Student Number _____

Caringbah High School
Physics: HSC Course
Trial 2013

Write all your answers in this answer booklet.

Use pen for written responses and pencil for diagrams and graphs.

Total Marks: 100

Exam Length: 3 hours + 5 minutes reading time

SECTION I

PART A: Multiple Choice Questions (20 marks)

PART B: Longer Response Questions (68 marks)

SECTION II

Option Question (12 marks)

- ***USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS***

OUTCOME	*MARK*
Knowledge and Understanding *Q 1-22, 25,26,29,31-36,38*	*/77*
Practical investigations *Q 23,37,38*	*/12*
Problem solving *Q, 27, 28, 30*	*/11*

Exam Prepared by: C. Williams

PART A: Circle the letter of the BEST answer on the grid (20 marks)

1.	It is not usually possible to communicate with spacecraft as they are reentering earth's atmosphere because **A**. the astronauts are too busy **B**. the spacecraft gets too hot as it reenters **C**. ionised air blocks any radio signal. **D**. any radio aerial would get ripped off.	
2.	In an electric motor the purpose of the split ring commutator is to: **A**. change the AC supply to a DC supply **B.** reverse the flow of current though the coil **C**. provide a complete circuit for current to reach the coil **D.** anchors the ends of the coil.	
3.	A positron is the antiparticle of an electron. It has the same mass but opposite charge. When antiparticles collide they completely annihilate one another and their mass is converted to energy. The total energy released when a positron and electron collide is- **A.** 1.64×10^{-13} J **B.** 0.82×10^{-13} J **C.** 0.0144 J **D.** 0.0288 J	
4.	Which one of the following statements is the best statement about inertial frames of reference? **A.** Inertial frames must be stationary. **B.** Inertial frames must be accelerating. **C.** The laws of physics have the same form in all inertial frames. **D.** Inertial frames cannot be moving at close to the speed of light.	
5.	Two beams of electrons are close to one another and are travelling in the same direction. In this situation **A.** there would be a resultant magnetic force of repulsion between the two beams. **B.** the two beams would have no effect upon each other. **C.** the two beams will decelerate to a final speed of zero. **D.** there would be a resultant magnetic force of attraction between the two beams.	
6.	Which statement is true for a step-down transformer? **A.** It reduces current and voltage. **B.** It has more turns in the primary than in the secondary. **C.** It has less turns in the primary than in the secondary. **D.** It has a non-laminated iron core.	
7.	Energy is lost in transmission lines. How can this loss be reduced? **A.** Use thinner wires in the transmission line. **B.** Increase the current in the transmission line. **C.** Decrease the current in the transmission line. **D.** Heat the wire	

8. This table provides information about the planets Earth and Uranus.

Planet	Mass (x 10^{24}kg)	Radius (km)
Earth	6.0	6.4×10^3
Uranus	86	2.4×10^4

An astronaut has a weight of 800 N at the Earth's surface.

Using the information in the table, what is the astronaut's weight on the surface of Uranus?

A. 800 N
B. 813 N
C. 786 N
D. 980 N

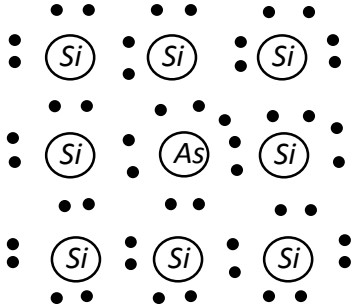
9. A wire of length 10 cm is at 90° to a magnetic field B of strength 10^{-2} T. A current of 2A flows in the wire.

What is the force on the wire caused by the field?

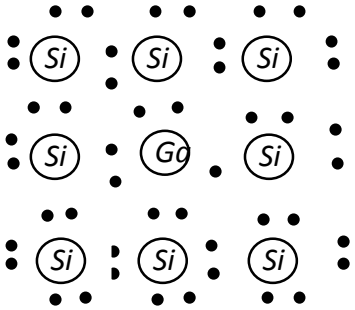
A. 2×10^{-1} N, parallel to B
B. 2×10^{-1} N, perpendicular to B
C. 2×10^{-3} N, parallel to B
D. 2×10^{-3} N, perpendicular to B

10. Diagrams (1) and (2) below show two possible arrangements of atoms in a substance with a silicon lattice structure. Diagrams (3) and (4) show two possible band structures for the energy relationships between the atoms of the same substance.

