2

SUPERVISOR'S USE ONLY

91173

911730

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Level 2 Physics, 2015

91173 Demonstrate understanding of electricity and electromagnetism

9.30 a.m. Tuesday 17 November 2015
Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of electricity and electromagnetism.	Demonstrate in-depth understanding of electricity and electromagnetism.	Demonstrate comprehensive understanding of electricity and electromagnetism.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L2–PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

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Achievement

TOTAL 12

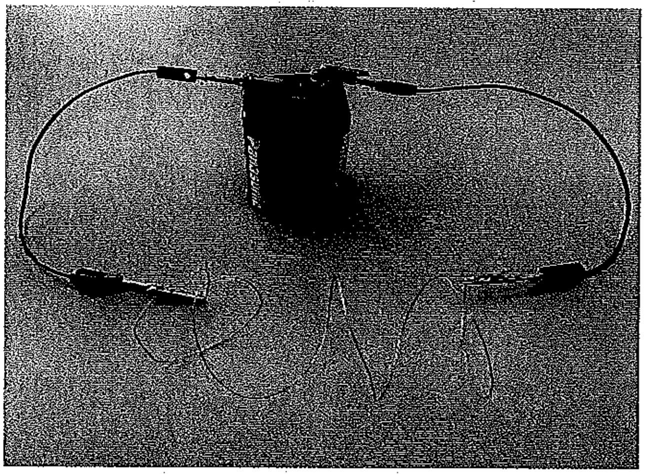
ASSESSOR'S USE ONLY

ASSESSOR'S USE ONLY

QUESTION ONE: ELECTRIC FIELD IN A WIRE

Charge on an electron $= -1.6 \times 10^{-19}$ C

Hamish connects a circuit as shown in the picture below. The circuit comprises a 6.0 V battery, 1.0 m of Nichrome resistance wire and two connecting wires. The battery produces a uniform electric field in the Nichrome resistance wire.



Assume that the connecting wires have no resistance.

(a) Calculate the strength of the electric field in the Nichrome resistance wire.

$E = \frac{V}{d}$ $\quad E = 6 \times 1 = 6$

$E = 6Vm^{-1}$

A

(b) Explain what happens to the size of the electric force on an electron as it travels through the Nichrome resistance wire.

~~[illegible]~~ $F = Eq$ $\quad F = 6 \times -1.6 \times 10^{-19}$

$F = -9.6 \times 10^{-19}$ N the force experienced when travelling through the normal wire. The ~~force~~ acting upon the electron will significantly decrease as the resistor/Nichrome wire decreases the current, voltage and increases resistance so a decrease in the strength of these components will decrease the electric force size.

electrical field strength needed to realise a uniform field is constant

N

(c) Calculate the distance moved by an electron as it loses 9.6×10^{-20} J of electrical potential energy.

$E_p = Eqd$

$(Eq)(d) = \frac{E_p}{(Eq)}$

$d = \frac{-9.6 \times 10^{-20}}{(6)(-1.6 \times 10^{-19})}$ $\rightarrow d = 1 \times 10^{-39}$ ~~m~~

$\rightarrow d = 0.95$ m

$\rightarrow d = 1$ m

M

(d) Hamish then adds another 6.0 V battery in series AND shortens the wire to 0.50 m. 1/2

Write a comprehensive explanation on what will happen to the size of the force on the electron.

Calculations are not needed.

When Hamish adds another identicle - 6V battery to the Series circuit the total voltage in the circuit will increase. Because of the equation $E = \frac{V}{d}$ an increase in voltage (→12V) and the decrease in distance from 1m to 0·5m will increase the strength of the ~~magnetic~~ field. With the negative charge on the electron remaining the same and an increase in the strength of the electric field, using the equation F (force) - or in this case the force on the electron = E(electric field strength) ~~which~~ which we know has increased↑ multiplied by q (charge in coulombs) which has remained the same. The increase in electric field strength because of the increase in voltage and decrease in what it is divided by - distance this being the increasing component of the size of the force the size of the force will increase on the electron.

