Student Number ___________________

Caringbah High School
Physics: HSC Course
Trial Exam 2017

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
PART A: Multiple Choice Questions (20 marks)
PART B: Longer Response Questions (67 marks)
OPTION: Quanta to quarks (13 marks)

Exam Prepared by: B.Walmsley

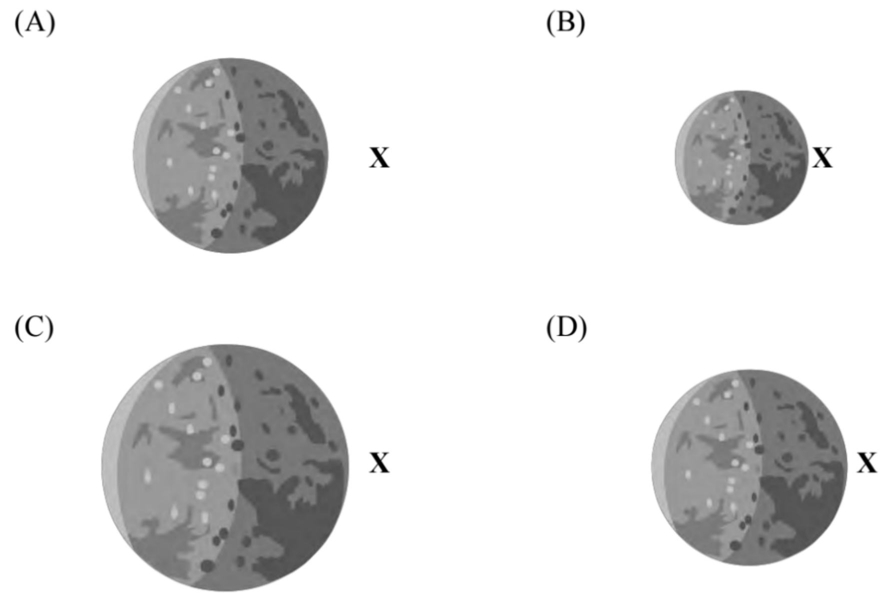
OUTCOME	*MARK*
Knowledge and Understanding	*/80*
Practical investigations *Q21*	*/7*
Problem solving *Q 25, 26b, 28 a & b, 31b*	*/13*

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

1. *An ideal transformer has 4000 turns on the primary coil and 250 turns on the secondary coil. The input and output voltages for this transformer could be:*

	Input voltage (volts)	***Output voltage (volts)***
A	2 000	3 200
B	32 000	2 000
C	1 600	10
D	20	100 000

2. *A gaseous planet expands and contracts in size while maintaining the same mass.*
In which diagram is the object at "X" experiencing the greatest gravitational force?
(The diagrams are to scale.)

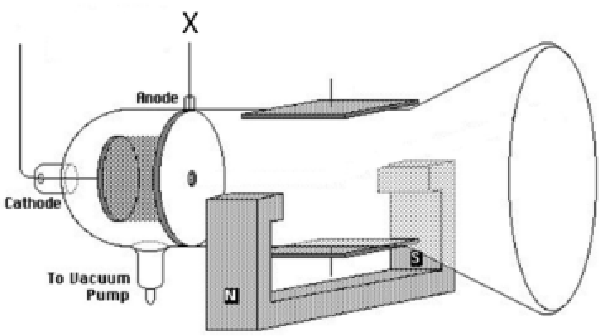


3. *What is the gravitational potential energy of an asteroid with a mass of 3.5 x 10^5 kg when it is at an altitude of 30 km above the ocean?*

radius of Earth = 6370 km
mass of the Earth = 6.0 x 10^{24} kg

A. -3.4 x 10^6 J
B. -2.2 x 10^{16} J
C. -1.3 x 10^{-6} J
D. -2.2 x 10^{13} J

4.	*What is the role of the anode, labelled "X" in the cathode ray tube of an oscilloscope?*	



A. To accelerate the electrons.
B. To deflect the electron beam.
C. To repel electrons from the cathode.
D. To reduce the brightness of the light on the screen.

5. *Astronaut Walmsley weighs 700N at the surface of Earth (she has worked hard to remain in the astronaut program since the 'pie incident'). With the aid of the information contained in the table, estimate Walmsley's weight on the surface of Mars.*

Planet	***Mass (10^{24}kg)***	***Radius (km)***
Earth	*6.0*	*6400*
Mars	*0.64*	*3400*

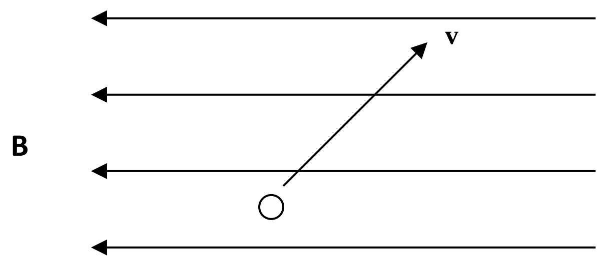
A. 167 N
B. 263 N
C. 348 N
D. 700 N

6. *The four diagrams below represent the atomic arrangements when impurity atoms (indicated in **bold**) are added to a pure semiconductor.*

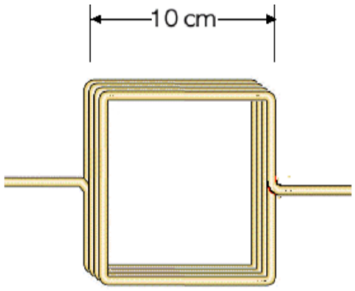
W Ge Ge **B** Ge Ge (n-type)	X Si Si **P** Si Si (n-type)
Y Si Si **N** Si Si (p-type)	Z Ge Ge **As** Ge Ge (p-type)

Which of the four diagrams correctly represents the process of doping?

A. W
B. X
C. Y
D. Z

7.	*The minimum amount of energy needed for photosynthesis in green plants is 3.0 x 10^{-19} J. What is the maximum wavelength of incident light that can be shone on the plant surface in order to carry out photosynthesis?* *A. 1.36 x 10^{23} m* *B. 4.45 x 10^{14} m* *C. 6.62 x 10^{-7} m* *D. 2.21 x 10^{-15} m*	
8.	*Which of the following is an advantage of solid state devices over thermionic devises?* *A. Solid state devices can tolerate a higher voltage than thermionic devices.* *B. Solid state devices can last forever and will not break down.* *C. Thermionic devices need a very low temperature to work but solid devices do not.* *D. Solid state devices consume less electrical power than thermionic devices.*	
9.	*At what stage is the torque acting on a motor coil zero?* *A. When the plane of the coil is perpendicular to the external magnetic field.* *B. When the plane of the coil is parallel to the external magnetic field.* *C. When the forces acting on each side of the coil act in opposite directions.* *D. When the forces acting on each side of the coil act in the same direction.*	
10.	*Consider an alpha particle (α) moving through a uniform magnetic field as shown below.*  What is the direction of the magnetic force on the alpha particle? *A. To the right.* *B. To the left.* *C. Into the page.* *D. Out of the page.*	
11.	*A large industrial electric motor has a minimum rotational speed to prevent the motor from overheating. Which response correctly identifies the reason for this?* *A. At lower speeds friction in the motor increases.* *B. The resistance of the coils increases at lower speeds.* *C. The back emf decreases at lower speeds causing more current in the coils.* *D. The induced eddy currents increase at lower speeds and this produces heat.*	

12. *A student constructs a small electric motor by winding 20 coils in a square shape as shown below.*



The resistance of the motor is 60 Ω and a 12V battery supplies energy. Two magnets in the motor produce a magnetic field of 0.5 T.

What is the maximum torque supplied by the motor?

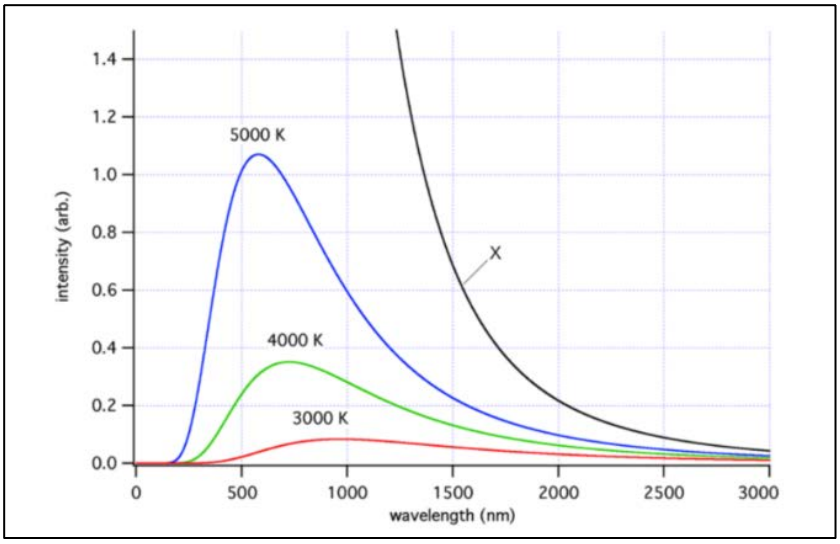
A. 0.02 N.m

B. 1 N.m

C. 6 N.m

D. 200 N.m

13. *The graph below shows the radiation curves for black bodies at three different temperatures.*



What does the curve labelled 'X' represent?

A. A black body with a temperature greater than 5000 K.

B. A black body with a temperature less than 3000 K

C. The result of a model for black body radiation first proposed by Planck.

D. The radiation curve for black bodies predicted by classical physics.

14. *A non-inertial frame of reference is one that is:*

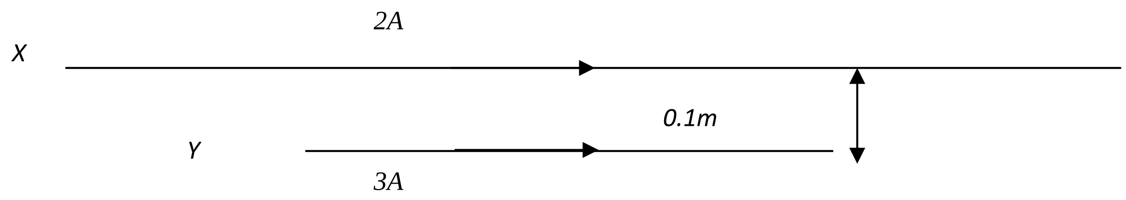
A. stationary.

