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3

91524M

915245

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

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, 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 2–23 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: TE NEKEHANGA WHAKAHURI I TE PAPA TĀKARO

E tākaro ana ētahi tamariki i tētahi takawhawhe.

Te mātāpuna: www.rehabmart.com/product/merry-go-round-44540.html

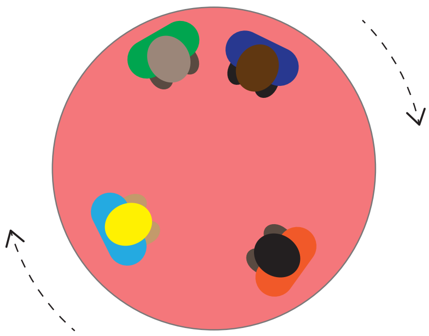
Ka pana a Riley i te takawhawhe, nāwai ka pūmau te tere ā-koki o te porotiti. Ka kotahi te huringa i te 1.23 s.

(a) Whakaaturia mai kua 5.11 rad s^{-1} te tere ā-koki o te takawhawhe.

(b) Ka mutu tā Riley pana, ā, e 30.0 s i muri, kua pōturi haere te takawhawhe e kotahi ai te huringa i te 2.04 s. E taea ana te whakaāwhiwhi te takawhawhe ki te kōpae porotiti e 57.6 kg m^2 nei te tūpuku hurihuri.

- Whakatauhia te toharite o te whakapōturi ā-koki o te takawhawhe i te wā e pōturi haere ana.
- Tātaihia te toharite o te tōpana whakahuri ā-waku e pā ana ki te takawhawhe i te wā e pōturi haere ana.

(c) Ka eke katoa ngā hoa e whā i te takawhawhe, i ngā pūwāhi e whakaaturia ana i te hoahoa.

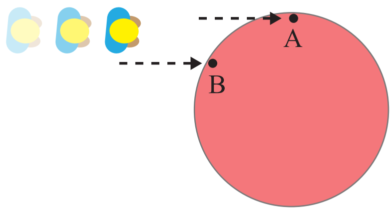


Whakamāramahia mai, mā te whakamahi i ngā mātāpono mātai ahupūngao, ngā mahi ka taea e ngā hoa i a rātou e noho tonu ana i te papa, e tere ake ai te takawhawhe.

Kaua e aro ki ngā whakaawenga mai o waho i te papa.

(d) E hiahia ana a Matilda ki te oma me te peke ki runga i te takawhawhe (kāore i te huri i te tuatahi), ka mauria ngā pou kei A, kei B rānei kia eke te tere o tōna huringa ki te taumata tere katoa ka taea. Ka whakamātauhia e ia ngā pekenga rerekē ki te takawhawhe.

Ngā pekenga ki runga



(i) Me kī, he ōrite te tere o ana peke i ngā wā katoa, nā runga i tēnā, whakamāramahia mai mā tēhea pekenga, arā, mā Pekenga A, mā Pekenga B rānei e tere ake ai te huringa o te takawhawhe.

QUESTION ONE: ROTATIONAL MOTION AT THE PLAYGROUND

Some children are playing on a roundabout.

Source: www.rehabmart.com/product/merry-go-round-44540.html

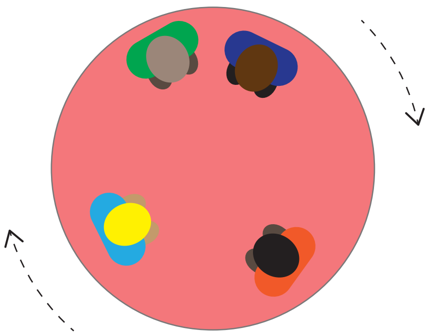
Riley pushes the roundabout and gets it spinning at a constant angular speed. It makes one revolution in 1.23 s.

(a) Show that the angular velocity of the roundabout is 5.11 rad s^{-1}.