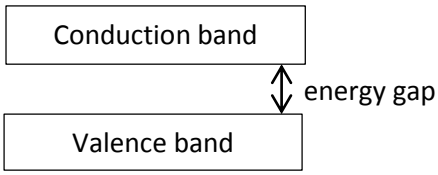
1.



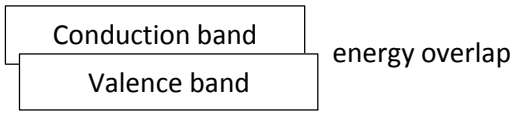
2.



3.



4.



Which pair of diagrams correctly represents P-type semiconductors?

A. 1 and 3
B. 1 and 4
C. 2 and 3
D. 2 and 4

11. Which of these groups of substances conducts electricity by the free movement of individual electrons through a crystal lattice?

A. low pressure gases
B. metallic conductors
C. semiconductors
D. superconductors

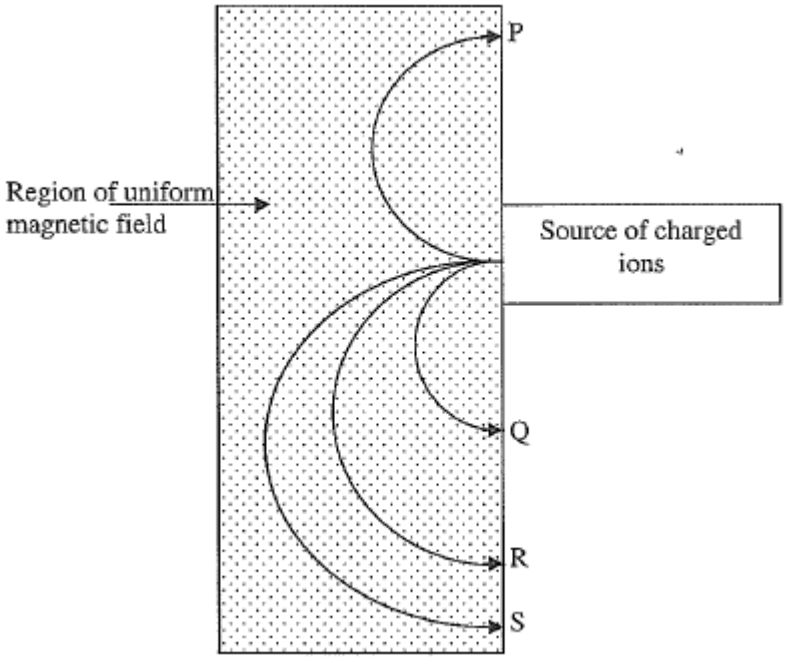
12. An ideal transformer has the following characteristics.

Coils in primary	100
Coils in secondary	20
Voltage produced in secondary	2 V

What is the voltage applied to the primary?

A. 0.1 V
B. 0.4 V
C. 2.5 V
D. 10 V

13. The diagram shows the paths taken by four charged particles, (P,Q,R and S),fired with identical speeds into a region of uniform magnetic field directed normally to the page.



Which statement about these particles could possibly account for these paths?

A. P and Q carry opposite and equal charges and Q has more mass than P
B. Q and R have the same mass, carry opposite charges and R has a larger charge than Q.
C. R and P have the same mass, carry opposite charges and R has a smaller charge than P.
D. R and S carry identical charges and R has a larger mass than S.

14. Why was germanium widely used as a semi-conducting material when scientists knew that silicon was more useful?

A. It could be more easily doped with impurities.
B. It was more readily available.
C. It was far less expensive to obtain.
D. It could be produced with the necessary purity.

