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91526M

915265

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

SUPERVISOR'S USE ONLY

Ahupūngao, Kaupae 3, 2019

91526M Te whakaatu māramatanga ki ngā pūnaha hiko

2.00 i te ahiahi Rāapa 20 Whiringa-ā-rangi 2019
Whiwhinga: Ono

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā pūnaha hiko.	Te whakaatu māramatanga hōhonu ki ngā pūnaha hiko.	Te whakaatu māramatanga matawhānui ki ngā pūnaha hiko.

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

Tirohia mēnā kei a koe te Pukapuka Rauemi L3–PHYSMR.

Ki roto i ō tuhinga, whakamahia ngā whiriwhiringa tohutau mārama, ngā kupu, ngā hoahoa hoki, tētahi, ētahi rānei o ēnei, ki hea hiahiatia ai.

Me hoatu te wae tika o te Pūnaha Waeine ā-Ao (SI) ki ngā tuhinga tohutau, ki ngā tau tika o ngā tau tāpua.

Mēnā ka hiahia whārangi atu anō mō ō tuhinga, whakamahia te wāhi wātea kei muri o tēnei pukapuka.

Tirohia mēnā e tika ana te raupapatanga o ngā whārangi 2–21 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TAPEKE

MĀ TE KAIMĀKA ANAKE

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TŪMAHI TUATAHI: NGĀ KĀRI UTU PĀKORE

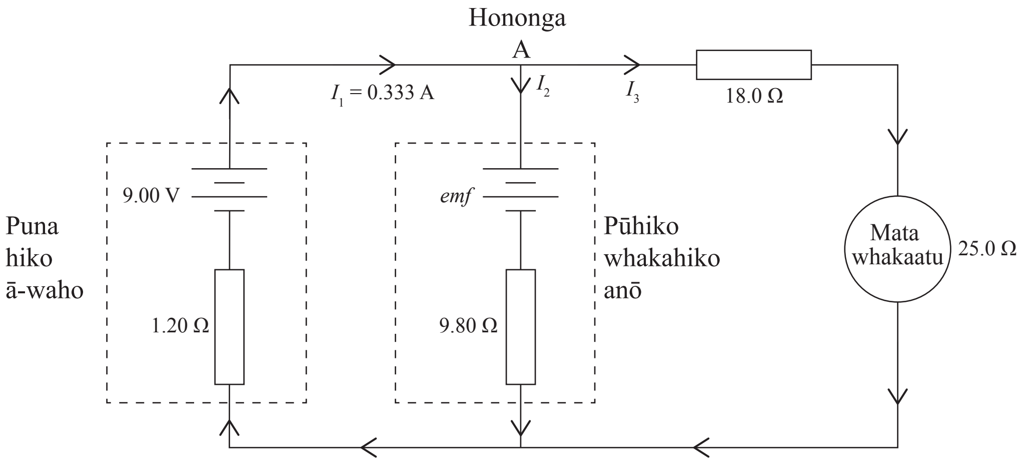
www.twitur.com/hashtag/cashquick

E whakamahia ana ngā pūnaha utu pākore pūkoro i ngā toa me ngā wharekai puta noa i Aotearoa.

Kei roto i te mīhini utu pūkoro tētahi pūhiko ka taea te whakahiko anō mā te whakahono ki tētahi puna hiko ā-waho 9.00 V DC. Ka heke te ngaohiko pīhono o te puna hiko ā-waho ki te 8.60 V DC ina toro te ara iahiko i te 0.333 A o te iahiko.

(a) Me whakaatu ko te parenga ā-roto o te puna hiko ā-waho he 1.20 Ω.

I te wā e whakahiko ana, e whakaatu ana te mīhini utu i tētahi tohu whakahiko ki te mata. E whakaatu ana te hoahoa i raro i tētahi tauira māmā o te ara whakahiko i tētahi wā kotahi i roto i te tukanga whakahiko anō.



(b) Mā te whakamahi i ngā ture a Kirchhoff, me whakatau i te emf o te pūhiko whakahiko anō i tēnei wā tonu.