(b) Riley stops pushing, and 30.0 s later the roundabout has slowed, so that it takes 2.04 s to make one revolution. The roundabout can be approximated to a spinning disc with a rotational inertia of 57.6 kg m^2.

- Determine the average angular deceleration of the roundabout as it slows.
- Calculate the average frictional torque acting on the roundabout as it slows.

(c) Four friends all ride on the roundabout, in the positions shown in the diagram.

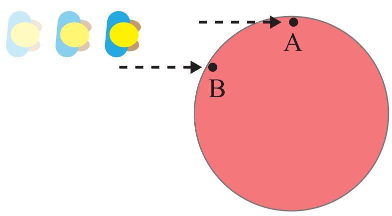


Explain, using physics principles, what the friends can do to make the roundabout speed up while staying on the platform.

Exclude all influences external to the platform.

(d) Matilda wants to run and jump onto the (initially stationary) roundabout, holding onto poles at A or B to make it spin as fast as possible. She tries different jumps onto the roundabout.

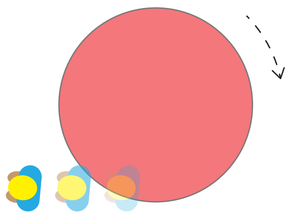
Jumps on



(i) Assuming that she always jumps at the same speed, explain which jump, Jump A or Jump B, will make the roundabout go round faster.

(ii) I muri iho, ka tuku a Matilda i te pou, ā, ka pahuhu ia i te takawhawhe.

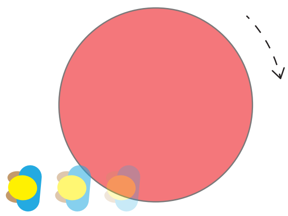
Ka pahuhu



Matapakina ngā pānga ki te tere o te takawhawhe tērā pea ka hua ake.
Me kī, he itiiti noa iho te waku i waenganui i a Matilda me te takawhawhe.

(ii) Matilda subsequently lets go of the pole and slips off the roundabout.

Slips off



Discuss the possible effects on the speed of the roundabout.

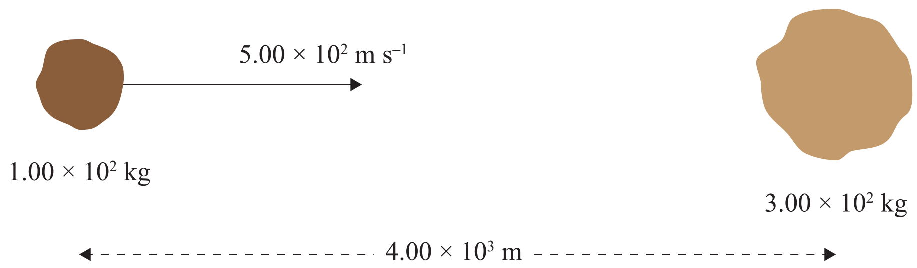
Assume there is negligible friction between Matilda and the roundabout.

TE TŪMAHI TUARUA: NGĀ TUKINGA I TUARANGI

He hanga tangatanga ngā unahiroa me ngā aorangi iti, ā, he māmā te potapota, inarā ka tūtuki ana ki te aha rā.

I tēnei tauira, ka tuki tētahi mea ko te 1.00×10^2 kg te rahi, e 5.00×10^2 m s^{-1} te tere whaiahu, ki tētahi atu mea kāore i te neke, e 3.00×10^2 kg nei te rahi.

I mua i te tūtukinga



(a) Tātaihia te tawhiti o te papatipu waenga pū o te pūnaha mai i te mea e 3.00×10^2 kg te rahi, ka 4.00×10^3 m ana te tawhiti i waenga i ngā mea e rua.

(b) (i) Tātaihia te tōpana tō ā-papa i waenga i ngā mea e rua ka 10.0 m ana te tawhiti o te papatipu waenga pū o tētahi i tō tētahi.

