91524M

915245

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

3

SUPERVISOR'S USE ONLY

Ahupūngao, Kaupae 3, 2019

91524M Te whakaatu māramatanga ki ngā pūhanga manawa

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

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā pūhanga manawa.	Te whakaatu māramatanga hōhonu ki ngā pūhanga manawa.	Te whakaatu māramatanga matawhānui ki ngā pūhanga manawa.

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

MĀ TE KAIMĀKA ANAKE

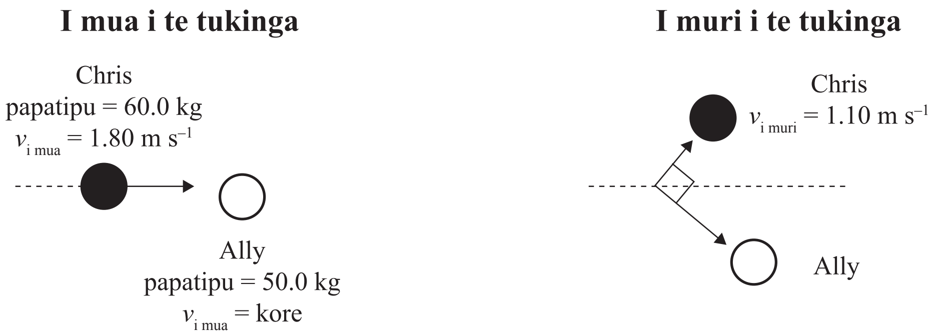
TŪMAHI TUATAHI: TE KŌNEKE

Kei te kōneke a Ally rāua ko Chris. Ko te whakapae he kore noa iho te waku, ko te pūnaha a Ally rāua ko Chris ka taea te kī he pūnaha taratahi ki te ahunga huapae.

(a) Tuhia tētahi rahinga ahupūngao hāngai ka pūmau i te wā o tētahi tukinga i waenga i a Chris rāua ko Ally.

(b) I tētahi wā tonu ka tū a Ally, ā, ka tuki a Chris ki a ia. Ka neke haere rāua kia koki hāngai tētahi ki tētahi, e ai ki te hoahoa i raro.

Me whakaatu ko te tere o Ally i muri i te tukinga he 1.71 m s^{-1}.



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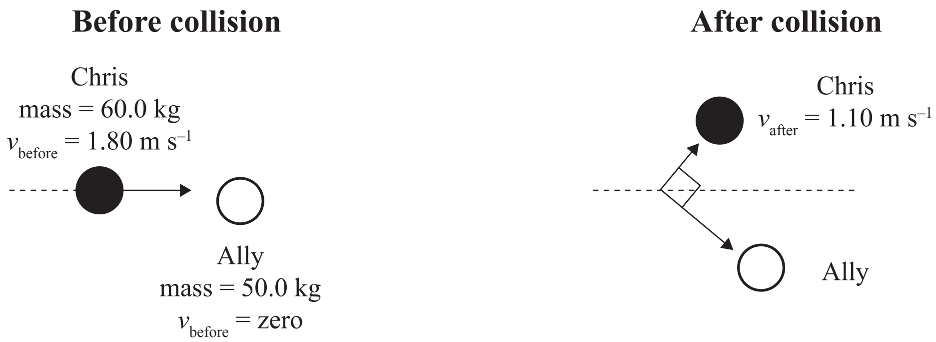
QUESTION ONE: ROLLERBLADING

Ally and Chris are rollerblading. Assuming friction is negligible, the system of Ally and Chris can be considered an isolated system in the horizontal direction.

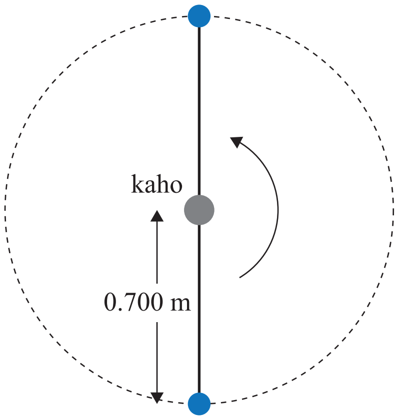
(a) State a relevant physical quantity that is conserved during a collision between Chris and Ally.

