

Name:..... Centre Number:.....

Candidate Number:.....

Set (Please circle): 4P1 AF 4P2 MGC
4P3 JJLD 4P4 JWC



Winchester College Physics Mock Thursday 21th April 2016 a.m.

Time allowed: 135 min

Write your name, candidate number and centre number at the top of this page, and on all work you hand in.

Write in dark blue or black pen, except the multiple choice answer grid, which should be answered in pencil. You may use a soft pencil for any diagrams, graphs or rough working. Do not use staples, paper clips, highlighters, glue or correction fluid.

You may use a calculator.

Multiple choice questions are worth two marks each.

The number of marks for the written answer questions is at the end of each question or part question.

You may lose marks if you do not show your working or if you do not use appropriate units.

You are advised to spend no more than 45 minutes on the multiple choice portion of the exam.

Section A:

This section has **twenty (20)** questions. Answer **all** the questions

For each question there are four possible answers; **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice on the separate answer sheet, following the instructions on that sheet.

Read the instructions on the answer sheet very carefully.

Each correct answer will score **two** marks. Marks will not be deducted for a wrong answer. Any working should be done in this booklet. You will not be marked on this.

Section B:

This section has **seven (7)** questions. Answer **all** the questions, writing on the question paper.

Section A

(Multiple Choice)

Answer on the separate
sheet

Each question is worth 2
marks

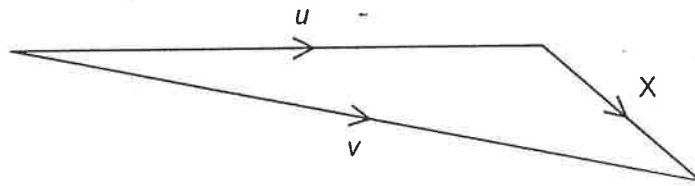
You are advised to spend
no more than 45 minutes on
this section

A 1 Which pair includes a vector quantity and a scalar quantity?

- A displacement; acceleration
- B force; kinetic energy
- C power; speed
- D work; potential energy

A 2. An object has an initial velocity u . It is subjected to a constant force F for t seconds, causing a constant acceleration a . The force is **not** in the same direction as the initial velocity.

A vector diagram is drawn to find the final velocity v .



What is the length of side X of the vector diagram?

- A F
- B Ft
- C at
- D $u + at$

A 3. A stone is dropped from the top of a tower of height 40 m. The stone falls from rest and air resistance is negligible.

What time is taken for the stone to fall the last 10 m to the ground?

- A 0.38 s
- B 1.4 s
- C 2.5 s
- D 2.9 s

A 4. A cyclist is riding at a steady speed on a level road.

According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

- A the force exerted by the cyclist on the pedals
- B the forward push of the road on the back wheel
- C the tension in the cycle chain
- D the total air resistance and friction force

A5.

A wooden block sits on a rough horizontal surface as shown. On the left, the block is at rest. The picture on the right shows the block is moving at constant velocity v . The force P is pulling the block to the right.



The coefficient of static friction between the block and the plane is μ_s .

The coefficient of dynamic friction between the block and the plane is μ_d and it is slightly smaller than μ_s .

Which of the statements below are correct?

- I. The pulling force P is the same in both cases.
- II. The resultant force on the block is the same in both cases.
- III. The work done on the block is the same in both cases.

- A. I only B. II only C. I & II D. I, II and III

A6.

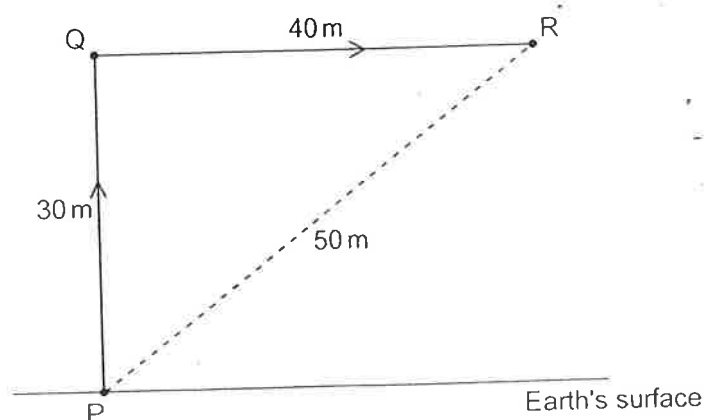
A motorist travelling at 10 m s^{-1} can bring his car to rest in a braking distance of 10 m.

