Student Number _____

Caringbah High School
Physics: HSC Course
Trial Exam 2014

Write all your answers in this answer booklet for section I.

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 (60 marks)
SECTION II
OPTION QUESTION (20 marks)

- ***Use a separate option booklet for your answers to this section***

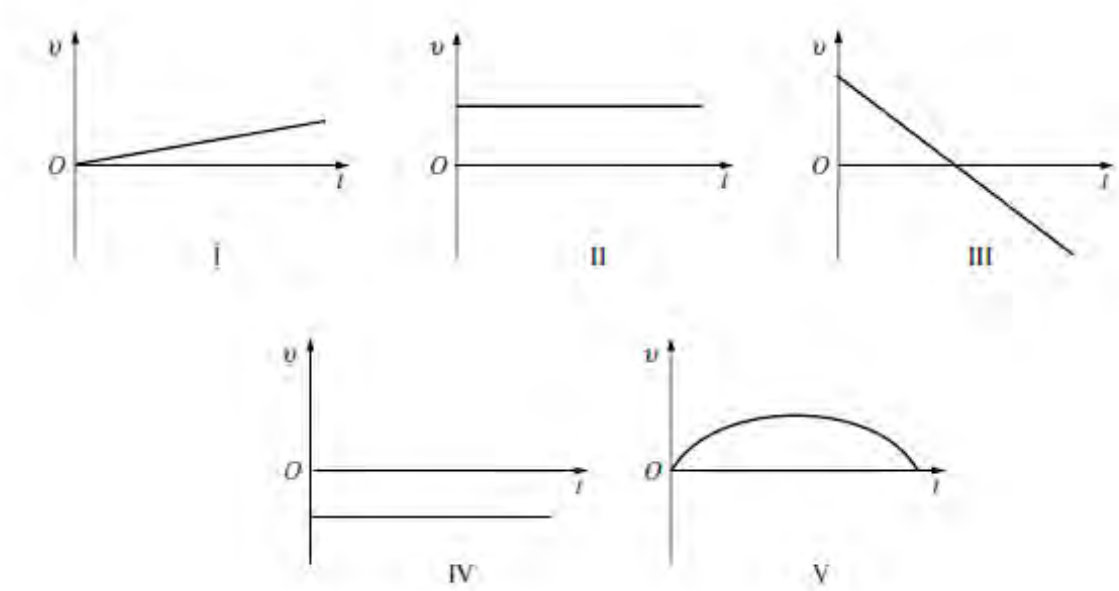
OUTCOME	*MARK*
Knowledge and Understanding	*/75*
Practical investigations *Q23, Q29*	*/12*
Problem solving *Q22, Q24, Q26 a, b, c*	*/13*

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

1. As a rocket blasts off from the surface of the Earth,

A. its gravitational attraction increases
B. the gravitational potential energy increases
C. the force of gravity doubles every 100 km of height
D. the gravitational potential energy decreases

2. A stone is thrown at an angle of 45^0 above the horizontal *x*-axis in the + *x*-direction. If air resistance is ignored, which of the **velocity *versus* time** graphs shown below best represents v_x *versus t* and v_y *versus t*, respectively?



	v_x *versus t*	v_y *versus t*
A.	I	IV
B.	II	I
C.	II	III
D.	IV	V

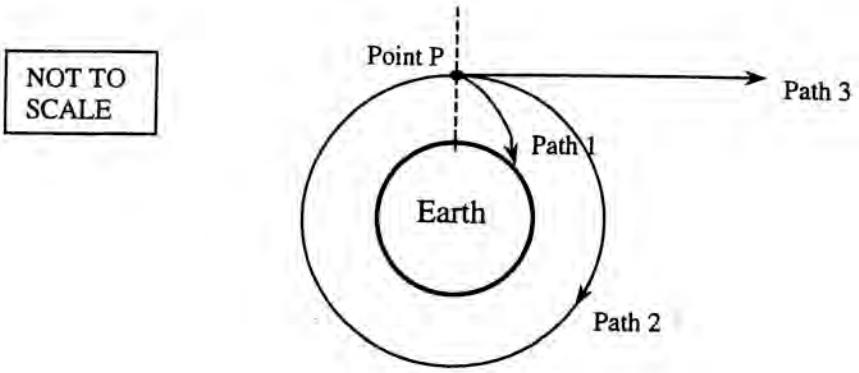
3. A satellite of mass *m* orbits a planet of mass *M* in a circular orbit of radius *R*. The time required for one revolution is

A. independent of *M.*
B. proportional to *m.*
C. proportional to $R^{3/2}$
D. proportional to R^2

4. Mars has become a prime focus for NASA and other international space agencies. When designing equipment to be used on Mars, the engineers need to take into account the difference in the pull of gravity compared to the Earth. Calculate the gravitational acceleration on Mars if an explorer with a weight of 3038 N on Earth has a weight of 1178 N on Mars.