(b) At one instant, Ally stops and Chris collides with her. They move off at right angles to each other, as shown in the diagram below.

Show that Ally's speed after the collision is 1.71 m s^{-1}.



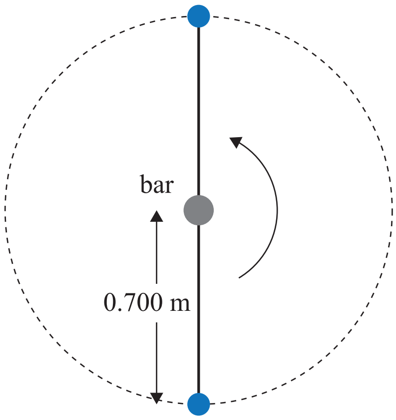
Kia kore ai a Chris e hinga, ka kite ia i tētahi kaho huapae ka nanao atu. Kātahi ka tārere ia i te kaho kia poutū ai te huri porohita. Ka taea te nekehanga a Chris te whakarūnā mā te tātari i te nekehanga o tana pū papatipu, arā he 0.700 m mai i te kaho. Ko te whakapae he kore noa iho ngā pānga o te waku.



(c) Tātaihia te tere iti rawa me neke te pū papatipu o Chris ki runga rawa o te huri porohita o te kaho huapae, kia taea ai te piu ki runga kia whiti i te kaho. (Ko te whakapae kei te ara porohita tonu tana neke.)

ASSESSOR'S USE ONLY

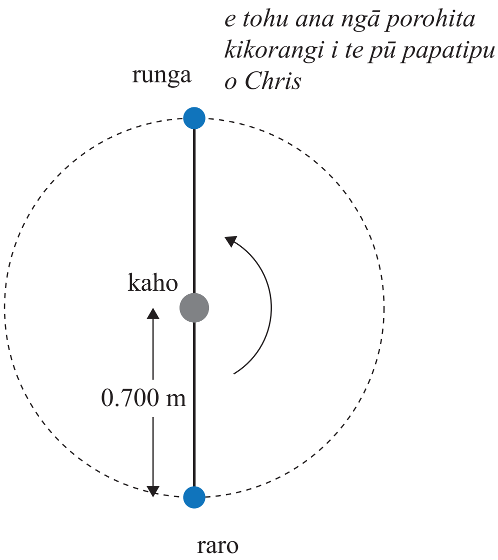
To save himself from falling, Chris sees a horizontal bar and grabs it. He then swings on the bar in a vertical circle. Chris's motion can be simplified by analysing the motion of his centre of mass, which is 0.700 m from the bar. Assume the effects of friction are negligible.



(c) Calculate the minimum speed Chris's centre of mass would need to have at the top of the vertical circle, in order to swing up and over the bar. (Assume he continues in a circular path.)

(d) Me whakaahua ka whakamārama i te rahi me te ahunga o ngā tōpana renarena me te taumaha kei ngā pūwāhi o raro me runga, ko te whakapae ka neke a Chris i runga rawa mā te tere mōkito.

Me whakauru ko ngā tapanga tōpana ki te hoahoa i raro hei tautoko i tō tuhinga.

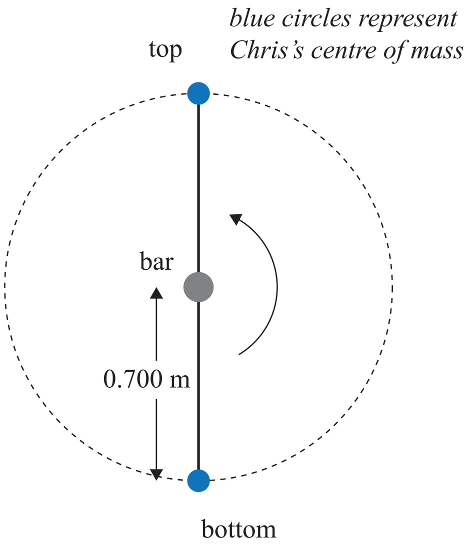


He tāruatanga tēnei o te hoahoa nō te whārangi 4. Ki te hiahia koe ki te tuhi anō i ngā tapanga tōpana, whakamahia te hoahoa kei te whārangi 18.

