STUDENT EDUCATION NUMBER									

Government of Sāmoa

Sāmoa Secondary Leaving Certificate

PHYSICS
2016

QUESTION and ANSWER BOOKLET

Time allowed: 3 Hours & 10 Minutes

INSTRUCTIONS:

1. You have 10 minutes to read **before** you start writing.
2. Write your **Student Education Number (SEN)** in the space provided on the top right hand corner of this page.
3. **ALL Strands are compulsory**. Write your answers in the spaces provided.
4. If you need more space for answers, ask the Supervisor for extra paper. Write your SEN on all extra sheets used and clearly number as per exam. Attach the extra sheets at the appropriate places in this booklet.
5. **All the formulas required are provided on the last page.**

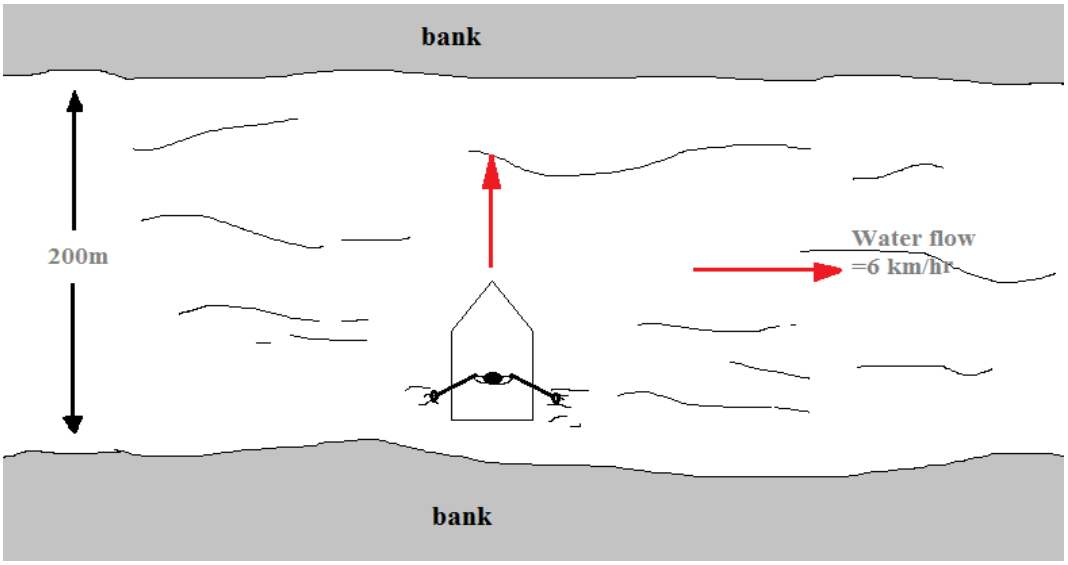
STRANDS		Page number	Time (minutes)	Weighting
1.	Measurement	2	18	10
2.	Waves	4	32	18
3.	Mechanics	9	44	24
4.	Electromagnetism	14	50	28
5.	Nuclear Physics	20	18	10
6.	Electricity	23	18	10
TOTAL			**180**	**100**

CHECK! This booklet contains pages 2-25 in the right order.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

STRAND 1 **Measurement** **Weighting 10**

Pepe rows a boat across a river at 4km/hr. The boat is always kept headed at right angle to the banks. The river is flowing at 6km/hr and is 200m across.



1a. In what direction does Pepe's boat actually go relative to the shore.

Skill Level 2

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1b. How long does it take Pepe to cross the river?

Skill Level 3

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1c. How far from Pepe's landing point downstream is the starting point?

Skill Level 3

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1d. How long would it take Pepe to cross the river if there were no current?

Skill Level 1

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1e. Convert 6km/hr to m/sec.