A. $6.7\ ms^{-2}$
B. $9.8\ ms^{-2}$
C. 3.8 N
D. $3.8\ ms^{-2}$

5. A mass is projected horizontally from a point P above the Earth's surface. Three possible pathways are shown for this projectile.



If the projectile follows path 2, instead of the other paths, we can conclude that

A. Point P must have been above the equator
B. the friction due to the atmosphere was too high for it to follow path 1
C. the horizontal velocity of the projectile was too low for it to follow path 3
D. the projectile experiences no gravitational pull towards the Earth because point P is too far above the Earth's surface.

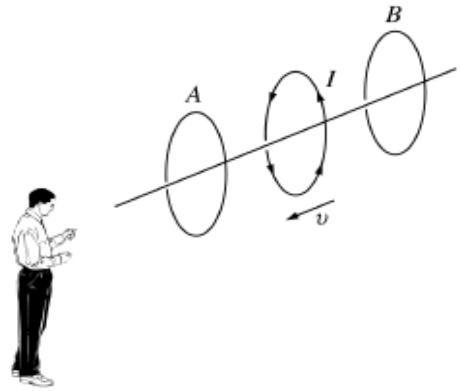
6. Kepler's Law of Periods often written as $T^2 = kr^3$ shows the relationship between the period and the orbital radius of a planet that revolves around a star. The value k, a constant, can be changed by varying

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

7. A stationary observer watches the space ship "Enterprise" fly past at 0.7 times the speed of light. Compared to the space ship's length at rest, the

A. space ship will appear to be shorter
B. space ship will appear wider
C. space ship will appear longer
D. time on his watch will slow down.

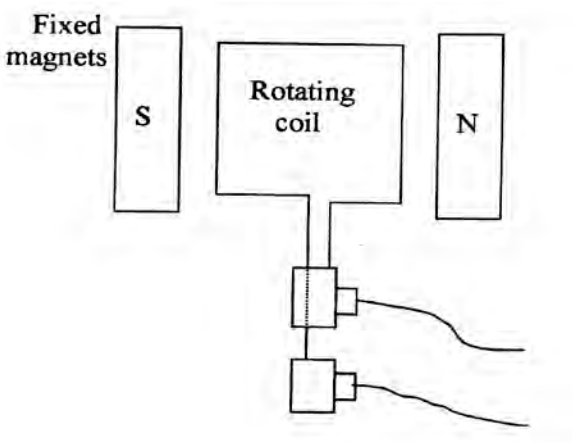
8.



Three wire loops and an observer are positioned as shown in the figure above. From the observer's point of view, a current ***I*** flows counterclockwise **(anticlockwise)** in the middle loop, which is moving towards the observer with a velocity ***v***. Loops *A* and *B* are stationary. This same observer would notice that

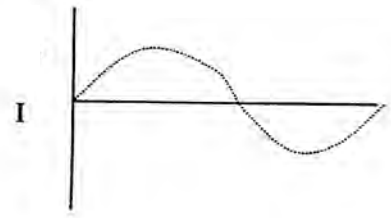
A. clockwise currents are induced in loops *A* and *B*
B. counterclockwise currents are induced in loops *A* and *B*
C. a clockwise current is induced in loop *A*, but a counterclockwise current is induced in loop *B*
D. a counterclockwise current is induced in loop *A*, but a clockwise current is induced in loop *B*

9.

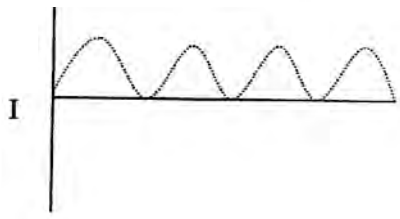


Which of the following graphs best represents the type of current produced by the above generator?

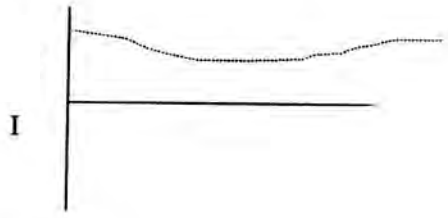
A.



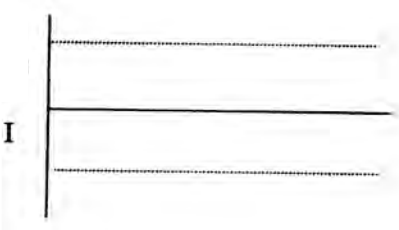
B.



