CWED/MNED COMMON PAPER

PHYSICAL SCIENCES - PAPER 1 **AUGUST 2019**

GRADE 12 **TIME: 3 HOURS**

EXAMINER: CW PLC **TOTAL: 150**
MODERATOR: JC NAUDE & Z MOERAT

INSTRUCTIONS AND INFORMATION

1. Write your name in the space below and submit the Examination Paper with your Answer Book.

   GRADE: ……

   NAME: ……..

2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper
4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions etc where required.

QUESTION 1 (Multiple-choice)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) on your ANSWER BOOK.

1.1 A horizontal force F is applied to a crate, causing it to move over a rough, horizontal surface as shown below.

The kinetic frictional force between the crate and the surface on which it is moving depends on ...

A the applied force F.

B the surface area of the crate in contact with the floor.

C how fast the crate moves on the surface.

D the upward force exerted by the surface on the crate. (2)

1.2 The weight of a man on the surface of the Earth is w. Planet X has the same radius as the Earth, but half the mass of the Earth.

If the same man goes to Planet X, his weight on the surface will be ...

A ¼ w

B ½ w

C w

D 2 w (2)

1.3 An object falls freely in a vacuum near the surface of the Earth.

Which ONE of the following statements regarding the motion of the object is CORRECT?

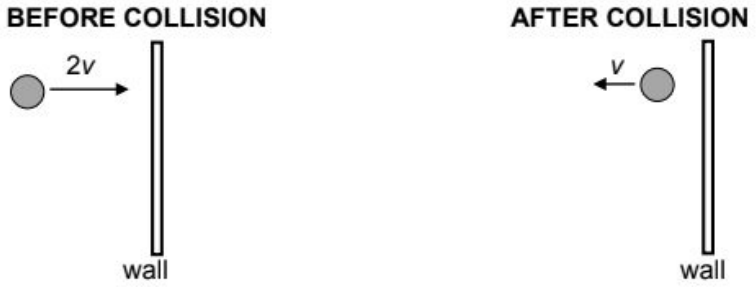
A The velocity of the object will remain constant.

B The velocity of the object will decrease uniformly.

C The rate of change of velocity of the object will increase uniformly.

D The rate of change of velocity of the object will remain constant. (2)

1.4 A ball, moving horizontally, hits a wall with a speed 2v. The ball then bounces back horizontally with a speed v, as shown in the diagram below.

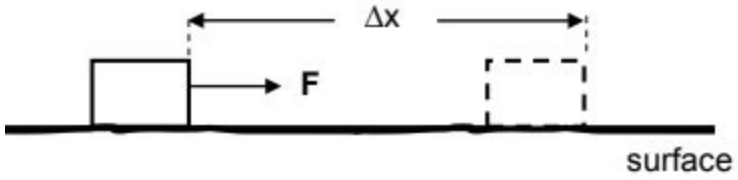


Which ONE of the following combinations regarding the linear momentum and the total kinetic energy of the ball for the collision above is CORRECT? Assume that the ball-wall system is isolated.

	LINEAR MOMENTUM	TOTAL KINETIC ENERGY
A	Conserved	Not conserved
B	Conserved	Conserved
C	Not conserved	Not conserved
D	Not conserved	Conserved

(2)

1.5 A constant horizontal force F displaces a box by Δx over a rough horizontal surface. Study the diagram below.



The normal force acting on the box does NO work on the box during the motion, because it is ...

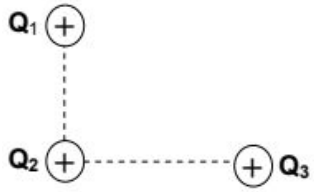
A equal to the applied force.

B perpendicular to the applied force.

C equal and opposite to the weight of the box.

D perpendicular to the displacement of the box. (2)

1.6 Three identical positive point charges, Q_1, Q_2 and Q_3, are initially situated on a smooth flat table at the corners of a right-angled triangle. The diagram below shows the charges as viewed from above.



Which ONE of the following diagrams shows the direction in which Q_2 will move as a result of the electrostatic forces exerted by Q_1 and Q_3 on it?