Me kī, he pūmau ngā tere whaiahu o ngā papatipu i mua i te tūtukinga.

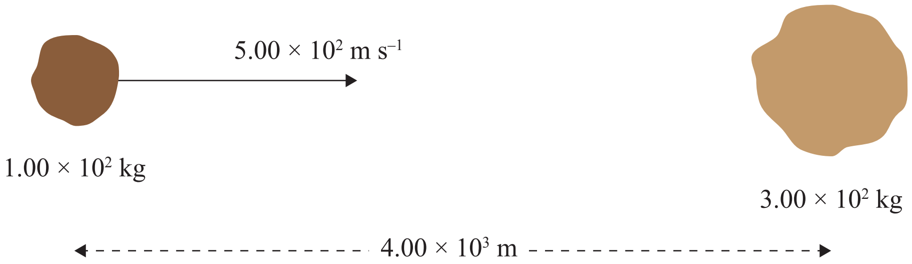
(ii) Nā konā, whiriwhirihia te whakateretanga o te mea ko te 1.00×10^2 kg te rahi i tēnei wehenga, hei whakatau mēnā e whaimana ana te whakapae he pūmau ngā tere whaiahu e rua i mua i te tūtukinga.

QUESTION TWO: COLLISIONS IN SPACE

Comets and asteroids are loosely formed objects that are easily broken up, especially when they collide.

In this scenario a 1.00×10^2 kg object moving with a velocity of 5.00×10^2 m s^{-1} collides with a stationary, 3.00×10^2 kg object.

Before collision



(a) Calculate the distance of the centre of mass of the system from the 3.00×10^2 kg object when the objects are 4.00×10^3 m apart.

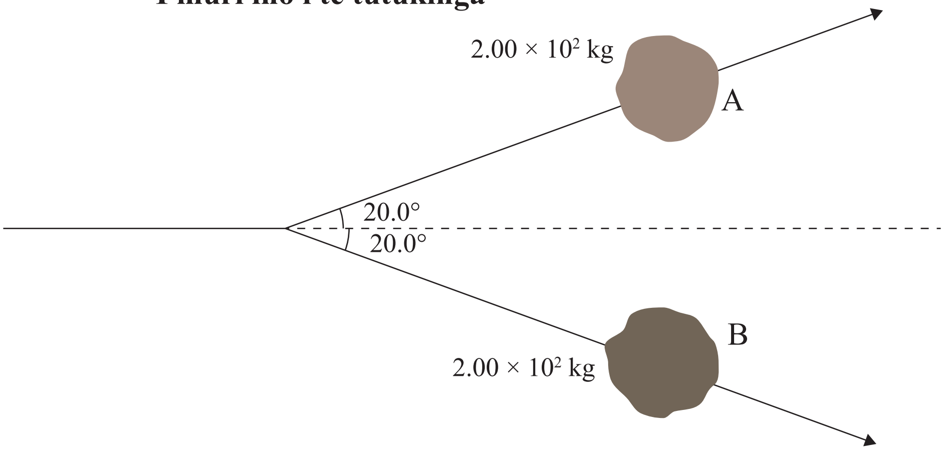
(b) (i) Calculate the gravitational force between the two objects, when their centres of mass are 10.0 m apart.

Assume that the velocities of the masses are constant before the collision.

(ii) Hence find the acceleration of the 1.00×10^2 kg object at this separation, to determine whether the assumption that their velocities are constant before the collision is valid.

(c) Ka tuki ngā mea e rua, ka mutu, kāore he pānga o waho, ā, ka puta mai ngā ‘toka’ e rua, a A me B, e 2.00×10^2 kg te papatipu o ia toka. Ka wehe haere rāua i a rāua, pēnei i tā te hoahoa e whakaatu mai nā, e 20° nei te ahunga i ia taha o te ahunga tuatahitanga o te toka whakaaweawe.