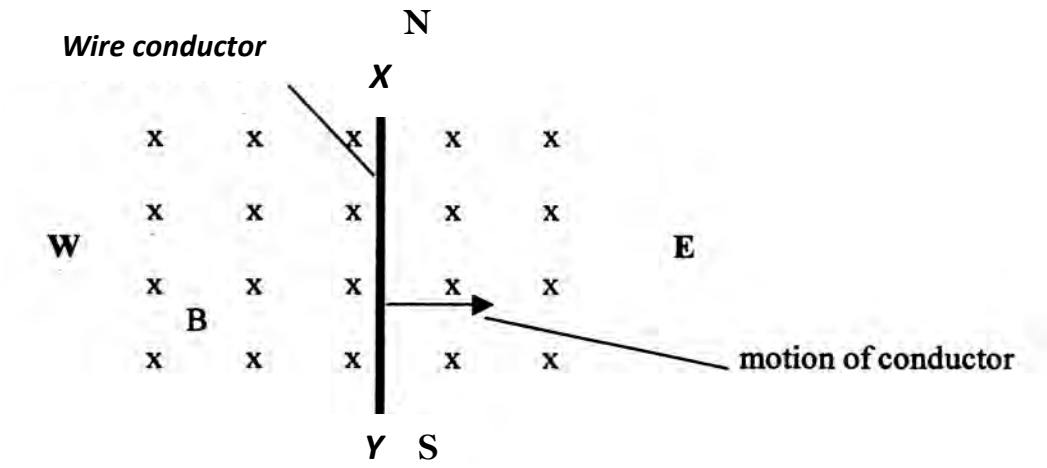
C.



D.



10. The following diagram shows a conductor moving to the EAST through a magnetic field (B).

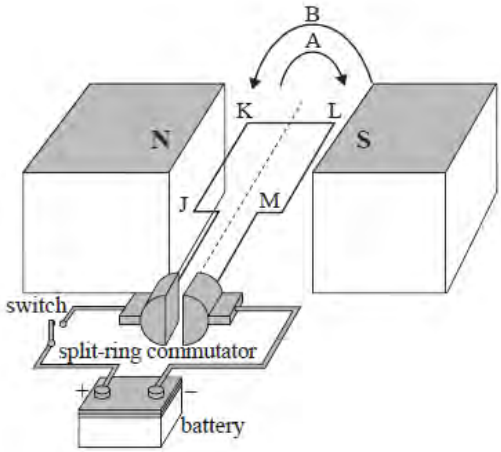


As conductor XY is moved through the magnetic field in the direction shown, which of the following correctly describes the direction of the current in the wire **and** its associated induced force?

	DIRECTION OF CURRENT	**DIRECTION OF INDUCED FORCE**
A.	**N**	**E**
B.	**S**	**W**
C.	**N**	**W**
D.	**S**	**E**

11. The figure below shows a small DC electric motor, powered by a battery through a split-ring commutator. The rectangular coil has sides KJ and LM of length 6.0 cm, and sides KL and JM of length 3.0 cm. The coil contains 50 turns of insulated wire.

The magnetic field between the poles of the magnet is uniform and of strength 0.050 T.



The current is switched on when the coil is stationary in the position shown in the figure above. Which of the following statements best describes the motion of the coil when the current is switched on?
You may assume that any frictional forces opposing rotation are very low.

A. The coil will rotate in direction A shown in the Figure above.
B. The coil will rotate in direction B shown in the Figure above.
C. The coil will oscillate regularly between directions A and B.
D. The coil will remain stationary.

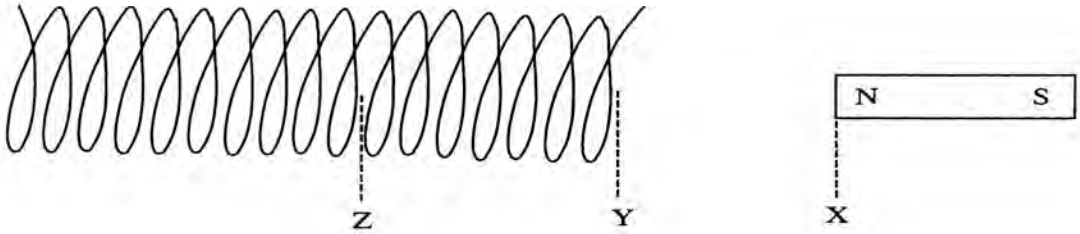
12. If a ray of pure red light from a laser has a wavelength of 621 nm, calculate the energy of the red photons.

