See back cover for an English translation of this cover

3

91526M

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

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Tohua tēnei pouaka mēnā KĀORE koe i tuhi kōrero ki tēnei pukapuka

Mātai Ahupūngao, Kaupae 3, 2022

91526M Te whakaatu māramatanga ki ngā pūnaha hiko

Ngā whiwhinga: E ono

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā pūnaha hiko.	Te whakaatu i te hōhonu o te māramatanga ki ngā pūnaha hiko.	Te whakaatu i te tōtōpū o te māramatanga ki ngā pūnaha hiko.

Tirohia kia kitea ai 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.

I ō tuhinga, whakaatuhia kia mārama ngā whiriwhiringa tohutau, ngā kupu, ngā hoahoa hoki/rānei, ki ngā wāhi me pērā.

Me hoatu te wae tika o te Pūnaha o te Ao (SI) ki ngā whakautu tohutau, ki ngā tau tika o ngā tau tāpua.

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

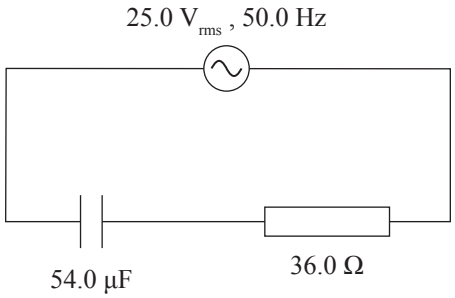
Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2 – 15 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (⁘). Ka poroa pea taua wāhanga ka mākahia ana te pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TE TŪMAHI TUATAHI: NGĀ ARA IAHIKO AC

E tūhuratia ana e George ngā ara iahiko AC. Ka tūhonoa e ia tētahi pūnga iahiko e 54.0 μF (54.0×10^{-6} F) ki tētahi parenga iahiko e 36.0 Ω me tētahi puna hiko AC e 25.0 V_{rms}, 50.0 Hz, e whakaaturia ana i te hoahoa o raro iho nei.



(a) Whakaaturia mai ko te 58.9 Ω te tauhohenga o te pūnga iahiko.

(b) Tātaihia te iahiko o te ara.

(c) Tātaihia te rerekētanga o ngā ngaru i waenganui i te ngaohiko me te iahiko o te ara mō te ara e whakaaturia ana i whārangi 2. Tuhia mai te mea o mua.

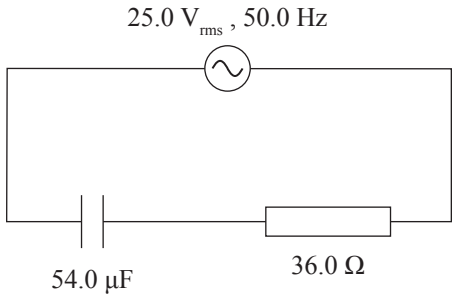
E pai ana tō tā i tētahi hoahoa koki pānga ki te wāhi ki raro nei.

(d) Whakamāramahia mai te āhua o tā te āpiti i tētahi pūkōpana ki te ara iahiko parenga-pūnga whai puna hiko AC tiori i te ara.

Tīmataria tō tuhinga mā te whakamārama i te tikanga o te tioritanga i roto i te ara iahiko.

QUESTION ONE: AC CIRCUITS

George is investigating AC circuits. He connects a 54.0 μF (54.0×10^{-6} F) capacitor in series with a 36.0 Ω resistor and a 25.0 V_{rms}, 50.0 Hz AC supply, as shown in the diagram below.

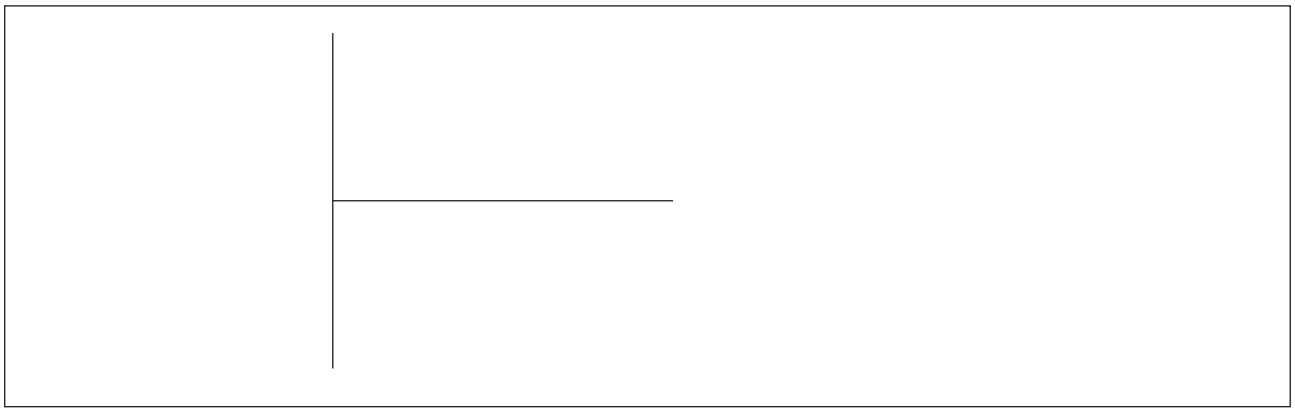


(a) Show that the reactance of the capacitor is 58.9 Ω.