15. Which property of cathode rays is demonstrated in a discharge tube with a “maltese cross”?

A. wave nature
B. momentum
C. negative charge
D. straight line propagation

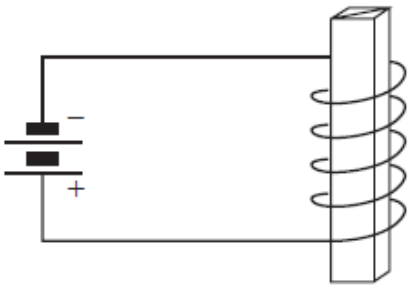
16.	A student observes the different striation patterns in a set of discharge tubes. The pressures in the tubes are different but are not in any particular order. He records the following observations: **Tube 1**: There is no glow, only the glass at the anode end of the tube glows green. **Tube 2**: The column is broken up into striations, separated from the glow at the cathode by a dark space. **Tube 3**: The tube is filled with a purple glow and thin red-purple streamers appear. What is the order of the discharge tubes from greatest to least pressure? **A.** Tube 1, Tube 2, Tube 3. **B.** Tube 1, Tube 3, Tube 2. **C.** Tube 2, Tube 1, Tube 3. **D.** Tube 3, Tube 2, Tube 1.	
17.	The wavelength of the radio waves being broadcast from radio station 2MMM in Sydney is 2.86m. What is the energy of a photon of that wave? **A.** 6.95×10^{-26} J **B.** 1.895×10^{-33} J **C.** 1.988×10^{-25} J **D.** 2.32×10^{-34} J	
18.	Galileo was able to deduce a relationship to explain parabolic projectile motion. Which of the following statements is in agreement with Galileo's findings on projectile motion? **A.** All masses fall to the ground at a constant velocity. **B.** The rate at which an object dropped is dependent upon its mass. **C.** The square of the distance an object travels from rest is proportional to the time elapsed. **D.** The rate at which an object dropped is independent of its horizontal velocity.	
19.	For a satellite in a low Earth orbit, the altitude above the earth is small in comparison with the Earth's radius. Compared to a geostationary satellite a low Earth satellite will have a period of orbit which is **A.** the same **B.** slower **C.** faster **D.** twice as slow	
20.	A number of long range space probes have been sent to the outer planets of our solar system on fly by missions. The main reasons for using the sling shot effect were **A.** To reduce the cost of launching a heavy probe and ensure that the mission was completed quickly. **B.** To ensure the mission was completed quickly and to maintain the quality of transmitted information returned. **C.** To ensure that the mission was completed quickly and to reduce the need to send astronauts with the dangers involved. **D.** To reduce the need to send astronauts with the dangers involved and to maintain the quality of transmitted information returned.	

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

1	**A B C D**	**11**	**A B C D**
2	**A B C D**	**12**	**A B C D**
3	**A B C D**	**13**	**A B C D**
4	**A B C D**	**14**	**A B C D**
5	**A B C D**	**15**	**A B C D**
6	**A B C D**	**16**	**A B C D**
7	**A B C D**	**17**	**A B C D**
8	**A B C D**	**18**	**A B C D**
9	**A B C D**	**19**	**A B C D**
10	**A B C D**	**20**	**A B C D**

