3

91524M

915245

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, 2017

91524M Te whakaatu māramatanga ki ngā pūhanga manawa

2.00 i te ahiahi Rāhina 20 Whiringa-ā-rangi 2017
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 2–19 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

HOATU TE PUKAPUKA NEI KI TE KAIWHAKAHAERE HEI TE MUTUNGA O TE WHAKAMĀTAUTAU.

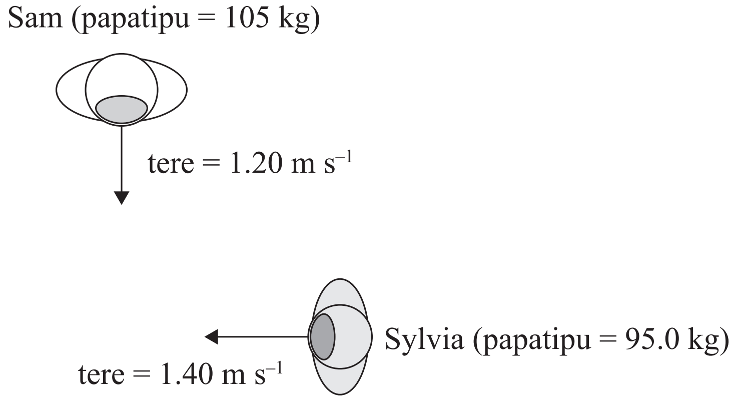
TAPEKE

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATAHI

E rua ngā kaipōkai tuarangi, a Syliva rāua ko Sam, e haere ana ki tētahi atu aorangi. I a rāua e haere ana ka "hīkoi ātea" rāua i waho i tō rāua waka ātea.

I tētahi wā kei te nekeneke haere noa rāua e ai ki te hoahoa i raro. Kātahi ka tuki ki a rāua anō, ā, kua piri tahi.



(a) Tātaihia te tawhiti i waenga i a Sam me te papatipu waenga pū o te pūnaha i te wā e 4.80 m te tawhiti tētahi i tētahi o Sam rāua ko Sylvia.

(b) Whakaahuahia mai ka ahatia te papatipu waenga pū o te pūnaha i te whakatatahanga atu o ngā kaipōkai tuarangi, ā, ka tuki rāua ki a rāua anō.

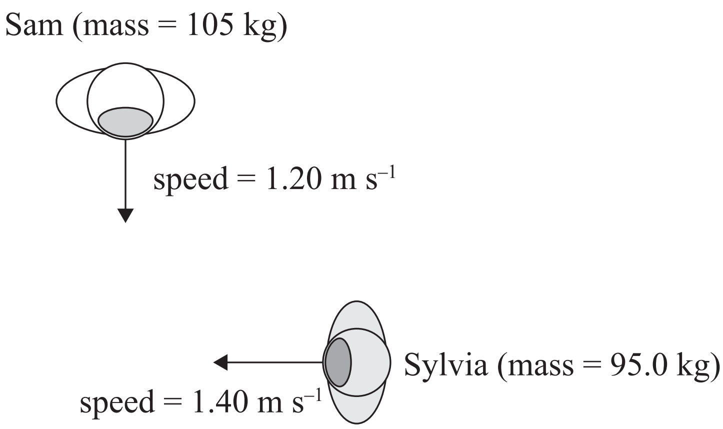
(c) Tātaihia te tere huitahi o ngā kaipōkai tuarangi i muri i te tukinga.

QUESTION ONE

ASSESSOR'S USE ONLY

Two astronauts, Sylvia and Sam, are on a mission to another planet. During their journey they are doing a "space walk" outside their spaceship.

At one time they are moving freely as shown in the diagram below. They collide and stick together.



(a) Calculate the distance between Sam and the centre of mass of the system when he and Sylvia are 4.80 m apart.

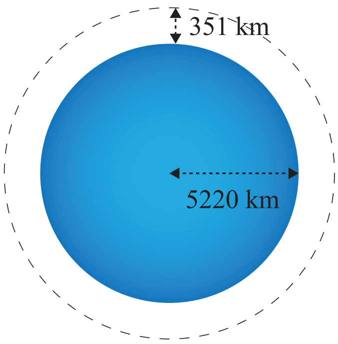
(b) Describe what happens to the centre of mass of the system as the astronauts move closer together and then collide.