Skill Level 1

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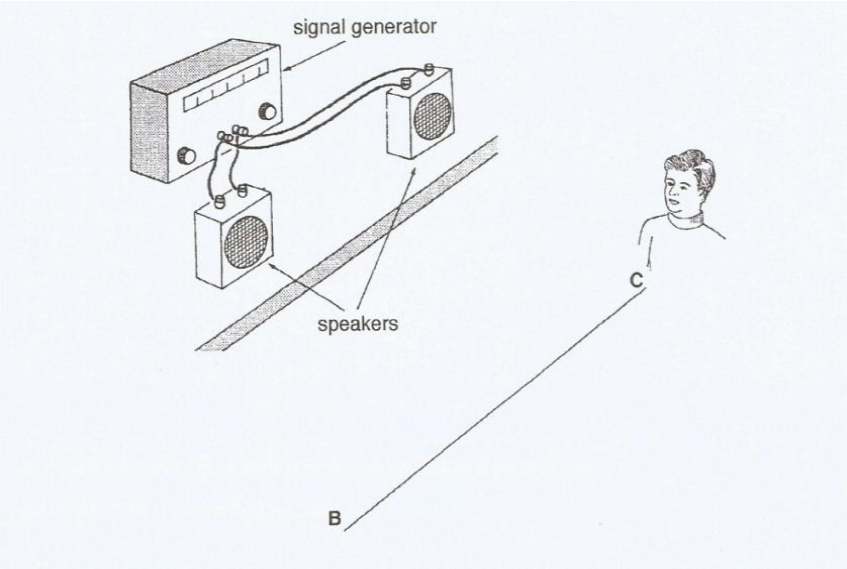
STRAND 2: **Waves** **Weighting 18**

In a Physics experiment to study sound waves, Sapa places two identical speakers some distance apart. He then connects them to a signal generator to send out sound waves of a certain frequency, as shown in the diagram below. An interference pattern is produced.



2a. The speed of sound in air is **340** ms^{-1} and the wavelength of the sound waves produced by the speakers is 0.48m.

Skill Level 2

Calculate the frequency of the sound waves produced by the speakers. Give the correct SI unit with your answer.

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2b. Define the term *frequency*

Skill Level 1

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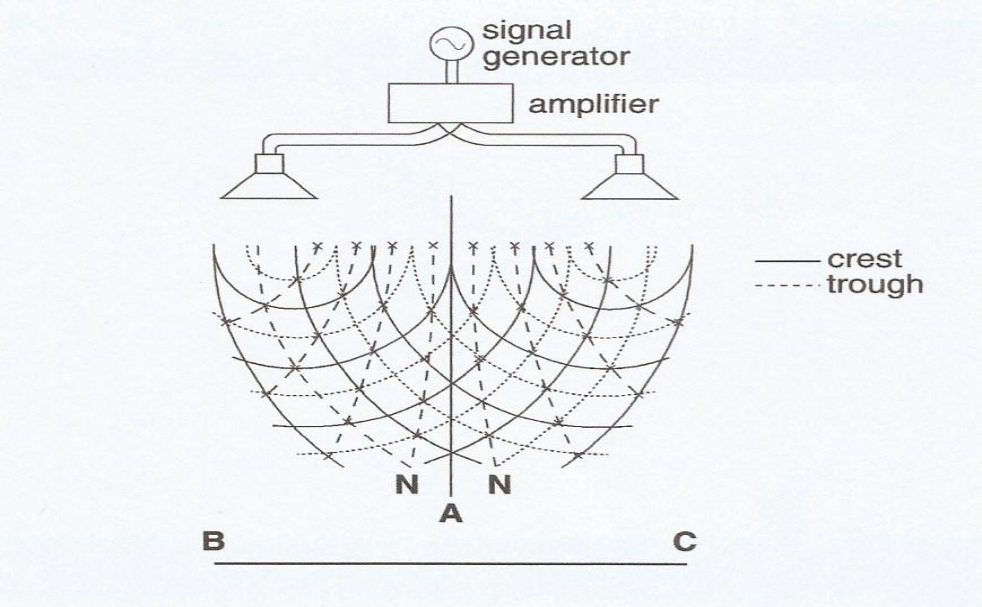
The interference pattern has a series of nodal lines (labelled **N**) and antinodal lines (labelled **A**), as shown in the diagram below.