I muri iho i te tūtukinga

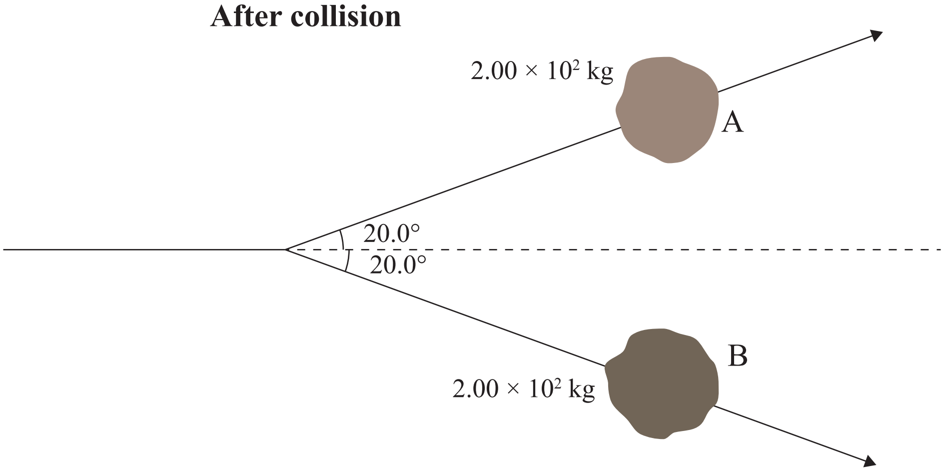


Whakaaturia mai he ōrite te rahi o te ānga o ngā toka, o A me B, ahakoa he rerekē te ahunga. E pai ana kia tāngia ō hoahoa pere ki te wāhi kei raro iho nei.

Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te wāhi kei te whārangi 18.

(c) The objects collide, with no external forces, and form two ‘rocks’, A and B, each with a mass of 2.00×10^2 kg. These move away from each other, as shown in the diagram, in directions at 20° either side of the initial direction of the impacting rock.

After collision



Show that the size of the momentum of rocks A and B are the same, even though they are in different directions. You may use the space below to draw vector diagrams.

If you need to redraw your response, use the space on page 19.

(d) Tātaihia te tere o ngā toka, o A me B. E pai ana kia tāngia ō hoahoa pere ki te wāhi kei raro iho nei. Me tīmata koe i tō tuhinga mā te tātai i te tapeke o te ānga i mua i te tūtukinga.

Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te wāhi kei te whārangi 18.

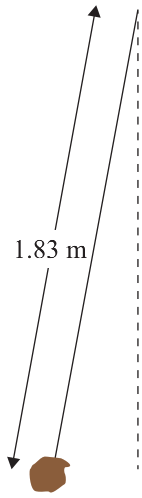
(d) Calculate the speed of rocks A and B. You may use the space below to draw vector diagrams.

Begin your answer by calculating the total momentum before collision.

If you need to redraw your response, use the space on page 19.

TE TŪMAHI TUATORU: HE TĀRERE I MATAWHERO

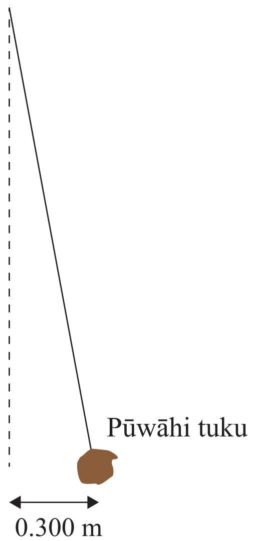
E hiahia ana ētahi kaihōpara tuarangi i Matawhero ki te titiro mēnā e tika ana te mahi a ā rātou ine-wā matihiko. Ka hanga rātou i tētahi tārere māmā mā te whakamahi i tētahi toka nui, e 2.30 kg te papatipu, kua herea ki tētahi waea.