(c) Calculate the astronauts' combined speed after they collide.

(d) Ina tae atu te waka ātea ki te aorangi, ka huri āmio te waka ātea i te aorangi me te wā o te 5.46×10^3 s, me te teitei o te 351 km i runga ake o te mata.

Me kī he porohitahita te āmionga.

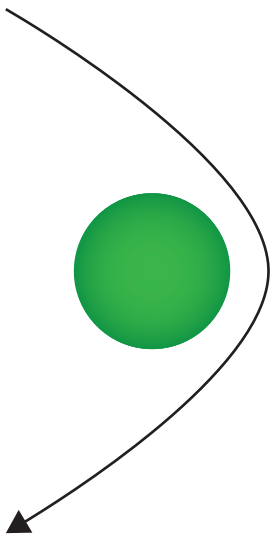
He 5220 km te pūtoro o te aorangi.



(i) Tātaihia te papatipu o te aorangi.

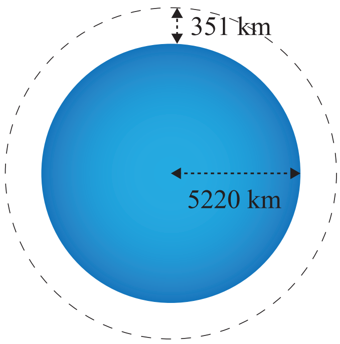
(ii) I te hokinga atu ki Papatūānuku, ka hipa i te waka ātea tētahi atu aorangi. E whakaaturia ana te ara o te waka ātea ki te hoahoa i raro nei.

Whakamāramahia he pēhea te huri o te tere o te waka ātea i te whakatatahanga atu ki te aorangi.



MĀ TE KAIMĀKA ANAKE

(d) When the spaceship reaches the planet, the spaceship goes into orbit around the planet with a period of 5.46×10^3 s, and at a height of 351 km above the surface.

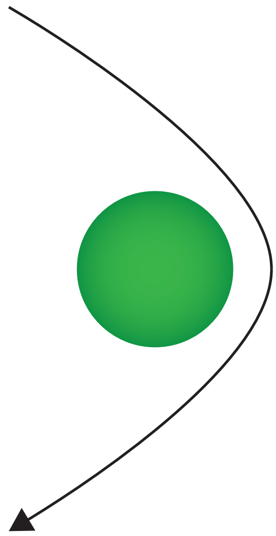


Assume the orbit is circular.

The planet has a radius of 5220 km.

(i) Calculate the mass of the planet.

(ii) On the return journey to Earth, the spaceship goes past a different planet. The spaceship's path is shown in the diagram.



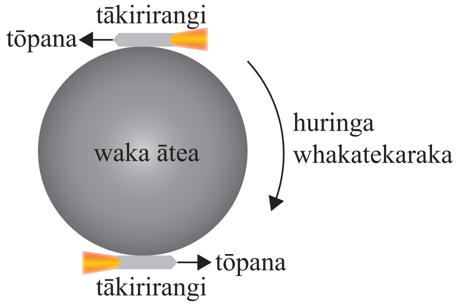
Explain how the spaceship's speed changes as it gets closer to the planet.

ASSESSOR'S USE ONLY

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUARUA

Ka hurihuri whakatekaraka te waka ātea o Sylvia rāua ko Sam ki tana tuaka i te wā e haere ana i te ātea. Ka taea e ngā kaipōkai tuarangi te tere koki o te waka ātea te huri mā te whakakā i ngā tākirirangi iti e rua e pātapa ana te mau e ai ki te whakaaturanga. Ka puta i ngā tākirirangi he tōpana whakahuri kōaro. Ko te tūpuku hurihuringa o te waka ātea he 5.80×10^4 kg m^2.



(a) Tātaihia te rahinga o te tōpana whakahuri e hiahiatia ana mai i ia tākirirangi kia puta ai he whakaterenga koki o te 2.00×10^{-2} rad s^{-2}.

(b) He whakatekaraka te hurihuri o te waka ātea i te 0.580 rad s^{-1} ina whakakāhia ngā tākirirangi.

Tātaihia te tere koki o te waka ātea i muri i tētahi huringa kotahi.

