potential energy of the spacecraft is constant.

2 Which of the graphs below best represents the gravitational force as a function of distance?

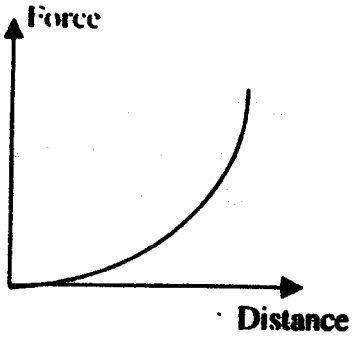
(A)



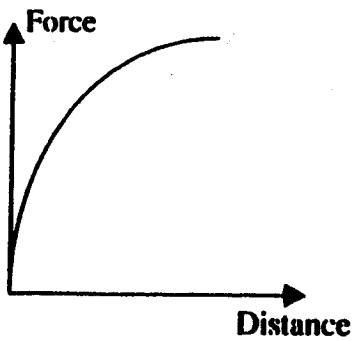
(B)



(C)



(D)



3 Which of the following conditions must hold in order for a satellite to remain in orbit around the Earth?

(A) The period of the satellite must equal the period of the Earth's rotation.
(B) The centripetal and gravitational forces on the satellite must be equal in magnitude.
(C) There must not be any forces acting on the satellite.
(D) The satellite must remain outside the Earth's gravitational influence.

4 Kepler's Law of Periods $T^2 = k R^3$ shows the relationship between the period and the orbital radius of the planet that revolves around the star. The value of k, a constant, can be changed by varying the:

(A) period of the planet.
(B) orbital radius of the planet.
(C) mass of the planet.
(D) mass of the star.

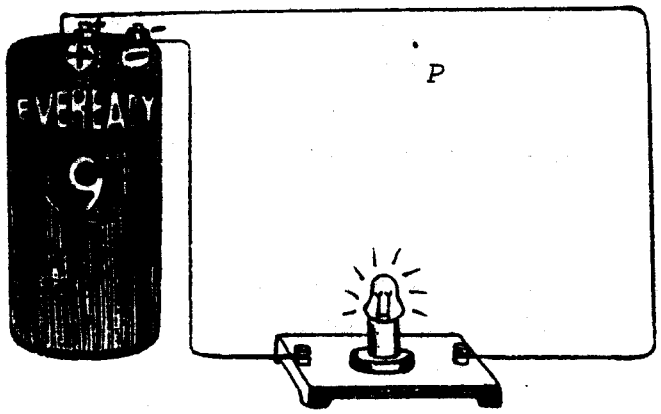
5. Satellite communication systems must be flexible to receive messages, respond with data and deal with difficulties. Which of the following statements is **false**?

(A) Communication with satellites and other space probes rely on electromagnetic radiation.
(B) Sunspot activity can affect the Earth's magnetic field, which in turn can cause communication problems for satellites.
(C) Deep space telecommunications utilise very low radio frequencies to avoid communication problems.
(D) Microwaves are the major carriers of data between Earth-based stations and satellites.

6 Two parallel copper wires, carrying electric currents in opposite directions exert a force of repulsion on each other. This is because

(A) electrons flow out of the wires leave them with net positive charges.
(B) electrons flow into the wires give them net negative charges.
(C) electric fields radiate at the speed of light.
(D) electric currents cause copper to become magnetised.

7 The direction of the magnetic field at point P in the diagram below is perpendicular to the wire. A line of magnetic force passing through P would point



(A) downwards into the page.
(B) upwards out of the page.
(C) towards the lamp.
(D) away from the lamp.

8 The turning moment on the coil of a moving coil galvanometer can be determined by, (I) the area of the coil, (II) the number of turns of the wire in the coil and (III) the current passing through the coil.

Which one of the following is correct?

(A) I & II only
(B) II & III only
(C) I, II & III
(D) I & III only

9 The AC induction motors have many advantages over other types of AC motors. However, a main disadvantage of the AC induction motors is that they

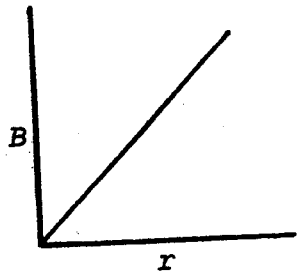
(A) consume less electrical energy and perform more work.
(B) produce high current and unsuitable for domestic use.
(C) uneconomical to manufacture.
(D) produce low power and unsuitable for heavy industry.