A. 2.9×10^{4} J
B. 3.2×10^{-19} J
C. 541 kJ
D. 6.4×10^{-34} J

13. The BCS theory is currently being used to help explain the observations surrounding superconductivity. Which of the following is a correct statement concerning this theory?

A. It explains how magnetic fields penetrate a material to produce the superconductivity.
B. It involves the magnetic attraction between positive ions in the crystal lattice.
C. They can be used to generate large magnetic fields.
D. Electrons pair up to move through the lattice more efficiently.

14. Two experiments are performed with a coil and a magnet.



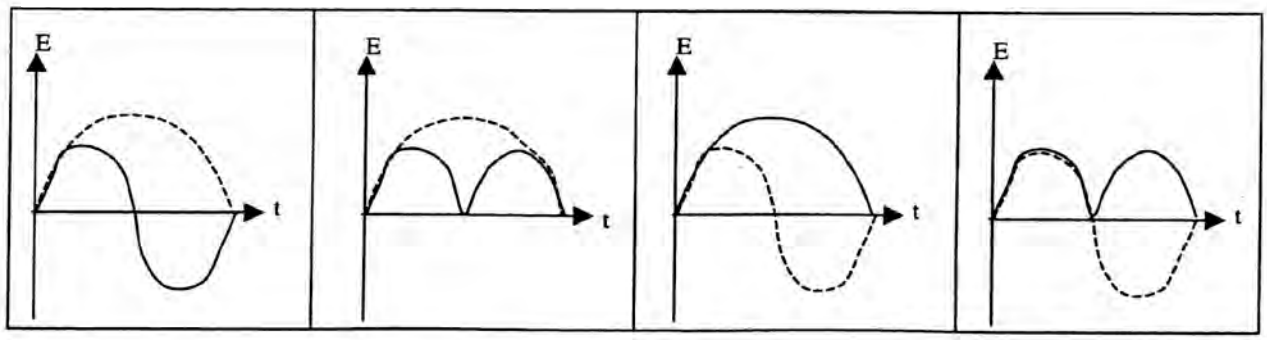
Experiment 1: Magnet moved from X to Y, then back to X

Experiment 2: Magnet moved from X through Y to Z

(The magnet was stationary at the beginning and at the end of each experiment)

Which of the following graphs of induced EMF in the coil *v's* time best illustrates the experimental results?

Experiment 1 —— Experiment 2 -------



A. *B.* *C.* *D.*

15. Energy is lost in transmission lines as electricity is transmitted through the electricity grid.

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.

16. What does a cathode ray tube containing a Maltese cross tell us about cathode rays?

A. They travel in straight lines.
B. They have mass.
C. They have momentum.
D. They have electric charge.

17. Figures A and B below show a square loop of wire being moved between the poles of a magnet. In the space between the poles there is a uniform magnetic field.
The loop moves at a steady speed from position 1 to position 3.
The loop is connected to a sensitive microammeter. The area of the loop is much less than the area of the magnetic field.

You may assume that the only magnetic field present is located directly between the north and south poles.