realised the voltage increases, but then mixed up magnetic and electric fields

G

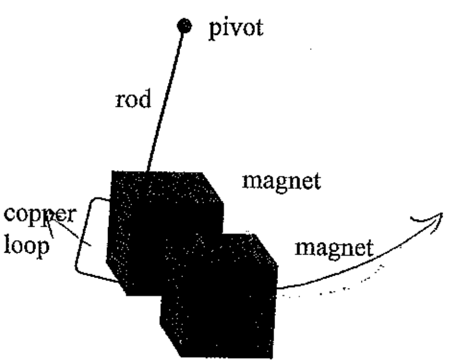
A1

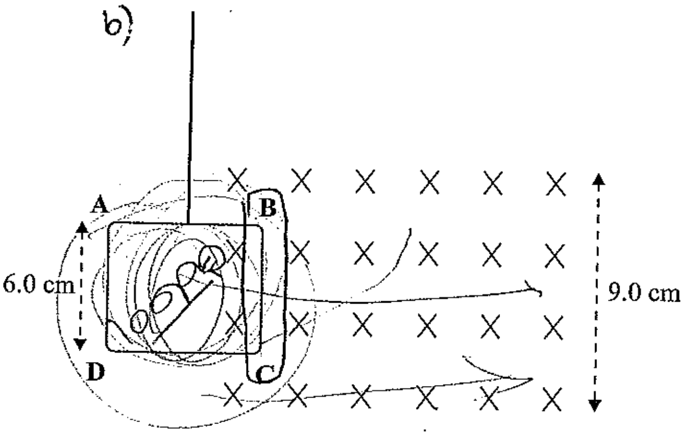
QUESTION TWO: THE ELECTROMAGNETIC SWING

conductor

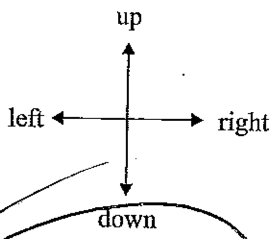
Monique builds a swing to show electromagnetic induction. It comprises a light rod, pivoted at the top so it can swing, and a loop of copper wire at the bottom. She places two strong magnets at the lowest point of the motion with opposite poles facing each other.] attraction

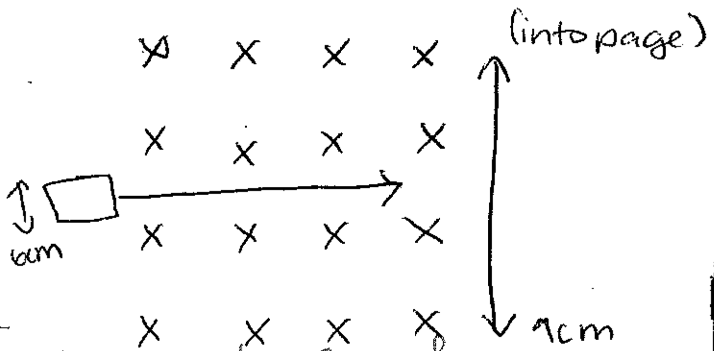
The diagrams below show the loop entering the magnetic field.





(a) Determine the direction of the force acting on **electrons** in the wire BC, due to their motion in the magnetic field.





Direction: upwards ↑

Incorrect use of rh rule.

(b) At the instant shown in the diagram, the voltage across the wire BC is 0.15 mV.

Calculate the speed of the wire loop. (through the Mg. field.) BC = 6cm 0.06m

The magnetic field strength is 3.0×10^{-3} T.

$B = 3.0 \times 10^{-3}$ T

$d = E \times V$

$d = 3.0 \times 10^{-3} \times 0.15$

$d = 4.5 \times 10^{-04}$

$d = 4.5$ m

$E = \frac{V}{d}$ $\quad \frac{V}{d} = E \times d$

$v = 3.0 \times 10^{-3} \times 4.5$

$v = 0.0135$ ms^{-1}

confused V for voltage for velocity

(c) Monique repeats the experiment, but starts the swing from a greater height. The speed of the loop at the point shown in the diagram is doubled.

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Explain what happens to the size of the current in the loop.

The current will increase as the velocity (speed) of the loop is doubled the current will increase as the loop is moving faster through the magnetic field and it is generating more magnetic and electrical energy interacting with other particles the current generated will increase.

a

(d) A short time later the whole loop is inside the magnetic field.

needed to support answer with evidence.