10 A transformer operates according to the principle of

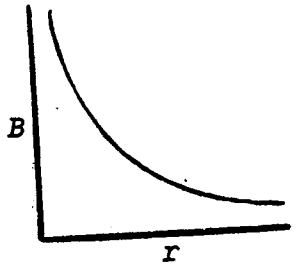
(A) Ohm's Law.
(B) electromagnetic induction.
(C) electrostatic transfer.
(D) electromagnetic radiation.

11 The graph which best represents the magnetic field intensity [B] at various distances [r] from a long, straight wire carrying a constant current is:

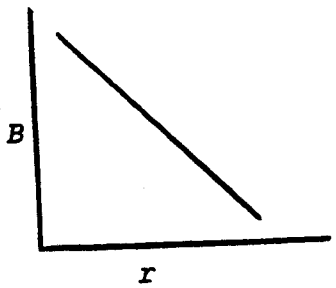
(A)



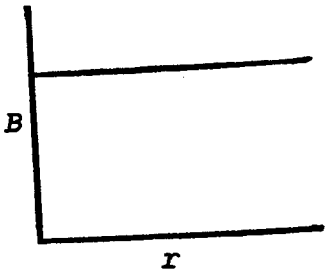
(B)



(C)



(D)



12 De Broglie explained why an electron was limited to certain orbits by showing that electrons

(A) form standing-wave patterns about the nucleus.
(B) have elliptical orbits like the planets around the Sun.
(C) occupy a continuum of orbits but only radiate from some.
(D) obey Maxwell's equations.

13 A clean surface of potassium metal will emit electrons when exposed to blue light. If the **intensity** of the blue light is increased, what property of the ejected electrons will also increase?

(A) maximum kinetic energy
(B) number
(C) average speed
(D) mass

14 An object is hot enough to emit a dull red glow. When this object is heated even more, it will

(A) emit shorter-wavelength, higher-frequency radiation.
(B) emit longer-wavelength, lower-frequency radiation.
(C) emit the same wavelengths as before, but with more energy.
(D) emit more of the same wavelengths with more energy

15 Which of the following would **not** change the drift velocity of electrons through a conductor?

(A) increasing the thickness of the wire.
(B) increasing the length of the wire.
(C) increasing the potential difference across the wire.
(D) increasing the temperature of the wire.

Student Number | | | | | | | | |

Part B – 75 marks
Attempt Questions 16 - 30
Allow about 2 hours and 30 minutes for this part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

The Saturn V rocket used in the Apollo Moon missions had a launch mass of approximately 2.7×10^6 kg. At lift-off, the rocket engines produced a force of 33.5×10^6 N vertically upwards. [Assume $g = 9.8\ ms^{-2}$ in all parts of the question]

(a) What was the initial vertical acceleration of the rocket? **2**

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(b) What net force acts on an astronaut of mass 90 kg in his space suit when the rocket is later accelerating vertically at 5 m/s^2? **1**

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(c) What is the force the seat exerts on the 90 kg astronaut when the rocket is accelerating vertically at 5 m/s^2? **2**

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Marks

Question 17 (5 marks)

Describe an experiment you conducted during the course to determine the acceleration due to gravity, g. Your answer should outline the equipment and method used and how the measured data is used in order to obtain the value of g. **5**

Marks

Question 18 (4 marks)

An aeroplane flying horizontally at an altitude of 490 m and a speed of 50 ms^{-1}, releases a relief package to a group of people isolated by flood waters. [Ignore air resistance on the package]

(a) How long a time before the plane flies over the target area must the package be released? **1**

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(b) At what horizontal distance from the target area should the package be released? **1**

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(c) While the package is falling it is in "free fall". Explain what this means in terms of the physics involved. **1**

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(d) Explain why astronauts in a space shuttle orbiting Earth feel weightless even though the acceleration due to gravity at the orbital altitude is not zero. **1**

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Marks

Question 19 (7 marks)

The Special Theory of Relativity discusses the physical consequences of the absence of a universal frame of reference. The theory, published in 1905, is concerned with problems involving inertial frames of reference. Its fundamental principles caused apparent discrepancies in measurements.