In what distance could he bring the car to rest from a speed of 30 m s^{-1} using the same braking force?

- A 17 m B 30 m C 52 m D 90 m

A7.

A stone of weight 4.0 N in the Earth's gravitational field is moved from P to Q and then to R along the path shown.

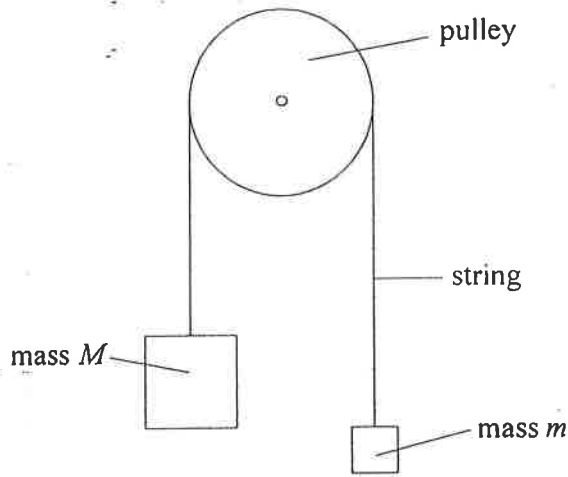


How much potential energy does the stone gain?

- A 120 J B 200 J C 280 J D 1200 J

A8.

A light inextensible string has a mass attached to each end and passes over a frictionless pulley as shown.



The masses are of magnitudes M and m , where $m < M$. The acceleration of free fall is g . The downward acceleration of the mass M is

- A. $\frac{(M - m)g}{(M + m)}$
- B. $\frac{(M - m)g}{M}$
- C. $\frac{(M + m)g}{(M - m)}$
- D. $\frac{Mg}{(M + m)}$

A9.

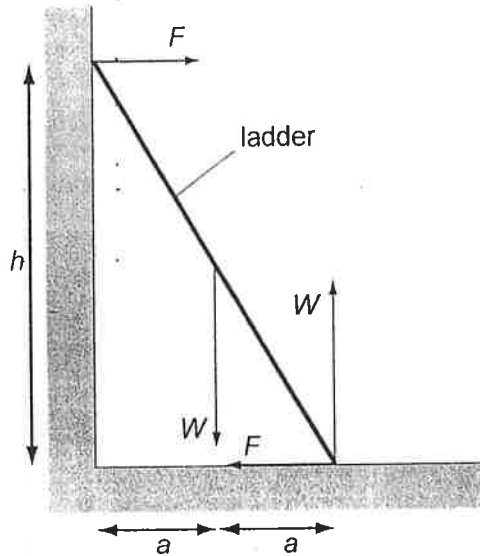
A particle has kinetic energy E and its associated de Broglie wavelength is λ . The energy E is proportional to

- A. λ^2
- B. λ
- C. λ^{-1}
- D. λ^{-2}

A10

A uniform ladder rests against a vertical wall where there is negligible friction. The bottom of the ladder rests on rough ground where there is friction. The top of the ladder is at a height h above the ground and the foot of the ladder is at a distance $2a$ from the wall.

The diagram shows the forces which act on the ladder.

