ST. MARY'S DSG KLOOF

PHYSICAL SCIENCES

TRIALS PAPER 1: PHYSICS

GRADE 12 **TIME: 3 hours**

AUGUST 2015 **MARKS: 200**

Examiner: Mrs T. Kirsten

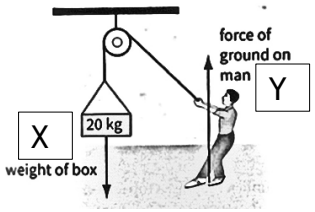
Moderator: Mrs K. Bolton

Read the Following Instructions Carefully:

1. This paper consists of:
   A question paper of 15 pages
   Answer sheet
   Data sheet
2. Read the questions carefully.
3. Answer **ALL** questions.
4. Number your answers exactly as the questions are numbered.
5. Write legibly and present your work neatly.
6. All working should be shown and units MUST be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode**.
7. Consult the data sheet where necessary.
8. Answers are to be collated in two separate parts:
   1. **Question 1 - 5.2 (including answer sheet)**
   2. **Question 5.3 - 9**

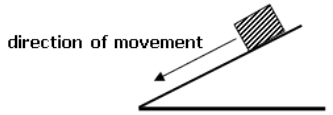
QUESTION 1 – MULTIPLE CHOICE

1.1 The diagram alongside shows a man who is supporting the weight of a box. Two of the forces acting, X and Y, are shown in the diagram. Newton's Third Law deals with action-reaction pairs. The reaction forces for forces X and Y respectively are:



	X	Y
A	Box on earth	Weight of man
B	Box on earth	Man on ground
C	Ground on box	Man on ground
D	Ground on box	Weight of man

1.2 A body slides down a frictionless inclined plane. Which one of the following physical quantities will remain constant throughout the motion?

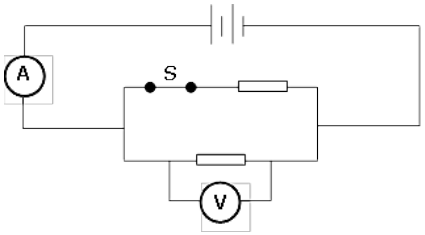


A velocity
B momentum
C acceleration
D kinetic energy

1.3 As an aircraft accelerates on a runway in preparation for take-off, passengers are required to wear seatbelts. Which of the following statements is correct regarding the take-off?

A Inertia causes the passenger to carry on moving in a forwards direction.
B The seat will exert a forward resultant force on the passenger.
C The seatbelt and the seat exert equal forces on the passenger.
D The passenger maintains a rest position due to inertia but the seatbelt exerts a backwards resultant force.

1.4 In the circuit, switch S is closed, and the internal resistance of the cells is negligible. How will the ammeter and voltmeter readings change if switch S is opened?



	Ammeter reading	Voltmeter reading
A	Increase	Increase
B	Increase	No change
C	Decrease	Decrease
D	Decrease	No change

1.5 The force of repulsion between two positive conducting spheres with charges of 2Q and 6Q separated by a distance, *r*, is ***F***. The spheres are momentarily touched and then separated to a distance of 2*r*. What will the new force between the charges be?

A $\frac{1}{3}F$

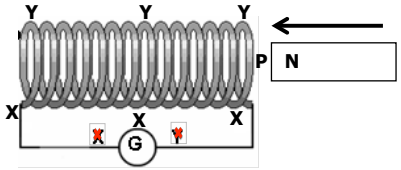
B F

C $\frac{4}{3}F$

D $\frac{1}{4}F$

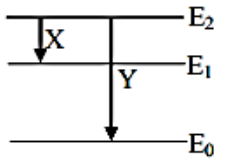
1.6 A girl enters a lift on the ground floor of a building and after travelling non-stop, gets out on the tenth floor. Which one of the following free-body diagrams is the best representation of the magnitude and direction of the forces acting on the girl just before the lift stops on the tenth floor?

1.7 The North pole of a magnet is pushed into a coil of wire connected to a galvanometer as shown in the diagram below. Which one of the following correctly gives the polarity of the solenoid at point P and the direction of the conventional current through the front side of the coil?