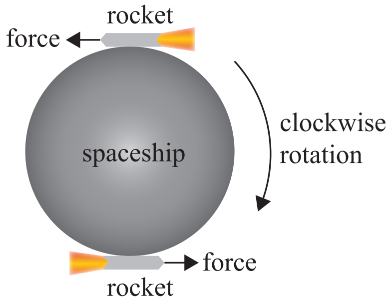
(c) Me kī he aumou te tōpana whakahuri ka puta i ngā tākirirangi.

Whakamāramahia mai ka ahatia te rahi o te whakaterenga koki i te whakaputanga haere o te kora e ngā tākirirangi.

ASSESSOR'S USE ONLY

QUESTION TWO

Sylvia and Sam's spaceship spins clockwise on its axis as it is moving through space. The astronauts can change the angular velocity of the spaceship by firing two small rockets that are mounted tangentially as shown. The rockets produce an anticlockwise torque. The rotational inertia of the spaceship is 5.80×10^4 kg m^2.



(a) Calculate the size of the torque required from each rocket to cause an angular acceleration of 2.00×10^{-2} rad s^{-2}.

(b) The spaceship is rotating clockwise at 0.580 rad s^{-1} when the rockets are fired.

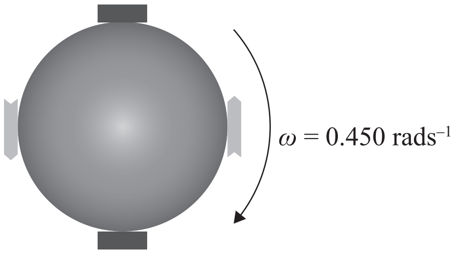
Calculate the angular speed of the spaceship after one rotation.

(c) Assume that the torque produced by the rockets is constant.

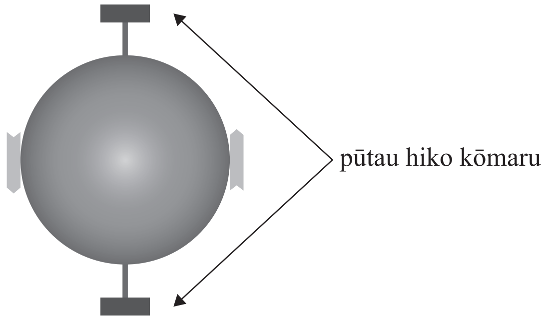
Explain what happens to the size of the angular acceleration as the rockets gradually emit burnt fuel.

(d) Nāwai rā, ka hurihuri noa te waka ātea i te 0.450 rad s^{-1} me te weto o ngā tākirirangi, e ai ki te Hoahoa 1. Kātahi ka whakaroahia ake ngā pūtau hiko kōmaru o te waka ātea, e piki ai te tūpuku hurihuri mā te 2.74×10^3 kg m^2.

Hoahoa 1



Hoahoa 2



(i) Whakamāramahia mai he aha i huri ai te wā hurihuri i te whakaroanga ake o ngā pūtau hiko kōmaru (Hoahoa 2).

(ii) Tātaihia te wā hurihuri i te whakaroanga whānuitanga o ngā pūtau hiko kōmaru.

(d) Some time later, the spaceship is rotating freely at 0.450 rad s^{-1} with the rockets turned off, as shown in Diagram 1. The spaceship's photo-voltaic cells are then extended out from the spaceship, causing the rotational inertia to increase by 2.74×10^3 kg m^2.

Diagram 1

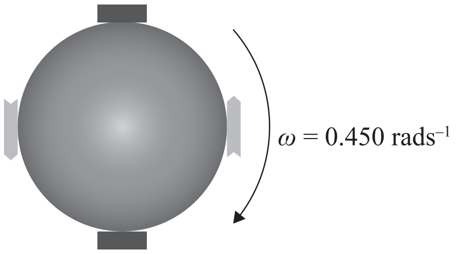
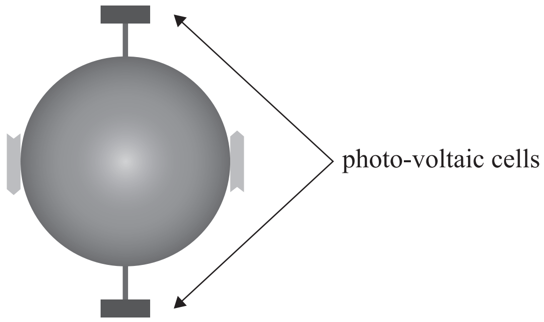