B. accelerating.

C. non-accelerating (either stationary or moving with constant velocity).

D. in motion (either accelerating or moving with constant velocity).

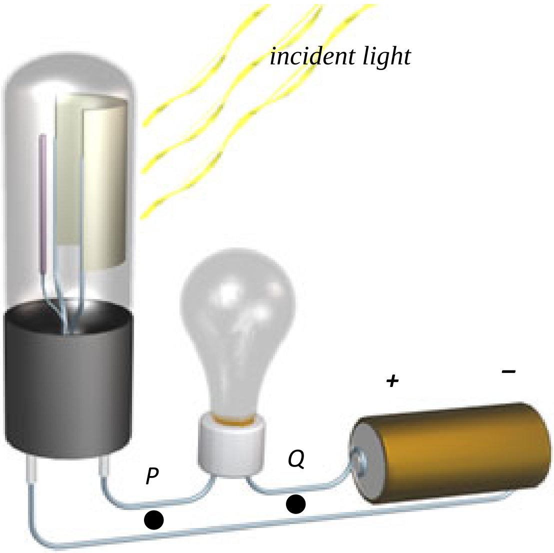
15. *Two long parallel wires X and Y carry currents of 2 A and 3 A respectively in the same direction as shown in the diagram below.*



Wire X is 3.0 m long and is twice the length of wire Y. Their separation is 0.1 m. The force between wires X and Y is:

A. 1.8×10^{-5} N repulsion
B. 1.8×10^{-5} N attraction
C. 3.6×10^{-5} N repulsion
D. 3.6×10^{-5} N attraction

16. *In the following diagram, light falling on the curved metal surface of the photocell produces a potential difference that opposes the voltage of the battery so that no electricity flows through the light bulb.*

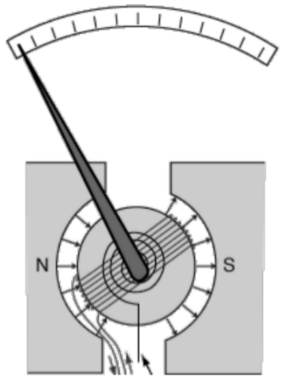
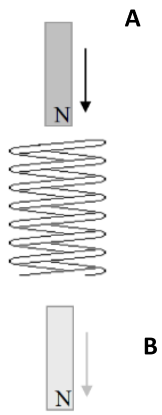


What changes to the incident light would produce a small flow of electrons through the light bulb from P to Q?

A. A small decrease in intensity of the incident light.
B. A small increase in intensity of the incident light.
C. A small decrease in frequency of the incident light.
D. A small increase in frequency of the incident light.

17. *A 5kg communications device is placed inside a spacecraft before it leaves Earth. What is the mass of the device when the spacecraft is travelling at 0.8c.*

A. 3kg
B. 5 kg
C. 8.3 kg
D. 4.5×10^{17} kg

18.	*A diagram of a galvanometer appears below.*  *The working principle of such a meter is:* *A. The magnets become stronger as current moves through the coils.* *B. The greater the current, the faster the needle rotates.* *C. The radial magnets provide a varying force on the current carrying conductor.* *D. A greater torque is produced as the current in the coil increases.*	
19.	*Which alternative describes the function of a split ring commutator in a DC motor?* *A. To ensure that the direction of the current in the coil relative to the magnetic field is constant so that continuous rotation can occur.* *B. To ensure that the direction of the current in the coil relative to the magnetic field is constantly changed so that continuous rotation can occur.* *C. To ensure that the direction of the current in the coil changes every 90˚ so that continuous rotation can occur.* *D. To ensure that the direction of the current in the coil remains constant so that continuous rotation can occur.*	
20.	*A bar magnet is dropped through a vertical solenoid, as shown below.* *What pole/s would be induced <u>at the top</u> of the solenoid as the magnet goes from position A to position B?*  *A. North the whole time* *B. South the Whole time* *C. North then South* *D. South then North*	

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 (80 marks)

21. *The motion of a simple pendulum has been studied for hundreds of years. In the 1600s Galileo observed a lamp swinging from the ceiling of the Pisa Cathedral and was able to time this pendulum motion using his pulse rate.*

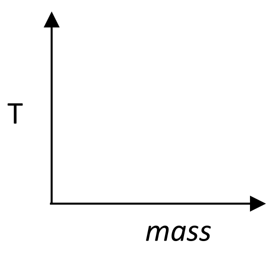
Newton later knew that for any swinging mass (m) the period of this motion (T) was affected by the length of string (l) and the value of acceleration due to gravity (g) as described by the following equation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

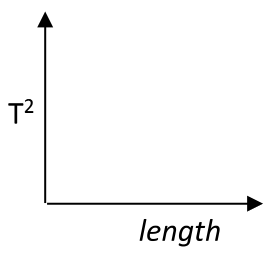
a. During your course, you performed an investigation to determine a value for acceleration due to gravity using pendulum motion. Outline how you conducted a valid investigation. **5**

b. Using the results from your experiment, and the equation above, indicate the relationship between the quantities on the graphs below. **2**

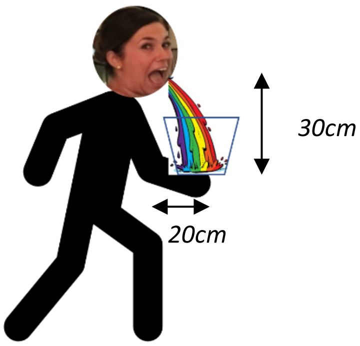
(i)



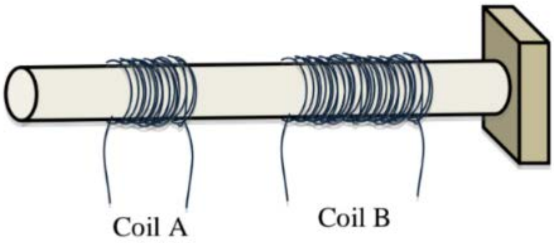
(ii)



22.	*a. A spacecraft is 80 m long, as measured by an astronaut on board. When a scientist working at a base on the moon observes the spacecraft flying overhead, it appears to be 64 m long. Calculate the speed of the spacecraft relative to the scientist on the moon.* …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… ……………………………………………………………………	**2**
	b. Discuss the impact of relativistic mass changes on our ability to make very large distance space-exploration journeys at speeds near the speed of light. …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… ……………………………………………………………………	**2**
23.	*A 200 kg satellite is orbiting Earth with an altitude of 800 km.* *a. Calculate the gravitational force between the satellite and Earth, if the radius of the Earth is 6370 km.* …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… ……………………………………………………………………	**2**
	b. Determine the orbital speed of this satellite. …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… …………………………………………………………………… ……………………………………………………………………	**2**
	c. Compare the speed of a 500 kg satellite in identical orbit. …………………………………………………………………… ……………………………………………………………………	**1**

24.	*Discuss how the principle of conservation of momentum and Newton's second law is utilised by rocket designers to place a satellite in orbit.* …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………	**4**
25.	*During recess Mrs Wynne was forced to listen to copious amounts of Mr. Cantor's terrible jokes. Upon arriving to her year 12 Chemistry class she realised that his jokes had, in fact, made her quite nauseous. As she began to outline the lesson objectives, she realised she needed to vomit, grabbed the bin and quickly made her way to the door. Mrs Wynne walked at a brisk 5 km/hr with the centre of the bin placed 30 cm below her mouth and extended 20 cm in front of her mouth. Unable to make it out of the room, but still walking, she projectile vomited into the centre of the bin.*  *Not to scale* *Calculate the horizontal velocity of Mrs Wynne's vomitus relative to the mortified students in the front row of her Class. You must show all working.* …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………	**3**

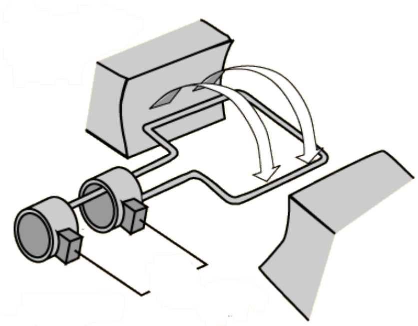
26. *A student builds a model using insulated wire along a steel bolt. Coil A is a coil of wire wound tightly around one end of the bolt. Coil B is another coil a little further down, with more turns of wire wound tightly around the steel bolt. The ends of coil A are connected to a 24 Volt, 50 Hz AC source. Coil B is attached to a multimeter.*



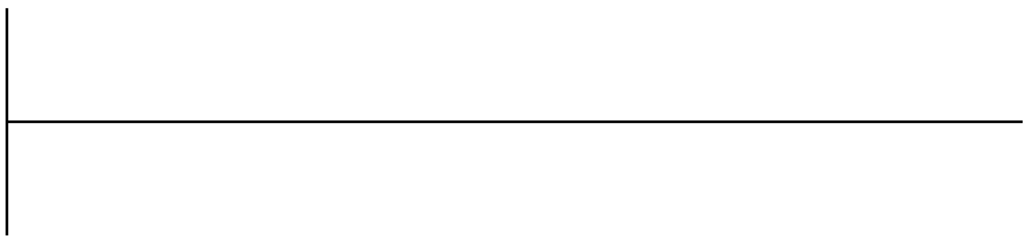
a. Identify the device studied in the Motors and Generators Module that this model represents. **1**