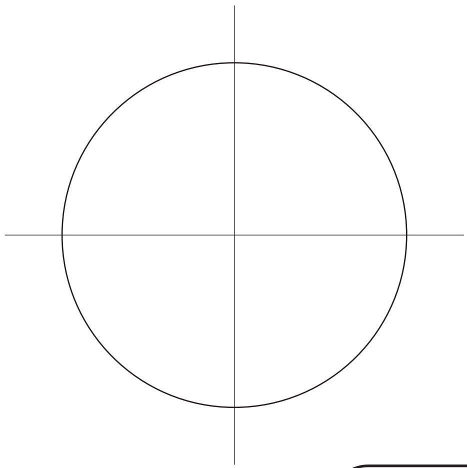


(a) Ko te 1.83 m te tawhiti mai i te papatipu waenga pū o te toka ki te pūwāhi whakamau. I Matawhero, e 3.72 N kg^{-1} te kaha o te whaitua tō ā-papa.

Whakaatuhia ko te 4.41 s te wā o te tārere.

(b) Ka whakaritea e rātou te tārere kia kōpiupiu mā te tuku i te tāwē tārere e 0.300 m mai i tana pūwāhi whakatā, ā, ka tīmatahia hoki te ine-wā i taua wā.

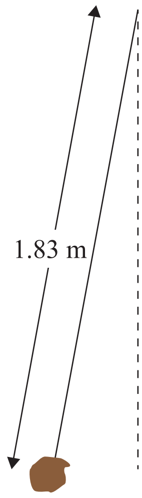




Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te hoahoa kei te whārangi 18.

Whakatauhia te pūwāhi o te tāwē tārere mai i te pūwāhi tuku e 2.00 s i muri iho i tōna tukunga. E pai ana tō tā i tētahi hoahoa koki pānga ki runga ake nei hei āwhina i tō tātaitanga.

QUESTION THREE: A PENDULUM ON MARS

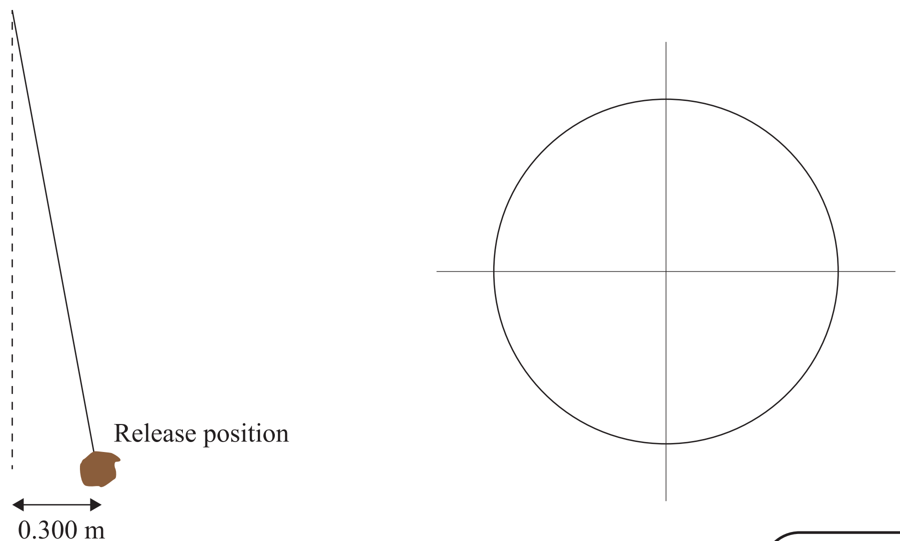


Some space explorers on Mars want to check that their electronic timers are functioning correctly. They make a simple pendulum, using a large rock, mass 2.30 kg, tied to a wire.

(a) The distance from the centre of mass of the rock to the fixing point is 1.83 m. On Mars, the gravitational field strength is 3.72 N kg^{-1}.

Show that the time period of the pendulum is 4.41 s.

(b) They set the pendulum oscillating by releasing the pendulum bob 0.300 m away from its rest position, and at the same moment they start a timer.