2c. Sapa would hear very little sound at any point along a nodal line.

Explain how this nodal line is produced.

Skill Level 3

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2d. Describe what Sapa would expect to hear if he walked in front of the speakers along the line BC.

Skill Level 2

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2e. The frequency of sound produced by the speakers is now reduced to half of its original value and Sapa hears a note of lower pitch. The distance between two nodal lines is directly proportional to the wavelength of the sound.

Skill Level 4

Describe ONE **other** change that he would hear when he walks along the line **BC** and give a reason for the change.

Description:

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Reason:

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2f. Define the terms:

Skill Level 1

(i) *Out of Phase*

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(ii) *In-phase*

Skill Level 1

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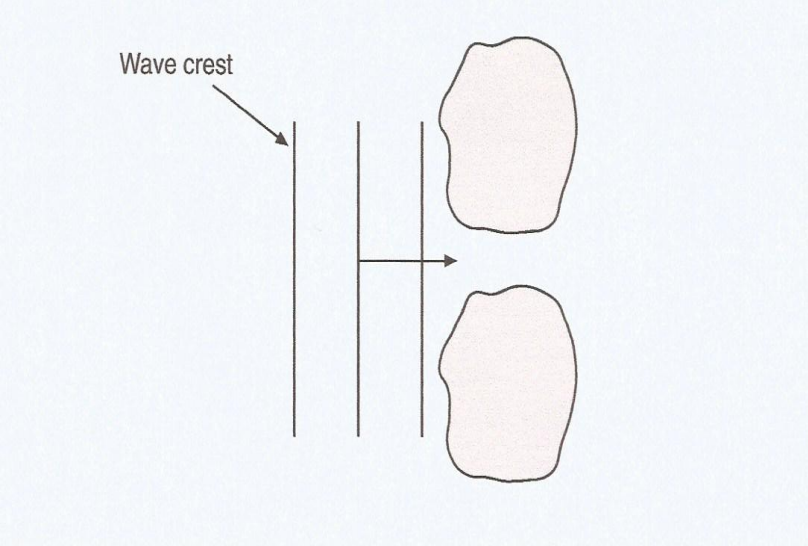
At a place near Apia harbour, the waves arrive at two large rocks and pass through the gap as shown in the diagram below.



2g. Show the wavelength of the incoming waves on the diagram.

Skill Level 1

2h. Show the direction of the waves after passing through the gap by using an arrow.

Skill Level 1

2i. What is the name given to this behaviour of wave as they pass through the gap?

Skill Level 1

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2j. Give the condition that is necessary for this wave pattern to be formed.

Skill Level 1

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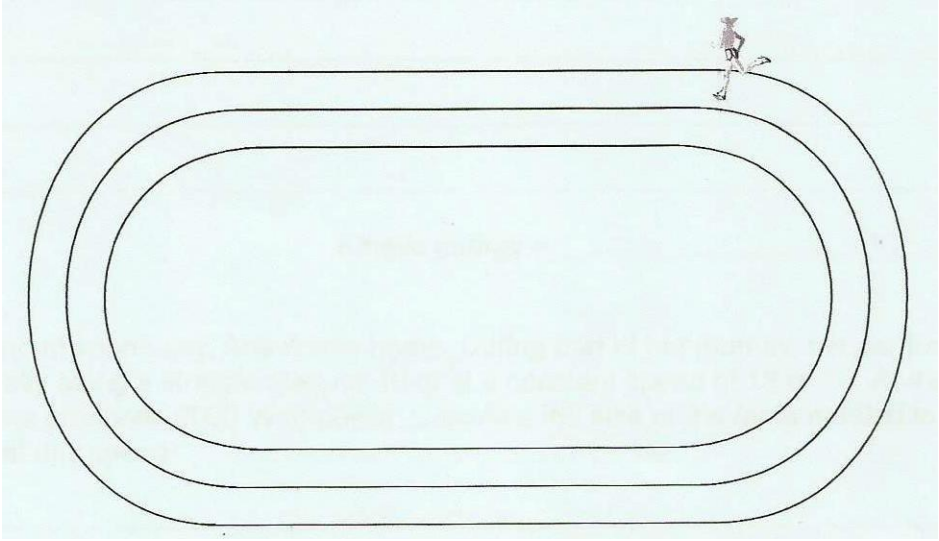
STRAND 3 **Mechanics** **Weighting 24**