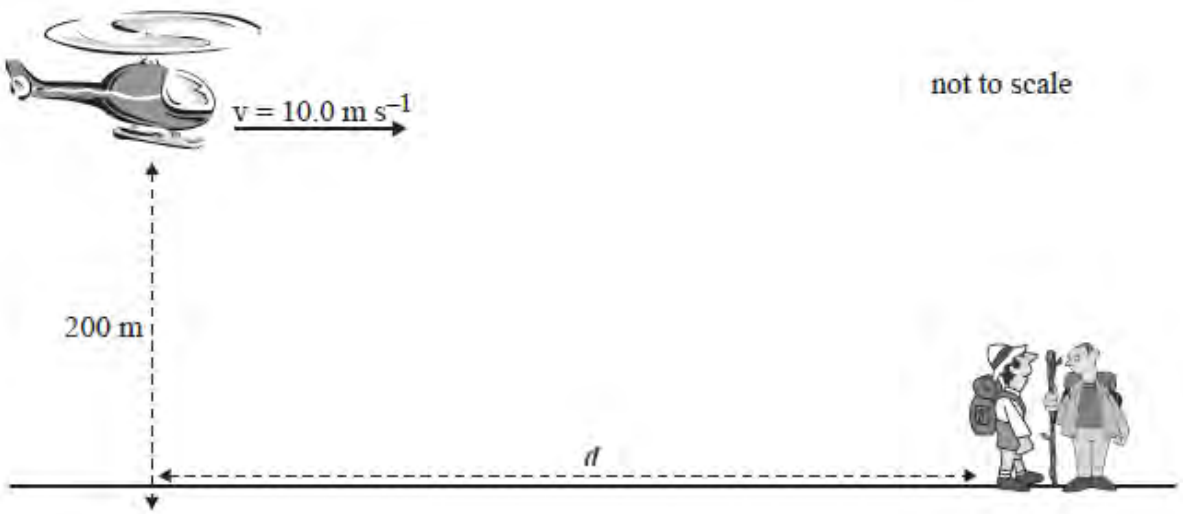
PART B: Longer Answers

21.	The planet Mars has a mass of 6.24×10^{24} kg and a radius of 3.40×10^{6} m. Calculate the escape velocity at the surface of Mars. …… …… …… …… ……	**2**
22.	a. If a space vehicle, sometime after launch, is accelerating vertically at 27.5 ms^{-2}, how many g's would the astronauts inside be experiencing? …… …… b. How would the astronauts be positioned so as to minimise the chances of them blacking out? …… …… c. Define the weight of an object. …… …… d. Justify the statement that an object moving in a circle at constant speed is accelerating. …… …… e. Predict what would happen to an orbiting satellite if the force of gravity suddenly ceased to act. …… …… ……	**1** **1** **1** **1** **1**
23.	Explain the difference in function between a split-ring commutator and a slip ring commutator. Describe the situations in which a split-ring commutator and slip ring commutator are used. …… …… …… …… …… …… ……	**3**

24.	An observer, Owen, in a manned space vehicle which is swooping low over the Earth's surface at 0.8 c, sees two simultaneous explosions below him at points A and B. At this instant he is just over a point C, halfway between A and B. Mary Ellen is at rest at B. a. Will Mary Ellen agree with Owen that the explosions were simultaneous? Discuss. …… …… …… …… b. Mary Ellen is now sitting at a railway station whose platform is 100 m long. Owen is now in a train which, at rest, is 150 m long. At what speed must the train be travelling so that Mary Ellen observes the whole length of the train to fit exactly along the platform? …… …… …… …… ……	**2** **2**
25.	A coil of wire is placed around an iron bar. The coil is connected to a DC battery. This is shown in the figure below.  On the diagram above, draw **four** lines, each with an arrow indicating direction, that show the magnetic field in the region around the iron bar.	**2**
26.	It can be shown experimentally that a DC electric motor operating at full speed uses less current than an identical motor running at half speed. Explain this observation. …… …… …… …… …… ……	**2**

27. A helicopter is to drop a rescue package to a group of hikers. The helicopter is travelling with a speed of 10.0 m s^{-1} at a constant height of 200 m over level ground. The situation is shown in the figure below.

You should ignore air resistance.



a. The pilot wants the package to land beside the hikers. At what horizontal distance, *d*, from the hikers must the package be released from the helicopter? **2**

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b. What is the speed with which the package then hits the ground? **2**