MĀ TE KAIMĀKA ANAKE

(d) Describe and explain the size and direction of the tension and weight forces at the bottom and the top positions, assuming Chris swings over the top at minimum speed.

Include force labels on the diagram below to support your answer.



This is a repeat of the diagram on page 5. If you need to redraw your force labels, use the diagram on page 19.

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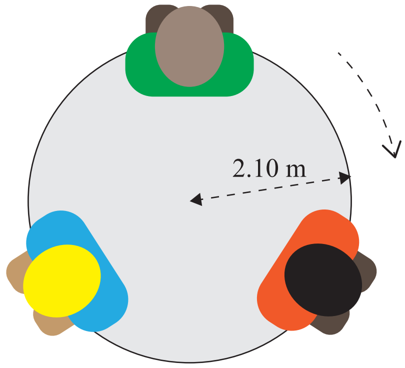
MĀ TE KAIMĀKA ANAKE

TŪMAHI TUARUA: PAPA TĀWHIOWHIO

E toru ngā tamariki kei te tākaro i runga i te papa tāwhiowhio me te tūpuku hurihanga o te 271 kg m^2. Ina hurihuri i ngā tamariki te papa tāwhiowhio, he ōrite te tawhiti o tā rātou tū huri noa i te taitapa o waho. He 28.0 kg te papatipu o ia tamaiti, ko te pūtoro o te papa tāwhiowhio he 2.10 m.



(a) Me kī ko te tūpuku hurihuri o te papatipu o tētahi tamaiti kei te taitapa o te kōpae he $I = mr^2$, me whakaatu ko te tūpuku hurihuri o te pūnaha he 641 kg m^2.

(b) Ko te pūngao tapeke o te pūnaha he 388 J.

Me whakaatu ko:

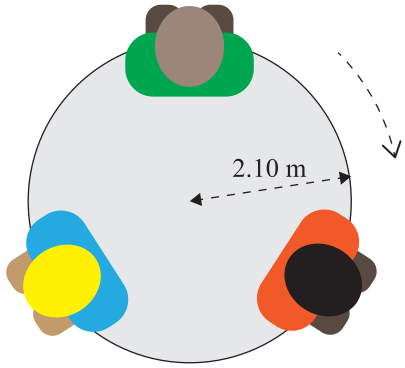
(i) te tere koki o te pūnaha he 1.10 rad s^{-1}, me

(ii) te tere rārangi o tētahi o ngā tamariki he 2.31 m s^{-1}.

ASSESSOR'S USE ONLY

QUESTION TWO: MERRY-GO-ROUND

Three children are playing on a merry-go-round with a rotational inertia of 271 kg m^2. Once the children get the merry-go-round spinning, they stand evenly spaced around the outer edge. Each child has a mass of 28.0 kg, and the merry-go-round has a radius of 2.10 m.



(a) Assuming the rotational inertia of a child's mass on the edge of the disc is given by $I = mr^2$, show that the rotational inertia of the system is 641 kg m^2.

(b) The total energy of the system is 388 J.

Show that:

(i) the angular velocity of the system is 1.10 rad s^{-1}, and

(ii) the linear velocity of one of the children is 2.31 m s^{-1}.

MĀ TE KAIMĀKA ANAKE

(c) Ka tōia e tētahi tamaiti tana wae i te whenua kia tū ai te papa tāwhiowhio i roto i te 2.80 s.

Tātaihia te tōpana whakahuri ka puta i te wae.

(d) Ka hurihuri anō i ngā tamariki te papa tāwhiowhio ki tētahi tere koki aumou. Kātahi ka neke whakaroto ia tamaiti ki te pokapū o te papa tāwhiowhio.