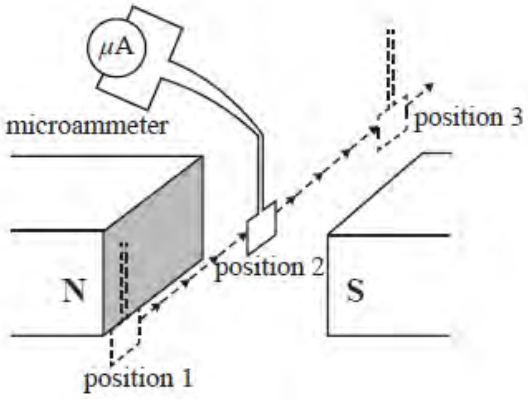


Figure A

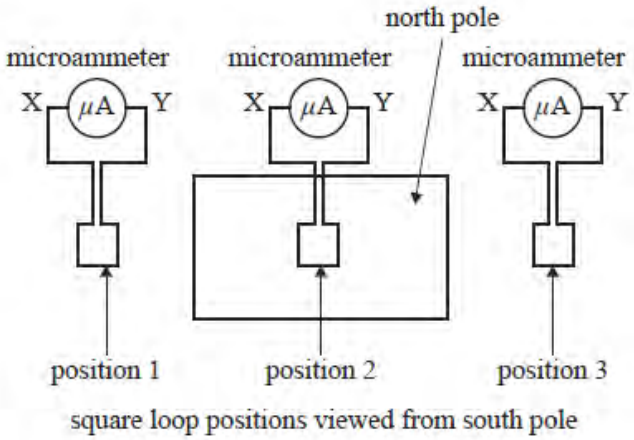
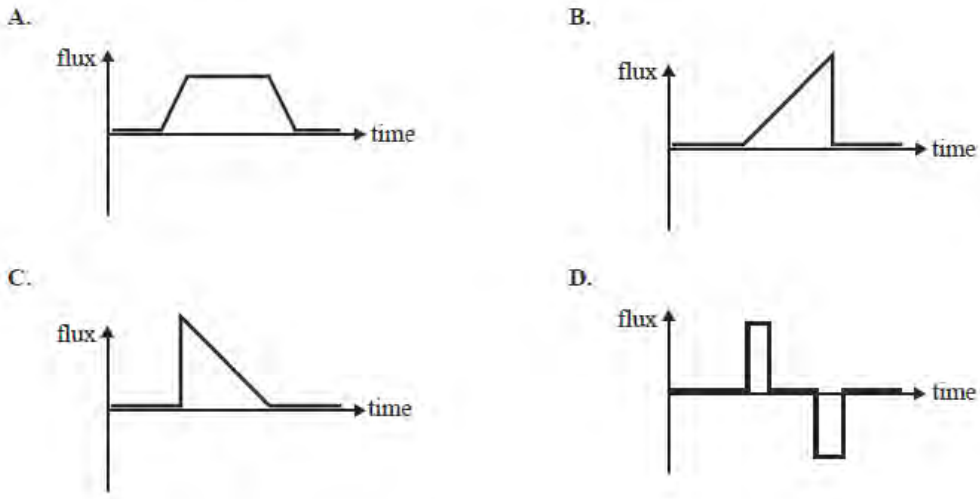


Figure B

Which of the following graphs best shows how the flux through the square loop varies with time as it moves from position 1 through to position 3?



18. Which substance, which could be easily purified, was used to make the first transistors?

A. Silicon
B. Germanium
C. n-type aluminum
D. p-type carbon

19. J. J. Thomson conducted a famous experiment aiming to measure various characteristics of cathode rays. Assuming that the cathode rays (electrons) produced by the cathode always have the same unknown velocity, which alternative correctly lists the independent and dependent variables in his experiment?

Variables:

E - strength of the electric field

r - radius of the circular path of the electrons

v - velocity of the electron

B – magnetic field strength

m – mass of the electron

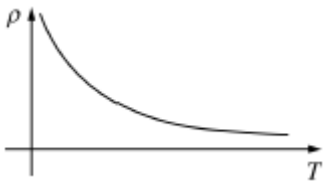
q – charge on the electron

	Independent variables	**Dependent variables**
A.	r, m v, q	E, B
B.	B, E, r	q, m
C.	E, B	r, m, v, q
D.	B	E, r

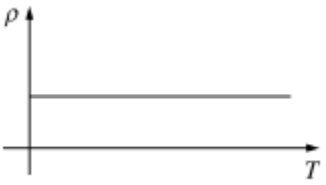
20. Which of the following best represents the temperature dependence of the resistivity (ρ) of an undoped semiconductor?

A.

B.



C.



D.

NOTE:

RESISTIVITY, ρ = RESISTANCE x AREA / length of conductor

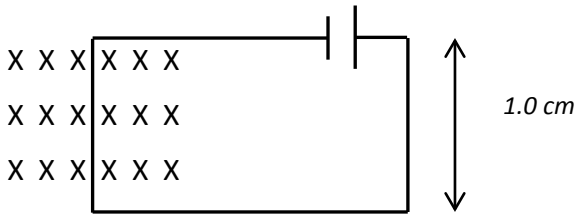
$$P = \frac{RA}{l}$$

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

Do NOT detach this page from the rest of the exam.