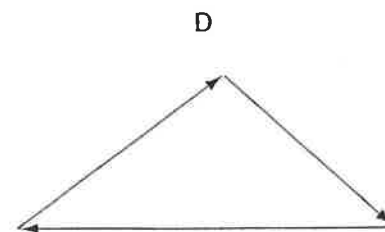
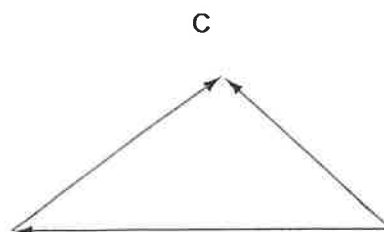
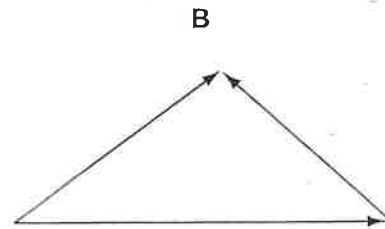
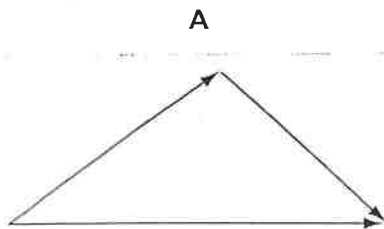


Which equation is formed by taking moments?

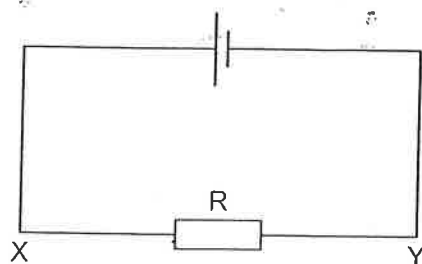
- A $Wa + Fh = 2Wa$
- B $Fa + Wa = Fh$
- C $Wa + 2Wa = Fh$
- D $Wa - 2Wa = 2Fh$

All. The diagrams show three forces acting on a body.

In which diagram is the body in equilibrium?



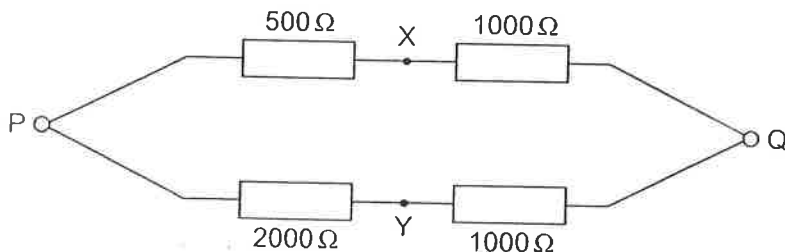
A12. The current in the circuit is 4.8 A.



What is the rate of flow and the direction of flow of electrons through the resistor R?

- A $3.0 \times 10^{19} \text{ s}^{-1}$ in direction X to Y
- B $6.0 \times 10^{18} \text{ s}^{-1}$ in direction X to Y
- C $3.0 \times 10^{19} \text{ s}^{-1}$ in direction Y to X
- D $6.0 \times 10^{18} \text{ s}^{-1}$ in direction Y to X

A13. A p.d. of 12V is connected between P and Q.



What is the p.d. between X and Y?

- A 0V
- B 4V
- C 6V
- D 8V

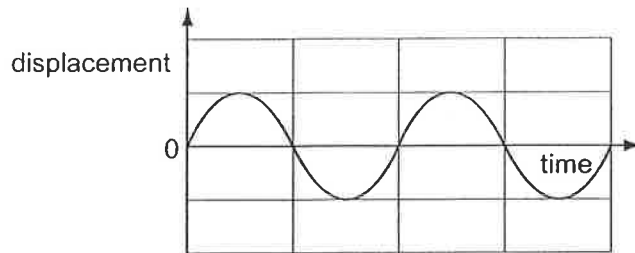
A14. An electric kettle running at 230 V and 8.0 A is used to boil water. The switch is kept pressed down so that the water keeps boiling. The specific latent heat of vaporization of water is $22.6 \times 10^6 \text{ J/kg}$. How much water will evaporate in 5 minutes?

- A 2.4 g
- B 3.0 g
- C 24 g
- D 30 g

A17 Which phenomenon is associated with transverse waves but not longitudinal waves?