Ana runs a 400 m race around the school track in 65 seconds.



3a. Calculate Ana's average speed for the race.

Skill Level 2

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3b. *At the start of the race, Ana accelerates to a speed of 6.0 m/s during the first 2.2 seconds.*

Skill Level 3

(i) Calculate her acceleration.

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(ii) What assumption do we need to make about Ana's acceleration?

Skill Level 1

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3c. Calculate the distance that Ana travels during the first 2.2 seconds.

Skill Level 2

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3d. State the difference between speed and velocity.

Skill Level 1

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3e. Ana possess some kinetic energy as she runs at a steady speed. State the SI unit for kinetic energy.

Skill Level 1

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3f. State what happens to Ana's kinetic energy when her speed doubles up.

Skill Level 1

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3g. At the end of sports day, Ana drives home. During part of her journey, her car travels horizontally along a straight road for 40m at a constant speed of 15 m/s. At this speed the car engine produces 6000W of power.

Skill Level 4

(i) Calculate the size of the force needed to keep the car moving at this speed.

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(ii) Define *Power* in relation to the car engine above.

Skill Level 1

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(iii) Convert 6000 W to Joules/second.

Skill Level 1

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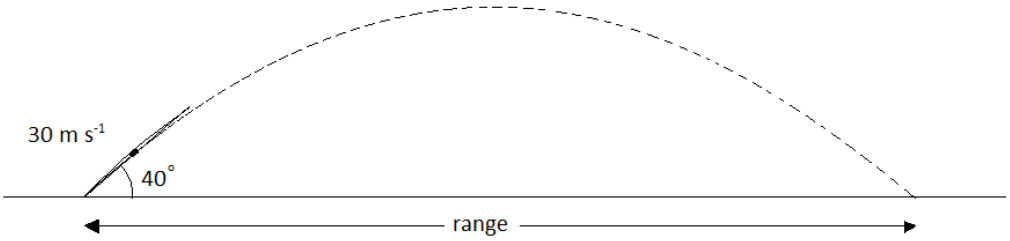
Joe, another athlete, is competing in the javelin field event. He throws the javelin into the air at an angle of 40^0 above the horizontal at an initial velocity of 30 m/s. The diagram below shows that.



3h. (i) Express the horizontal component **in terms of the initial velocity and the angle** 40^0**.** Do not solve the expression.

Skill Level 1

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(ii) Express the vertical component in **terms of the initial velocity and the angle** 40^0**.** Do not solve the expression.

Skill Level 1

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(iii) Which of the two components in (i) and (ii) above is constant throughout the flight?

Skill Level 1

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(iv) Calculate the **range** (horizontal distance travelled) of the javelin under these conditions.