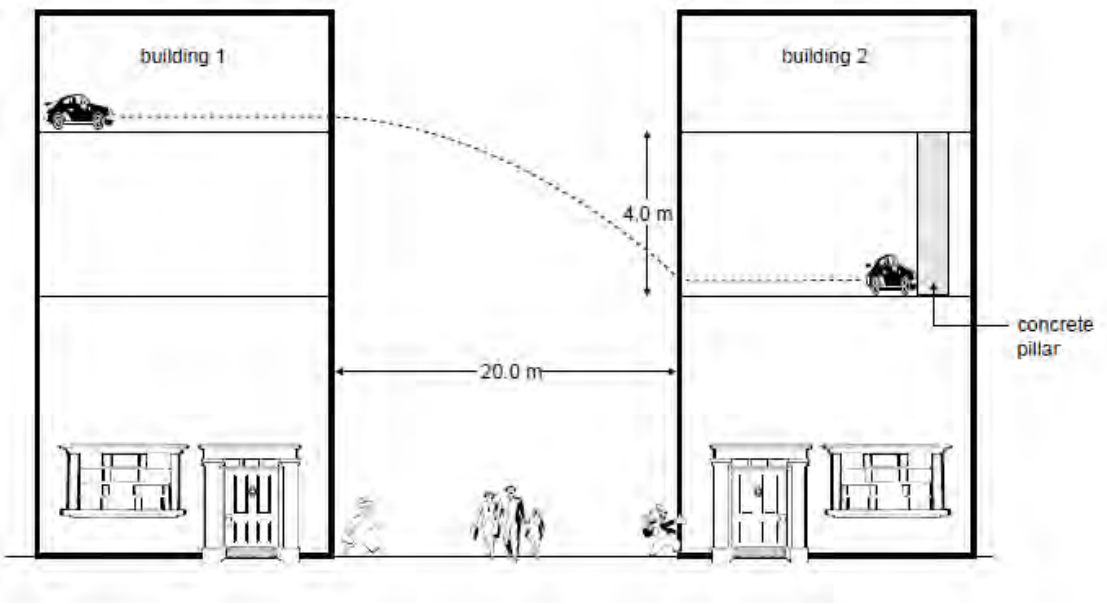
1	A B C D	11	A B C D
2	A B C D	12	A B C D
3	A B C D	13	A B C D
4	A B C D	14	A B C D
5	A B C D	15	A B C D
6	A B C D	16	A B C D
7	A B C D	17	A B C D
8	A B C D	18	A B C D
9	A B C D	19	A B C D
10	A B C D	20	A B C D

PART B: Longer Answers

21.	A 1.0 cm long wire carrying a current of 10 A is part of a circuit and passes at right angles through a magnetic field of 1.0 mT as shown in the diagram below.  Calculate the magnitude and direction of the force on the wire. …… …… …… ……	**2**
22.	The planet ZOGG is 0.1 times the mass of the Earth and its radius is 0.4 times that of the Earth. Determine the gravitational field strength (g) on the surface of the planet ZOGG. **NOTE:** Earth's radius = 6380 km …… …… …… …… …… ……	**3**

23.	From your first hand investigation activities, describe an activity that would allow you to determine the value of “g “(acceleration due to gravity) on earth. Explain why differences may arise compared to the accepted value of g. …… …… …… …… …… …… …… …… …… …… …… …… …… …… …… ……	**8**

24.



In the movie, *Car Escape*, two escapees, Allan and Craig drove their sports car across a horizontal car park in building 1 and landed it in the car park of building 2, landing one floor lower. Building 2 is 20 metres from building 1, as shown in the figure above. The floor where the car lands in building 2 is 4.0 metres below the floor from which it started in building 1.
<u>Assume air resistance is negligible in the situation above.</u>

a. Calculate the time of flight for the car to fall the 4 metres into building 2. **2**

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b. Calculate the initial horizontal velocity component of the car as it left building 1 to just land in building 2. **2**

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25. A transformer has 250 turns on the primary coil and 15 000 turns on the secondary coil. If an AC voltage of 1000 V is placed on the primary coil, a current of 50 A is measured on the secondary coil.

a. Where would this type of transformer be found in an electrical power distribution system, and why would it be used there? **2**

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b. Assuming the transformer is 100% efficient; calculate the current passing through the primary coil. **2**

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c. Outline why real transformers are never 100% efficient and explain what steps can be taken to improve the efficiency of transformers. **4**

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26. Muons are formed at an altitude of about 10 km above the surface of the Earth when cosmic rays interact with atoms in the atmosphere. The life span of a muon has been measured to be 2.2×10^{-6} s. After this time interval the muon decays into other particles.

a. If a muon travelled at the speed of light, how far would it be able to travel during its lifespan before it decayed? **1**

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b. From the muon's point of view, in its frame of reference, how is it possible for it to travel the distance to the surface of the Earth before it decays? **2**

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c. If the muon travelled at 0.999c, would it be able to reach the surface of the Earth? Show your working. **3**

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d. From the point of view of an observer at the surface of the Earth, the muon will travel the same distance as calculated in *part a above* in its life span. How then does this observer explain the fact that the muon can travel 10 km and reach the surface of the Earth? **3**

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27. After the discovery of cathode rays, there was debate as to whether the rays were waves or particles. This was resolved in 1897 when J. J. Thomson demonstrated that they were negatively charged particles. Before 1897 a number of different tubes were constructed (known as Crookes tubes) that enabled scientists to make observations of the cathode rays.