Diagram 2



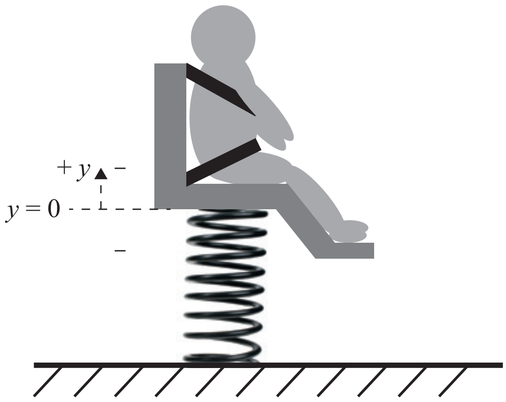
(i) Explain why the period of rotation changes as the photo-voltaic cells are extended (Diagram 2).

(ii) Calculate the period of rotation when the photo-voltaic cells are fully extended.

ASSESSOR'S USE ONLY

TŪMAHI TUATORU

Me āhei ngā kaipōkai tuarangi ki te ine auau i ō rātou papatipu kia taea ai ō rātou hauora te aroturuki. Ka taea e rātou tēnei mā te here ki tētahi tūru māmā te taumaha e mau ana ki tētahi pūnikoniko e ai ki te hoahoa i raro.

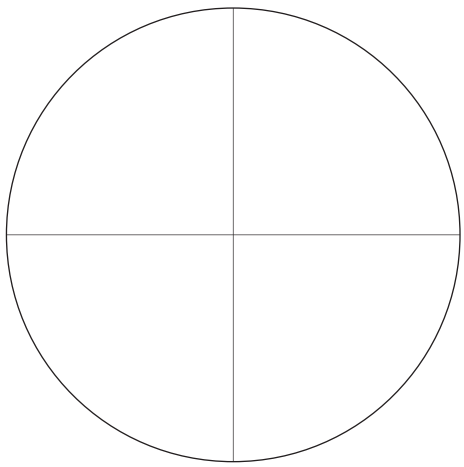


Ina peia a Sylvia mai i te tauritenga, he nekehanga hawarite māmā tana kōpiupiu me te wā o te 8.00 s. Ko te whakapae he rārangi te nekehanga.

(a) Whakaahuatia mai ngā huringa ki te rahi, ahunga rānei o te tōpana whakarite ina tawhiti haere atu a Sylvia mai i te tauritenga i te ahunga $+y$.

(b) Ko te teitei o te kōpiupiu o Sylvia he 0.120 m.

Whakamahia he porowhita whakatara, tētahi atu tikanga rānei hei tātai i te wā poto rawa mō Sylvia ki te neke i te 0.080 m i runga ake i tana tūnga tauritenga.

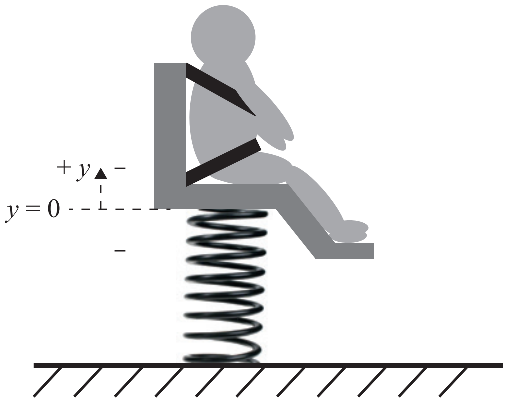


Ki te hiahia koe ki te tātuhi anō i tō urupare, whakamahia te hoahoa i te whārangi 14.

ASSESSOR'S USE ONLY

QUESTION THREE

Astronauts need to be able to measure their mass regularly so that they can monitor their health. They can do this by being strapped on to a lightweight seat that is attached to a spring as shown in the diagram below.