If you need to redraw your response, use the diagram on page 19.

Determine the position of the pendulum bob from its release point 2.00 s after it is released. You may use the space above to draw a phasor diagram to help your calculation.

(c) Ka heke iho te teitei o te tārere mai i te 0.300 m ki te 0.200 m.

Whakamāramahia mai he take i kore ai te wā o te tārere e rerekē.

(d) Tātaihia te tapeke o te pūngao ka taero ka heke iho ana te teitei o te tārere mai i te 0.300 m ki te 0.200 m.

Tīmataria tō tuhinga mā te tātai i te mōrahi o te tere whaiahu o te tāwē mō te teitei tutatahi me te teitei whakamutunga.

(c) The amplitude of the pendulum decreases from 0.300 m to 0.200 m.

Explain why the period of the pendulum remains unchanged.

(d) Calculate the total energy lost when the amplitude decreases from 0.300 m to 0.200 m.

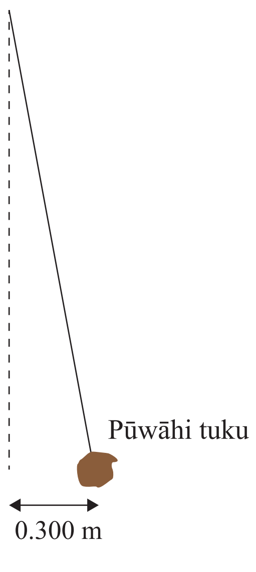
Begin your answer by calculating the maximum velocity of the bob for the initial and the final amplitude.

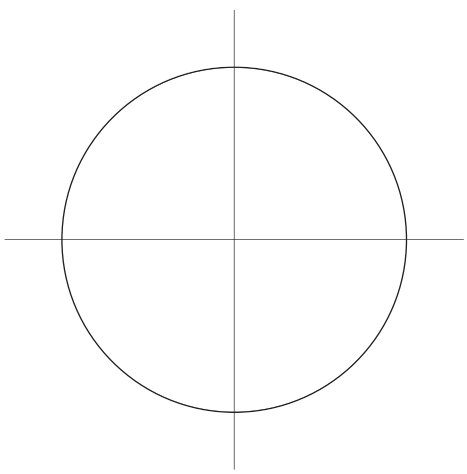
HE HOAHOA WĀTEA

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.

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



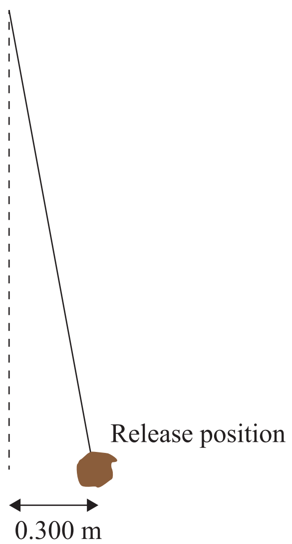


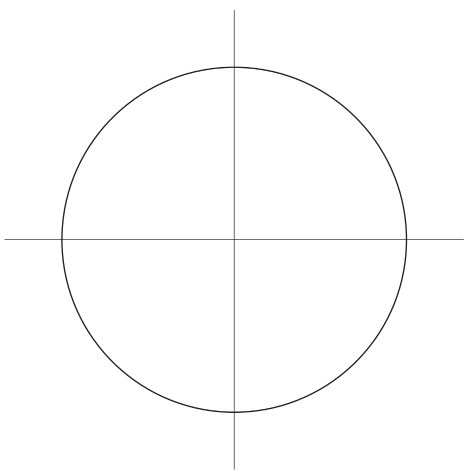
SPARE DIAGRAMS

If you need to redraw your response to Question 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 Two (d), 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 diagram below. Make sure it is clear which answer you want marked.





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

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

91524M Demonstrate understanding of mechanical systems

Credits: Six

91524M

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–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 2–23 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.