	Polarity of solenoid at P	Direction of current
A	South	Y to X
B	South	X to Y
C	North	X to Y
D	North	Y to X

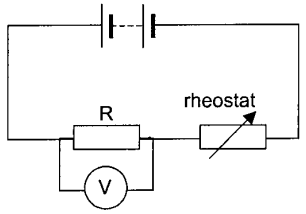
1.8 The diagram represents transitions of electrons in the energy levels in a certain atom.



Which one of the following statements is true concerning the emission of photons associated with transitions X and Y? The photon associated with X has a greater …

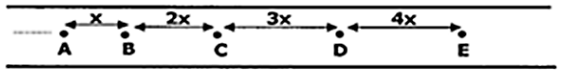
A frequency than the photon associated with Y.
B wavelength than the photon associated with Y.
C energy than the photon associated with Y.
D intensity than the photon associated with Y.

1.9 In the circuit represented by the diagram alongside, the resistance of resistor R is independent of temperature and the battery has negligible internal resistance. When the voltmeter reading is V, the power dissipated in resistor R is P. The rheostat is adjusted such that the reading on the voltmeter becomes 2V. The power dissipated in resistor R, will then be equal to:



A $\frac{1}{4}$P.
B P.
C 2P.
D 4P.

1.10 The diagram below shows a portion of a length of ticker tape obtained in an experiment in which a trolley, with a ticker tape attached, was pulled along by a constant force. The time interval between the consecutive dots is t.



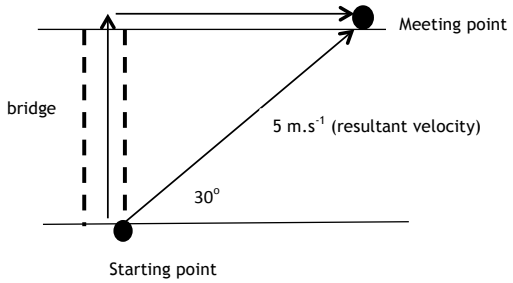
The magnitude of the acceleration of the trolley is

A x/t^2
B $2x/t^2$
C x^2/t
D $x/2t^2$

10 x 2 = [20]

QUESTION 2 – KINEMATICS (VECTORS)

Mrs Main tries to paddle in a canoe across a river from a point below a bridge, to a point directly across from her on the opposite bank. Meanwhile Miss Simpson runs across the bridge, and they agree to meet on the opposite bank. However, there is a strong current flowing in an Easterly direction, and Mrs Main finds that the *resultant velocity* of the canoe is 5 $m.s^{-1}$, at an angle of 30 ^{0} to the bank where she left from. Miss Simpson runs across the bridge, then parallel to the river on the opposite bank to meet Mrs Main downstream. She runs for 2 minutes to reach the meeting point. (diagram not to scale)



2.1. By means of a calculation determine the magnitude of

i) Mrs Main's initial velocity of her canoe. (i.e the velocity at which she paddled)
ii) the velocity of the current (5)

2.2. Define *distance*, and hence state which of the two teachers travelled the greater distance in reaching the meeting point downstream. (2)

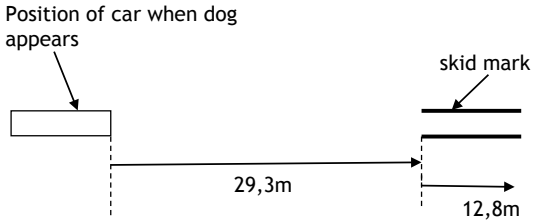
2.3 Define *displacement*, and hence state which of the two teachers had the greater displacement in reaching the meeting point downstream. (2)

2.4 If the bridge across the river is 60 m, and the meeting point on the opposite bank is 50 m from the bridge, calculate the magnitude of Miss Simpson's average velocity from the starting point to the meeting point. (4)

[13]

QUESTION 3 – KINEMATICS (MOTION)

3.1 A car is travelling along a straight road at speed *v* when a dog suddenly runs out in front of the car. In the time interval between the dog appearing and the car applying its brakes, the car moves forward a distance of 29,3 m.
Once the brakes are applied, bringing the car to rest, the front wheels of the car leave skid marks on the road that are 12,8 m long. During the skid, the magnitude of the acceleration of the car is 8 $m.s^{-2}$.