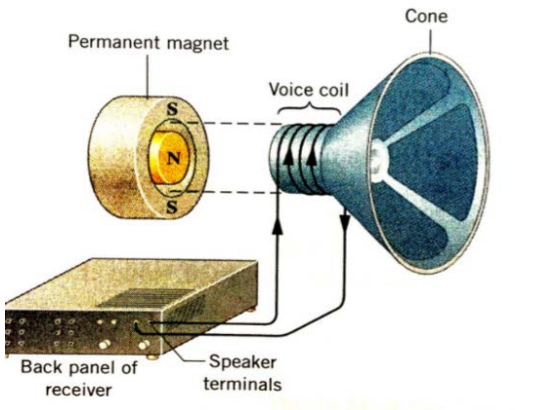
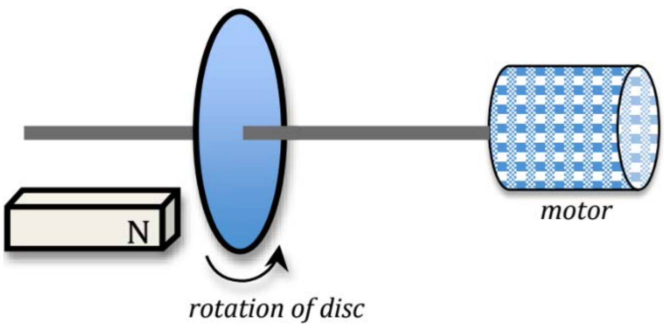
b. Describe one way of increasing the voltage across coil B by changing a structural variable in the above set-up, and justify your reasoning. **3**

27. *This diagram shows a simple type of motor composed of a single 2 cm long square loop rotating in a magnetic field. Assume that time '0' is the orientation displayed.*

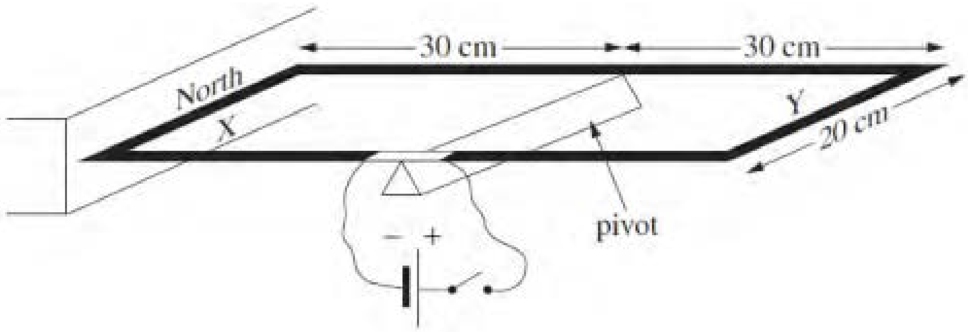


Use the axes below to sketch a current-time graph for the power supply required to operate this type of motor. **1**



28.	*The voice coil of a speaker has a diameter d = 0.025 m, 55 turns of wire and is placed in a 0.10 T magnetic field. The current in the voice coil is 2.0 A.*  *a. Calculate the magnetic force that acts on the coil and cone.* .... *b. The voice coil and the cone have a combined mass of 20 g. Calculate their acceleration.*	**2** **2**
29.	*An aluminium disc, attached to the axle of an electric motor, is initially spinning with a constant angular speed. A magnet is brought near the spinning disc, as shown.*  *Explain the effect that this would have on the spinning disc.*	**3**

30. *A rectangular wire loop is connected to a DC power supply. Side X of the loop is placed next to the magnet. The loop is free to rotate about a pivot. When the power is switched on, a current of 20 A is supplied to the loop. To prevent rotation, a mass of 40 g can be attached to either side X or Y of the loop.*



a. On which side of the loop should a mass be placed to prevent rotation? **1**

………

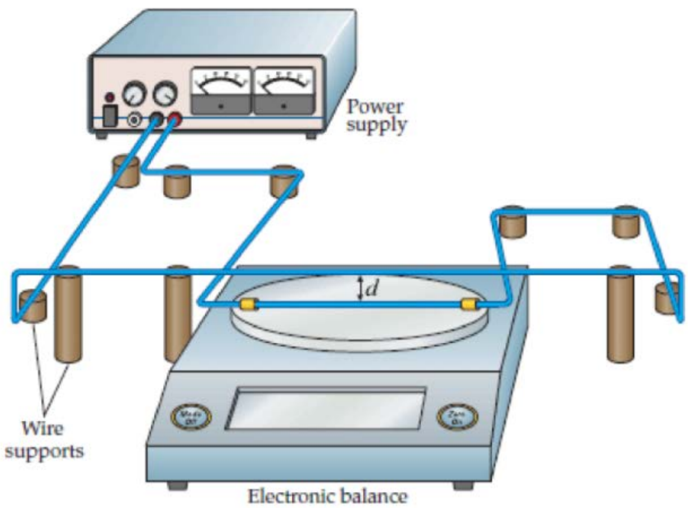
b. Calculate the torque provided by the 40 g mass. **2**

………

………

………

31. *An investigation was conducted to examine the force between two current carrying wires. The following equipment was set up using an electronic balance to determine the force between the wires.*



The electronic balance was zeroed before the current was switched on so that the reading was directly measuring the force between the wires. The effective length over which the wires interact was measured to be 0.0975 m.

Question continued next page

Question 31 cont.

Below is the data collected during this experiment;

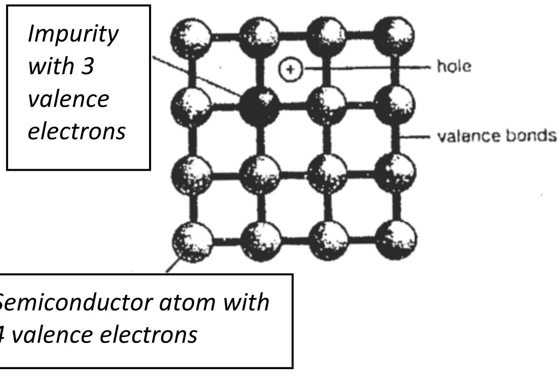
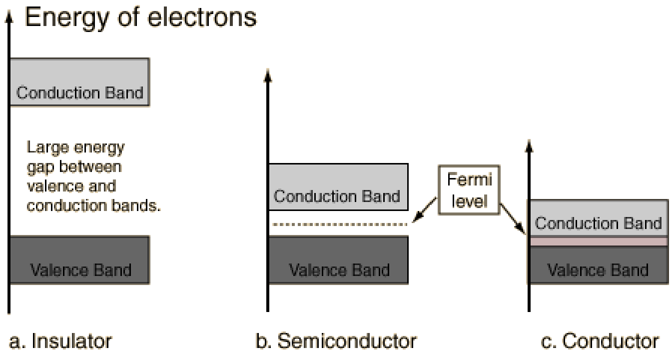
I (A)	Balance reading (g)	I^2 (A^2)	Force between wires (N)
20	0.55	4.0×10^{2}	5.4×10^{-3}
30	1.22	9.0×10^{2}	1.2×10^{-2}
40	2.18	1.6×10^{3}	2.1×10^{-2}
45	2.75	2.0×10^{3}	2.7×10^{-2}
50	3.40	2.5×10^{3}	3.3×10^{-2}

4

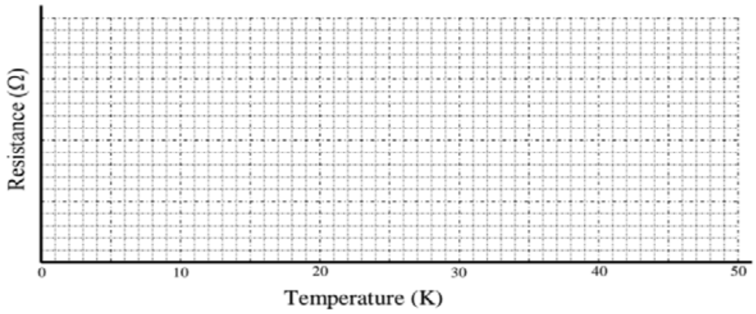
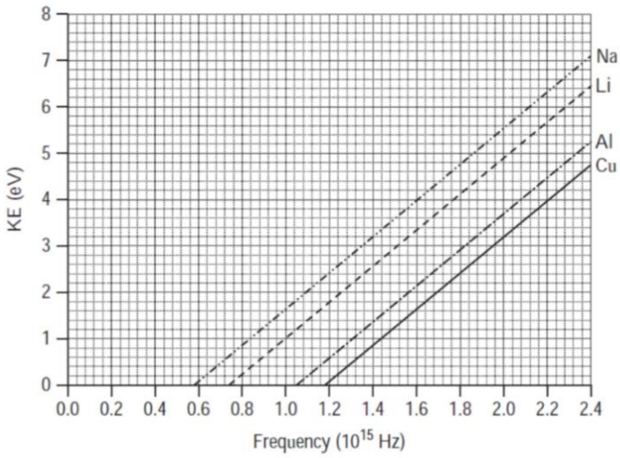
*a. Use the data collected (above) to construct a graph of the **force between the wires** (y-axis) against the **current squared** (x-axis).*

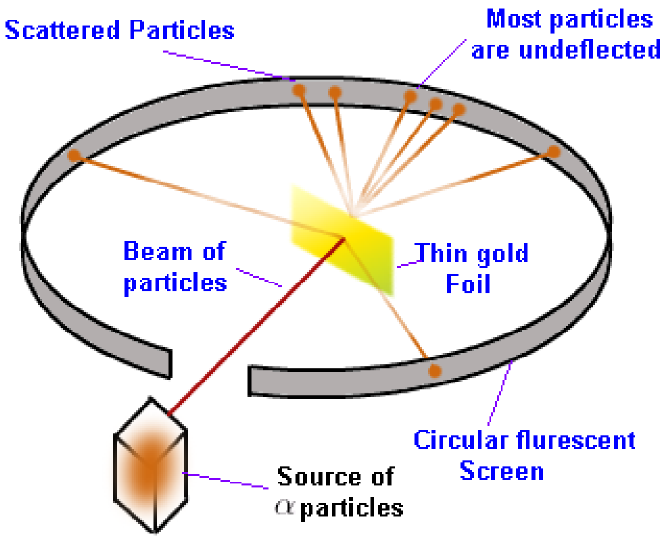
3

b. Using the calculated gradient of your line above, in addition to other relevant formula determine the separation, d, of the wires.