A 

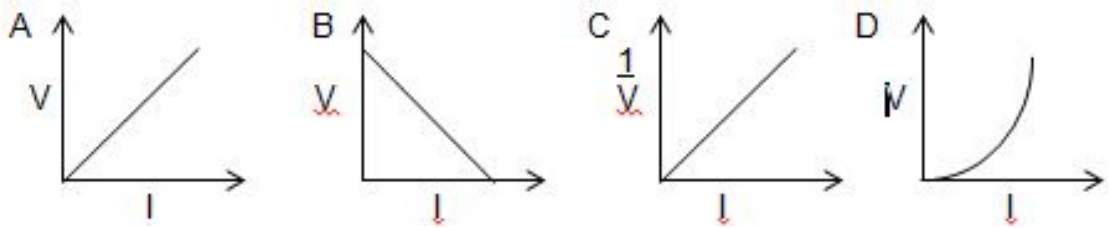
B 

C 

D 

(2)

1.7 Which one of the following graphs represents the relationship between potential difference (V) and strength of current (I) for an ohmic conductor?



(2)

1.8 The hooter of a car emits sound of constant frequency as the car moves away from a stationary listener.

Which ONE of the following properties of the sound heard by the listener will NOT change?

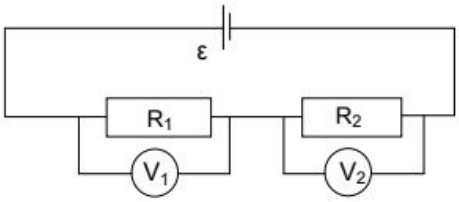
A Velocity

B Frequency

C Both wavelength and frequency

D Both frequency and loudness (2)

1.9 The diagram below shows a cell of emf (ε), and two resistors, R_1 and R_2 in series, with $R_1 < R_2$. The cell has negligible internal resistance and the voltmeters have very high resistances.



Which ONE of the following is CORRECT?

A $V_1 = V_2 = \varepsilon$

B $V_1 > V_2$

C $\frac{V_1}{R_1} = \frac{V_2}{R_2}$

D $\frac{V_1^2}{R_1} > \frac{V_2^2}{R_2}$

(2)

1.10 A DC generator operates at 80 Hz. The number of times the output voltage reaches a maximum in 1 second is ...

A 40

B 80

C 120

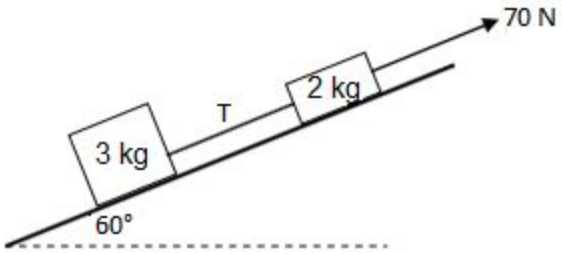
D 160

(2)

[20]

QUESTION 2 (Start on a new page.)

Two objects with masses 2 kg and 3 kg, respectively, are attached with a light, inelastic string. The objects are being pulled by constant force of 70 N up a rough inclined plane, at an angle of 60° to the horizontal. Ignore the mass of the string.



The kinetic friction coefficient is 0,3 for the 3 kg object. The tension in the string is T.

2.1 State Newton's Second Law of Motion in words. (2)

2.2 Draw a labelled free body diagram showing ALL the forces acting on the 3 kg object, as it moves up the inclined plane. (4)

2.3 Calculate the magnitude of the kinetic frictional force acting on the 3 kg object. (4)

The magnitude of the kinetic frictional force acting on the 2 kg object is 1,96 N.

2.4 Calculate the:

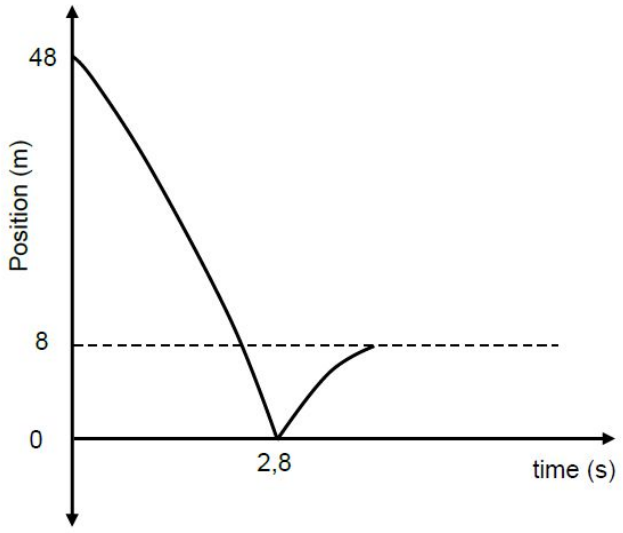
2.4.1 Magnitude of the acceleration of the objects as it moves up the inclined plane. (4)

2.4.2 Value of T, the magnitude of the tension in the string. (2)

[16]

QUESTION 3 (Start on a new page.)