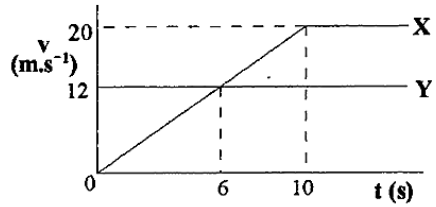


3.1.1 Calculate the speed, *v*, of the car before the brakes were applied. (4)

3.1.2 Calculate the reaction time of the driver of the car. (time between dog appearing and brakes being applied) (3)

3.1.3 **Sketch** (no x and y axis values necessary) the following graphs to represent the motion of the car from the moment that the dog is seen by the driver until it comes to rest :
a. velocity /time graph
b. acceleration/time graph (4)

3.2 The velocity-time graph below represents the motion of two cars, X and Y. Car X is stationary at a traffic light, and as it pulls off from rest, it is passed by car Y, which is moving at a constant velocity in the same direction.



3.2.1 How long does it take car X to reach the same speed as car Y? (1)

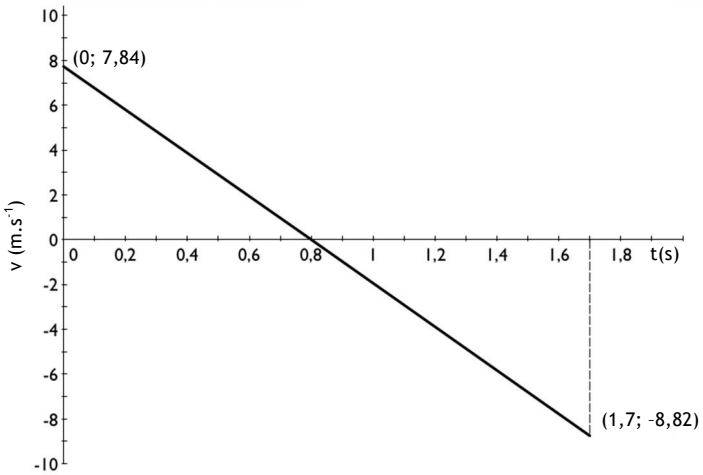
3.2.2 Which of the two cars is ahead after 10 s? Prove your answer by calculation. (4)

3.3 A gymnast is training by jumping on a trampoline.

3.3.1 What is the acceleration of the gymnast while she is in the air? (2)

3.3.2 While the gymnast is in contact with the trampoline mat, her acceleration is different to your answer in Question 3.3.1. Explain. (2)

Unfortunately the gymnast is still learning. She manages to bounce up, but she misses the trampoline on the way down. She leaves the trampoline mat with a velocity of 7,84 $m.s^{-1}$ up. The velocity-time graph for her **vertical motion** from the moment she leaves the mat to the moment she lands on the ground is given below. Up is the positive direction.



3.3.3 Use the graph to determine the height of the trampoline above the ground. (5)

3.3.4 Draw a graph of the gymnast's displacement against time on the axes provided on your answer sheet. Take displacement to be zero on the mat of the trampoline (frame of reference). (6)

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QUESTION 4 – NEWTON'S LAWS

4.1 A man pushes a 25 kg hand mower across thick lawn. He exerts a force of 200 N at 35° to the horizontal, causing the mower to move forward. The lawn provides a maximum friction of 100 N on the mower. (ignore any air resistance)

4.1.1 Draw a labelled free body diagram to show all the forces acting on the mower while it is being pushed. (5)

4.1.2 State *Newton's Second Law of Motion*. (3)

4.1.3 Calculate the magnitude of the acceleration with which the mower moves forward. (4)

4.1.4 As the grass-catcher at the back of the mower fills up, how will the man's applied force have to change in order to maintain the acceleration calculated in 4.1.3? EXPLAIN your answer (3)

4.2 Before mowing the lawn, the man wants to move a large flower pot of mass 100 kg from the lawn. It is too heavy to lift, so he ties a rope around the flower pot and pulls it **horizontally.** The coefficient of static friction between the flower pot and the lawn is 0,6. The man is not able to move the flower pot.