Mā te whakamahi i ngā mātāpono ahupūngao, whakamāramahia mai te pānga o tēnei ki te pūngao hurihanga o te pūnaha.

ASSESSOR'S USE ONLY

(c) One child drags her foot on the ground to bring the merry-go-round to a stop in 2.80 s.

Calculate the amount of torque produced by the foot.

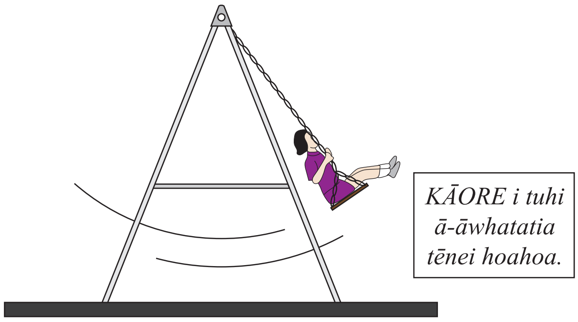
(d) The children get the merry-go-round spinning once again at a constant angular speed. Then each child moves inward towards the centre of the merry-go-round.

Using physics principles, explain the effect this has on the rotational energy of the system.

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATORU: TE TĀRERE

Kei te pārekareka ki a Jay te tārere i te papatākaro. Ko te wā mō tētahi tīkorikori he 2.40 s, ā, ka mau tonu te hōkai aumou o Jay ki te 0.310 m mā te piu whakamua, whakamuri haere i ōna waewae hei whakakapi i te pūngao ka ngaro i te waku. Ko te papatipu o te pūnaha (Jay me te tārere) he 70.0 kg. Ka taea te kī ko te nekehanga a Jay he nekehanga hawarite māmā.



(a) Tātaihia te tere mōrahi o Jay me te tārere.

(b) Whakamahia he porohita tauira, tētahi atu tikanga rānei hei whakatau e hia te roa o te wā e nui ake te hūnukutanga (displacement) o Jay i te 0.200 m mai i te tauritenga i tētahi wāhanga wā kotahi.

ASSESSOR'S USE ONLY

QUESTION THREE: SWING

Jay is enjoying a swing at the playground. The period of one oscillation is 2.40 s and Jay maintains a constant amplitude of 0.310 m by swinging her legs back and forth to replace the energy lost due to friction. The mass of the system (Jay and the swing) is 70.0 kg. Jay's motion can be considered simple harmonic motion.

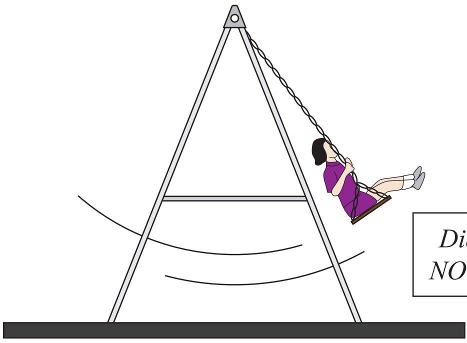


Diagram is NOT to scale

(a) Calculate the maximum velocity of Jay and the swing.

(b) Use a reference circle or other method to determine how much time Jay's displacement is greater than 0.200 m from equilibrium over one period.

MĀ TE KAIMĀKA ANAKE

(c) Ka mutu te piu a Jay i ōna waewae ina tae te tārere ki te hūnukutanga nui rawa.

Ki te tukutuku i raro tuhia he kauwhata mō ana hūnukutanga i roto i ngā wāhanga wā e toru e whai ake.

Me whakauru ko ngā uara mō te wā me te hūnukutanga tuatahi i te t = kore.

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

(c) Jay stops swinging her legs when the swing is at its maximum displacement.

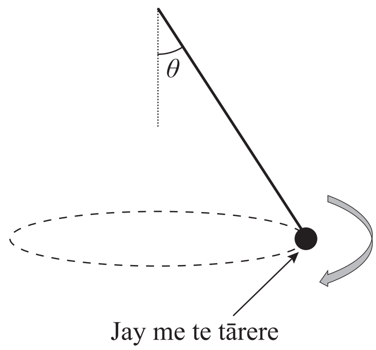
On the grid below sketch a graph of her displacement over the next three periods.