Me uru ki tō otinga:

- tētahi whārite e whakaatu ana i te pānga i waenga i a I_1, I_2 me I_3 i te Hononga A
- he tātaitanga e whakaatu ana ko I_3 = 0.200 A.

QUESTION ONE: CONTACTLESS PAYMENT CARDS

ASSESSOR'S USE ONLY

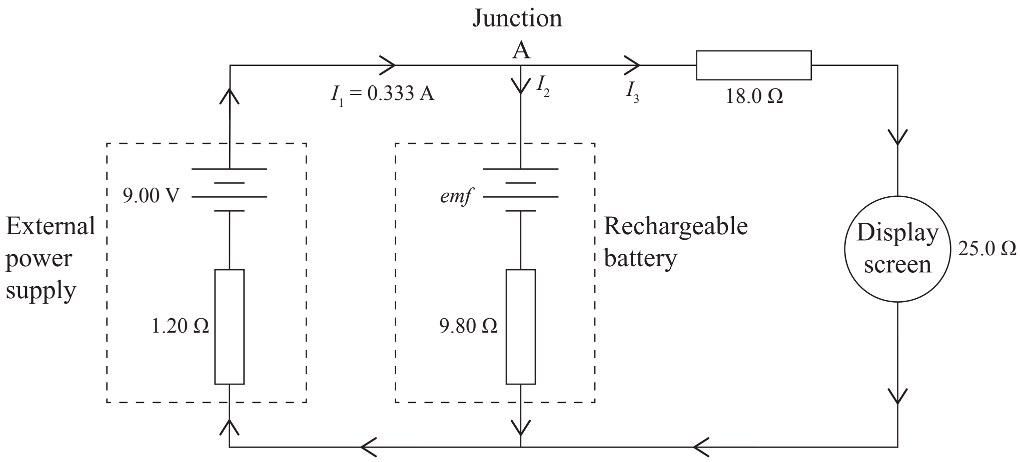
www.twitur.com/hashtag/cashquick

Mobile contactless payment systems are used in shops and restaurants throughout New Zealand.

The mobile payment machine contains a battery that can be recharged by connecting to an external 9.00 V DC power supply. The terminal voltage of the external power supply drops to 8.60 V DC when the circuit draws 0.333 A of current.

(a) Show that the internal resistance of the external power supply is 1.20 Ω.

While it is recharging, the payment machine displays a charging symbol on its screen. The diagram below shows a simplified model of the charging circuit at one moment in the recharging process.

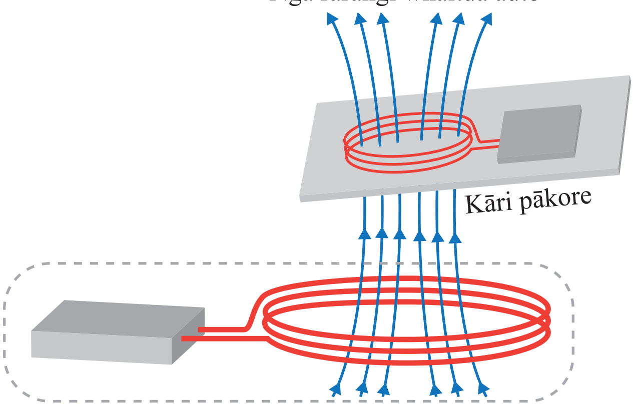


(b) Using Kirchhoff's laws, determine the emf of the rechargeable battery at this moment.

Your solution should include:

- an equation showing the relationship between I_1, I_2 and I_3 at Junction A
- a calculation to show that I_3 = 0.200 A.

Kāore he puna hiko ake o te ara iahiko i roto i te kāri pākore. E whākahatia ana e te poapoa mā te whakamahi i ētahi pōkai e rua: kotahi ki te kāri pākore, ā, kotahi ki te mīhini utu. E whakaaturia ana tētahi tauira māmā ki te hoahoa i raro.