(b) Calculate the circuit current.

(c) Calculate the phase difference between the supply voltage and the circuit current for the circuit shown on page 4. State which one leads.

You may draw a phasor diagram in the space below.



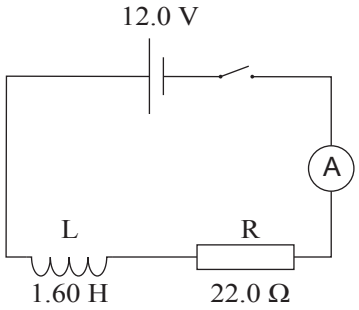
(d) Explain how the addition of a suitable inductor to the resistor-capacitor circuit with the AC supply, can make the circuit resonate.

Begin your answer by explaining the meaning of resonance in a circuit.

TE TŪMAHI TUARUA: TE AUTŌHIKO

E tūhuratia ana e David ngā pūkōpana me ngā autō.

Ka whakamahi ia i tētahi pūkōpana 1.60 H, 22.0 Ω, ka tūhonotia ai ki tētahi puna hiko 12.0 V. E taea ana te kī, he pūkōpana e hātepetia ana me tētahi parenga iahiko te pūkōpana, e whakaaturia ana i te hoahoa o raro nei.



(a) Tātaihia te iahiko o te ara i muri i ngā **aumou wā e rua**, ka katia rawatia te panahiko, ka tīmata ana hoki te rere o te iahiko.

(b) Tuhia mai te ngaohiko puta noa i te pūkōpana me te ngaohiko puta noa i te parenga iahiko ka rōnaki ana te iahiko.

Te ngaohiko puta noa i te pūkōpana = _____

Te ngaohiko puta noa i te parenga iahiko = _____

(c) Kia eke rawa te iahiko ki tētahi uara rōnaki, ka huakina te panahiko, ka heke iho hoki te iahiko ki te kore i te 2.50×10^{-2} s.

Tātaihia te rahi o te ngaohiko poapoa e toharite ana.

Tuhia mai te ahunga o te ngaohiko poapoa puta noa i te pūkōpana.

(d) Ka whakakapia te parenga iahiko e 22.0 Ω ki tētahi parenga iahiko e 44.0 Ω, ka katia ai te panahiko.

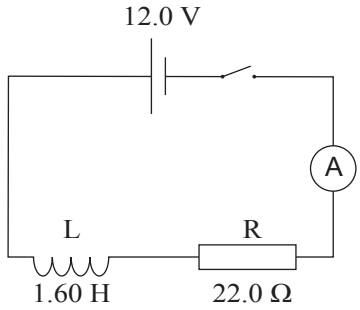
Whakamāramahia mai, mā te whakatairite ā-rahi nei (te maha), ngā panonitanga ka puta mō:

- te rahi o te iahiko mōrahi mai i te ara iahiko
- te pūmau o te wā
- te pūngao ka puritia i roto i te pūkōpana kia rōnaki rā anō te iahiko.

QUESTION TWO: ELECTROMAGNETISM

David is investigating inductors and magnets.

He uses a 1.60 H, 22.0 Ω inductor, and connects it to a 12.0 V power supply. The inductor can be considered as a pure inductor in series with a resistor, as shown in the diagram below.



(a) Calculate the circuit current **after two time constants**, once the switch is closed and current begins to flow.

(b) State the voltage across the pure inductor and the voltage across the resistor once the current is steady.

Voltage across the pure inductor = _____

Voltage across the resistor = _____

(c) Once the current has reached a steady value, the switch is opened, and current falls to zero in 2.50×10^{-2} s.

Calculate the size of the average induced voltage.

State the direction of the induced voltage across the inductor.

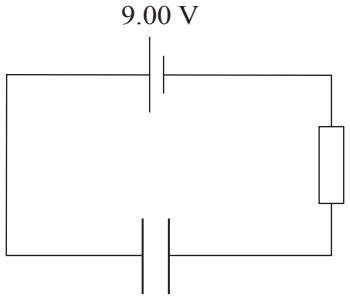
(d) The 22.0 Ω resistor is replaced with a 44.0 Ω resistor, and the switch is then closed.

Explain, by comparing quantitatively (how much), the changes that will take place for:

- the size of the maximum current drawn from the circuit
- the time constant
- the energy stored in the inductor once the current is steady.

