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See back cover for an English translation of this cover.

3

91524M

915245

Tuhia he (☒) ki te pouaka mēnā kāore koe i tuhi kōrero ki tēnei puka

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Te Mātai Ahupūngao, Kaupae 3, 2024

91524M Te whakaatu māramatanga ki ngā pūnaha pūhanga

Ngā whiwhinga: E ono

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

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.

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

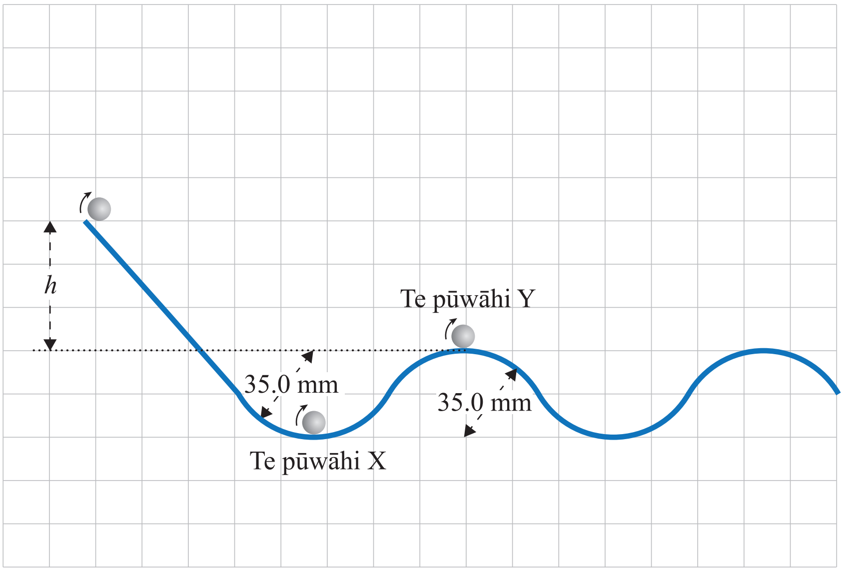
Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–19 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki ngā paenga (⁄⁄⁄). Ka poroa taua wāhanga ka mākahia ana te pukapuka.

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

TE TŪMAHI TUATAHI: TE NEKE POROTAKA ME TE NEKE HURIHANGA

I tukua tētahi poi maitai, e 7.00 mm tōna pūtoro, 11.2 g tōna papatipu i ngā teiteitanga rerekē i tētahi ara maitai. Ka pīrori ki raro ka rere atu ai i ētahi puku. Ko te 35.0 mm te pūtoro o ia pito o runga me te pito o raro.



KĀORE i tuhia ā-āwhatatia te hoahoa

(a) I tētahi whakamātautau, i te taunga o te poi maitai ki te pito o raro o te auheke tuatahi, ko te 0.850 m s^{-1} tōna tere whaiahu.

Tātaihia te tere whaiahu ā-koki o te poi maitai i tana taunga ki te pito o raro o te auhekenga tuatahi (Te pūwāhi X).

(b) Whakaaturia mai ko te 0.586 m s^{-1} te tere mōrahi e pā tonu ai te poi maitai ki te ara ka whakawhiti ana i te puku tuatahi, i Te pūwāhi Y.

Ko te 35.0 mm te pūtoro o te puku.

QUESTION ONE: CIRCULAR AND ROTATIONAL MOTION

A solid steel ball bearing with a radius of 7.00 mm and a mass of 11.2 g is released from different heights on a steel track. It rolls down and then travels over a series of bumps. Each bump and dip has a radius of 35.0 mm.