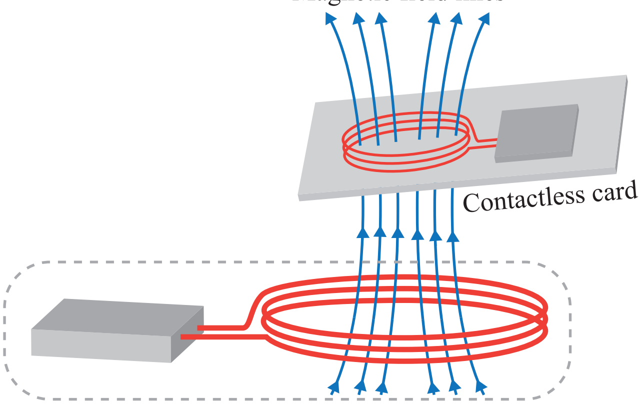


(c) Kei te pōkai poapoa o te mīhini utu tētahi auau iahiko hohoko o te 13.6×10^6 Hz.

Mā te whakamahi i ngā mātāpono ahupūngao, whakamāramahia mai he pēhea te poapoa i tētahi ngaohiko i roto i te pōkai o te kāri pākore ina raua kia tata atu ki te pōkai o te mīhini utu (kāore e hiahiatia ana he tātaitanga).

ASSESSOR'S USE ONLY

The circuit inside the contactless card does not have its own power source. It is powered by induction using a pair of coils: one in the contactless card and the other in the payment machine. A simplified model is shown in the diagram below.



(c) The payment machine's induction coil has an alternating current of frequency 13.6×10^6 Hz.

Using physics principles, explain how a voltage is induced in the coil of the contactless card when it is placed near the coil of the payment machine (no calculations required).

(d) I te auau o te 13.6×10^6 Hz, he 427 Ω te tauhohenga (reactance) o te pōkai poapoa o te kāri pākore. Kei roto i te ara iahiko o te kāri pākore ko tētahi pūnga iahiko i tūhonoa hātepetia ki te pōkai e kōwaro ai te ara iahiko ki tēnei auau anake.

- Tuhia ngā āhuatanga e pā mai ai te kōwaro.
- Tātaihia te āheipuringa (capacitance) e hiahiatia ana mō te kōwaro.

MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

(d) At the frequency 13.6×10^6 Hz, the contactless card's induction coil has a reactance of 427 Ω. The contactless card circuit contains a capacitor in series with the coil that causes the circuit to resonate only at this frequency.

- State the conditions under which resonance occurs.
- Calculate the capacitance that is needed for resonance.

TŪMAHI TUARUA: NGĀ KĒTI AUNOA

Whakamahia anō ai ngā koropewa poapoa (inductive loops) kia rongo ai i ngā waka. Ko ngā koropewa poapoa he pōkai waea kei roto i te mata o te rori, ā, e whakahikotia ana e tētahi puna AC ko te ngaohiko me te auau e mōhiotia ana.

www.exhibitorlist.co.uk/vision-london-2015/exhibitors.php?OSECid=21d7a0e2d99836190e5336fa549618e6

www.picswe.com/pics/induction-loop-detector-diagram-3a.html

He 4.00 Ω te parenga o tētahi koropewa poapoa ake, ā, e whakahikotia ana e tētahi puna hiko AC 24.0 V_{RMS}, 1.20×10^2 Hz. Ko te hanga o te koropewa he tapawhā hāngai 1.60 m × 0.600 m, me ngā pōkai waea e toru.

(a) Tātaihia te ngaohiko nui rawa o tēnei puna hiko.

(b) Ko te kaha o te whaitua autō i roto i te koropewa he 0.0413 T

Tātaihia te ngaorere autō mōrahi kei ia pōkai waea o ngā pōkai e toru o te koropewa poapoa.

ASSESSOR'S USE ONLY

QUESTION TWO: AUTOMATIC GATES

Inductive loops are also used to sense the presence of cars. Inductive loops are wire coils embedded into the surface of the road, and are powered by an AC supply of known voltage and frequency.

www.exhibitorlist.co.uk/vision-london-2015/exhibitors.php?OSECid=21d7a0e2d99836190e5336fa549618e6

www.picswe.com/pics/induction-loop-detector-diagram-3a.html

One particular inductive loop has 4.00 Ω of resistance and is powered by a 24.0 V_{RMS}, 1.20×10^2 Hz AC power supply. The loop is a 1.60 m × 0.600 m rectangular shape, with three coils of wire.