The position-time graph for a ball thrown vertically downwards from the top of a 48 m tall building is shown below. The graph is not drawn to scale. The ball bounces off the ground, reaching a maximum height of 8 m.
Ignore the effect of air resistance and the contact time with the ground.



3.1. Define a projectile. (1)

3.2. Calculate the speed at which the ball:

3.2.1 is thrown downwards. (4)

3.2.2 hits the ground. (3)

3.2.3 bounces off the ground. (3)

3.3. Draw a velocity-time sketch graph (not to scale) for the entire motion of the ball.

Indicate the following on your graph:

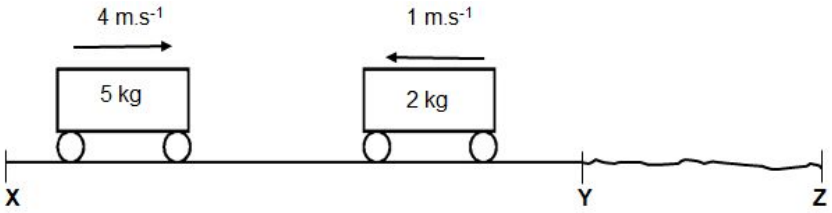
(i) initial velocity with which the ball was thrown
(ii) velocity with which the ball hits the ground
(iii) time taken to attain this velocity
(iv) the velocity with which the ball bounces off the ground (4)

[15]

QUESTION 4 (Start on a new page.)

The diagram below shows two sections, **XY** and **YZ**, of a horizontal, flat surface. Section **XY** is *smooth*, while section **YZ** is *rough*.

A 5 kg trolley, moving with a velocity of 4 $m.s^{-1}$ to the right, collides head-on with a 2 kg trolley moving with a velocity of 1 $m.s^{-1}$ towards the 5 kg trolley. After the collision, the two trolleys stuck together and move to the right pass point **Y.**



4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the magnitude of the velocity of the combined trolleys at point Y. (4)

The combined trolleys travel for 0,3 s from point **Y** before coming to a stop at point **Z**.

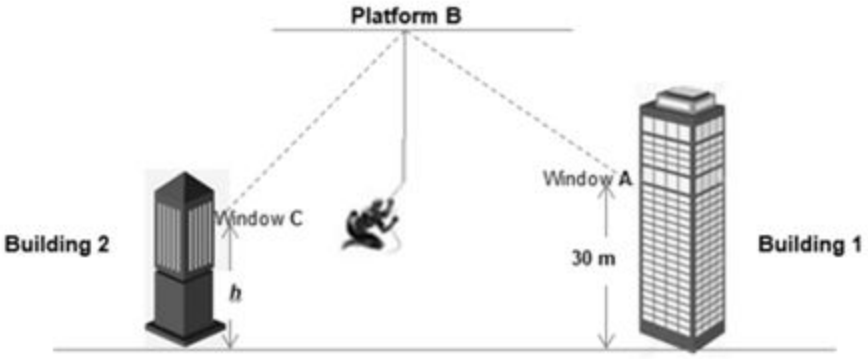
4.3 Calculate the magnitude of the net force acting on the combined trolleys when they move through section **YZ**. (4)

4.4 Section **YZ** serves the same function as an arrestor bed (sandpit to stop run-away heavy trucks). Explain this function of arrestor beds on our roads using the impulse-momentum theorem. (2)

[12]

QUESTION 5 (Start on a new page.)

The emergency services received a 911 call that building **2** was on fire and people were trapped inside at window **C**. The emergency service dispatched a fire-truck but Spiderman, the local superhero, intercepted the call. He rushed to the scene and arrived at building **1** before the fire truck.
Spiderman has a mass of 70 kg and was initially located at window **A**. He is stationary, 30 m above the ground at building **1**. He spins an inelastic spiderweb to platform **B** in order to swing to window **C** which is located at building **2**. He swings to window **C** which is ***h*** meters above the ground.