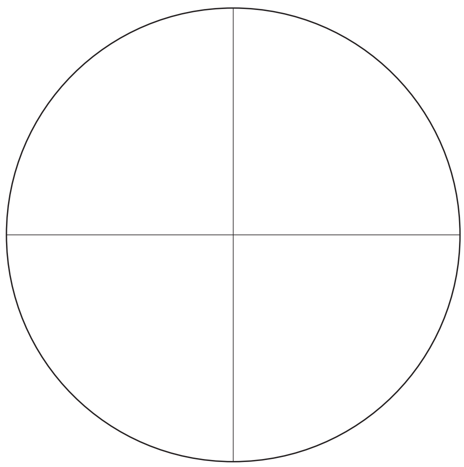


When Sylvia is displaced from equilibrium, she oscillates in simple harmonic motion with a period of 8.00 s. You may assume her motion is linear.

(a) Describe any changes in the size or direction of the restoring force as Sylvia moves away from equilibrium in the $+y$ direction.

(b) The amplitude of Sylvia's oscillation is 0.120 m.

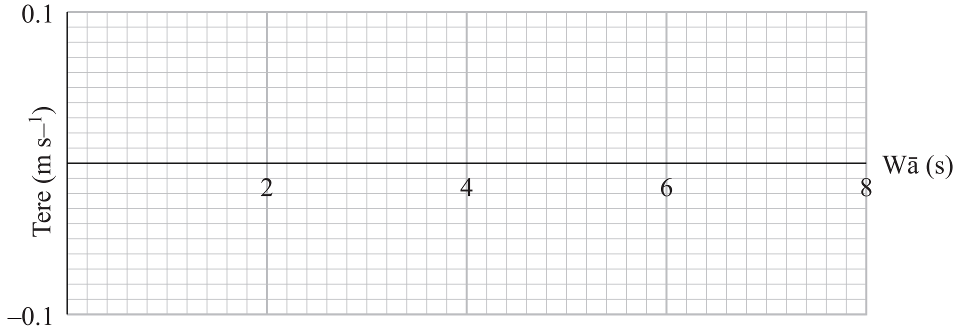
Use a reference circle or other method to calculate the shortest time it takes for Sylvia to move up 0.080 m from her equilibrium position.



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

(c) Ki te tuaka i raro, tātuhia he kauwhata e whakaatu ana i te tere o Sylvia ki te wā, ka tīmata mai i te wā i tūtata rawa ia ki te papa.

Me whakauru te uara o te tere mōrahi.



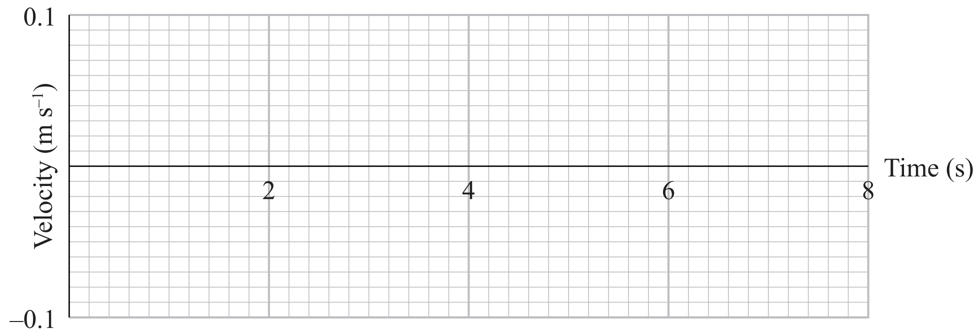
Ki te hiahia koe ki te tātuhi anō i tō urupare, whakamahia te tukutuku i te whārangi 14.

(d) Hei tīmata i te kōpiupiu, ka hoatu e Sam he tōpana poutū o te 4.40 N ki a Sylvia. Nā tēnei tōpana he 0.120 m te tawhiti o te neke a Sylvia.

- Tātaihia te papatipu o Sylvia.
- Whakaahuahia mai ngā whakapae i puta i a koe hei whakamāmā i tō tātaitanga.

(c) On the axis below, draw a graph showing Sylvia's velocity vs time, starting when she is closest to the floor.

Include the value of the maximum velocity.