(a) Calculate the peak voltage of this power supply.

(b) The strength of the magnetic field inside the loop is 0.0413 T

Calculate the maximum magnetic flux in each of the three coils of wire of the inductive loop.

Ina wīrahia e tētahi motokā te koropewa poapoa, ka paheko te maitai o te tinana o te motokā me te mīhini ki te whaitua autō o te koropewa poapoa. Ko te pānga whānui o tēnei pahekotanga he whakaheke i te poapoatanga o te koropewa.

(c) Whakamāramahia mai te pānga o te hekenga o te poapoatanga (inductance) ki te iahiko kei te ara iahiko.

(d) Ko te poapoatanga hou he 5.00×10^{-3} H.

Whakatauhia te iahiko RMS kei te ara iahiko.

When a car drives over the inductive loop, the steel in the car's body and engine interacts with the magnetic field of the inductive loop. The overall effect of this interaction is to reduce the inductance of the loop.

ASSESSOR'S USE ONLY

(c) Explain the effect decreased inductance would have on current in the circuit.

(d) The new inductance is 5.00×10^{-3} H.

Determine the RMS current in the circuit.

TŪMAHI TUATORU: TE TATAU MOTOKĀ

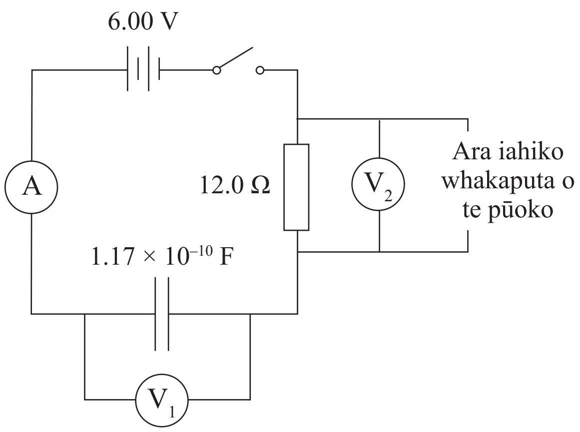
MĀ TE KAIMĀKA ANAKE

http://ciudadanosenred.com.mx/movilidad-lo-que-no-sabias-sobre-los-topes/ https://parkomate.com/

Ka whakamahia ngā pūnga iahiko i whakaurua ki ngā rapa o ngā tuapuku whakaheke tere kia rongo ai i te maha o ngā motokā e kuhu ana, e puta ana i ngā whare tūnga waka. Kei tētahi pūnga iahiko i roto i te tuapuku whakaheke tere ko ngā pereti maitai 0.687 m^2 e rua. Mēnā kāore he motokā, ka wehea ngā pereti mā te 0.0519 m o te hau takiwā ($\mathcal{E}_r = 1.00$).

(a) Me whakaatu ko te āheipuringa (capacitance) o te pūnga iahiko he 1.17×10^{-10} F.

E whakahono ana te pūnga iahiko ki tētahi arahiko rongo e ai ki te whakaaturanga i raro:



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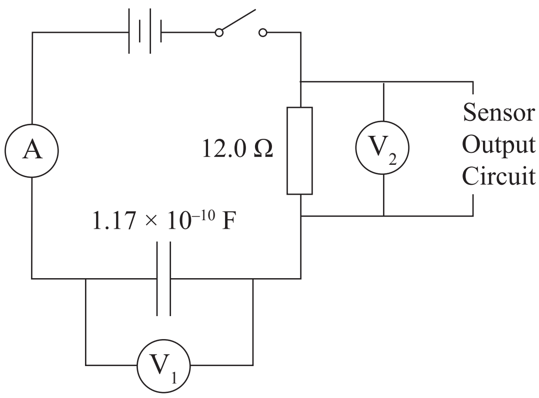
QUESTION THREE: COUNTING CARS

http://ciudadanosenred.com.mx/movilidad-lo-que-no-sabias-sobre-los-topes/ https://parkomate.com/

Capacitors built into rubber speed bumps can be used to sense the number of cars entering and leaving parking buildings. One particular speed bump capacitor consists of two 0.687 m^2 metal plates. When no car is present, the plates are separated by 0.0519 m of air ($\mathcal{E}_r = 1.00$).