- A polarisation
- B reflection
- C refraction
- D superposition

A18 A displacement-time graph is shown for a particular wave.

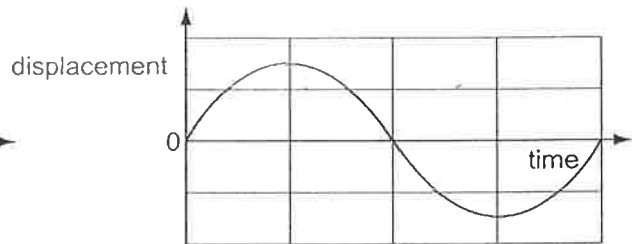
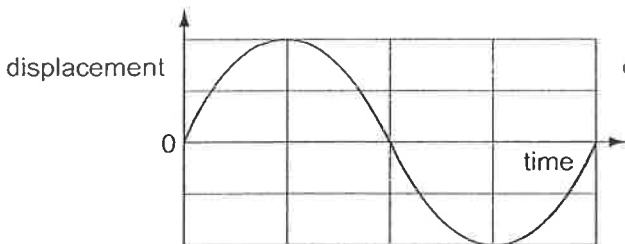


A second wave of similar type has twice the intensity and half the frequency.

When drawn on the same axes, what would the second wave look like?

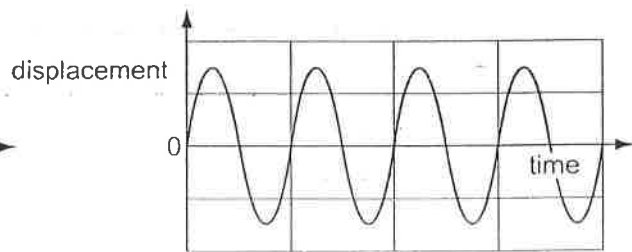
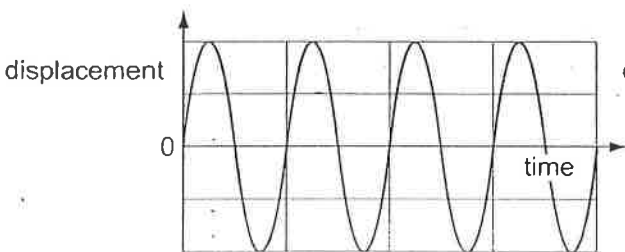
A

B



C

D



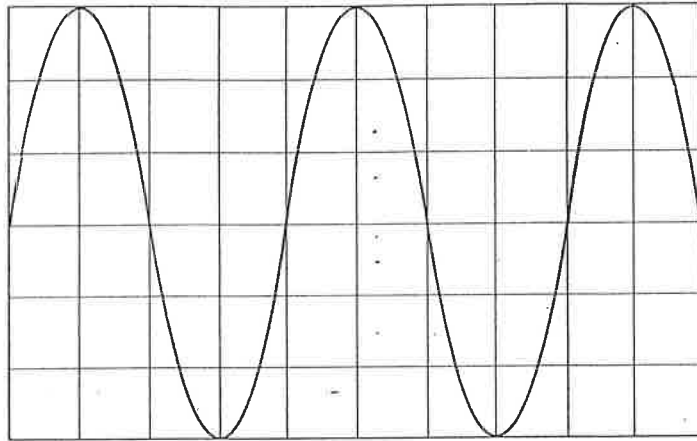
A19 The frequency of a certain wave is 500 Hz and its speed is 340 m s⁻¹.

What is the phase difference between the motions of two points on the wave 0.17 m apart?

- A $\frac{\pi}{4}$ rad
- B $\frac{\pi}{2}$ rad
- C $\frac{3\pi}{4}$ rad
- D π rad

A 20

The cathode-ray oscilloscope (c.r.o.) display shows the waveform produced by an electronic circuit. The c.r.o. time-base is set at 10 ms per division.



What is the period of the signal shown?