Skill Level 4

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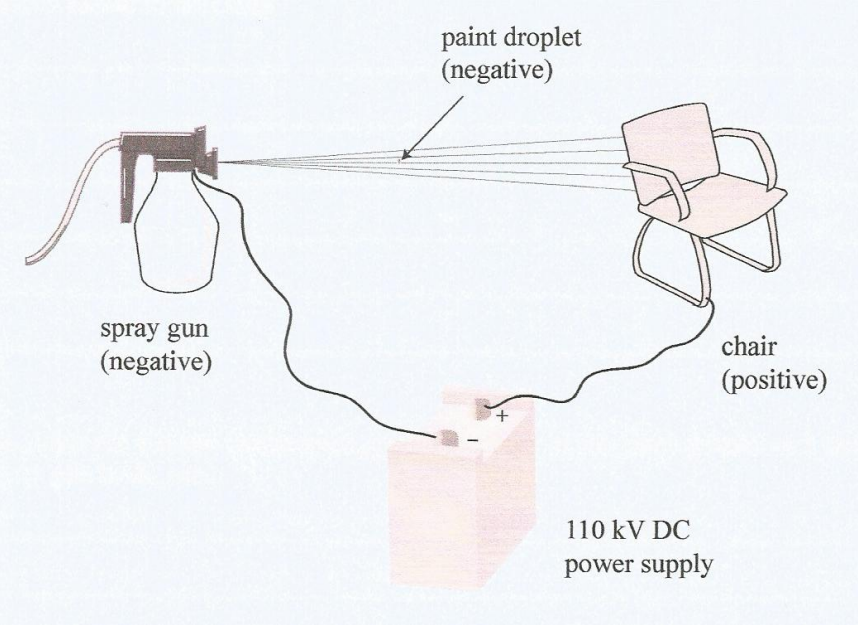
STRAND 4 **Electromagnetism** **Weighting 28**

Spray painting involves firing fine droplets of liquid paint at the object to be sprayed. One problem is that many of the droplets miss the object. A solution to this problem is to use electrostatics. The electrostatic spray painter in the diagram below shows how a metal chair can be painted. The negative terminal of the power supply is connected to the spray gun so the paint droplets become charged. The positive terminal of the power supply is connected to the chair. This creates an electric field between the spray gun and the chair, and the charged paint droplets are repelled from the gun and attracted to the chair.

Assume the electric field is constant.
The charge on one electron is: $-1.60 \times 10^{-19} C$



4a. Draw an arrow on the diagram above to show the direction of the electric field between the spray gun and the chair.

Skill Level 1

4b. Indicate on the diagram the direction of the current as they flow in the circuit above.

Skill Level 1

4c. State the SI unit for current.

Skill Level 1

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4d. One particular paint droplet has 3.0×10^{6} electrons added to it. **Show** that it has a total charge of $-4.8 \times 10^{-13} C$.

Skill Level 2

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4e. The spray gun and chair are 0.65m apart. The voltage between the spray gun and the chair is 110kV.

Calculate the **size** of the **force** acting on the paint droplet.

Skill Level 4

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4f. Explain clearly what will happen to the force acting on the paint droplets if the spray gun is moved **closer** to the chair.

Skill Level 3

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4g. Express 110kV in mV.

Skill Level 1

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4h. State what is meant by the term **Voltage**

Skill Level 1

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4i. Calculate the **change** in electrical potential energy of this paint droplet as it travels from the spray gun to the chair.

Skill Level 3

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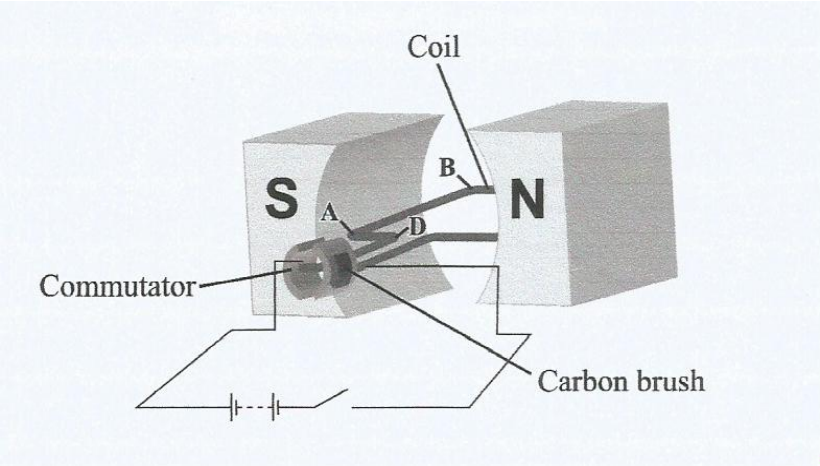
4j. The spray gun fires out 6.5×10^5 paint droplets every minute. The average charge on each paint droplet is $-8 \times 10^{-13} C$.