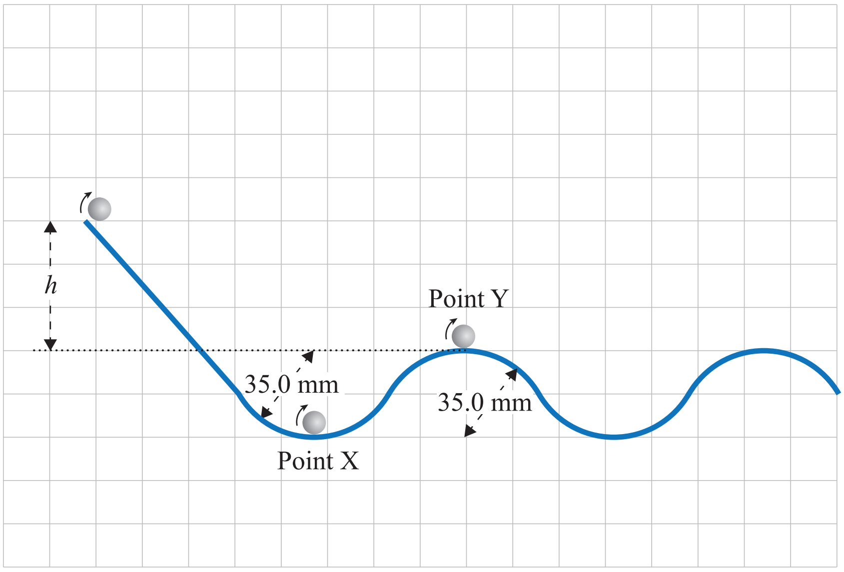


Diagram is NOT to scale

(a) In one trial, the ball bearing reaches the bottom of the first dip with a velocity of 0.850 m s^{-1}.

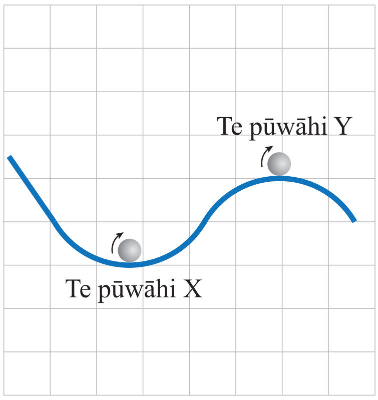
Calculate the angular velocity of the ball bearing when it is at the bottom of the first dip (Point X).

(b) Show that the maximum speed is 0.586 m s^{-1} in order for the ball bearing to remain in contact with the track while going over the bump, at Point Y.

The bump has a radius of 35.0 mm.

(c) Whakatairitea ngā tōpana e whai pānga ana i te wāhanga o runga (Te pūwāhi Y) me te wāhanga o raro (Te pūwāhi X) o ia puku, ā, nā konā, whakamāramahia te āhua o te rerekētanga o te tōpana tapeke i aua pūwāhi.

Ka whai hua ētahi hoahoa tōpana whai tapanga hei tautoko i tō tuhinga.



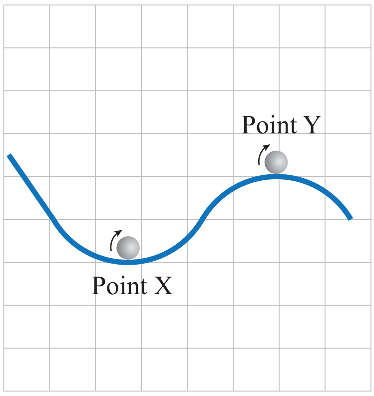
Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te hoahoa kei te whārangi 14.

(d) Mā roto mai i te whai whakaaro ki te panonitanga o te ngao, tātaihia te teitei mōrahi, te h, i runga ake o te puku tuatahi (Te pūwāhi Y) e tukua tuatahitia ai te poi maitai e pūmau tonu ai te noho ki te ara ka rere ana te poi i ngā puku.

He poi totoka te poi maitai, ka mutu, ko tōna tūpuku hurihanga, ko te $I = \frac{2}{5}mr^2$.

(c) Compare the forces acting at the top (Point Y) and bottom (Point X) of each bump, and hence explain how the net force varies in these positions.

Labelled force diagrams will be useful in supporting your answer.

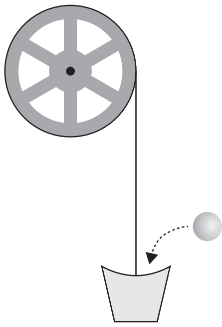


If you need to redraw your response, use the diagram on page 15.

(d) By considering energy changes, calculate the maximum height, h, above the top of the first bump (Point Y) that the ball bearing can be initially released from if it is to remain in contact with the track as it travels over the bumps.