- A 20 ms B 30 ms C 40 ms D 80 ms

Section B

(Structured Questions)

Answer all the questions

Answer in this booklet

B2
A sample of copper wire has an electrical resistance of 5Ω . A sample of iron wire has a resistance of 10Ω . Both wires are of cylindrical construction and have the same radius. The resistivity of copper is $1.7 \times 10^{-8} \Omega\text{m}$ and that of iron is $1.0 \times 10^{-7} \Omega\text{m}$. The copper wire has length L .

a. What is the length of the iron sample, in terms of L ? [3]

b. Given that the radius of the (cylindrical) wire is $3 \times 10^{-4} \text{ m}$, calculate L . [2]

A 1Ω resistor and a 4Ω resistor are connected in parallel and a 15 V cell with an internal resistance of 0.2Ω is connected across the pair of resistors.

c. Under these circumstances, what is the total power dissipated by the *load* in the circuit? [3]

d. The 4Ω resistor is replaced with a 0.25Ω resistor. Without actually performing a complete calculation state whether the power dissipated in the load will now be higher or lower. Justify your answer. [2]

[Total: 10]

B3

(a)

One end of a long string is attached to an oscillator. The string passes over a frictionless pulley and is kept taut by means of a weight, as shown in Fig. 5.1.

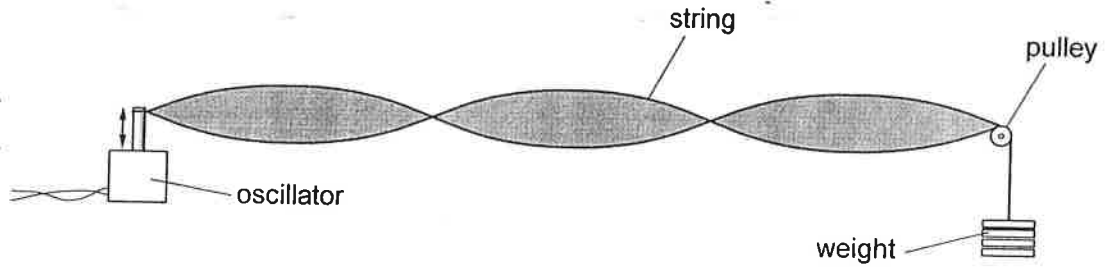


Fig. 5.1

The frequency of oscillation is varied and, at one value of frequency, the wave formed on the string is as shown in Fig. 5.1.

(i) Explain why the wave is said to be a *stationary wave*.

.....
..... [1]

(ii) State what is meant by an *antinode*.

.....
..... [1]

(iii) On Fig. 5.1, label the antinodes with the letter A. [1]

(b) A weight of 4.00 N is hung from the string in (b) and the frequency of oscillation is adjusted until a stationary wave is formed on the string. The separation of the antinodes on the string is 17.8 cm for a frequency of 125 Hz. The speed v of waves on a string is given by the expression

$$v = \sqrt{\frac{T}{m}}$$

where T is the tension in the string and m is its mass per unit length. Determine the mass per unit length of the string.

mass per unit length = kg m⁻¹ [4]

(TOTAL 7)

B4.

A laser pointer emits light of wavelength 532 nm and has a power output of 100 mW. In a science lecture, the laser is directed at a balloon and after about 0.05 s the balloon bursts.

a. Calculate the frequency of the light emitted by the laser. [2]

b. Calculate the energy required to burst the balloon. [2]

A lower power version of the laser is directed at a diffraction grating with a slit density of 400 lines per mm.

c. Calculate the distance between adjacent slits on the diffraction grating, giving your answer in metres. [3]

A very large white wall is located 4 m behind the grating and the diffraction pattern can be seen on the wall.

d. In the space below, draw a diagram of the experimental set up. [2]

e. Calculate the distance on the screen between the bright central maximum and the first order maximum for this diffraction pattern. [3]

The width of each individual slit in the grating is $0.625 \mu\text{m}$.

f. Calculate the number of maxima that you would expect to be visible either side of the bright central maximum. [4]

[...]