Ignore the effects of air friction and accept that no loss of mechanical energy occurred.
He swings with an initial velocity of 0 $m.s^{-1}$.

5.1 Determine the potential energy of Spiderman at window **A** when he is located, stationary at building **1**. (3)

5.2 State the principle of conservation of mechanical energy. (2)

5.3 If Spiderman reaches window **C,** with a speed of 10 $m.s^{-1}$, calculate the height (***h***) in meters, of window **C** from the ground level. (4)

The fire-truck eventually arrives at building **2** and uses a water pump to extinguish the flames. The water pump converts kinetic energy to hydro- dynamic energy.

5.4 If the water pump converts 4,8 x 10^5 J of energy in 2 minutes, calculate the average power of the pump. (3)

5.5 The water is pumped at a constant velocity of 10 $m.s^{-1}$. Determine the magnitude of the force generated by the water pump. (3)

[15]

QUESTION 6 (Start on a new page.)

A siren of a stationary ambulance emits sound waves of frequency 280 Hz. A car is moving towards a stationary ambulance at a constant speed that is 30 $m.s^{-1}$.

6.1 Define the *Doppler Effect*. (2)

6.2 Calculate the frequency of sound detected by the driver of the car.
Use the speed of sound in air as 340 $m.s^{-1}$. (5)

6.3 How will the answer in QUESTION 6.2 be affected if the car moves away from the ambulance at the same constant speed?

Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Explain the answer. (2)

6.4 Give ONE use of the Doppler flow meter. (1)

6.5 When a line in a hydrogen spectrum is measured in a laboratory, it has a wavelength of 1,32 x 10^{-15} m. The same line in the light of a star has a wavelength of 1,38 x 10^{-15} m.

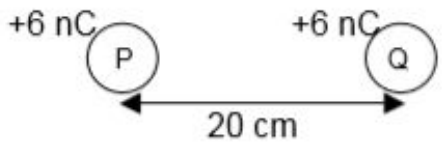
Is the star moving TOWARDS, or AWAY from the earth?

Explain your answer. (2)

[12]

QUESTION 7 (Start on a new page.)

The diagram below shows two identical insulated metal spheres . Sphere **P** and **Q** each carry a charge of +6 nC.

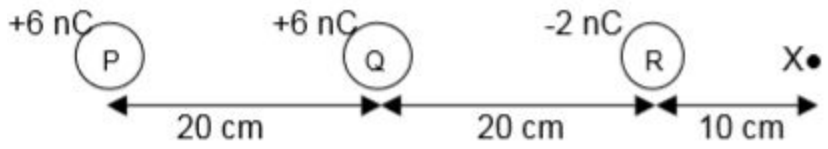


7.1 State Coulomb's Law in words (2)

7.2 Draw the electric field pattern due to the two spheres **P** and **Q** (3)

7.3 Calculate the magnitude of the electrostatic force between spheres **P** and **Q** (4)

A third sphere, **R**, of charge -2 nC is now placed at a position 20 cm to the right of sphere **Q** . **X** is a point to the right of the spheres as shown in the diagram below.

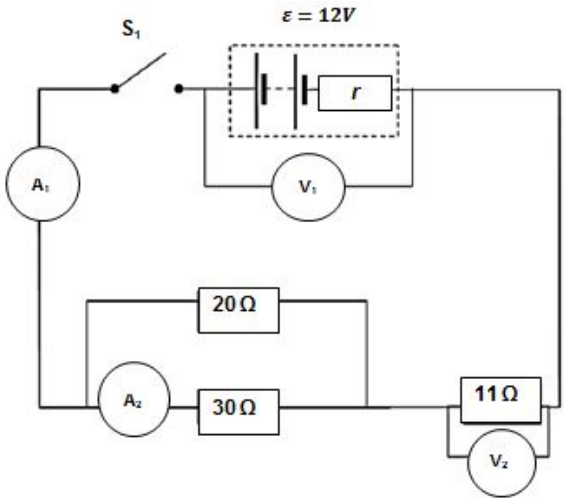


7.4 Calculate the net electric field at point **X** due to spheres **P**,**Q** and **R**. (6)

[15]

QUESTION 8 (Start on a new page.)