a. State one observation, made with a Crookes tube, which supported the particle nature of the cathode rays. **1**

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When he showed that the rays were in fact particles, Thomson fired them through electric and magnetic fields.

b. Draw a diagram to show how the cathode rays were deflected by the electric field. **2**

c. Draw a diagram to show how the cathode rays were deflected in a magnetic field. **2**

d. Thomson was able to determine the velocity of cathode rays by firing them through crossed electric and magnetic fields. Determine the value of the velocity of cathode rays if the electric field strength is 5000 V m^{-1} and the magnetic field strength is 2.0×10^{-3} T. **2**

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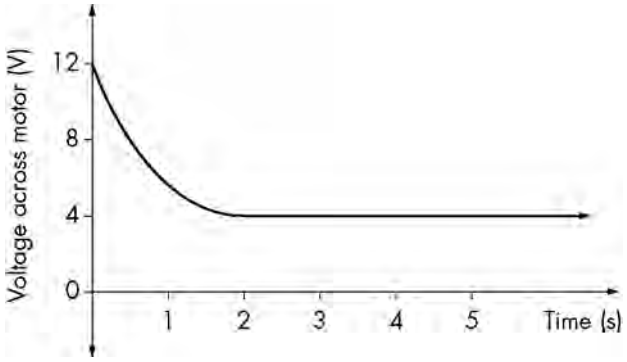
27. **Cont.**	*e.* Consider a TV set with a conventional cathode ray tube display. Outline the role of the : • electrodes in the electron gun …… …… …… …… • deflection coils …… …… …… ……	**2** **2**

28. A student connected a DC motor to a 12 V battery and measured the voltage across the motor as a function of time after the motor was switched on.



With reference to Lenz's law, explain the shape of the graph obtained by the student. **4**

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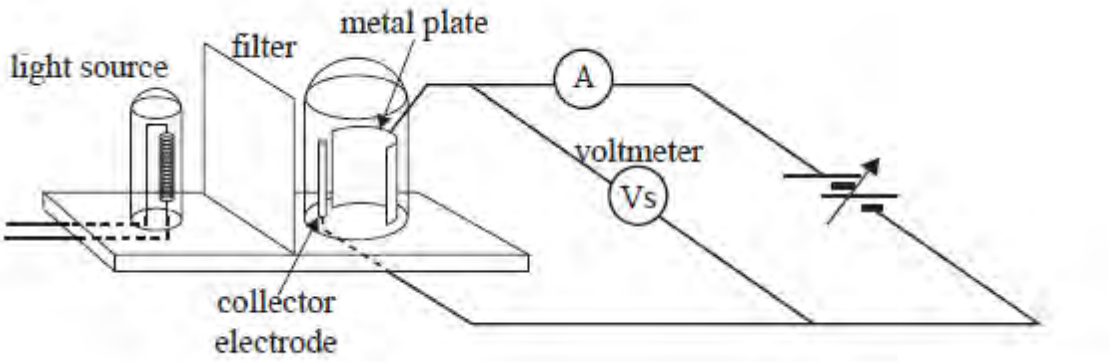
29. Will, a Physics student, is carrying out photoelectric effect experiments. His apparatus is shown in the figure below.



Will uses two metal plates in the photoelectric cell. One plate is made of zinc and the other is made of aluminium.
Will uses light of a particular frequency to illuminate the zinc plate and then the aluminium plate, but finds that photoelectrons are emitted only by the zinc plate.
The threshold frequency of zinc for photoelectric emission is 7.40×10^{14} Hz and that of aluminium is 9.90×10^{14} Hz.

a. Calculate the maximum wavelength (in nm) of the light required to emit electrons from the zinc plate. **1**

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In an effort to eject photoelectrons from the aluminium plate, Will increases the intensity of the light beam, but still finds that no photoelectrons are emitted.

b. Explain how this observation supports the particle model of light, but not the wave model of light. **3**

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30.	Explain how the doping of silicon changes its conductivity from its undoped condition. Labelled diagrams should be included. …… …… …… …… …… …… …… …… …… ……	**5**
31.	Metals have a regular, 3-D crystal lattice structure. Outline the method used by the Braggs' to determine crystal structure. …… …… …… ……	**2**

32.

SECTION II: OPTION QUESTION

OPTION: QUANTA TO QUARKS

- ***USE A SEPARATE BOOKLET FOR YOUR ANSWERS***

The Rutherford–Bohr model of the atom is unable to completely explain a phenomenon called the hyperfine structure. This is a splitting of spectral lines associated with the fact that the nucleus of the atom has a magnetic dipole moment that interacts with the orbital and/or spin magnetic dipole moments of the electron.