32.	*Consider the diagram below of a doped semiconductor.*	
		
	a. Identify whether the diagram represents an n-type or p-type semiconductor. ……	**1**
	b. Explain how doping with an impurity containing three valence electrons results in improved conduction. …… …… …… …… …… …… …… ……	**4**
33.	*With specific reference to the diagram below, discuss* ***two*** *limitations of models in Science.*  …… …… …… …… …… ……	**4**

34.	*Evaluate the role of experiments that were conducted in the late nineteenth century to resolve the debate over the nature of cathode rays.*	**6**

35.	*In 1908 Dutch Scientist Heike Onnes discovered a phenomenon called superconductivity, and found that the element mercury has a critical temperature of 4.15 Kelvin.* *a. On the graph paper below, show how the resistance of mercury varies with temperature.* 	**1**
36.	*Heinrich Hertz performed an experiment where he measured the speed of radio waves using the principle of interference of waves produced by a reflection from a metal plate. Outline the significance of the results of this experiment.* …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………	**2**
37.	*The graph below shows the kinetic energy (KE) of photoelectrons emitted from a range of metals for different incident frequencies*  *Identify which metal requires the least amount of energy to stimulate a photocurrent. Justify your answer.* …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………	**2**

38.	*Explain how the photoelectric effect provides evidence for both the quantisation of the energy carried by electromagnetic radiation and its particle nature.* …… …… …… …… ……	**2**
39.	***From Quanta to Quarks (13 marks)*** *In 1909, Rutherford, Geiger and Marsden conducted the now famous alpha particle scattering experiment using apparatus like that shown below:*  *a. Rutherford made changes to the pre-existing model of the atom because of these experiments. Describe two features of Rutherford's model of the atom and, with reference to the gold foil experiment, identify the evidence on which they are based.* …… …… …… …… …… …… …… …… ……	**4**

	b. Explain why Rutherford's model was criticised at the time. …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… ……………………………………………………………………………………………………	**2**
40.	*Explain how energy is conserved when an electron makes a transition from one energy level to another.* …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… ……………………………………………………………………………………………………	**3**
41.	*a. Calculate the wavelength of the H_β spectral line for hydrogen, given that H_β light is associated with an electron transition from the n = 4 state to the n = 2 state in a hydrogen atom.* …………………………………………………………………………………………………… …………………………………………………………………………………………………… …………………………………………………………………………………………………… *b. Calculate the amount of energy carried by one Photon of the H_β spectral line.* …………………………………………………………………………………………………… …………………………………………………………………………………………………… ……………………………………………………………………………………………………	**2** **2**

Student Number ___________________

Caringbah High School
Physics: HSC Course
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MARKING SCHEME

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Exam Prepared by: B.Walmsley

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Practical investigations *Q21*	*/7*
Problem solving *Q 25, 26b, 28 a & b, 31b*	*/13*

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

1. *An ideal transformer has 4000 turns on the primary coil and 250 turns on the secondary coil. The input and output voltages for this transformer could be:*

	Input voltage (volts)	***Output voltage (volts)***
A	2 000	3 200
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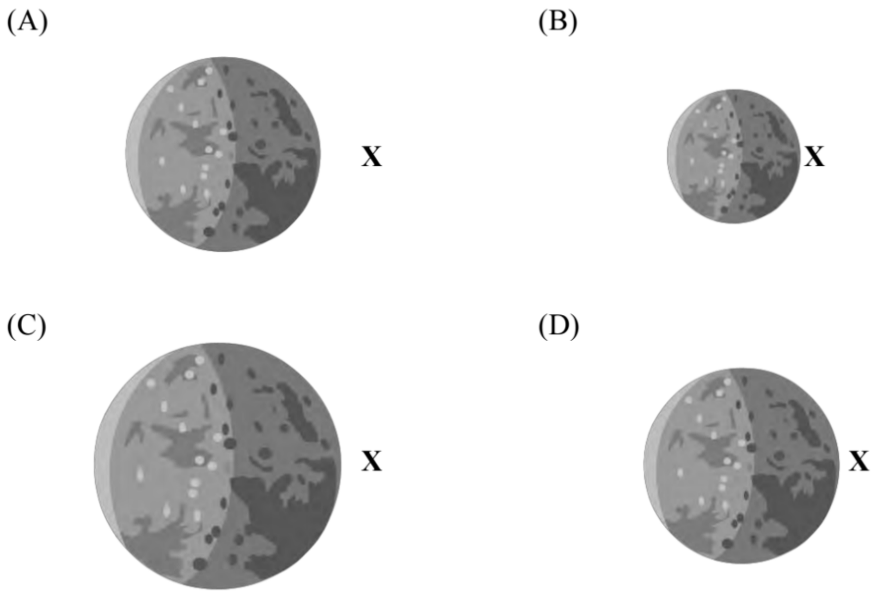
D	20	100 000

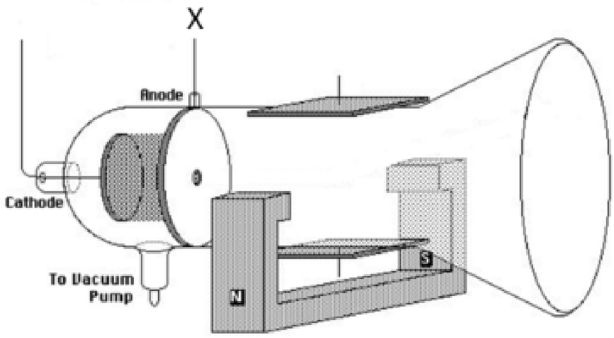
2. *A gaseous planet expands and contracts in size while maintaining the same mass.*
In which diagram is the object at "X" experiencing the greatest gravitational force?
(The diagrams are to scale.)

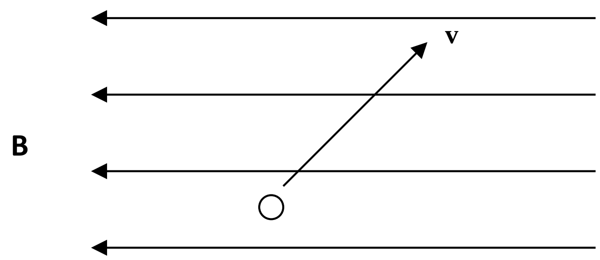


3. *What is the gravitational potential energy of an asteroid with a mass of 3.5 x 10^5 kg when it is at an altitude of 30 km above the ocean?*

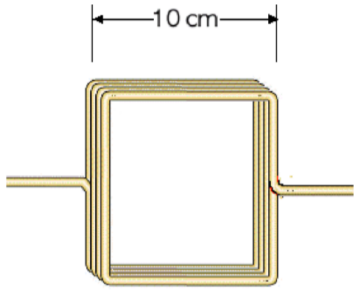
radius of Earth = 6370 km
mass of the Earth = 6.0 x 10^{24} kg

A. -3.4 x 10^6 J
B. -2.2 x 10^{16} J
C. -1.3 x 10^{-6} J
D. -2.2 x 10^{13} J

4.	*What is the role of the positive electrode labelled "X" in the cathode ray tube of an oscilloscope?*  *A. To accelerate the electrons.* *B. To deflect the electron beam.* *C. To repel electrons from the cathode.* *D. To reduce the brightness of the light on the screen.*	
5.	*Astronaut Walmsley weighs 700N at the surface of Earth (she has worked hard to remain in the astronaut program since the 'pie incident'). With the aid of the information contained in the table, estimate Walmsley's weight on the surface of Mars.* **Planet** / **Mass (10^{24}kg)** / **Radius (km)** **Earth**: 6.0, 6400 **Mars**: 0.64, 3400 *A. 160 N* *B. 270 N* *C. 340 N* *D. 700 N*	
6.	*The four diagrams below represent the atomic arrangements when impurity atoms (indicated in* ***bold****) are added to a pure semiconductor.* W: Ge / Ge **B** Ge / Ge (n-type) X: Si / Si **P** Si / Si (n-type) Y: Si / Si **N** Si / Si (p-type) Z: Ge / Ge **As** Ge / Ge (p-type) *Which of the four diagrams correctly represents the process of doping?* *A. W* *B. X* *C. Y*	

	D. z	
7.	*The minimum amount of energy needed for photosynthesis in green plants is 3.0 x 10^{-19} J. What is the maximum wavelength of incident light that can be shone on the plant surface in order to carry out photosynthesis?* *A. 1.36 x 10^{23}* *B. 4.45 x 10^{14}* *C. 6.62 x 10^{-7}* *D. 2.21 x 10^{-15}*	
8.	*Which of the following is an advantage of solid state devices over thermionic devises?* *A. Solid state devices can tolerate a higher voltage than thermionic devices.* *B. Solid state devices can last forever and will not break down.* *C. Thermionic devices need a very low temperature to work but solid devices do not.* *D. Solid state devices consume less electrical power than thermionic devices.*	
9.	*At what stage is the turning moment of the force acting on a motor coil zero?* *A. When the plane of the coil is perpendicular to the external magnetic field.* *B. When the plane of the coil is parallel to the external magnetic field.* *C. When the forces acting on each side of the coil act in opposite directions.* *D. When the forces acting on each side of the coil act in the same direction.*	
10.	*Consider an alpha particle (α) moving through a uniform magnetic field as shown below.*  What is the direction of the magnetic force on the alpha particle? *A. To the right.* *B. To the left.* *C. Into the page.* *D. Out of the page.*	
11.	*A large industrial electric motor has a minimum rotational speed to prevent the motor from overheating. Which response correctly identifies the reason for this?* *A. At lower speeds friction in the motor increases.* *B. The resistance of the coils increases at lower speeds.* *C. The back emf decreases at lower speeds causing more current in the coils.* *D. The induced eddy currents increase at lower speeds and this produces heat.*	

12. *A student constructs a small electric motor by winding 20 coils in a square shape as shown below.*



The resistance of the motor is 60 Ω and a 12V battery supplies energy. Two magnets in the motor produce a magnetic field of 0.5T.

What is the maximum torque supplied by the motor?