Write a comprehensive explanation about the current in the loop when the whole loop is in the magnetic field.

$IR = \frac{V}{R}$ $P = IV$ $IV = \frac{PT}{VT}$

Since now the whole loop is inside the magnetic field - to create an electric field an object or particle must be inserted - with movement between two polar magnets. This is done in this experiment and for the current in the loop to change there must be an increase in the magnetic field strength - there is! The increase is caused by the increased size of the object - and because the loop of copper wire is increased, when the whole loop is in, wire being a conductor it increases the voltage across the wires and increases the magnetic field strength as there is far more movement generating more power. Because of this increase in field strength and voltage the current in the loop will increase - as it is moving far more and is fully inside the magnetic field causing it to increase in strength.

n

N2

QUESTION THREE: THE SMOKE DETECTOR

ASSESSOR'S USE ONLY

Charge on an electron = -1.6×10^{-19} C

electric field.

One type of smoke detector comprises a pair of metal plates 4.8 mm apart, connected to a battery. Alpha particles from a radioactive source ionise particles of smoke between the plates. This causes the smoke particles to lose one or more electrons and become charged.

losing electrons when smoke is there it is to thick to stop and alpha stream stops causing the circuit to break = alarm!

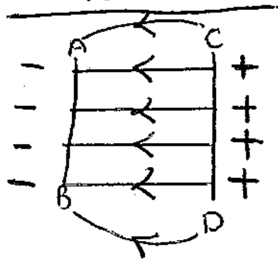
The diagram below shows a positively charged smoke particle. The force on the particle is towards AB.

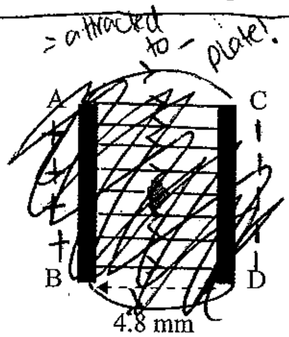
= attracted to - plate!

-tive

→ down.

a) Redrawn diagram!





= smoke particle.

(a) Draw lines showing the electric field between the plates.

Include the direction of the field lines.

G

The mass of the smoke particle is 1.7×10^{-7} kg

(b) A particular smoke particle loses two electrons. It then experiences a force of 5.88×10^{-16} N due to the electric field.

Calculate the strength of the electric field.

$F = Eq \quad Eq = F \rightarrow E = \frac{F}{q}$

$E = \frac{5.88 \times 10^{-16}}{(-1.6 \times 10^{-19}) \times 2} \quad E = -1837.5 \text{ NC}^{-1}$

M

(c) Maria brings a magnet close to the smoke detector. The magnet produces a magnetic field of strength 3.0×10^{-2} T, which, with reference to the diagram above, is directed into the page.

For ×××

State the size of the force due to the magnet on the stationary smoke particle.

Explain your answer.

Applied wrong concept

$F = Eq \quad F = 5.88 \times 10^{-16} + 3.0 \times 10^{-2} = 0.03\text{N}$

The force is small, this is because of the ~~magn~~ magnetic field now created there is no movement as the particle is stationary and even though it is positively charged there ~~dire~~ also needs to be ~~a force acting on the~~ movement for the magnetic field to increase and therefore the strength force to also increase.

r

$\frac{4.8}{2} = 2.4$

(d) The smoke particle becomes ionised by losing two electrons when it is 2.4 mm from plate AB.

ASSESSOR'S USE ONLY

Calculate the speed of the smoke particle when it reaches the plate AB.

Assume that only the electric force acts on the smoke particle.