(a) What are inertial frames of reference? **1**

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(b) State TWO fundamental principles upon which the Special Theory of Relativity is based. **2**

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(c) State TWO phenomena caused by these fundamental principles and outline how Einstein was able to explain them. **4**

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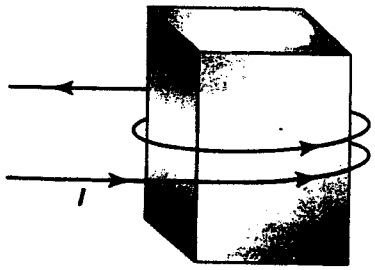
Marks

Question 20 (5 marks)

The diagram below shows a coil of wire carrying AC current wrapped around an iron core. The iron core becomes hot after a short while.



(a) Explain what caused this heat build-up in the iron core? **1**

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(b) State <u>two processes</u> by which the heat gained may be minimised in the case above and for <u>each</u> process explain the principles involved. **4**

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Student Number | | | | | | | | | |

Part B (continued)

Marks

Question 21 (5 marks)

A transformer is used to power an appliance.

(a) If the primary voltage is 250 V and there are 500 turns on the primary, how many turns are required on the secondary to obtain a voltage of 12.5 V? **1**

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(b) If the primary consumes 2500 watts of power and the transformer is 100 % efficient, what would be the current in the secondary coil? **1**

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(c) If the alternating current used in the primary was replaced by a direct current, what would be the effect on the secondary? Explain. **1**

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(d) Discuss one advantage and one disadvantage of not having an iron core in the transformer. **2**

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Marks

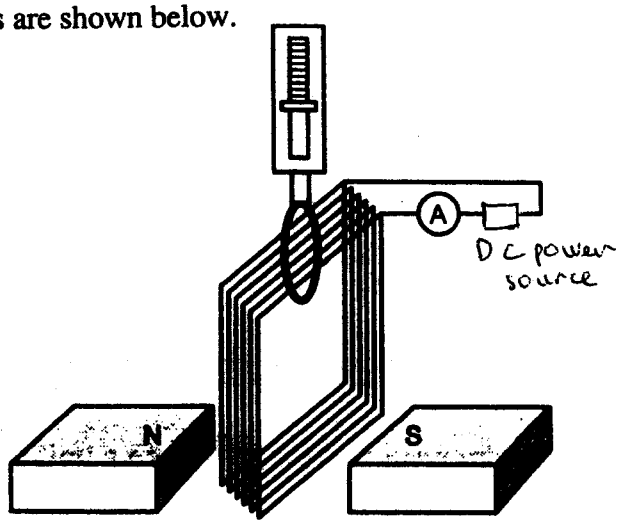
Question 22 (5 marks)

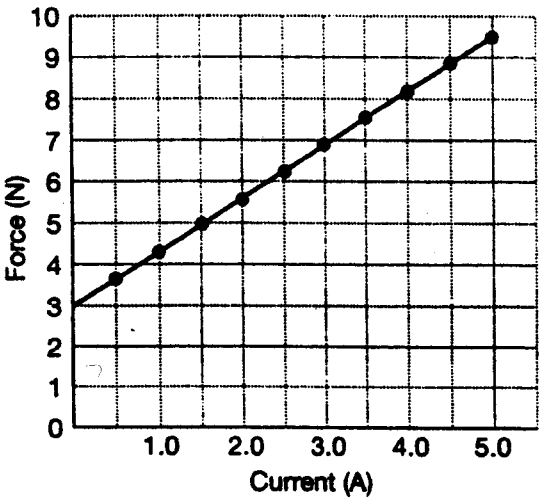
Compare and contrast the structure and function of a simple AC electric generator with that of a DC motor. **5**

Marks

Question 23 (4 marks)

A coil of wire is suspended from a spring balance between the poles of two magnets. The coil is rectangular with dimensions of 8 cm high by 10 cm wide and has 100 turns of wire. In one experiment, the spring balance readings were recorded for different currents. The apparatus and results are shown below.





(a) What was the weight of the coil of wire? **1**

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(b) Determine the magnetic field strength between the poles of the magnet. **1**

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(c) Is the direction of the current in the coil clockwise or anticlockwise? **1**

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(d) The current is adjusted so that the balance reads 0.0N. What current flows in this case and in which direction? **1**

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Marks

Question 24 (5 marks)

A small DC motor operates at 12 volts and the armature windings have a resistance of 1.6 ohms. When the motor is running normally, the current drawn is 0.50 A.