The ball bearing is a solid sphere, and has rotational inertia given by $I = \frac{2}{5}mr^2$.

TE TŪMAHI TUARUA: TE NEKE HURIHANGA



Ka hoatu tētahi poi hahaupōro, ko te 0.0460 kg tōna papatipu ki roto i tētahi kapu māmā kua āpitihia ki tētahi tōhito, ko te 0.220 m tōna whitianga, kātahi ka heke whakararo, ā, ko tōna tere pūmau, ko te 1.83 m s^{-2}.

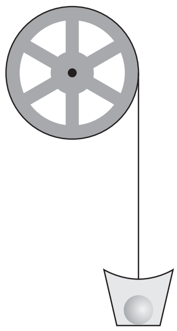
(a) Whakaaturia mai ko te whakaterenga ā-koki o te tōhito, ko te 16.6 rad s^{-2}.

(b) Mēnā ka tū te kapu me te poi i te tīmatanga, ka 0.750 m ai te hekenga, tātaihia te tere whaiahu ā-koki whakamutunga o te tōhito.

(c) Tātaihia te tūpuku hurihanga o te tōhito.

Tīmataria tō tuhinga mā te tātai i te tōpana e whakatere ana i te tōhito.

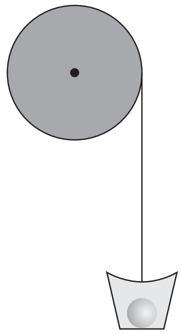
Ka whai hua pea tētahi hoahoa o ngā tōpana katoa ka pā ki tētahi hanga hei tātai i te renarena o te taura.



te hoahoa o ngā tōpana katoa ka pā ki tētahi hanga

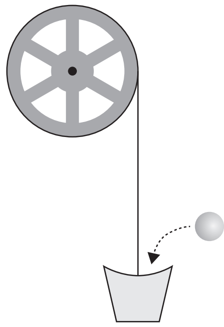
Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te hoahoa kei te whārangi 14.

(d) Whakamāramatia mai te āhuatanga o te tere whakamutunga o te poi me te kapu mēnā ka whakakapia te tōhito ki tētahi kōpae totoka e ōrite ana te pūtoro me te papatipu ki ō te tōhito.



QUESTION TWO: ROTATIONAL MOTION

A golf ball of mass 0.0460 kg is placed into a light cup that is attached to a flywheel, diameter 0.220 m, and begins to accelerate downwards at a constant rate of 1.83 m s^{-2}.



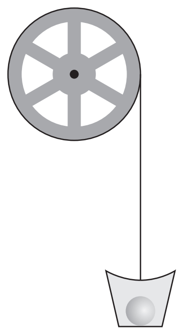
(a) Show that the angular acceleration of the flywheel is 16.6 rad s^{-2}.

(b) If the ball and cup start from rest and fall through a distance of 0.750 m, calculate the final angular velocity of the flywheel.

(c) Calculate the rotational inertia of the flywheel.

Begin your answer by calculating the force that is causing the flywheel to accelerate.

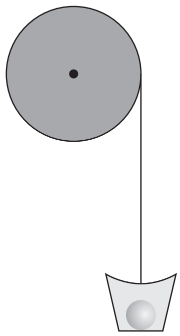
A free-body force diagram may assist you in calculating the tension in the string.



free-body force diagram

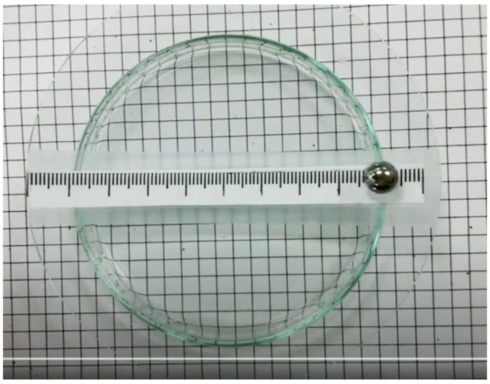
If you need to redraw your response, use the diagram on page 15.