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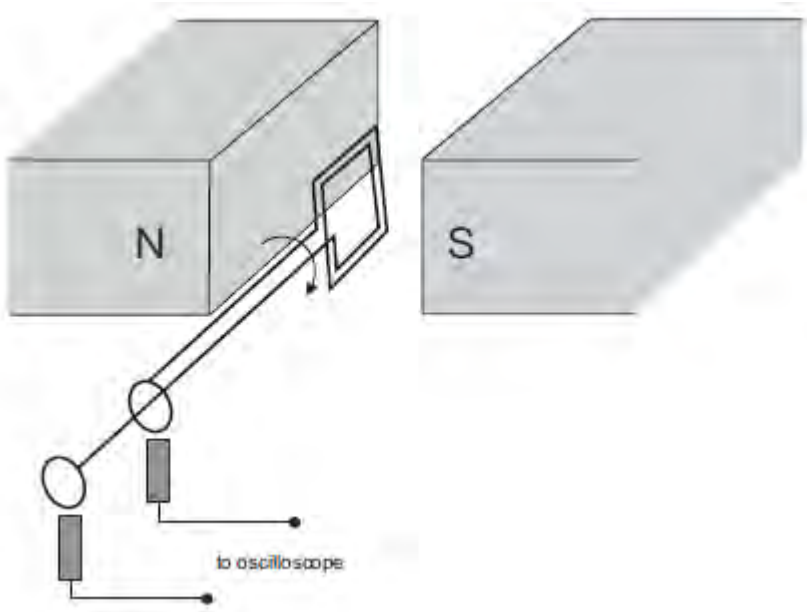
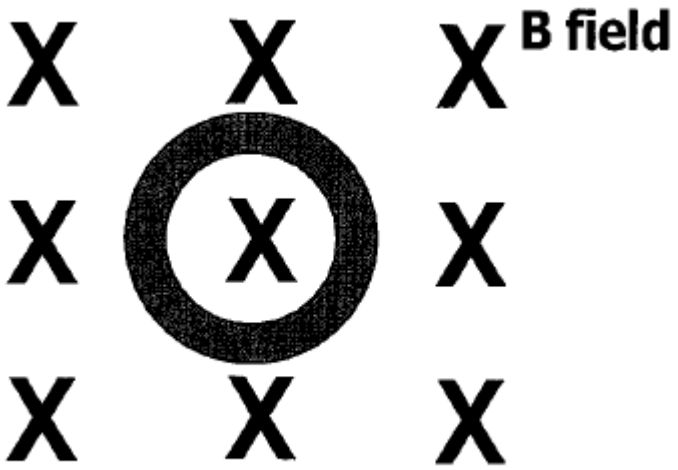
28.	The Chinese Space Station (CSS) is currently under construction in Earth orbit. It is incomplete, with a current mass of 3.04×10^5 kg. The CSS is in a circular orbit of 6.72×10^6 m from the centre of Earth. In the following questions the data below may be needed. Mass of CSS 3.04×10^5 kg Mass of Earth 5.98×10^{24} kg Radius of Earth 6.37×10^6 m Radius of CSS orbit 6.72×10^6 m Gravitational constant 6.67×10^{-11} N m^2 kg^{-2} a. Calculate the gravitational force on the CSS in its orbit? …… …… …… …… b. What is the period of orbit of the CSS around Earth? …… …… …… …… c. When the CSS is completed in 2020, its mass will have increased to 3.70×10^5 kg. Will the period of orbit of the CSS around Earth then be greater, the same, or less? …… ……	**2** **2** **1**
29.	Assess Einstein's contribution to quantum theory and its relation to black body radiation. …… …… …… …… …… …… …… …… …… …… ……	**3**

30.	Some students are studying the emf induced by a magnetic field in a coil of wire. Their experimental apparatus consists of a coil of 100 turns of wire in a magnetic field of 2.0×10^{-2} T as shown in the figure below.  With the coil vertical as shown in Figure 2, the flux through the coil is 8×10^{-6} Wb. What is the area of the coil? …… …… …… ……	**2**
31.	Explain how induction is used in some modern cooktops. …… …… …… …… …… …… …… …… …… ……	**3**

32.	Transformers allow for the conversion of high voltages to low voltages and vice versa. Power stations generate electricity at 25 000 volts before large transformers step this up to 500 000 volts. a. Explain why power stations transfer electrical energy at very high voltages. …… …… …… …… b. In the above step up transformer, what is the ratio of the number of turns in the secondary coil to the number of turns in the primary coil? …… …… c. If power stations generate electricity with current of 1000 amperes, calculate the current after the voltage has been stepped up to 500 000 volts. …… …… …… …… d. Outline how energy losses within the transformer are reduced to a minimum. …… ……	**2** **1** **2** **1**
33.	Discuss how shortcomings in available communication technology lead to the invention of the transistor. …… …… …… …… …… …… …… …… …… …… …… …… ……	**5**

34. In the diagram below a thin loop of copper wire is sitting stationary in a uniform magnetic field directed down into the plane of the page. The magnetic field is supplied by an electromagnet with the north pole sitting above the plane of the page and the south pole sitting below.



a. Describe how a potential difference could be generated within the loop without touching or moving the copper loop. **2**

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b. Assume the potential difference across the loop produces a clockwise current viewed from above the plane of the page. Explain how such a current direction could be achieved. **2**

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35. Discuss the advantages of using superconductors and identify ONE limitation to their use. **4**

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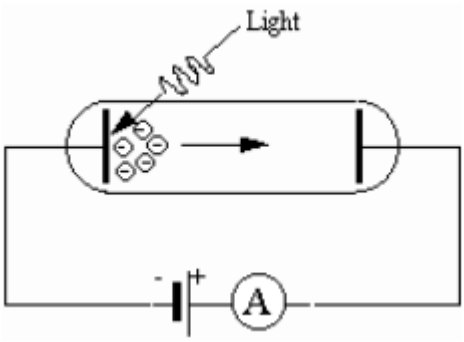
36. An evacuated tube is set up as shown below to demonstrate the photoelectric effect.