(a) What back emf is developed in the coil? **2**

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(b) What current is drawn by the motor if the coil is held fast and prevented from turning? **1**

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(c) Large DC motors have a start-up resistance in series with the armature coil. This resistance is gradually reduced as the motor speeds up. Explain the need for this. **2**

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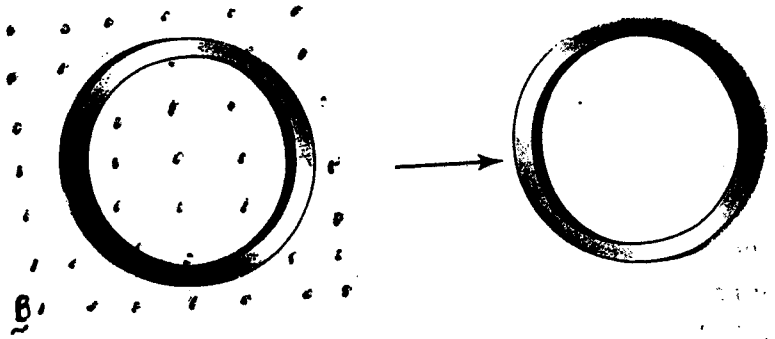
Marks

Question 25 (4 marks)

A metal ring lies in a magnetic field as shown below. As the ring is removed from the magnetic field a current flows in the ring. John is of the opinion that the direction of the current in the ring is anti-clockwise whereas Bill is of the opinion that the current flows in a clockwise direction. The magnetic field is directed perpendicularly out of the plane of the paper.



(a) Decide who is right, John or Bill and explain your reasoning. **3**

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(b) Explain what happens to the current in the ring when it is completely outside the magnetic field **1**

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Marks

Question 26 (6 marks)

Discuss how electrical energy is generated and transmitted from source to point of use. **6**

Student Number | | | | | | | | | |

Part B (continued)

Marks

Question 27 (11 marks)

J. J. Thomson is attributed with discovering the electron in 1897. One possible method he might have used was to first send a stream of cathode rays simultaneously through an electric and magnetic field in order to measure their velocity. He then could have passed the beam through a magnetic field only and measured the deflection of the beam.

(a) The electron (in the form of cathode rays) had been studied by scientists for almost 40 years before Thomson performed his famous experiment. Explain why Thomson has been accredited with the discovery of the electron. **2**

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(b) Thomson passed the cathode ray beam through crossed electric and magnetic fields of such strengths that the beam passed undeflected. Use mathematical formulae to help demonstrate how the velocity of a cathode ray beam can be determined using this method. **2**

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(c) Thomson then switched off the electric field and the beam deflected through the magnetic field. Describe the path of the cathode rays while in the magnetic field. **1**

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Question 27 continues next page

Marks

Question 27 (continued)

(d) Contrast the operation of a black and white television and a cathode ray oscilloscope. Describe any differences in the images formed. **6**

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Marks

Question 28 (11 marks)

Heinrich Hertz was instrumental in the discovery of the photoelectric effect.

(a) Describe Hertz's observation of the effect of a radio wave on a receiver and the photoelectric effect he produced. **2**

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(b) Define the term *photoelectric effect* as it applies to modern physics. **1**

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(c) A student performs an experiment to measure the maximum kinetic energy of electrons (in J) released in the photoelectric effect and the frequency of light shone onto the sodium metal target. Her data is as follows:

wavelength of light used ($\times 10^{-7}$ m)	Kinetic Energy of released electrons ($\times 10^{-19}$ J)	Frequency of light used ( )
5.5	8.01	
4.3	1.60	
4.1	1.92	
3.6	2.56	
3.1	3.36	