Skill Level 2

Calculate the size of the electric current from the spray gun.

A simplified electric motor.



Length AB of the coil = 12 cm

Strength of magnetic field = 0.75 T

Voltage across the terminals of the battery = 12 V

Total resistance of all the wires including the coil = 4.5 Ω

4k. (a). Calculate the size of the magnetic force on AB, which has 100 turns of wire.

Skill Level 4

(ii). Explain why the part of the wire labelled AD, which is 5.0 cm long, will not experience a magnetic force while at the position shown in the diagram above.

Skill Level 2

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(iii). List TWO changes that must be made in order to make the coil spin faster.

Skill Level 2

Change 1:

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Change 2:

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(d) State the purpose of the commutator.

Skill Level 1

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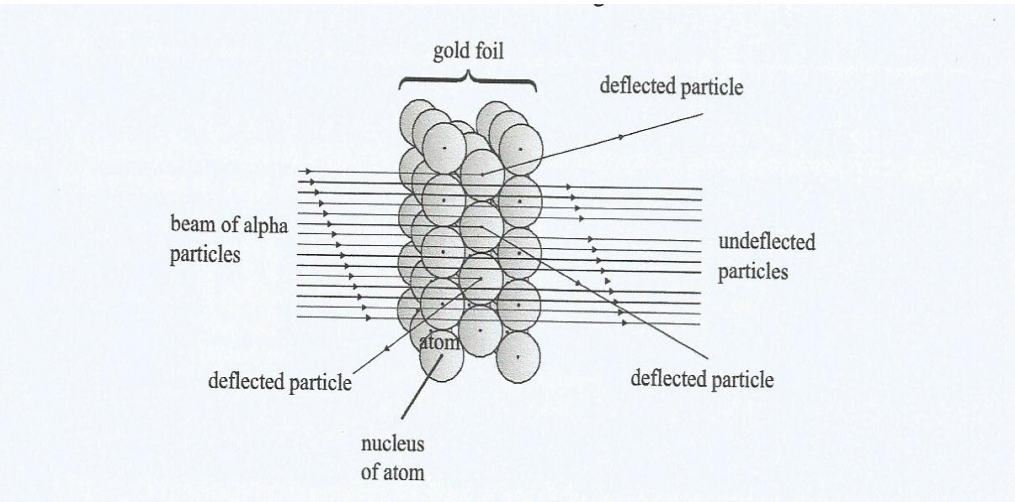
STRAND 5: **<u>Nuclear Physics</u>** **Weighting 10**

The following diagram shows the observations that Rutherford made during his gold foil experiment of the atom's structure.



Based on his observations, Rutherford came to certain conclusions about the structure of the atom.

5a. Explain ONE of Rutherford's **main** conclusions about the structure of the atom and give the evidence that the conclusion is based on.

Skill Level 3

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5b. One of the first artificial nuclear reactions was carried out by Rutherford when he fired alpha particles into a jar of nitrogen gas $^{14}_{7}\mathrm{N}$. He discovered that the products were oxygen $^{17}_{8}\mathrm{O}$, and one other particle.

Skill Level 2

i) Write a nuclear equation for the reaction.

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ii) Name the other particle that was produced as a result of this nuclear reaction.

Skill Level 1

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5c. State ONE conservation law that you used in order to write the equation in (i) above.

Skill Level 1

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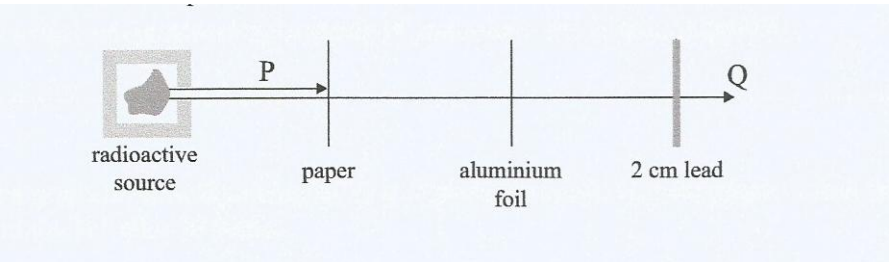
The type of radiation emitted from a radioactive source can be determined using absorbers. The diagram below shows an example.