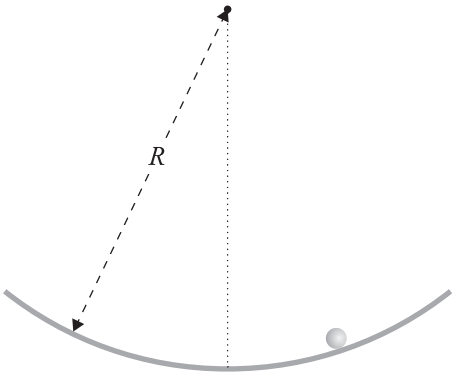
(d) Explain what will happen to the final velocity of the ball and cup if the flywheel is replaced with a solid disc of the same radius and mass as that of the flywheel.



TE TŪMAHI TUATORU: TE NEKE TĪREMI MĀMĀ

Ka tukua tētahi poi maitai i tētahi kōpae kōata, ka tīremi tana pīrori, ā, ko te neke tīremi māmā tēnei. Ko te kōpae kōata, he pāpaku, he haurua porowhita hoki te āhua o te kōata kumete, ā, ko te pūtoro o tōna ānau, ko te *R*.

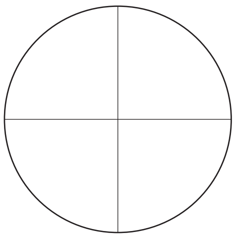




(a) Kōrerotia ngā āhuatanga e rua me mātua puta kia kīia ai he neke tīremi māmā te āhua o te neke o te poi maitai.

(b) Ka tukua te poi maitai i te 0.0400 m kei te pito whakatematau o tōna taunga māori, ka neke kōpiupiu ai i ia 0.882 s.

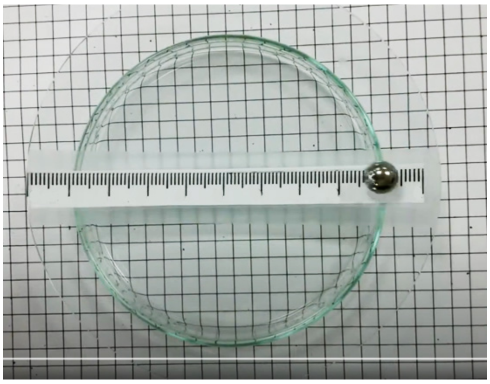
Mā te whakamahi i ngā porowhita tohutoro, mā ara kē atu rānei, tātaihia te peinga o te poi maitai ā muri i te 1.20 hākona.

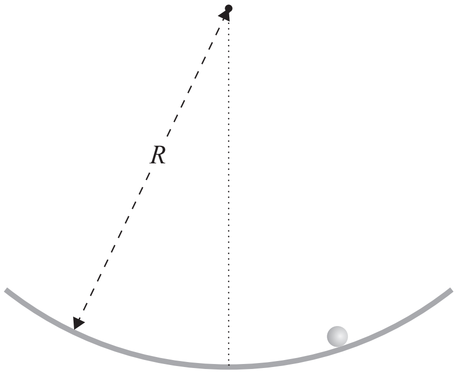


Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te hoahoa kei te whārangi 14.

QUESTION THREE: SIMPLE HARMONIC MOTION

A ball bearing is released on a watch glass, and rolls back and forth with simple harmonic motion. The watch glass is a shallow, semi-circular glass bowl with a radius of curvature, *R*.

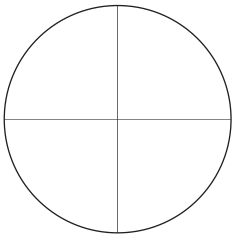




(a) State the two conditions necessary for the ball bearing to be considered to be moving with simple harmonic motion.

(b) The ball bearing is released 0.0400 m from the right of the equilibrium position, and oscillates with a time period of 0.882 s.

Using reference circles or otherwise, calculate the displacement of the ball bearing after 1.20 seconds.