4.2.1 Calculate the magnitude of the maximum frictional force between the flower pot and the lawn. (4)

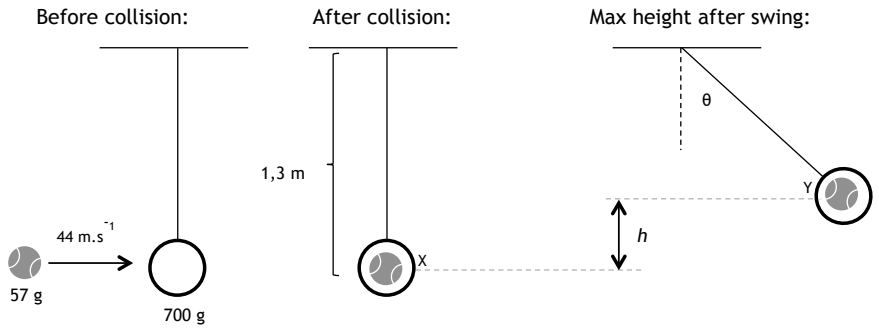
The man decides to pull on the rope so that the applied force makes an angle of 40° to the horizontal.

4.2.2 Why does pulling on the rope at an angle to the horizontal make it easier to move the flower pot? (2)

[21]

QUESTION 5 – MOMENTUM, ENERGY AND POWER

5.1 An experiment is conducted whereby a pupil hits a tennis ball, (mass 57 g), at an initial velocity of 44 m.s^{-1} horizontally at a ball of clay suspended by a string (of negligible mass). The length of the string to the centre of mass of the clay ball is 1,3 m.
The ball of clay has a mass of 700 g. When the tennis ball hits the clay at X, it becomes embedded in the clay. The combination of the clay and tennis ball rises a height, *h*, to point Y. Assume that air resistance is negligible.

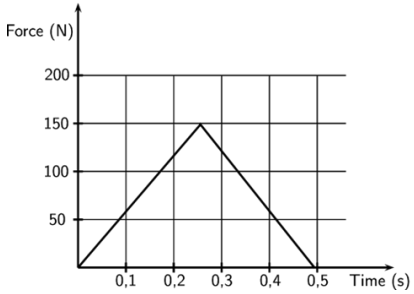


5.1.1 Prove by calculation that the speed of the tennis ball and clay at point X is 3,31 m.s^{-1}. (3)

5.1.2 Calculate the height, *h*, to which the tennis ball-clay combination rises at Y. (4)

5.1.3 Prove by calculation that the angle, θ, is approximately 55°. (3)

5.2 During a game of hockey, a player strikes a stationary ball of mass 150 g. The graph below shows how the force of the ball varies with time.



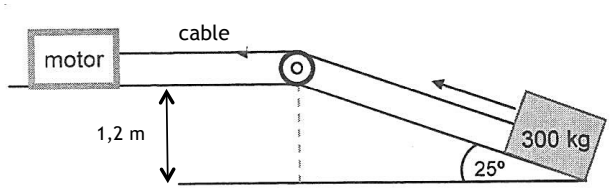
5.2.1 What does the area under the graph represent? (1)

5.2.2 Calculate the speed at which the ball leaves the hockey stick. (4)

5.2.3 The same player hits a practice ball of the same mass, but which is made from a softer material. The hit is such that the ball moves off with the same speed as before. How will the i) *height* and ii) *base* of the triangle that forms the graph compare with that of the original ball? (2)

START THIS QUESTION ON A NEW PAGE

5.3 A motor pulls a crate of mass 300 kg with a constant force up a slope inclined at 25° by means of a light cable running over a frictionless pulley as shown below. The crate moves up the incline at a constant speed of 0,5 m.s^{-1}. The gain in vertical height is 1,2 m.



5.3.1 Calculate the gain in gravitational potential energy of the crate when it moves from the bottom to the top of the slope. (3)

5.3.2 Calculate the magnitude of the force applied by the cable to the crate if the frictional force between the crate and the slope is a constant 100 N. (5)

5.3.3 Calculate the work done by the force calculated in 5.3.2. (4)

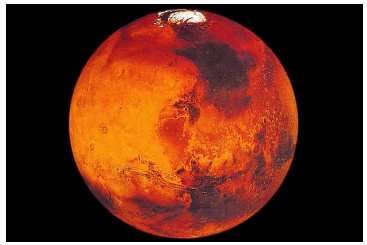
5.3.4 Explain why your answer to 5.3.3 is greater than your answer to 5.3.1 (2)

5.3.5 Calculate the output power of the motor. (3)

[34]