B5 (a) Tensile forces are applied to opposite ends of a copper rod so that the rod is stretched. The variation with stress of the strain of the rod is shown in Fig. 5.1.

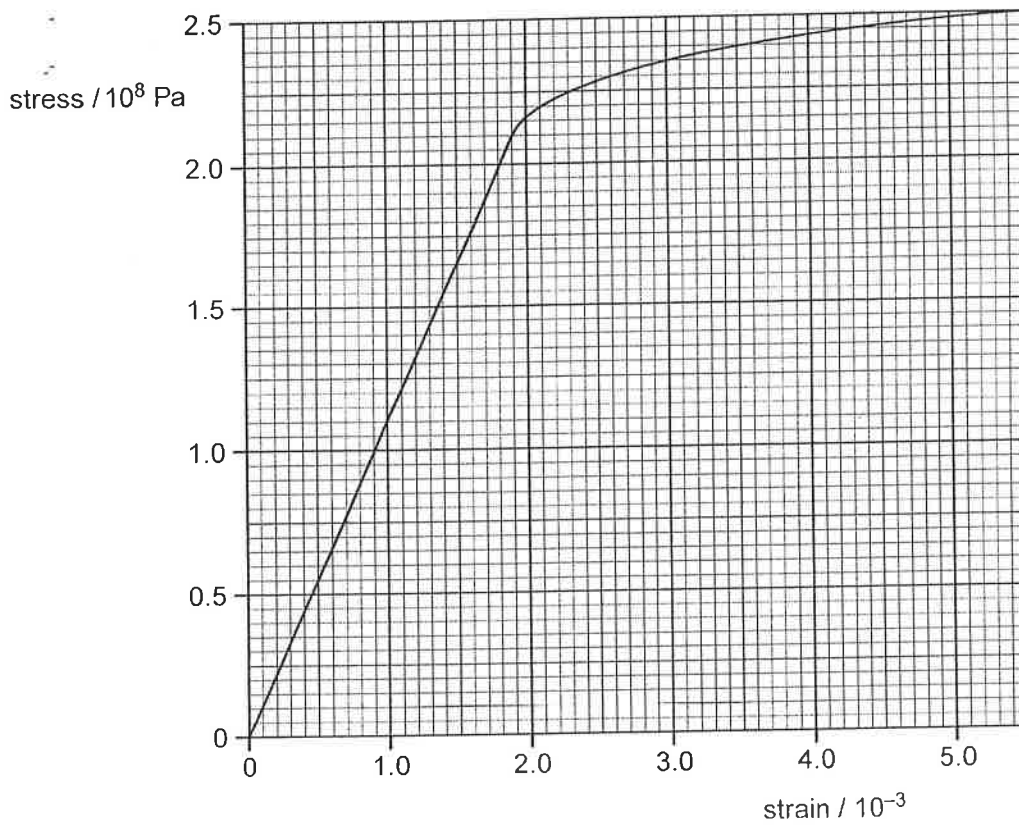


Fig. 5.1

(i) Use Fig. 5.1 to determine the Young modulus of copper.

Young modulus = Pa [3]

(ii) On Fig. 5.1, sketch a line to show the variation with stress of the strain of the rod as the stress is reduced from 2.5×10^6 Pa to zero. No further calculations are expected. [1]

- (b) The walls of the tyres on a car are made of a rubber compound. The variation with stress of the strain of a specimen of this rubber compound is shown in Fig. 5.2.

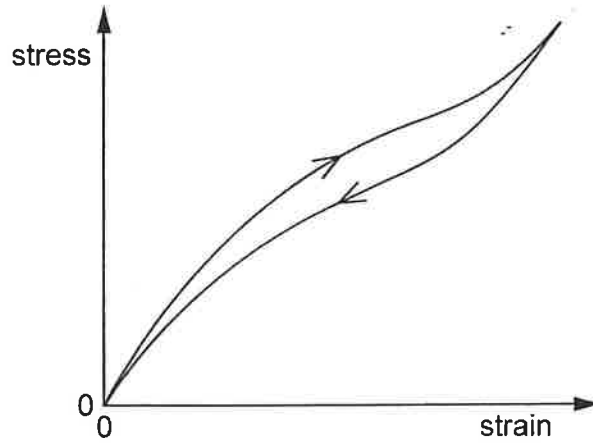


Fig. 5.2

As the car moves, the walls of the tyres bend and straighten continuously.