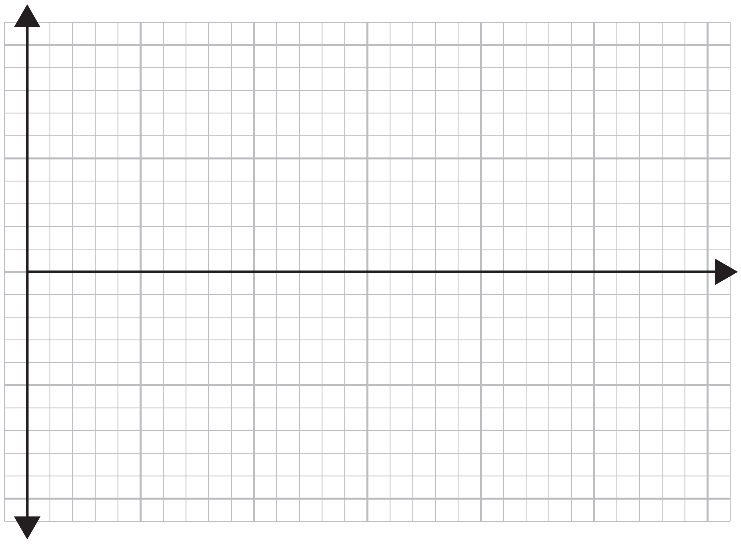


If you need to redraw your response, use the diagram on page 15.

(c) Nāwai, nāwai, ka tau te poi maitai.

Mā te whakamahi i ngā tuaka o raro nei, tuhia tētahi kauwhata whai tapanga o te hāngai o te peinga me te wā i ngā kōpiupiunga e rima.

Me whai wāhi ngā uara o te peinga me te wā.



Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te hoahoa kei te whārangi 16.

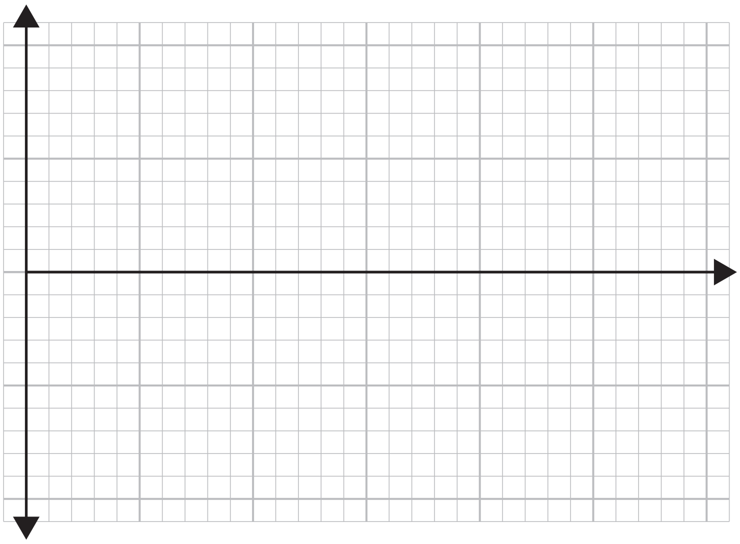
(d) Tapaina tēnei tūāhuatanga, ka whakamārama ai ki ngā taipitopito te take ka tau te poi maitai ā tōna wā.

Taunakihia tō tuhinga ki ngā ture tātai e hāngai ana.

(c) Eventually, the ball bearing comes to rest.

Using the axes provided, draw a labelled graph of the displacement vs time for five complete oscillations.

Include values for displacement and time.



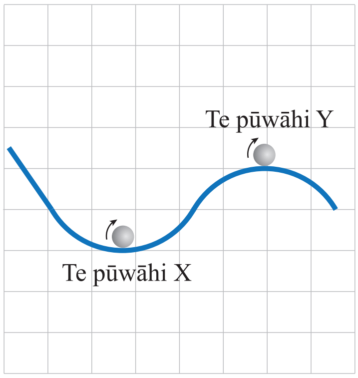
If you need to redraw your response, use the diagram on page 16.

(d) Name this phenomenon, and explain in detail why the ball bearing eventually comes to rest.

Support your answer with any relevant formulae.

HE HOAHOA WĀTEA

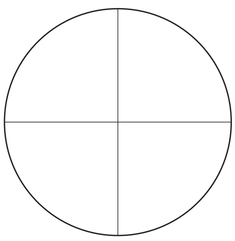
Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatahi (c), whakamahia te hoahoa i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.



Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuarua (c), whakamahia te wāhi i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.