QUESTION 6 – FIELDS

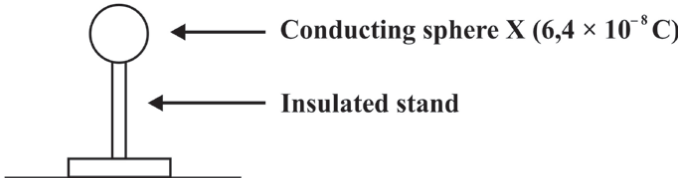
6.1 *Mars One* is an organisation based in the Netherlands that has put forward plans to land the first humans on Mars. They aim to establish a permanent human colony there by 2027, with no plan of returning to earth. Mars is an average distance of $2{,}25 \times 10^{8}$ km from Earth. The planet has a mass of $6{,}42 \times 10^{23}$ kg, and a radius of 3380 km.



6.1.1 Calculate the magnitude of the acceleration due to gravity on the surface of Mars. (4)

6.1.2 Calculate the magnitude of the weight of a 500 kg spaceship on Mars. (2)

6.2 The diagram shows a conducting sphere X carrying a charge of $6{,}4 \times 10^{-8}$ C. The sphere is at the top of an insulated stand.



6.2.1 Define *electric field strength*. (2)

6.2.2 Calculate the magnitude of the electric field strength at a point, Y, 20 mm above sphere X. (3)

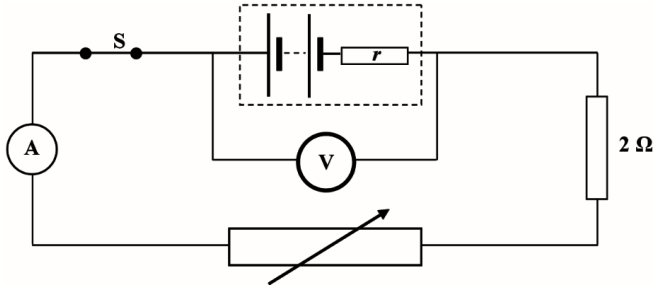
6.2.3 Another sphere, Z, carrying a charge of $-4{,}8 \times 10^{-8}$ C is held so that its centre is 60 mm vertically above the surface of sphere X. Calculate the magnitude of the resultant electric field strength at point Y. (4)

6.2.4 An electron is placed at point Y. Calculate the force experienced by the electron due to the resultant electric field. (4)

[19]

QUESTION 7 – ELECTRIC CIRCUITS

7.1 Two pupils conduct an experiment to determine how the potential difference across the terminals of a battery is affected by the size of the current through the battery. They set up the circuit shown below. They change the current through the battery by adjusting the resistance of the rheostat (variable resistor). They record the potential difference across the terminals of the battery as given by the reading on the voltmeter. The battery has significant internal resistance. The resistances of the wires and ammeter is negligible. The voltmeter has high resistance.



Results

Current (A)	Potential difference (V)
0,0	15,0
0,6	13,5
1,2	12,0
2,0	10,0
2,6	8,5
3,2	7,0

7.1.1 Define *emf*. (2)

7.1.2 What is the emf of the battery used in this experiment? (1)

7.1.3 What is the dependent variable in this experiment? (1)

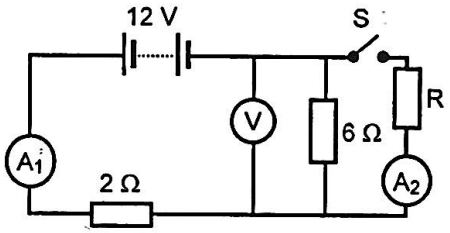
7.1.4 Is this a fair test? Explain. (2)

7.1.5 Determine the internal resistance of the battery. (4)

7.1.6 Explain why the potential difference across the battery decreases as the current through the battery increases. Make reference to one or more suitable formulae to support your answer. No calculations are required. (3)

7.1.7 Calculate the resistance of the rheostat when the current is 2,0 A. (4)

7.2 In the circuit diagram below the battery has negligible internal resistance.



With the switch, S OPEN, determine the reading on

7.2.1 ammeter A_1 (3)

7.2.2 voltmeter V (2)

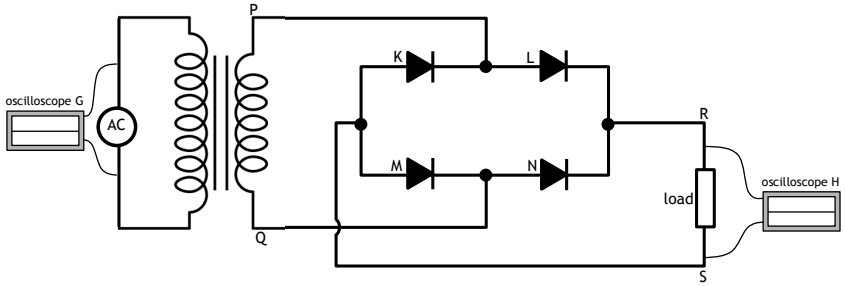
The switch S is now CLOSED, and the reading on the voltmeter V *decreases*.