~~Δfa~~ $E_p = (-1837.5) \times (1.7 \times 10^{-7}) \times (.4.8)$

Speed $= -1.4994 \times 10^{-03}$

$= 1.4994 \times 10^{-03}$

used mass of electron not the charge

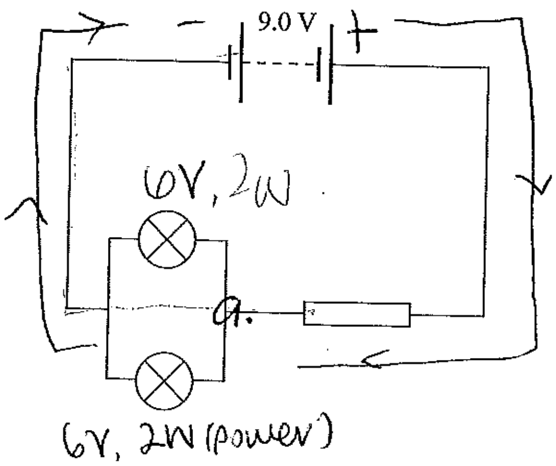
n

A4

QUESTION FOUR: CIRCUITS

Kahu has two identical lamps marked 6.0 V, 2.0 W. He wants to connect them to a 9.0 V battery. He realises that he will have to connect a resistor to reduce the voltage across the lamps.

He connects the circuit shown below.



(a) Calculate the current in each lamp when it is operating at its normal brightness.

$P = IV \quad I = \frac{P}{V} \quad I = \frac{2}{6}$ ~~I = 0.33A~~ $0.33\,A$

(b) Calculate the resistance of the resistor that he should use so that the lamps are at their normal brightness.

9-3=6V 3Ω resistor, as current

correct voltage

flows from positive to negative and the lamps ~~have~~ are 6V at normal brightness so 9-6 = 3 = 3Ω.

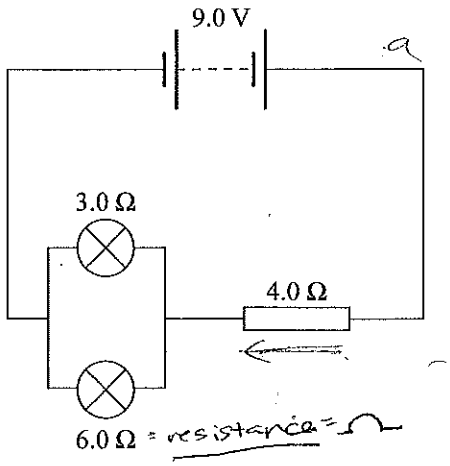
(c) What will happen to the current in the resistor if one lamp "blows"?

Explain your answer.

If one lamp blows the current in the resistor will remain the same as even though the current is divided when both lamps are working because of the parallelism in the series circuit once both wires connect again at a. (on diagram) the current combines to its original and that is what is in the resistor. Because in a parallel circuit there are alternat paths the current will all go through the working lamp and the same amount will flow through the resistor.

Kahu sets up a new circuit with different lamps and resistor, as shown in the diagram below.

ASSESSOR'S USE ONLY



(d) Calculate the voltage across the 4.0 Ω resistor.

~~V = IR Voltage = current~~

$V = IR$

$V = I\,(13)$

~~I = power / Voltage~~

$= 5\,V$

N2

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Achievement

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ASSESSOR'S USE ONLY

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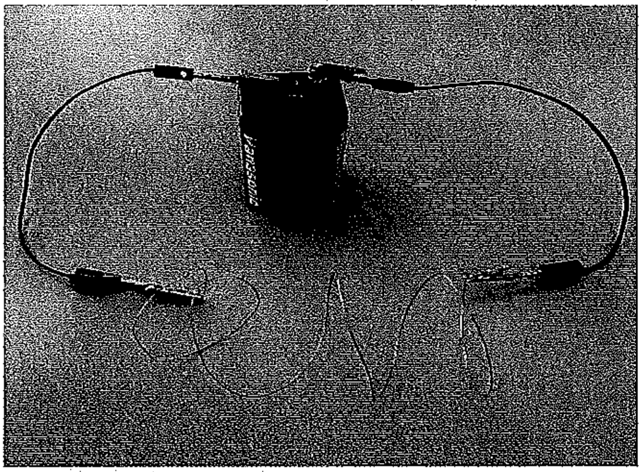


Assume that the connecting wires have no resistance.

(a) Calculate the strength of the electric field in the Nichrome resistance wire.

$E = \frac{V}{d} = \frac{6V}{1m} = 6Vm^{-1}$

g

(b) Explain what happens to the size of the electric force on an electron as it travels through the Nichrome resistance wire.

n

(c) Calculate the distance moved by an electron as it loses 9.6×10^{-20} J of electrical potential energy.