ASSESSOR'S USE ONLY

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

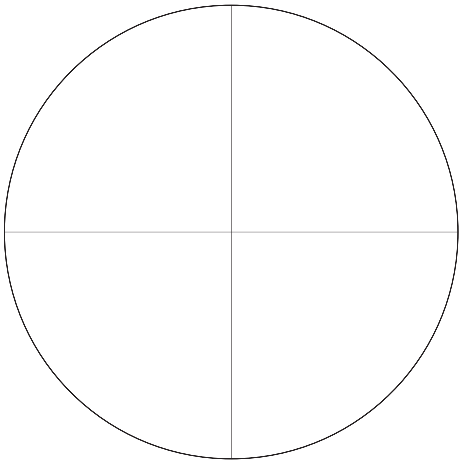
(d) To start the oscillation, Sam applies a vertical force of 4.40 N to Sylvia. This force causes Sylvia to move a distance of 0.120 m.

- Calculate Sylvia's mass.
- Describe any assumptions you have made to simplify your calculation.

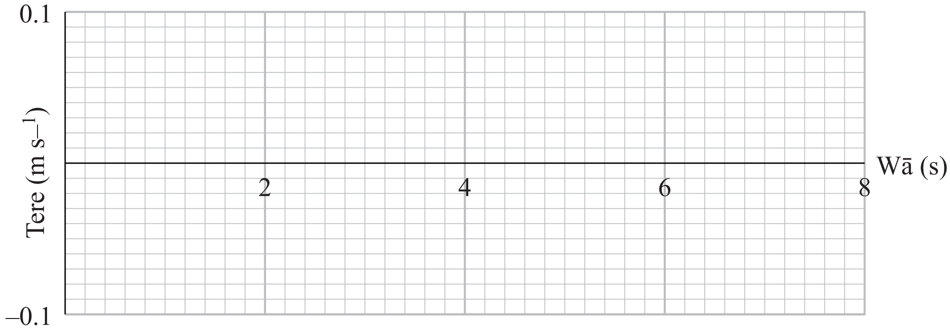
MĀ TE KAIMĀKA ANAKE

HE HOAHOA TĀPIRI

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



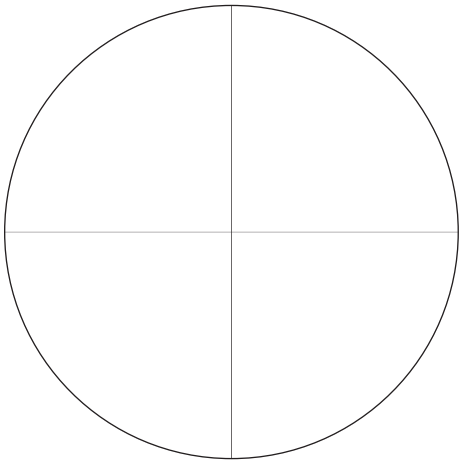
Ki te hiahia koe ki te tuhi anō i tō urupare mai i te Tūmahi Tuatoru (c), tuhia ki te tukutuku o raro. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.



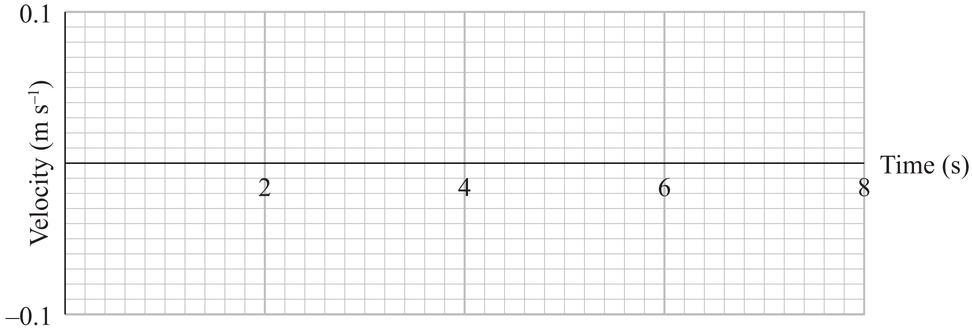
ASSESSOR'S USE ONLY

SPARE DIAGRAMS

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



If you need to redraw your response to Question Three (c), draw it on the grid 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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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, 2017

91524 Demonstrate understanding of mechanical systems

2.00 p.m. Monday 20 November 2017
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–PHYSR.

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 2–19 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.