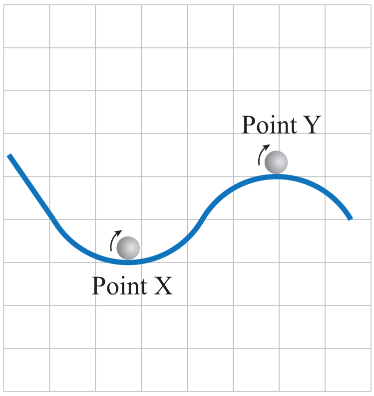
te hoahoa o ngā tōpana katoa ka pā ki tētahi hanga

Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatoru (b), whakamahia te porowhita tohutoro i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.

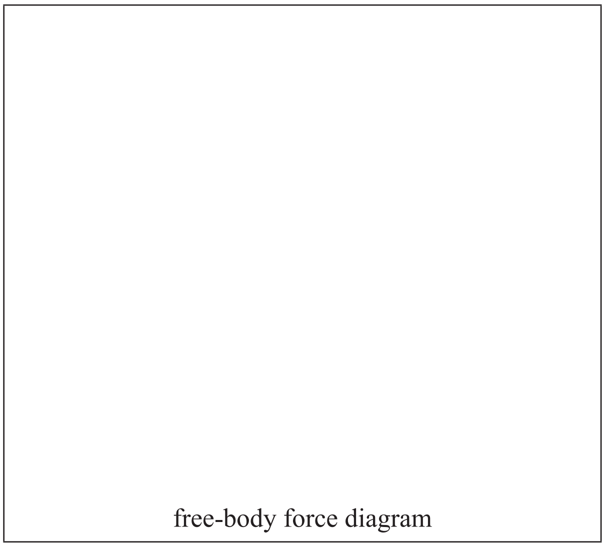


SPARE DIAGRAMS

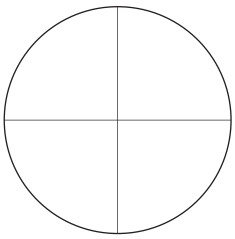
If you need to redraw your response to Question One (c), use the diagram below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Two (c), use the space below. Make sure it is clear which answer you want marked.

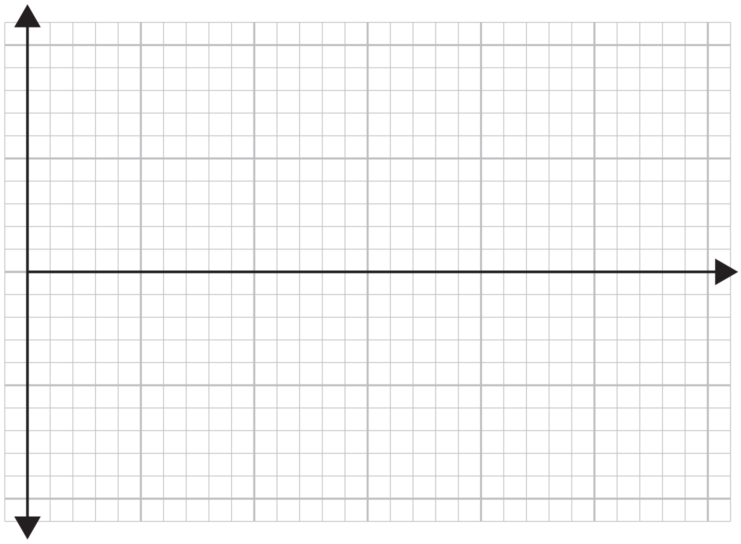


If you need to redraw your response to Question Three (b), use the reference circle below. Make sure it is clear which answer you want marked.



Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatoru (c), whakamahia ngā tuaka i raro nei. Kia mārama te tohu i te tuhinga ka hiahia koe kia mākahia.

If you need to redraw your response to Question Three (c), use the axes below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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 2024

91524M Demonstrate understanding of mechanical systems

91524M

Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of mechanical systems.	Demonstrate in-depth understanding of mechanical systems.	Demonstrate comprehensive understanding of mechanical 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–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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–19 in the correct order and that none of these pages is blank.

Do not write in the margins (⁄⁄⁄). This area will be cut off when the booklet is marked.

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