$d = \Delta E_P / E \times q$

$d = 9.6 \times 10^{-20} / 6Vm^{-1} \times -1.6 \times 10^{-19} C$

$d = 0.1 m$

m

(d) Hamish then adds another 6.0 V battery in series AND shortens the wire to 0.50 m.

Write a comprehensive explanation on what will happen to the size of the force on the electron.

Calculations are not needed.

When you add 6v and take off 0.5m of wire there is no change to the ~~E~~ electric field strength so therefore you are not making any changes to the ~~field~~ force on the electron. ~~you~~ The size of the force on the electron will remain the same.

Could not apply $E = \frac{V}{d}$.

ASSESSOR'S USE ONLY

n

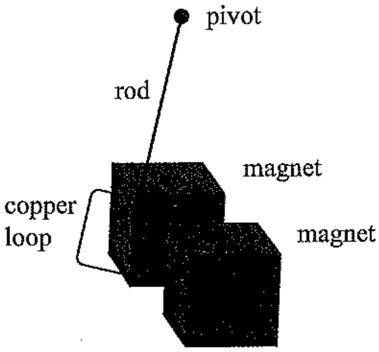
A4

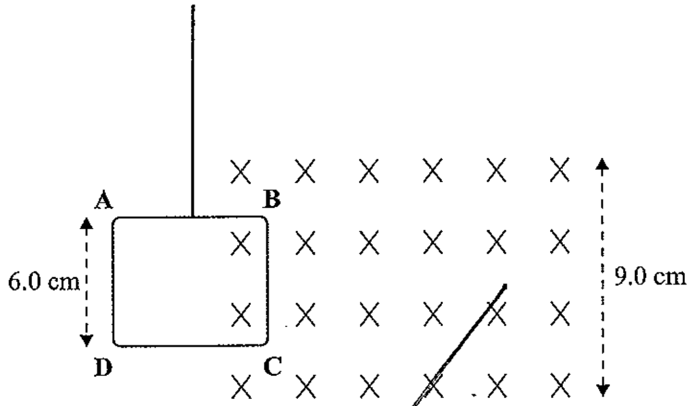
ASSESSOR'S USE ONLY

QUESTION TWO: THE ELECTROMAGNETIC SWING

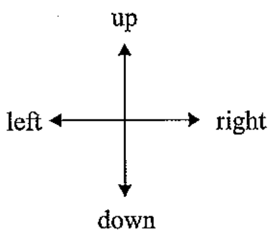
Monique builds a swing to show electromagnetic induction. It comprises a light rod, pivoted at the top so it can swing, and a loop of copper wire at the bottom. She places two strong magnets at the lowest point of the motion with opposite poles facing each other.

The diagrams below show the loop entering the magnetic field.





(a) Determine the direction of the force acting on **electrons** in the wire BC, due to their motion in the magnetic field.



Direction: up

incorrect use of rh rule.

(b) At the instant shown in the diagram, the voltage across the wire BC is 0.15 mV.

Calculate the speed of the wire loop.

The magnetic field strength is 3.0×10^{-3} T.

$V = BvL$

$v = \frac{V}{BL}$

$= \frac{0.00015}{0.003\text{T} \times 0.06\text{m}}$

$v = 0.83 \text{ ms}^{-1}$

(c) Monique repeats the experiment, but starts the swing from a greater height. The speed of the loop at the point shown in the diagram is doubled.

Explain what happens to the size of the current in the loop.

(d) A short time later the whole loop is inside the magnetic field.

Write a comprehensive explanation about the current in the loop when the whole loop is in the magnetic field.

ASSESSOR'S USE ONLY

A3

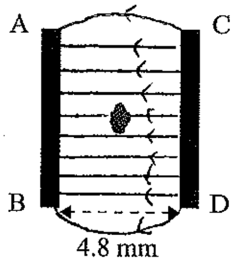
QUESTION THREE: THE SMOKE DETECTOR

ASSESSOR'S USE ONLY

Charge on an electron = -1.6×10^{-19} C

One type of smoke detector comprises a pair of metal plates 4.8 mm apart, connected to a battery. Alpha particles from a radioactive source ionise particles of smoke between the plates. This causes the smoke particles to lose one or more electrons and become charged.