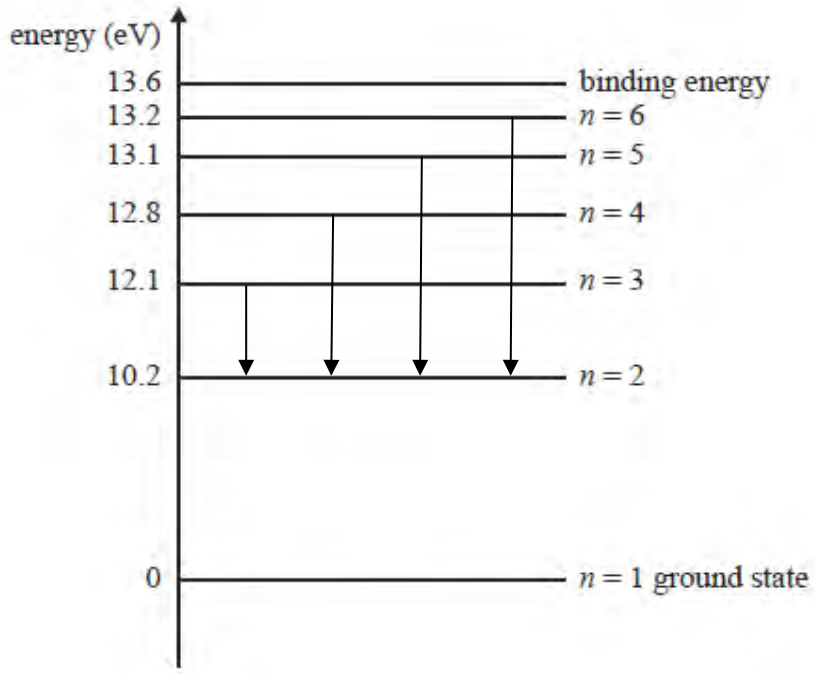
For example, the ground level of hydrogen is split into two states, separated by only 5.9×10^{-6} eV. The photon that is emitted in the transition between these states is used by radio astronomers to map interstellar clouds of hydrogen gas that are too cold to emit visible light. From an analysis of the intensity of this radiation, astronomers have learned a great deal about the density distribution of neutral hydrogen in interstellar space.

a. Identify two other limitations of Bohr's model of the hydrogen atom. **2**

b. Calculate the wavelength, λ, which radio astronomers are looking for to enable them to study interstellar clouds of hydrogen. **2**

OPTION QUESTION CONTINUED ON NEXT PAGE

The figure below shows the Bohr explanation for the energy level diagram of the hydrogen atom.



c. Describe this diagram by explaining the meaning of the horizontal lines and vertical arrows, and by identifying the name given to the number *n*. **2**

An electron in a hydrogen atom makes a transition from the n = 2 level to the n = 4 level by absorbing a photon.

d. Calculate the wavelength of the photon involved. **2**

OPTION QUESTION CONTINUED ON NEXT PAGE

The energy levels of the hydrogen atom are discrete (quantised) and there are no stable levels between them.

e. In terms of the properties of the electron, explain why only certain energy levels are stable. **2**

In 1924, Louis de Broglie first proposed that any particle that has momentum can have a wavelength, and therefore it can behave like a wave called a matter wave.

An electron, ***q***, has been accelerated from rest through a potential difference, **V**, of 45 V.

f. i. Write an expression for the work done on the particle (and hence E_k gained by the electron) by the potential difference. **1**

ii. Calculate the de Broglie wavelength of this electron as it passes through the potential difference. **3**

During the Caringbah High School 2014 Year 12 Physics class's excursion to ANSTO, the presenter talked about some of the products that they obtain from various processes on their site. Neutron rich products are obtained from their nuclear reactor, while neutron poor products are obtained from a cyclotron.

Fluorine -18 is a neutron poor isotope that is obtained by bombarding oxygen -18 with a high speed proton.

g. i. Write a balanced nuclear equation for this transmutation. **1**

The nuclear reactor at ANSTO uses enriched uranium as its nuclear fuel. The percentage of uranium-235 in yellowcake must be increased to be a suitable fuel for the ANSTO nuclear reactor. The uranium-235 undergoes alpha decay in the reactor, with only 1 alpha particle being liberated per decay.

ii. Write a balanced nuclear equation for this transmutation. **1**

h. Assess the contributions made by Werner Heisenberg and Wolfgang Pauli to the development of atomic theory. **4**

END OF EXAMINATION