Include values for the time and for the initial displacement at t = zero.

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

ASSESSOR'S USE ONLY

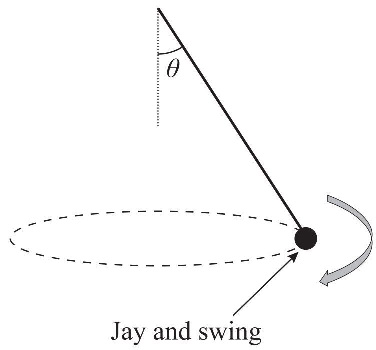
(d) Ka neke a Jay ki tētahi atu tārere, he tāia e tārewa poutū ana i tētahi mekameka kotahi. He tārere koeko te pūnaha. He 2.61 m s^{-1} te haere a Jay i tētahi porohita me te pūtoro o te 0.411 m. Ko te papatipu tapeke o Jay me te tārere he 70.0 kg. Me kī he kore noa iho te waku me te papatipu o te mekameka tautoko i a Jay.



Tātaihia te renarena kei te mekameka e tautoko ana i te tārere me te koki o te mekameka mai i te poutū.

MĀ TE KAIMĀKA ANAKE

(d) Jay moves to a new swing that is a tyre hanging vertically on a single chain. The system is a conical pendulum. Jay travels at 2.61 m s^{-1} around a circle of radius 0.411 m. The total mass of Jay and the swing is 70.0 kg. Assume friction and the mass of the supporting chain are negligible.

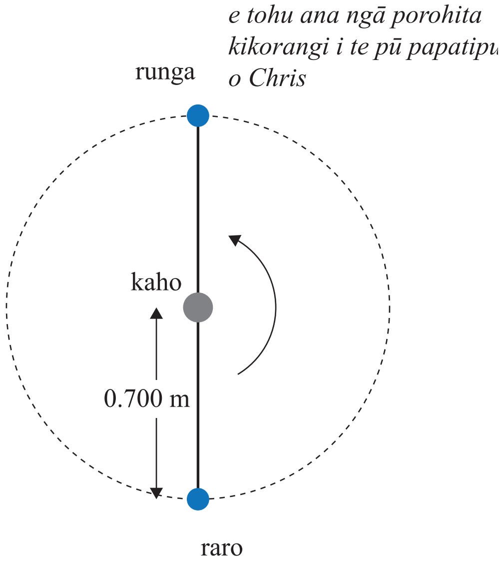


Calculate the tension in the chain supporting the swing and the angle of the chain from vertical.

MĀ TE KAIMĀKA ANAKE

HE HOAHOA WĀTEA

Ki te hiahia koe kia tuhi anō i ngā tapanga tōpana mai i te Tūmahi Tuatahi (d), tuhia ki raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.



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

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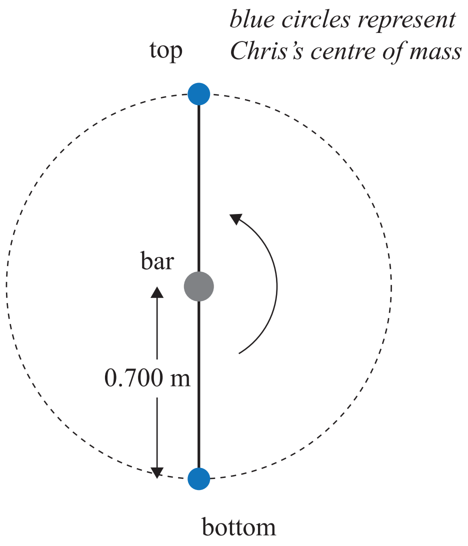
SPARE DIAGRAMS

If you need to redraw your force labels from Question One (d), draw them below. Make sure it is clear which answer you want marked.



If you need to redraw your graph from Question Three (c), 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

91524 Demonstrate understanding of mechanical systems

2.00 p.m. Wednesday 20 November 2019
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.

91524M

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.