5d. Identify the radioactive emissions labelled P and Q, giving reasons.

Skill Level 3

P:

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Q:

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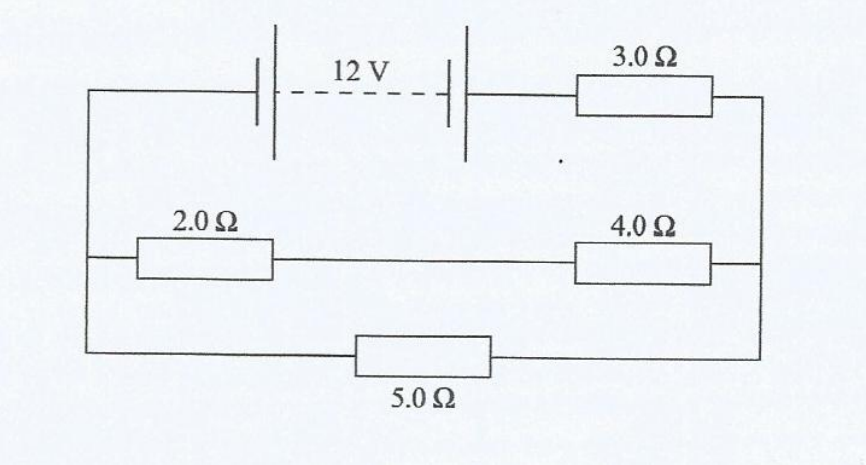
STRAND 6 **Electricity** **Weighting 10**

Sione is out camping. He has just one 12V battery with him. He connects various low voltage devices to this battery, as shown in the diagram below.



6a. Draw an arrow on the circuit diagram to show the direction of the conventional current flow.

Skill Level 1

6b. Insert a single switch into the circuit diagram to control only the 5Ω device.

Skill Level 1

6c. Calculate the effective (total) resistance of the circuit.

Skill Level 3

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6d. Calculate the total current flowing through the circuit, using the total resistance calculated in (c).

Skill Level 2

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6e. Calculate the current through the 5.0Ω resistor.

Skill Level 3

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PHYSICS EQUATIONS SHEET

Kinematics

$v = u + at$

$d = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2ad$

$v = \frac{\Delta d}{\Delta t}$

$a = \frac{\Delta v}{\Delta t}$

Momentum

$p = mv$

$\Delta p = p_f - p_i$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$\tau = BANI\cos\theta$

Light and Waves

$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$

$m = \frac{H_i}{H_o} = \frac{d_i}{d_o}$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$T = \frac{1}{f}$

$v = f\lambda$

Circular Motion

$a = \frac{v^2}{r}$

$F = \frac{mv^2}{r}$

$v = \frac{2\pi r}{T}$

Electricity and Magnetism

$P = \frac{W}{t}$

$I = \frac{Q}{t}$

$V = \Delta E/q$

$V = IR$

$P = VI$

$B = \frac{kI}{d}$

$F = Bqv$

$P = \Delta E/t$

$V = Bvl$

Energy and Mechanics

$W = Fd$

$E = mgh$

$E_k = \frac{1}{2}mv^2$

$F = k\,x$

$E_p = \frac{1}{2}k\,x^2$

List of constants

$e = 1.6 \times 10^{-19} C$

$k = 2 \times 10^{-7}\ NA^{-2}$

$m_e = 9 \times 10^{-31} kg$

$G = 6.67 \times 10^{-11} Nm^2/kg^2$

$k = 9.0 \times 10^9\ Nm^2C^{-2}$