An electric circuit is set up as shown in the diagram below. The resistances of the switch, ammeters and connecting wires are negligible. The voltmeters have very high resistance. The battery has an emf (ε) of 12V and has significant internal resistance (*r*).



8.1 Write down the respective readings on voltmeters V_1 and V_2 when switch S_1 is open. (2)

The switch S_1 is CLOSED. The ammeter A_2 reads 0,2 A.

8.2 Calculate:

8.2.1 the total external resistance of the circuit. (3)

8.2.2 the internal resistance (*r*) of the battery. (5)

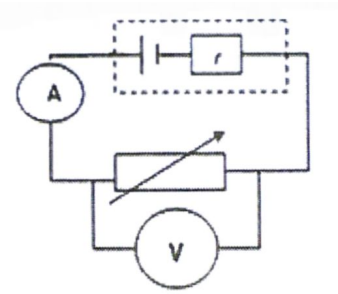
The 11 Ω resistor is replaced by a new resistor of greater resistance.

8.3 Will the reading on the voltmeter **V_1** connected across the terminals of the battery *INCREASE, DECREASE* or *REMAIN THE SAME*? Explain your answer. (4)

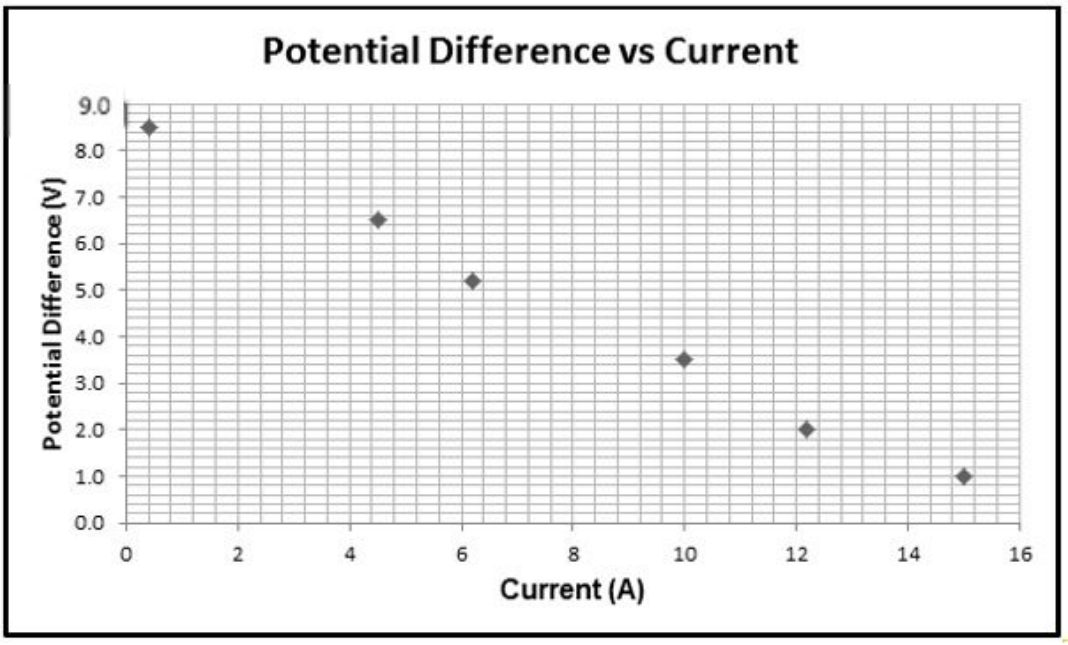
[14]

QUESTION 9 (Start on a new page.)

A Grade 12 class did an experiment to determine the internal resistance and emf of an unknown cell provided by the teacher. They completed an electrical circuit with the components as shown in the diagram.



The rheostat was changed to a different setting six times and the readings on the ammeter and voltmeter (V) were taken after each setting. The readings were plotted on a graph. Complete the line graph and answer the following questions.