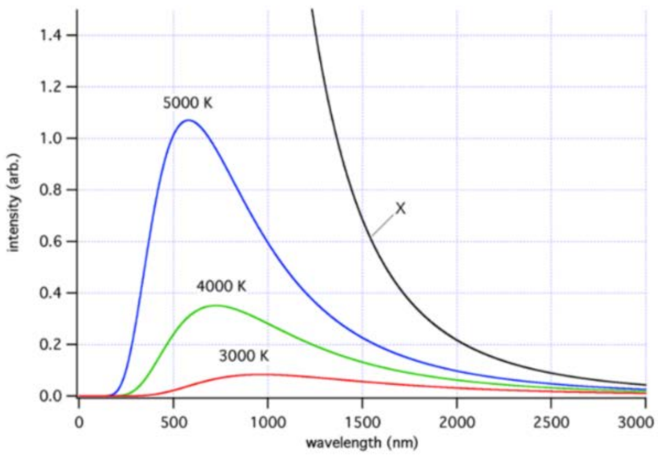
A. 0.02 N.m

B. 1 N.m

C. 6 N.m

D. 200 N.m

13. *The graph below shows the radiation curves for black bodies at three different temperatures.*



What does the curve labelled 'X' represent?

A. A black body with a temperature greater than 5000 K.

B. A black body with a temperature less than 3000 K

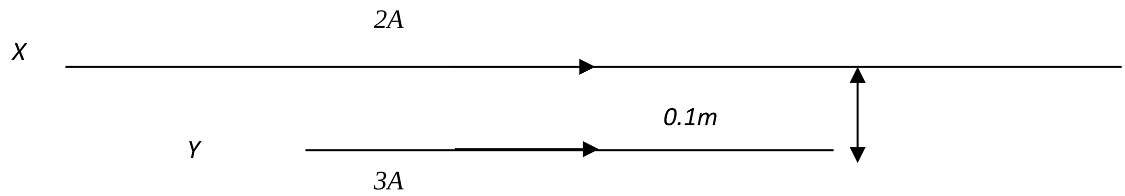
C. The result of a model for black body radiation first proposed by Planck.

D. The radiation curve for black bodies predicted by classical physics.

14. *A non-inertial frame of reference is one that is:*

A. stationary.
B. accelerating.
C. non-accelerating (either stationary or moving with constant velocity).
D. in motion (either accelerating or moving with constant velocity).

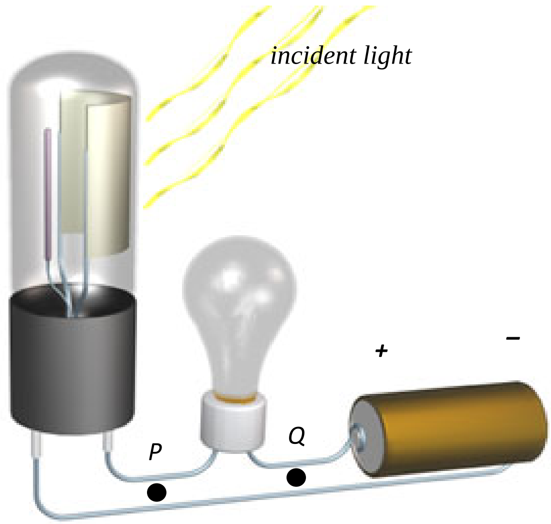
15. *Two long parallel wires X and Y carry currents of 2A and 3A respectively in the same direction as shown in the diagram below.*



Wire X is 3.0m long and is twice the length of wire Y. Their separation is 0.1m.
The force between wires X and Y is:

A. 1.8×10^{-5} N repulsion
B. 1.8×10^{-5} N attraction
C. 3.6×10^{-5} N repulsion
D. 3.6×10^{-5} N attraction

Light falling on the curved metal surface of the photocell produces a potential difference that opposes the voltage of the battery so that no electricity flows through the light bulb.

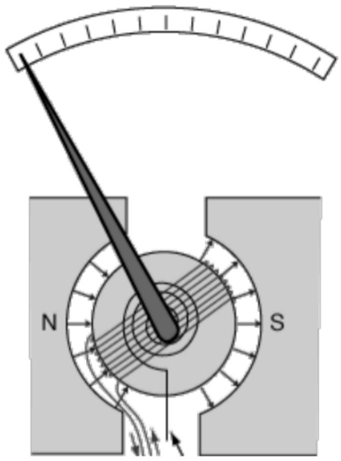
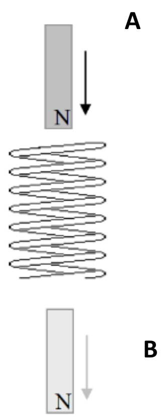


What changes to the incident light would produce a small flow of electrons through the light bulb from P to Q?

A. A small decrease in intensity of the incident light.
B. A small increase in intensity of the incident light.
C. A small decrease in frequency of the incident light.
D. A small increase in frequency of the incident light.

17. *A 5kg communications device is placed inside a spacecraft before it leaves Earth. What is the mass of the device when the spacecraft is travelling at 0.8c.*

A. 3kg
B. 5 kg
C. 8.3 kg
D. 4.5×10^{17} kg

18.	*A diagram of a galvanometer appears below.*  *The working principle of such a meter is:* *A. The magnets become stronger as current moves through the coils.* *B. The greater the current, the faster the needle rotates,* *C. The radial magnets provide a varying force on the current carrying conductor.* *D. A greater torque is produced as the current in the coil increases.*	
19.	*Which alternative describes the function of a split ring commutator in a DC motor?* *A. To ensure that the direction of the current in the coil relative to the magnetic field is constant so that continuous rotation can occur.* *B. To ensure that the direction of the current in the coil relative to the magnetic field is constantly changed so that continuous rotation can occur.* *C. To ensure that the direction of the current in the coil changes every 90˚ so that continuous rotation can occur.* *To ensure that the direction of the current in the coil remains constant so that continuous rotation can occur.*	
20.	*A bar magnet is dropped through a vertical solenoid, as shown below.* *What pole/s would be induced <u>at the top</u> of the solenoid as the magnet goes from position A to position B?*  *A. North the whole time* *B. South the Whole time* *C. North then South* *D. South then North*	

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

PART B: Longer Answers (80 marks)

21. *The motion of a simple pendulum has been studied for hundreds of years. In the 1600s Galileo observed a lamp swinging from the ceiling of the Pisa Cathedral and was able to time this pendulum motion using his pulse rate.*
Newton later knew that for any swinging mass (m) the period of this motion (T) was affected by the length of string (l) and the value of acceleration due to gravity (g) as described by the following equation:

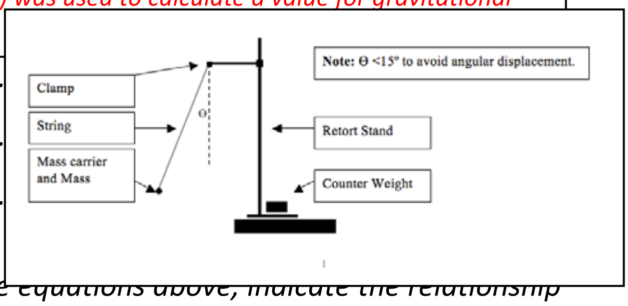
$$T = 2\pi\sqrt{\frac{l}{g}}$$

a. During your course, you performed an investigation to determine a value for acceleration due to gravity using pendulum motion. Outline how you conducted this investigation. **5**

1 marks: Numbered, Logical steps
1 mark: Change of length clearly specified
1 mark: Identifies control variables (angle and mass kept the constant)
1 mark: Use of Pendulum equation to calculate 'g'
1 mark: appropriate diagram

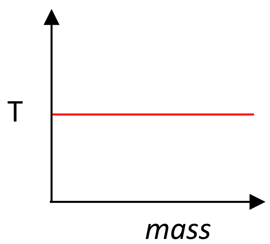
Sample answer:

1. *A clamp was attached to a retort stand and the retort stand was placed on the edge of a table/desk.*
2. *A piece of string was attached to a mass (50 g) and attached to the clamp so that it had a hanging length of 20cm from the clamp to the centre of the mass. (See diagram).*
3. *Using a protractor, the mass was pulled to create an angle of 15 degrees between the string and the vertical.*
4. *Using a stop watch, the time to complete 5 oscillations was recorded. This was repeated 3 times and an average was calculated.*
5. *Steps 1-4 were repeated for lengths of 40, 60, 80 and 100cm*
6. *Newton's equation for pendulum motion (above) was used to calculate a value for gravitational acceleration.*

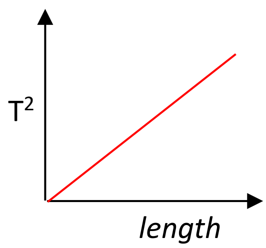


b. Using the results from your experiment, and the equations above, indicate the relationship between the quantities on the graphs below. **2**

(i)



(ii)



i) 1 mark: straight horizontal line
ii) 1 mark: positive directly proportional linear relationship

22. a. *A spacecraft is 80m long, as measured by an astronaut on board. The spacecraft appears to be 64m long, when measured by a scientist working on a base on the Moon. Calculate the speed of the spacecraft relative to the moon.* **2**

2 marks: correct answer
1 mark: Correct substitution, incorrect answer.

Sample answer:
0.6c or 1.8×10^8 m/s

b. *Discuss the impact of relativistic mass changes on our ability to make very large distance space-exploration journeys at near light speed.* **2**

2 marks: Demonstrates understanding of mass dilation (mass increase) and links mass increase to fuel problems
1 mark: Identifies increased mass OR fuel problem

Sample answer:
To increase speed to near light speed, fuel has to be used to provide the forces needed. As the speed of the spacecraft increases, so does the mass of the craft itself and the fuel carried and therefore more and more fuel is needed to maintain the same acceleration. Eventually, the fuel need will approach a volume so large, that it renders the ability to even start the journey impossible.

23. *A 200kg satellite is orbiting Earth with an altitude of 800km.*

a. *Calculate the gravitational force between the satellite and Earth.* **2**

2 marks: Correct answer& direction given
1 mark: Correct substitution, no direction given.