Use Fig. 5.2 to explain why the walls of the tyres become warm.

.....

.....

.....

..... [3]

[Total: 7]

B6.

Starbase Ulysses and Starbase Pikachu have zero velocity relative to each other. A radio signal takes 8 days to travel from one to the other. Camp Ewok is a small base half-way between them, which is also stationary with respect to the starbases.

- a. Captain Zep of the starship Condor travels at 80% of the speed of light from Starbase Ulysses to Starbase Pikachu. Showing your working:
 - i. calculate the time in days taken for the journey in Starbase Ulysses's frame of reference.

.....
..... [2]

- ii. calculate the time in days taken for the journey in Captain Zep's frame of reference.

.....
.....
..... [3]

- b. As Captain Zep passes Camp Ewok, he sends out two radio signals – one towards Starbase Ulysses and one towards Starbase Pikachu.

State and explain which radio signal arrives at its destination first:

- i. in Camp Ewok's frame of reference

.....
..... [2]

- ii. in Captain Zep's frame of reference

.....
..... [2]

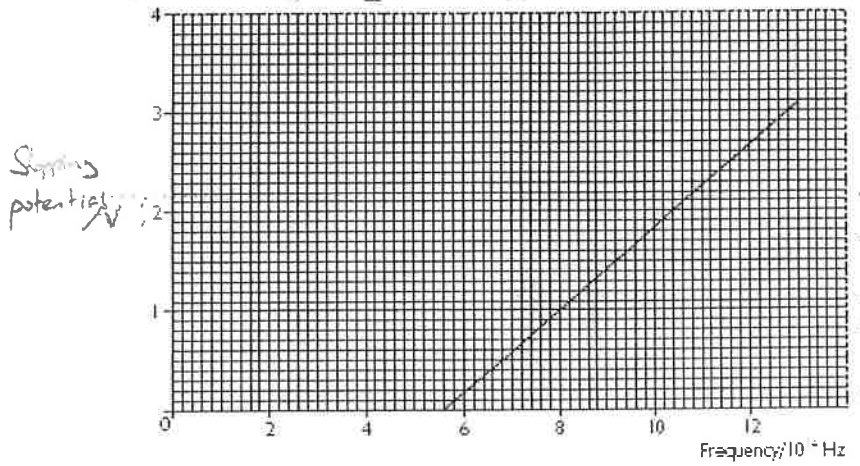
- c. While in flight, the starship Condor is 160m long from beak to tail in Camp Ewok's frame of reference. State and explain whether it is longer, shorter or the same length in Captain Zep's frame of reference.

.....

..... [2]

[Total: 11]

A graph of stopping potential versus frequency is shown below



For light of frequency 1.15×10^{15} Hz, Millikan's results suggest a stopping voltage of 2.5V.

b) Showing your working, calculate:

i. The wavelength of this light

.....
.....
.....(2)

ii. The energy of a photon of this light

.....
.....
.....(2)

c) Multiplying the stopping voltage of 2.5V by the charge on an electron (1.6×10^{-19} C) gives 4.0×10^{-19} J.

Explain why this value represents the maximum kinetic energy of the emitted photoelectrons.

.....
.....
.....(2)

d) Showing your working, use the graph to find:

i. the threshold frequency for sodium.

.....(1)

ii. the value of Planck's constant

.....
.....
.....(3)

iii. the work function of sodium

.....
.....
.....(2)

e) Explain the meaning of the term *work function*.

.....
.....
.....(2)

f) The work function for lithium is a little larger than it is for sodium. On the graph, sketch a line showing how the results might be expected to differ if the lithium target were used. (2)

[Total: 20]