9.1 What is the independent variable in this experiment? (1)

9.2 Name one constant variable for this experiment. (1)

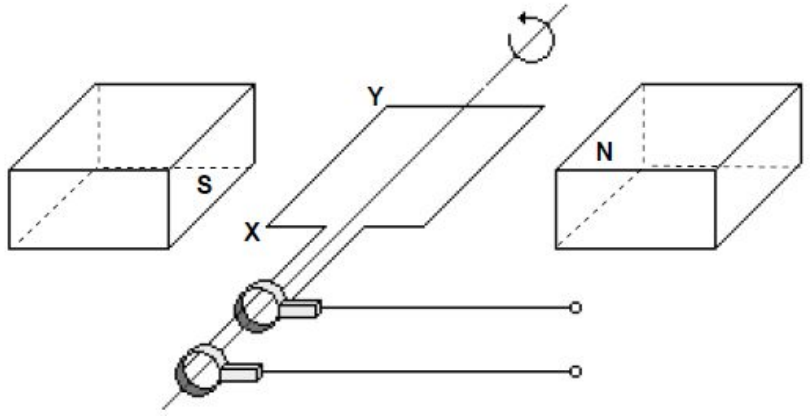
9.3 Determine the emf of the cell using the graph provided. (1)

9.4 Determine the internal resistance of the cell using the graph. (4)

[7]

QUESTION 10 (Start on a new page.)

10.1 A coil is rotated anticlockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



10.1.1 What type of generator is illustrated in the diagram? Write only ALTERNATING CURRENT or DIRECT CURRENT. Give a reason for your answer. (2)

10.1.2 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (1)

10.1.3 Assume that the speed and direction of rotation are constant. Draw a sketch graph of potential difference against time that represents the output of this device. (2)

10.2 The municipality of Drakenstein implements a power cutback in the area. As a result of the cutback the rms voltage drops from 220 V_{rms} to 200 V_{rms}.

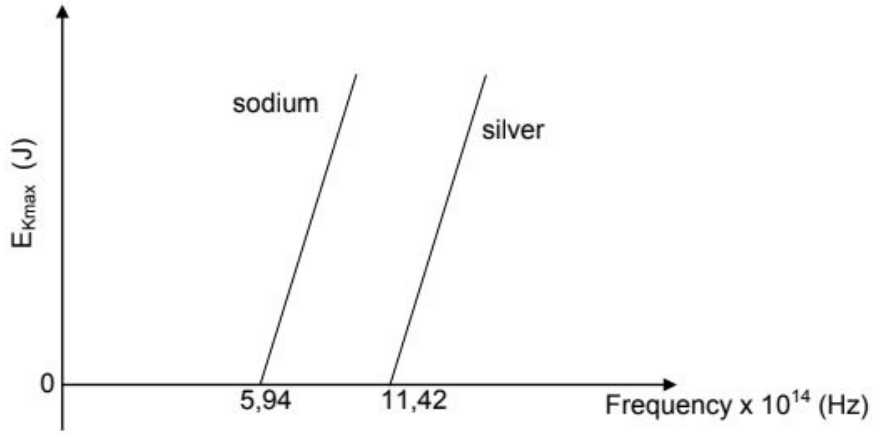
10.2.1 Calculate the peak voltage during the cutback. (3)

10.2.2 A certain electrical appliance dissipates 1 200 W when it is operated at 220 V_{rms}. Calculate the power at which it will operate during the cutback. (4)

[12]

QUESTION 11 (Start on a new page.)

11.1 A learner is investigating the photoelectric effect for two different metals, silver and sodium, using light of different frequencies. The maximum kinetic energy of the emitted photoelectrons is plotted against the frequency of the light for each of the metals, as shown in the graphs below.



11.1.1 Define the term threshold frequency (2)

11.1.2 Which metal, sodium or silver, has the larger work function? Explain the answer. (3)

11.1.3 Name the physical constant represented by the slope of the graphs (1)

11.1.4 If light of the same frequency is shone on each of the metals, in which metal will the ejected photoelectrons have a larger maximum kinetic energy? (1)

11.2 In a different photoelectric experiment blue light obtained from a light bulb is shone onto a metal plate and electrons are released.

The wavelength of the blue light is 470 x 10^{-9} m and the bulb is rated at 60 mW. The bulb is only 5% efficient.

Calculate the number of photons that will be incident on the metal plate per second, assuming all the light from the bulb is incident on the metal plate. (5)

[12]

TOTAAL: 150