1.56×10^3 N, towards the centre of the Earth

$$F = G\frac{m_1 m_2}{d^2}$$
$$= 6.67 \times 10^{-11} \frac{6.0 \times 10^{24} \times 200}{((6370 + 800) \times 10^3)^2}$$
$$= 1556.9N$$
$$= 1.56 \times 10^3 N$$
(towards centre of Earth)

b. *Determine the orbital speed of this satellite.* **2**

2 marks: Correct answer
1 mark correct substitution (calc error)

$V = 7471 m.s^{-1}$

$$F = \frac{mv^2}{r}$$
$$v^2 = \frac{Fr}{m}$$
$$= \frac{1.56 \times 10^3 \times (6370 + 800) \times 10^3}{200}$$
$$v = 7471\ ms^{-1}$$
$$= 7.5 kms^{-1}$$

c. *Compare the speed of a 500kg satellite in identical orbit.* **1**

The speed of both satellites should be equal in identical orbit

24. *Discuss how the principle of conservation of momentum and Newton's second law is utilised by rocket designers to place a satellite in orbit.* **4**

4 marks: Clearly and correctly states the two named physical principles (eg. Conservation of momentum & Newtons's second law) and explains their relevance in rocket design
3 marks: Gives a mostly correct statement of both principles and how they apply (some information missing)
2 marks: Gives a correct statement or both principles or a correct statement and explanation involving one principle
1 mark: Provides a correct statement of the conservation of momentum or Newton's second Law.
Sample answer:
Rocket engines produce their thrust forces by burning fuel and expelling the gases produced. The principle of conservation of momentum ((total) momentum before ignition = (total) momentum after ignition) ensures that the rocket is propelled in the opposite direction to that of the exhaust gases. When the fuel is burnt by the engines, the total mass of the rocket is decreased. From Newton's second law F=ma, the acceleration is inversely proportional to the mass (m∝1/a). This means that, given a constant thrust force, the acceleration of the rocket will increase as fuel is consumed (decreased mass) , thus achieving the required velocity to maintain a stable orbit (approx. 8.2km.s^{-1})

25. *During recess Mrs Wynne was forced to listen to copious amounts of Mr. Cantor's terrible jokes. Upon arriving to her year 12 Chemistry class she realised that his jokes had, in fact, made her quite nauseous. As she began to outline the lesson objectives, she realised she needed to vomit and speedily make her way to the door. Mrs Wynne walked at a brisk 5km/hr with the centre of the bin placed 30cm below her mouth and extended 20cm in front of her mouth. Unable to make it out of the room, but still walking, she projectile vomited into the centre of the bin.*

Calculate the horizontal velocity of Mrs Wynne's vomitus. You must show all working. **3**

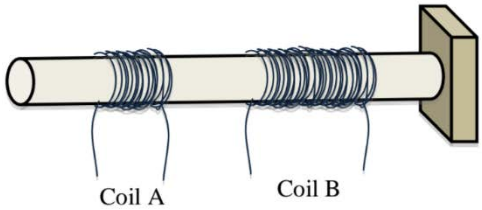
1 mark: Calculates time
1 mark: Calculates x velocity (fails to allow for walk speed)
OR
2 marks Calculates x velocity (allows for walk speed)

Sample answer:
Δy = ½ ut + ½ at^2
0.3 = 0 + ½ x 9.8 x t^2
t^2 = 0.061s
t = 0.25s

Δx = ut
0.2 = u x 0.25
u = 0.2/0.25
u = 0.8m. s^{-1}

Relative to observers:
X velocity = u + 5km/hr
0.8 + (5000/3600) = 2.19 m.s^{-1}

26.	*A student builds a model using insulated wire along a steel bolt. Coil A is a coil of wire wound tightly around one end of the bolt. Coil B is another coil a little further down, with more turns of wire wound tightly around the steel bolt. The ends of coil A are connected to a 24 Volt, 50 Hz AC source. Coil B is attached to a multimeter.*	



a. Identify the device studied in the Motors and Generators Module that this model represents. **1**

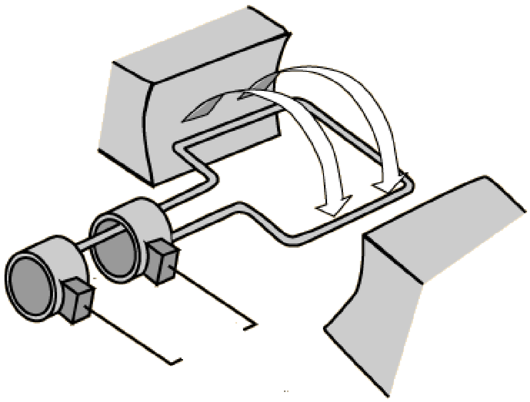
Transformer

b. Describe one way of increasing the voltage across coil B by changing a structural variable in the above set-up, and justify your reasoning. **3**

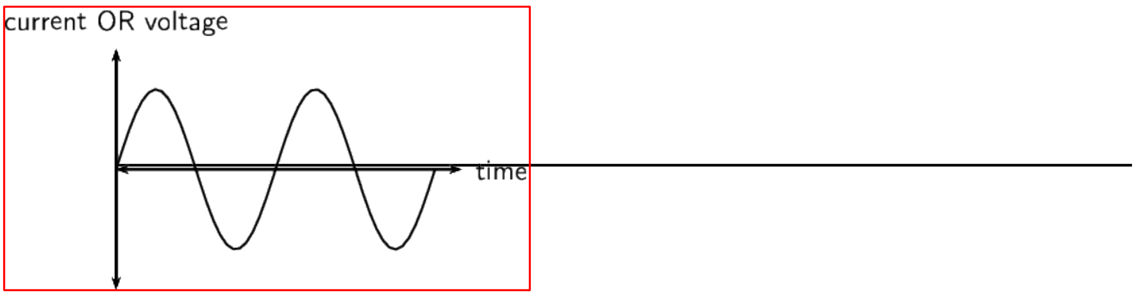
3 marks: Stating the dependence of voltage on ratio of turns, identifies a correct change and uses equation to support the answer. Or moving coil location.
2 marks: Makes two of any of the above points
1 mark: one of any of the above points.
Sample answer:
The ratio of voltages in coils A and B depends upon the ratio of their turns as per the equation: Vp/Vs = np/ns. Therefore, the voltage in the secondary coil could be increased by removing turns from coil A.

3

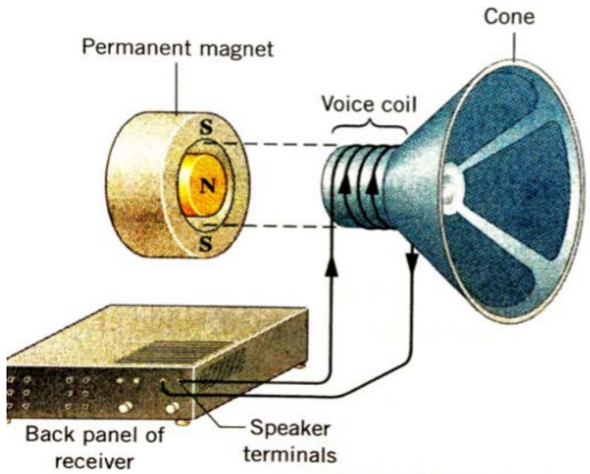
27. *This diagram shows a simple type of motor composed of a single 2 cm long square loop rotating in a magnetic field.* **1**



(a) Use the axes below to sketch a current-time graph for the power supply required to operate this type of motor.



28. *The voice coil of a speaker has a diameter d = 0.025m, 55 turns of wire and is placed in a 0.10 T magnetic field. The current in the voice coil is 2.0A.*



a. Calculate the magnetic force that acts on the coil and cone. **2**

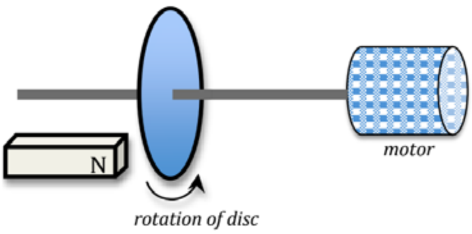
....

2 marks: Correct answer
1 mark: Correct substitution (incorrect answer)
Sample answer
$F = ILB \sin \vartheta$
$F = (0.2)\ (55\pi(0.025)(0.10)\sin 90^{o}$
0.86N

b. ... . Calculate their acceleration. **2**

2 marks: Correct answer with units
1 mark: Correct substitution (incorrect answer)/ no units
Sample answer
$a = F/m$
0.86/0.020kg
$= 43\ m.s^{-2}$

29. *An aluminium disc, attached to the axle of an electric motor, is initially spinning with a constant angular speed. A magnet is brought near the spinning disc, as shown.*



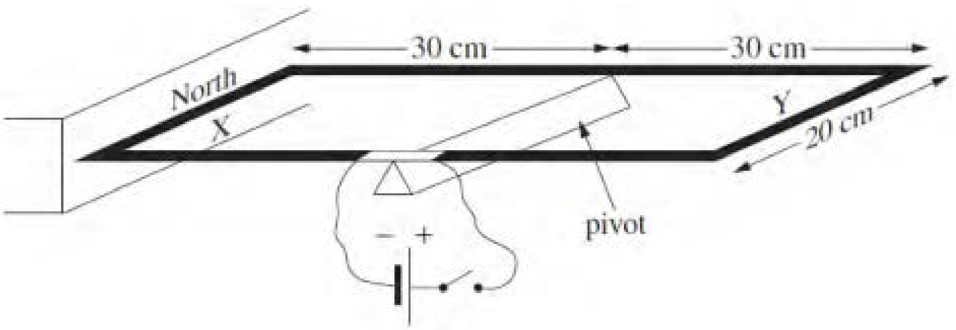
a. Explain the effect of the motion of the disc as the magnet is brought near.

marks	criteria
3	Explains the slowing of disc in terms of lenz's law. Must relate induced currents to change of flux. (must be written in a logical sequence of cause and effect)
2	Identifies creation of eddy currents and relate slowing to lenz's law
1	Identifies a relevant feature

Note: Lots of students used all the right terms but the sequencing of their answer was not logical therefore didn't get full marks

Sample answer: As the magnet is brought near the spinning disc the disc experiences a change in flux. This change in flux will induce eddy currents in the disc. According to Lenz's law the magnetic field associated with these currents will be such that it will interact with the permanent magnet to oppose the change and therefore slow the disc.