7.2.3 If the reading on A_1 is three times that of A_2, what is the resistance of resistor R? (4)

[26]

QUESTION 8 – ELECTRODYNAMICS

8.1 The diagram below shows how a transformer and rectifier can be set up to convert 220 V using alternating current to 12 V with direct current. The primary coil of the transformer consists of 1000 turns and the current in the primary coil is 0,05 A.



8.1.1 Name the type of transformer that is shown in the diagram. (1)

8.1.2 Briefly explain why alternating current is required in transformers. (2)

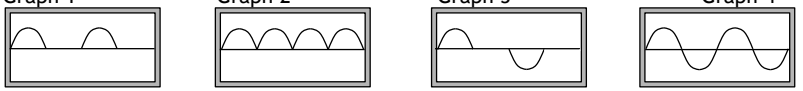
8.1.3 If the transformer is only 80% efficient, calculate the current induced in the secondary coil. (4)

8.1.4 What is a *diode*? (2)

8.1.5 Using the letters shown on the diagram, indicate the path taken by conventional current in the circuit when P is positive. Start with P. (2)

8.1.6 The four graphs below show possible read-outs of an oscilloscope.

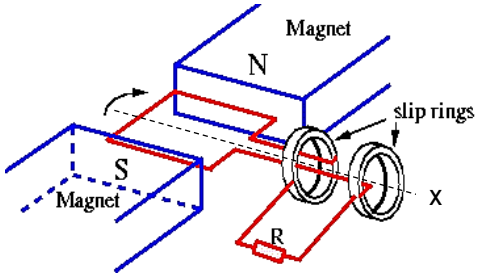
Graph 1 Graph 2 Graph 3 Graph 4



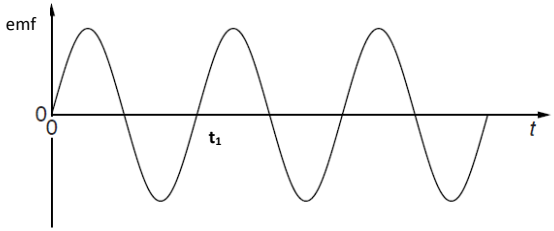
a. Give the number of the graph that would be observed on oscilloscope G's screen (1)

b. Give the number of the graph that would be observed on oscilloscope H's screen. (1)

8.2 Refer to the following diagram of an **AC generator**.



The coil is rotated in a clockwise direction when viewed from X. The frequency of rotation is 5 Hz. The emf produced is represented by the following graph:



8.2.1 For the time t_1 on the graph, is the coil vertical or horizontal? EXPLAIN your answer. (3)

8.2.2 Determine the value of the time t_1. (2)

8.2.3 If a **flux vs time** graph were drawn for this same generator over the same period of time, would you expect the flux value at time t_1 to be a maximum or a minimum? Explain your answer (3)

[21]

QUESTION 9 - PHOTONS AND ELECTRONS

The line emission spectrum for strontium is given below. There are several lines in the spectrum, and one of them has a wavelength of 461 nm.

9.1 Explain how spectral lines are produced in a spectrum such as this one. (3)
9.2. Calculate the frequency of the 461 nm light produced in the strontium spectrum. (3)

This light (i.e. wavelength 461 nm) from a strontium vapour lamp is shone onto sodium metal which has a work function of 2,46 eV.

9.3 Define *work function* of a metal. (2)
9.4 Calculate the kinetic energy of electrons released from the sodium metal. Give your answer in Joules. (4)
9.5 The intensity of this strontium lamp is now increased.
9.5.1 What is the effect of this change on the number of electrons emitted? (1)
9.5.2 Give a reason for your answer to 9.5.1. (2)

[15]