a. When blue light strikes the metal plate a current is detected on the ammeter but when only red light is shone on the plate the current reads zero. Explain these observations **3**

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b. Explain what would happen to the reading on the ammeter if the intensity of the blue light was increased. **2**

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37. You have performed an experiment to demonstrate magnetic levitation.

a. describe the procedure including any safety measures that were taken. **2**

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b. Explain your observations. **2**

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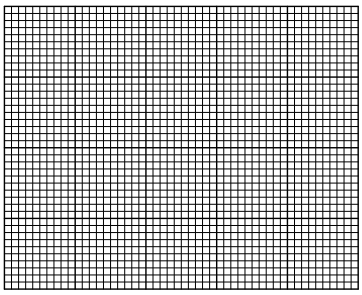
38. The following data was obtained from a YBCO superconductor

TEMPERATURE (K)	RESISTANCE ($m\Omega$)
118.2	13.37
106.9	10.90
97.9	9.51
92.3	8.29
90.8	0.0001
90.7	0.00001

a. Using the information in the table plot a graph of resistance versus temperature **3**



b. With reference to your graph, estimate the critical temperature for this superconductor. Explain your answer. **2**

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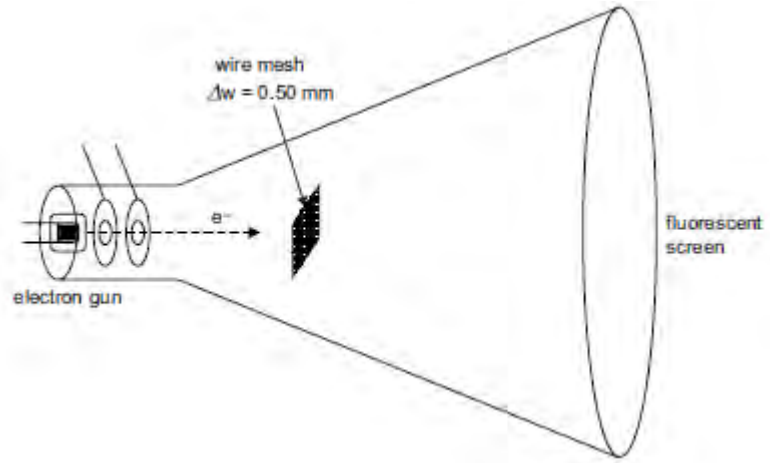
Section II: Question 38. Quanta to Quarks (12 marks)

<u>Answer these questions in a separate answer booklet</u>.

39.	a. Explain how Neils Bohr was able to adapt the concept of the quantization of energy to improve upon the Rutherford model of the atom.	**2**
	b. Explain how Neils Bohr's postulates were utilised to explain the line emission spectra of hydrogen.	**3**
	c. Calculate the wavelength of the photon of light released when an electron falls from the n = 3 level to the n =2 level.	**2**
	d. A sketch of a cathode ray tube (CRT) is shown in the figure below. In this device, electrons of mass 9.10×10^{-31} kg are accelerated to a velocity of 2.0×10^{7} m s^{-1}.  Calculate the de Broglie wavelength of the electrons. You must show your working.	**2**
	e. Explain how the Davisson and Germer experiment confirmed de Broglie's proposal about the nature of electrons.	**3**

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number
Symbol
Standard Atomic Weight
Name

79 Au 197.0 Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium						

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Elements with atomic numbers 113 and above have been reported but not fully authenticated.
Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of data. Some data may have been modified.

DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k = \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

FORMULAE SHEET

$$v = f\lambda$$

$$I \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$E = \frac{F}{q}$$

$$R = \frac{V}{I}$$

$$P = VI$$

$$\text{Energy} = VIt$$

$$v_{av} = \frac{\Delta r}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} \text{ therefore } a_{av} = \frac{v-u}{t}$$

$$\Sigma F = ma$$

$$F = \frac{mv^2}{r}$$

$$E_k = \frac{1}{2}mv^2$$

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

$$E_p = -G\frac{m_1 m_2}{r}$$

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

$$v_y^2 = u_y^2 + 2a_y\Delta y$$

$$\Delta x = u_x t$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = \frac{Gm_1 m_2}{d^2}$$

$$E = mc^2$$

$$l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$$

$$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$m_v = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

$$d = \frac{1}{p}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{h}{mv}$$

$$A_0 = \frac{V_{out}}{V_{in}}$$

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$