(i) Complete the above table, including correct units for frequency. **2**

Question 28 continues next page

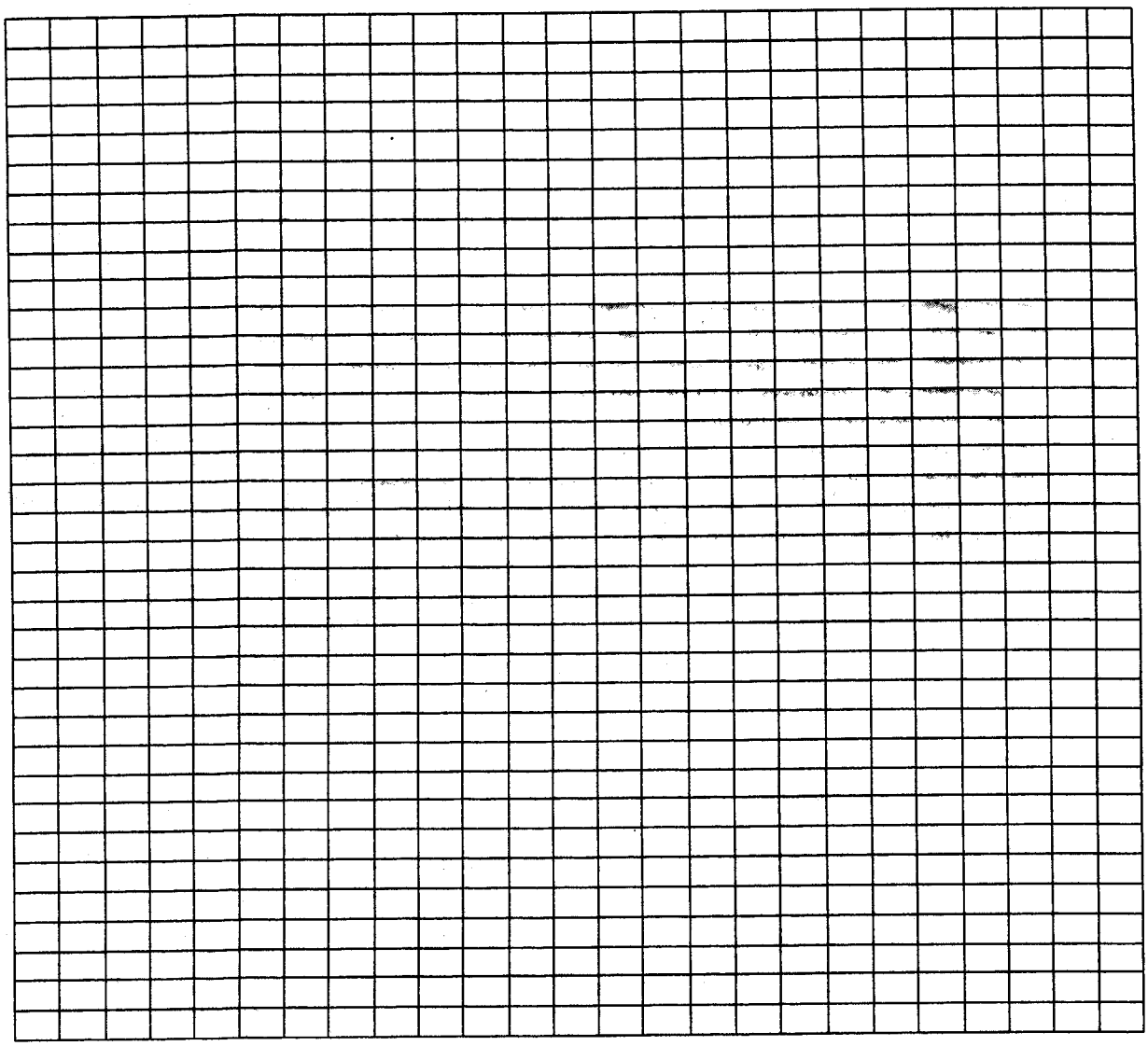
Marks

Question 28 (continued)

(ii) On the following grid, plot a graph of Kinetic Energy as a function of frequency of light used using the equation

$$KE = h f - W$$

Plan your scale carefully.
Draw the correct line of best fit. **3**



Question 28 continues next page

Marks

Question 28 (continued)

(iii) ***Use your graph*** to determine: **3**

The work function, W, for sodium metal.

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Planck's constant.

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Question 29 (4 marks)

Explain why a metal's resistance increases as its temperature *increases* yet the resistance of a semiconductor increases when its temperature *decreases*. **4**

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Marks

Question 30 (4 marks)

The Braggs were the first two scientists to discover of the crystal structure of metals.

(a) Outline the method used by the Braggs to determine crystal structure of metals. **2**

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(b) Explain why the drift velocity of electrons in a metal conductor is very small compared to the velocity of electrons in cathode rays. **2**

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