TE TŪMAHI TUATORU: NGĀ PŪNGA IAHIKO I NGĀ ARA IAHIKO DC

E whakahaere ana a Anne i ētahi whakamātautau e whakamahi ana i ngā papana-whakarara maitai hei tūhura i ngā pūnga iahiko. Ka tūhonotia e ia ngā papana maitai e rua, ko te 0.160 m^2 te horahanga, ki tētahi ara iahiko DC e 9.00 V.



Ngā papana maitai

Ko ngā papana o te pūnga iahiko e kī ana i te hau takiwā ($\varepsilon_{air} = 1.00$) kua 1.00×10^{-3} m te tawhiti o tētahi i tētahi.

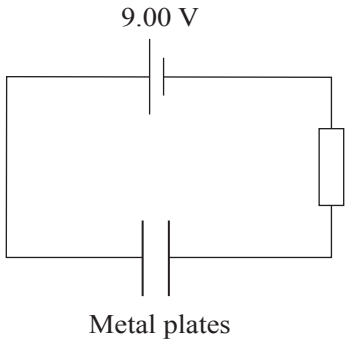
(a) Whakaaturia mai ko te 1.42×10^{-9} F te āheipuringa o te pūnga iahiko.

(b) (i) Tātaihia te pūngao e puritia ana i roto i te pūnga iahiko ka oti ana te whakahiko.

(ii) Whakaahuatia te pānga o te whakaurunga o tētahi hīti maeka, e 7.00 te pūmau o te pūkawe-kore, ki waenganui i ngā papana pūnga iahiko ki te pūngao e puritia ana i roto i te pūnga iahiko.

QUESTION THREE: CAPACITORS IN DC CIRCUITS

Anne is carrying out some experiments using parallel metal plates to investigate capacitors. She takes a pair of metal plates with an area of 0.160 m^2 and connects them to a 9.00 V DC supply.



The plates of the air-filled capacitor ($\varepsilon_{air} = 1.00$), are separated by a distance of 1.00×10^{-3} m.

(a) Show that the capacitance of the capacitor is 1.42×10^{-9} F.

(b) (i) Calculate the energy stored in the capacitor once it is fully charged.

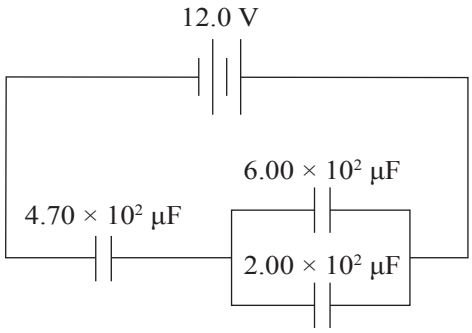
(ii) Describe the effect on the energy stored in the capacitor when a sheet of mica with relative permittivity of 7.00 is introduced between the capacitor plates.

(c) Kātahi ka momotu a Anne i ngā papana mai i te puna hiko DC e 9.00 V kia tūhāhā ā-hiko ai ngā papana. Kātahi ia ka whakawehe i ngā papana.

Whakamāramahia mai te hua ka pā ki te:

- whana kei ngā papana
- ngaohiko puta noa i ngā papana.

(d) Kātahi a Anne ka whakamātau i te tūhono i ngā pūnga iahiko rerekē, kia hātepe, kia whakarara hoki, puta noa i te puna 12.0 V, e whakaaturia ana i te hoahoa o raro nei.



Tātaihia te ngaohiko puta noa i te pūnga iahiko e 4.70×10^2 μF.

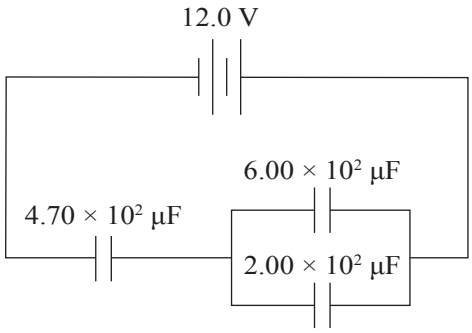
Tīmataria tō whakautu mā te tātai i te tapeke o te āheipuringa.

(c) Anne then disconnects the plates from the 9.00 V DC supply, so that the plates are electrically isolated. She then pulls the plates apart.

Explain what would happen to:

- the charge on the plates
- the voltage across the plates.

(d) Anne then experiments with connecting some different capacitors, in series and in parallel, across a 12.0 V supply, as shown in the diagram below.



Calculate the voltage across the 4.70×10^2 μF capacitor.

Begin your answer by calculating the total capacitance.

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

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

QUESTION NUMBER

English translation of the wording on the front cover

Level 3 Physics 2022

91526M Demonstrate understanding of electrical systems

Credits: Six

91526M

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.

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 – 15 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (//). This area may be cut off when the booklet is marked.

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