30. *A rectangular wire loop is connected to a DC power supply. Side X of the loop is placed next to the magnet. The loop is free to rotate about a pivot. When the power is switched on, a current of 20A is supplied to the loop. To prevent rotation, a mass of 40g can be attached to either side X or Y of the loop.*



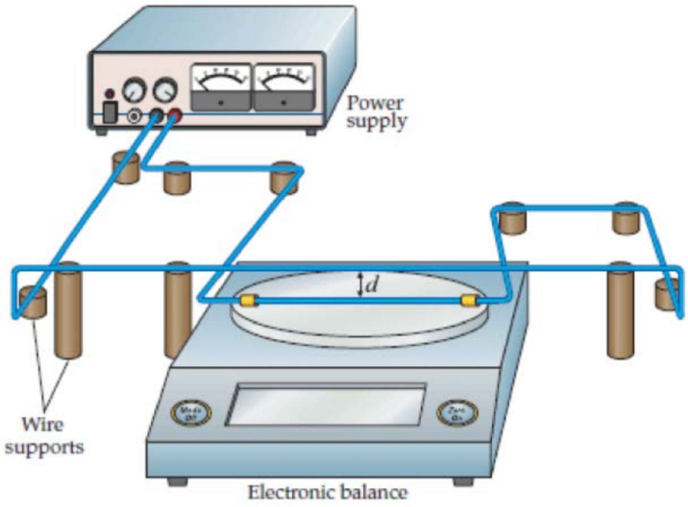
a. On which side of the loop should a mass be placed to prevent rotation? **1**

.... Side x ....

b. Calculate the tourque provided by the 40g mass. **2**

1 mark: Correct substitution/ correct answer without units.
1 mark: correct answer with units
Sample answer
$T = Fd = mgh$
$T = 0.04 \times 9.8 \times 0.3 = 1.176 \times 10^{-1}$ Nm

31. *A investigation was conducted to examine the force between two current carrying wires. The following equipment was set up using an electronic balance to determine the force between the wires.*



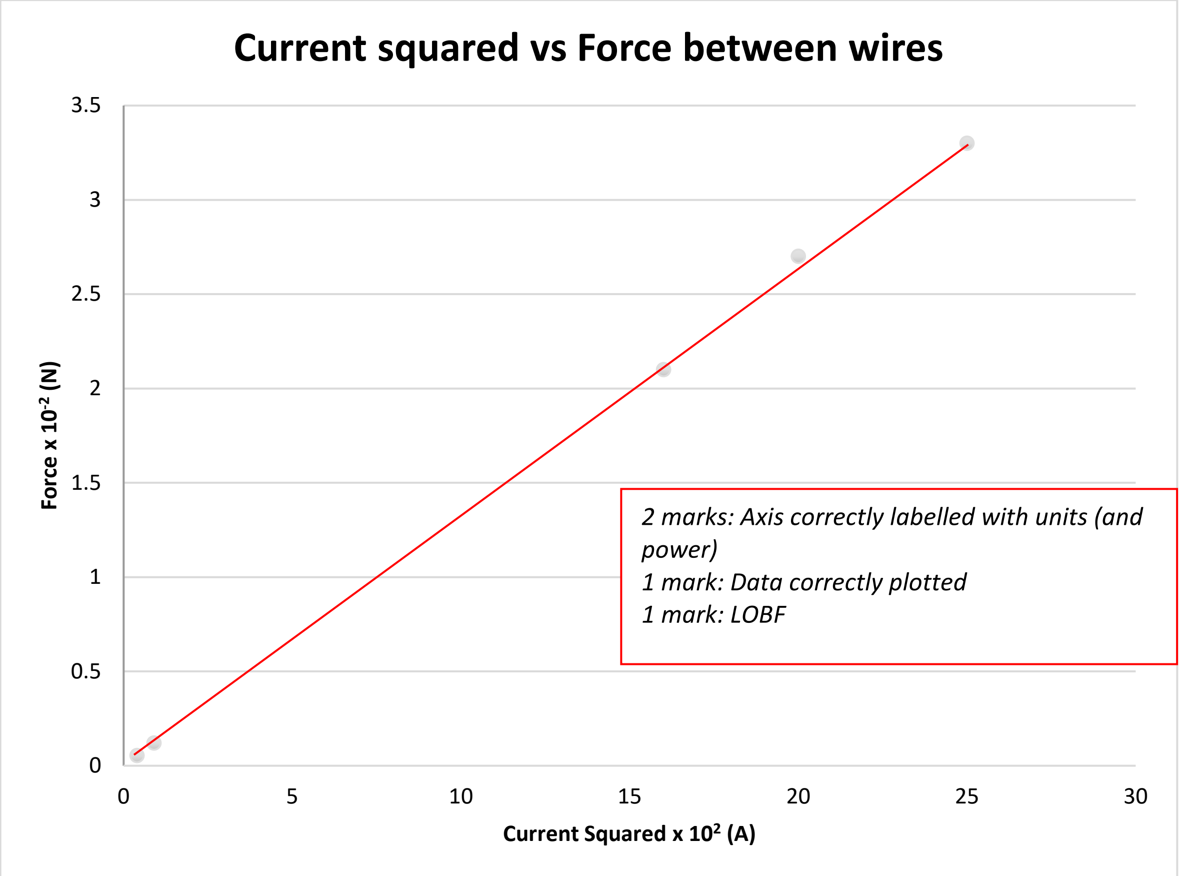
The electronic balance was zeroed before the current was switched on so that the reading was directly measuring the force between the wires. The effective length over which the wires interact was measured to be 0.0975m.

Question continued next page

Below is the data collected during this experiment.

I (A)	Balance reading (g)	I^2 (A^2)	Force between wires (N)
20	0.55	4.0×10^2	5.4×10^{-3}
30	1.22	9.0×10^2	1.2×10^{-2}
40	2.18	1.6×10^3	2.1×10^{-2}
45	2.75	2.0×10^3	2.7×10^{-2}
50	3.40	2.5×10^3	3.3×10^{-2}

a. Use the data on the previous page to construct a graph of the force between the wires (y-axis) against the current squared (x-axis). **4**



2 marks: Axis correctly labelled with units (and power)
1 mark: Data correctly plotted
1 mark: LOBF

b. Using the calculated gradient of your line above, in addition to other relevant formulae to determine the separation, d, of the wires. **3**

1 mark: calculation of gradient
1 mark: correct use of formula
1 mark: correct answer

- *Note- Maximim of 2 marks if gradient not used (from graph)*

Sample answer:

$\frac{F}{l} = K\frac{I_1 I_2}{s}$

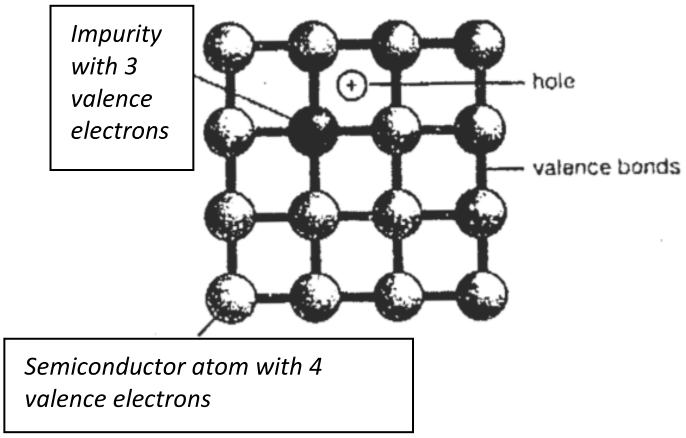
$F/I_1I_2 = kl/d$

Gradient = $kl/d = (2 \times 10^{-7} \times 0.0975)/d = 0.027/2100$

$= 1.51 \times 10^{-3}$

(note: this will depend on gradient)

32. *Consider the diagram below of a doped semiconductor.*



a. Identify whether the diagram represents an n-type or p-type semiconductor. **1**

.. *p-type semiconductor* ....

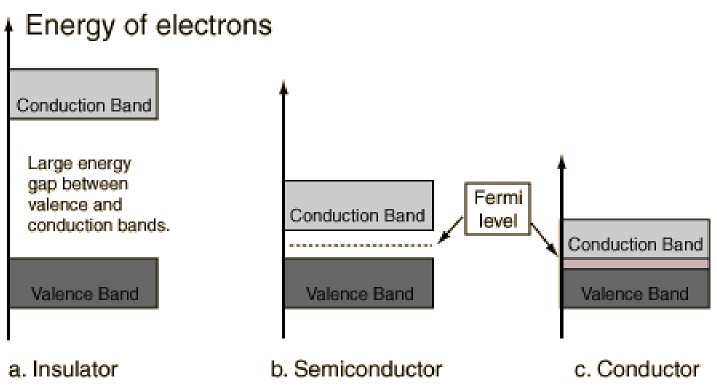
b. Explain how doping with an impurity containing three valence electrons results in improved conduction. **4**

marks	criteria
4	Explains how conductivity is increased by the creation and movement of holes. (must discuss energy and applied field)
3	Describes creation of holes due to electron deficiency and identifies that less energy is required for movement of electrons
2	Identifies creation of holes and one other relevant feature
1	Identifies a relevant feature

Notes; Students confused about charge of doped semiconductors. Despite having one less electron the doped semiconductor is still neutral overall.

Sample answer: A group 3 element has 1 less electron therefore creating a hole in the valence band. As a result only a small amount of energy is required to promote the movement of an electron into the hole. When a potential difference is applied electron migrate from negative to positive to fill the holes while the holes migrate toward the negative thus increasing

33. *With specific reference to the diagram below, discuss* ***two*** *limitations of models in Science.* **4**



....

2 marks per limitation and link- total 4 marks (see below)
1 mark for identifying limitation of the model
1 mark for specific link to conduction band model with appropriate physics reference.