(a) Show that the capacitance of the capacitor is 1.17×10^{-10} F.

The capacitor is connected to a sensing circuit as shown below:



MĀ TE KAIMĀKA ANAKE

Ina kati ana te pana, ka tīmata te rere o te iahiko me te whakahiko i ngā pereti pūnga iahiko.

(b) Tuhia he kauwhata hei whakaatu he pēhea te huri o te iahiko mai i te wā ka katia te pana ki te wā kua tino whakahikotia te pūnga iahiko.

Me whakauru ko ngā uara i tātaihia mō ngā pūwāhi raraunga e rua i te iti rawa.

Ki te hiahia koe ki te tuhi anō i tēnei kauwhata, whakamahia te tukutuku i te whārangi 18.

Ina oti te whakahiko katoa i te pūnga iahiko, ka hipa te motokā i te tuapuku whakaheke tere. Ka pēhia e te taumaha o te motokā ngā pereti pūnga iahiko kia piritata, e piki ai te āheipuringa ki te 2.30×10^{-10} F.

Me kī, kāore he rerekētanga ki te rahinga o te whana kei ia pereti i tēnei wā.

(c) Me whakaatu ko te ngaohiko o te pūnga iahiko i tēnei wā he 3.05 V.

Ka haere tonu te Tūmahi Tuatoru i te whārangi 16.

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When the switch is closed, current will begin to flow and charge the capacitor plates.

(b) Sketch a graph to show how the current changes from when the switch is closed to when the capacitor is fully charged.

Calculated values for at least two data points should be included.

If you need to redraw this graph, use the grid on page 19.

After the capacitor has been fully charged, a car passes over the speed bump. The weight of the car pushes the capacitor plates closer together, increasing the capacitance to 2.30×10^{-10} F.

Assume the amount of the charge on each of the plates at this moment is unchanged.

(c) Show that the voltage of the capacitor at this moment is 3.05 V.

Question Three continues on page 17.

(d) Whakamāramahia mai te pānga o te ngaohiko hou o te pūnga iahiko ki ngā pānuitanga i hopukia e te ine-iahiko me te ine-ngaohiko 2 i muri tonu mai i te pēhitanga o ngā pereti pūnga iahiko kia piri.

Tātaihia te mōrahi iahiko e rere ana i te ara iahiko.

MĀ TE KAIMĀKA ANAKE

(d) Explain the effect the new capacitor voltage will have on the readings recorded by the ammeter and voltmeter 2 immediately after the capacitor plates are pushed together.

Calculate the maximum current through the circuit.

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MĀ TE KAIMĀKA ANAKE

HE HOAHOA TĀPIRI

Ki te hiahia koe ki te tuhi anō i tō hoahoa mai i te Tūmahi Tuatoru (b), tuhia ki raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.

SPARE DIAGRAMS

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If you need to redraw your graph from Question Three (b), draw it below. Make sure it is clear which answer you want marked.

He whārangi anō ki te hiahiatia.
Tuhia te (ngā) tau tūmahi mēnā e tika ana.

TAU TŪMAHI

MĀ TE KAIMĀKA ANAKE

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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English translation of the wording on the front cover

Level 3 Physics, 2019

91526 Demonstrate understanding of electrical systems

2.00 p.m. Wednesday 20 November 2019
Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of electrical systems.	Demonstrate in-depth understanding of electrical systems.	Demonstrate comprehensive understanding of electrical systems.

91526M

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 Booklet L3–PHYSMR.

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

Numerical answers should be given with an SI unit, to an appropriate number of significant figures.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–21 in the correct order and that none of these pages is blank.

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