The diagram below shows a positively charged smoke particle. The force on the particle is towards AB.



(a) Draw lines showing the electric field between the plates.

Include the direction of the field lines.

The mass of the smoke particle is 1.7×10^{-7} kg

(b) A particular smoke particle loses two electrons. It then experiences a force of 5.88×10^{-16} N due to the electric field.

Calculate the strength of the electric field.

$F = Eq$ $E = F/q$ $E = 5.88 \times 10^{-16}\text{ N} / 2(1.6 \times 10^{-19})$

$E = 1837\ NC^{-1}$

(c) Maria brings a magnet close to the smoke detector. The magnet produces a magnetic field of strength 3.0×10^{-2} T, which, with reference to the diagram above, is directed into the page.

State the size of the force due to the magnet on the stationary smoke particle.

Explain your answer.

$F = Bqv$

$F = 3.0 \times 10^{-2}\,T \times 3.2 \times 10^{-19}\,C$

could not use v=0 as stationary

(d) The smoke particle becomes ionised by losing two electrons when it is 2.4 mm from plate AB.

Calculate the speed of the smoke particle when it reaches the plate AB.

Assume that only the electric force acts on the smoke particle.

ASSESSOR'S USE ONLY

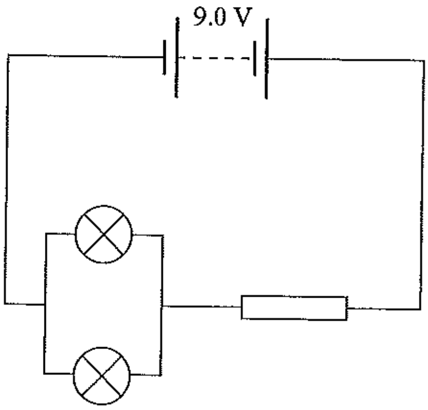
A4

QUESTION FOUR: CIRCUITS

ASSESSOR USE ONLY

Kahu has two identical lamps marked 6.0 V, 2.0 W. He wants to connect them to a 9.0 V battery. He realises that he will have to connect a resistor to reduce the voltage across the lamps.

He connects the circuit shown below.



(a) Calculate the current in each lamp when it is operating at its normal brightness.

$I = P/V$ $I = 1/3$ or 0.33 amps

$I = 2/6$

G

(b) Calculate the resistance of the resistor that he should use so that the lamps are at their normal brightness.

$R = V/I = 9v / 0.66A =$ ~~[illegible]~~ $13.5\,\Omega$

Found total current.

G

(c) What will happen to the current in the resistor if one lamp "blows"?

Explain your answer.

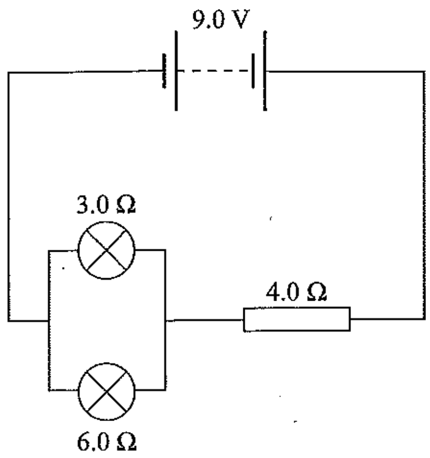
nothing will happen the current in the resistor. The resistor is in series with the two lamps ~~so the~~ but the lamps are in parrallel so the current will only have an effect on the other lamp.

N

Did not realise that changing part of the circuit alters the resistance and current

ASSESSOR'S USE ONLY

Kahu sets up a new circuit with different lamps and resistor, as shown in the diagram below.



(d) Calculate the voltage across the 4.0 Ω resistor.

~~[illegible]~~ in Series Voltage is Shared so

$\frac{1}{R_T} = \frac{1}{6} + \frac{1}{3}$ $\qquad \frac{4}{6} \times 9 = 6V$

$R_T = 2$

$R_T = 2 + 4 = 6\Omega$

The Voltage across the 4Ω Resistor is $6V$