Sample answer:
The model does not model dynamic processes: For example, in metals/conductors, there is a constant movement of electrons between conduction and valence band
Over simplification/ incorrect- does not model electrons moving back into valence band following a decrease in energy /temperature

34.	*Evaluate the role of experiments that were conducted to determine the nature of cathode rays in the late nineteenth century.*	6

Outlines *early experiments with cathode ray tubes to investigate the properties of cathode rays and* ***links*** *the experiment to apparent properties of cathode rays.*

- *Maltese cross (CR straight lines/ shadows) wave/particle nature*
- *Paddle Wheel (momentum): Evidence of particle nature*
- *Deflected magnetic fields (-ve charge) Evidence of Particle nature*
- *Not deflected by electric fields (form of EM radiation) (incorrectly by Hertz)- evidence of wave nature*

(2 marks – at least 3 experiments must be outlined and nature of CR relative to results of experiment stated))

Outlines *apparent contradictory properties of cathode rays/ nature of the debate (1 mark)*

- *CR's exhibited both properties of particles and waves*

Describes *the measurement of electron mass by Thompson and recognises that this experiment – credited as discovering the electron- is key to resolving the debate over the nature of CR.*
(2 marks)

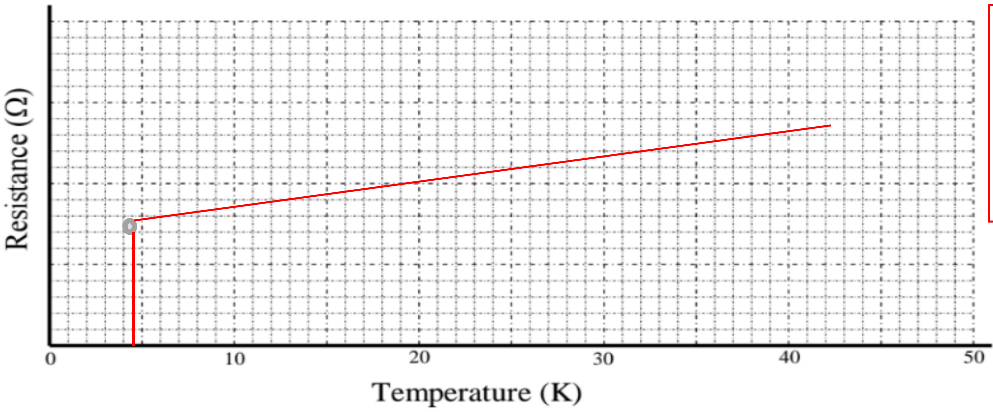
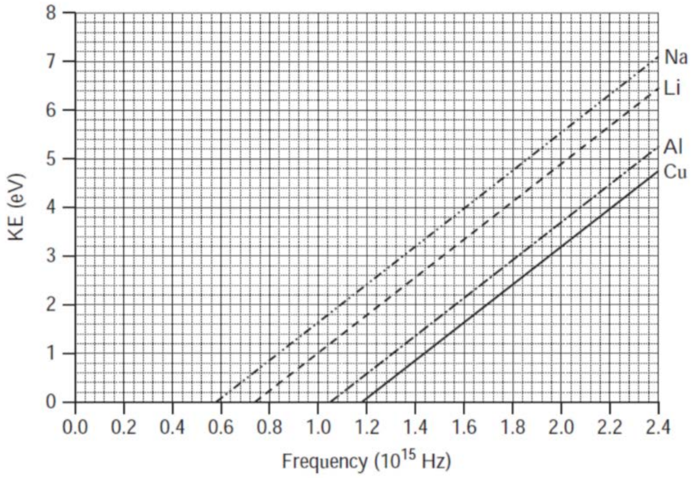
JJ Thompson's experiments, where he fired a beam of electrons at anode collimators, was extremely signifigant. He was able to determine that CR's were negatively charged, and was able to determine that they have mass. (It allowed the mass of electrons to be calculated). Therefore, this experiment was key to resolving the debate between CR's being waves or particles.

Provides a judgement *– recognising the key role of experiments in the determination of the nature of CR.*
(1 mark)

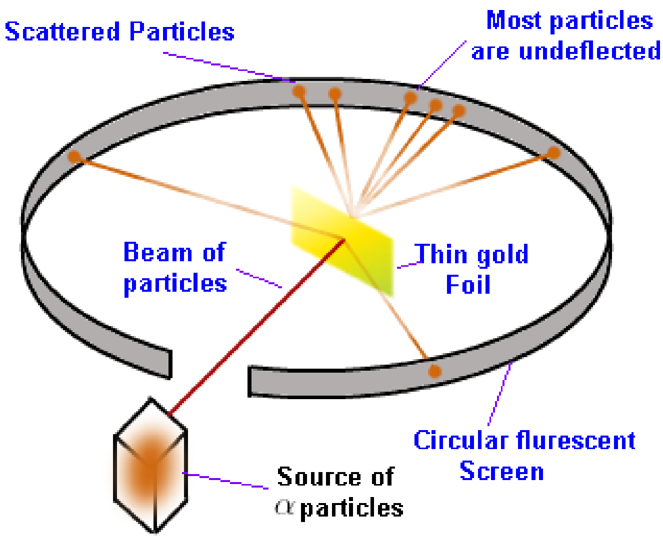
The experiments performed in the late nineteenth century were fundamental in determining the nature of cathode rays.

Note:

- *Many failed to mention JJ Thompson (and did not identify neg charge of electron)*
- *Many students did not link the results of the experiment to the wave/particle debate*
-

35.	*In 1908 Dutch Sceintist Heike Onnes discovered a phenomenon called superconductivity, and found that the element mercury has a critical temperature of 4.15 Kelvin.* *a. On the graph paper below, sketch the resistance of mercury as temperature decreases*  *(Line should be curved; however, mark is awarded for vertical drop-Must have vertical line at 4.15 Kelvin)*	**1**
36.	*Heinrich Hertz performed an experiment where he measured the speed of radio waves using the principle of interference of waves produced by a reflection from a metal plate. Outline the significance of the result of this experiment.* *1 mark per reason for significance (total of 2 marks)* *Sample answer:* *Hertz's results were very significant at the time of his experiment:* • *He was able to determine the speed of EMR* • *He concluded that all EMR was travelling at the same speed as light* • *Verified Maxwell's earlier predictions* • *His results (reflection, refraction etc) supported the wave model of light.*	**2**
37.	*The graph below shows the kinetic energy (KE) of photoelectrons emitted from a range of metals for different incident frequencies*  *Identify which metal requires the least amount of energy to stimulate photocurrent. Justify your answer.* *1 mark: Na* *1 mark: Justification* *Sample answer:* *Na has the lowest threshold frequency, since E is proportional to f, this corresponds to the lowest energy.*	**2**

38.	*Explain how the photoelectric effect provides evidence for both the quantisation of the energy carried by electromagnetic radiation and its particle nature.* *2 marks: Outlines PE, and clearly explains implications of Threshold frequency* *1 marks: provides some explanation of the importance of the threshold frequency* *Sample answer: In the photoelectric effect, photoelectrons will be emitted from its surface when light above the threshold frequency of an emitter is incident of the emitter. The threshold frequency is important, the fact that a minimum frequency is required for photoemission, indicates that photons must be discrete particles containing specific energy amounts (quantised amounts of energy). If this was not the case and photons had a wave nature, then emission would occur at energy frequency and there would be a continuous build-up of absorbed energy.*	**2**
39.	***From Quanta to Quarks (13 marks)*** *In 1909, Rutherford, Geiger and Marsden conducted the now famous alpha particle scattering experiment using apparatus like that shown below:*	



a. Rutherford made changes to the pre-existing model of the atom because of these experiments. Identify TWO changes and the evidence on which they were based. **4**

4 marks: 2 changes to the model, with evidence
3 marks: One change to model with evidence and one other change
2 marks: One change to model with evidence or two changes
1 mark: Provides one change to the model of the atom.

Sample answer:

- *Atom mostly empty space with a very small nucleus*
  - *Evidence: Most alpha particles were able to penetrate gold foil without deflection*
- *Nucleus was positively charged*
  - *Evidence: Repulsive deflection of alpha particles (which are positive)*

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b. Explain why Rutherford's model was criticised at the time. **2**

2 marks: Identification of issue + explanation (total of 2 marks)
1 mark for identification (only) of two issues

Sample answer

- *Failed to explain how the negative electrons could stay away from the positive nucleus without collapsing into it. The only way for electrons to overcome attractive force of nucleus, was to orbit the nucleus, this meant that they were constantly experiencing centripetal acceleration, and thus radiating EMR (and would lose kinetic energy and spiral back to nucleus)*
- *Could not explain composition of the nucleus as the existence of protons and neutrons were not known at the time.*

40. *Explain how energy is conserved when an electron makes a transition from on stationary state to another in an atom.* **3**

1 mark: States that energy difference in initial and final state is proportional to absorbed photons.
1 mark: States that absorbed photon energy results in excited electron & electron releases energy in the form of photons when it relaxes.
1 mark: Uses equations to support answer.

When an atom absorbs a photon of light, the energy of the photo is added to the energy of the atom. Energy is conserved because the difference in energy between the initial and final state of the electron is equal to the photon energy. When an excited electron in the atom relaxes to a less excited state, energy is conserved because a photon is released with an energy that is equal to the energy difference between the states. This is equal to planks constant multiplied by the frequency of the EMR emitted; $\Delta E = E_i - E_f = hf$.

41. *a. Calculate the wavelength of the H_β spectral line for hydrogen, given that H_β light is associated with an electron transition from the n = 4 state to the n = 2 state in a hydrogen atom.* **2**

2 Marks: correct answer
1 mark correct substitution: / calc error

$1/\lambda = 1.097 \times 10^{7} (1/2^2 - 1/4^2)$
$\lambda = 4.86 \times 10^{-7}$ m

b. Calculate the amount of energy carried by one Photon of the H_β spectral line. **2**

2 Marks: correct answer
1 mark: Correctly calculates frequency

$c = f\lambda$
$f = c/\lambda = 3 \times 10^{8}\ ms^{-1} / 4.86 \times 10^{-7}\ m = 6.17 \times 10^{14}$ Hz
$E = hf = 6.626 \times 10^{-34}\ Js \times 6.17 \times 10^{14}\ Hz = 4.09 \times 10^{-19}$ J