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91524



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Level 3 Physics 2020

91524 Demonstrate understanding of mechanical systems

2.00 p.m. Wednesday 2 December 2020

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 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 2–8 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.

TOTAL

ASSESSOR'S USE ONLY

QUESTION TWO: SOMERSAULTS WHILE DIVING

Sandra dives from a diving board that is 10.0 m high. She finds she can do somersaults (rotations) by tucking her body in. In the tucked position, her body can be modelled as a sphere of mass 60.0 kg and radius 0.200 m.

The rotational inertia of a sphere is given by $I = \frac{2}{5}mr^2$.

- (a) While in the tucked position, she dives (rotates) with a constant angular velocity of 9.56 rad s^{-1} .

Show that her angular momentum is $9.18 \text{ kg m}^2 \text{ s}^{-1}$.

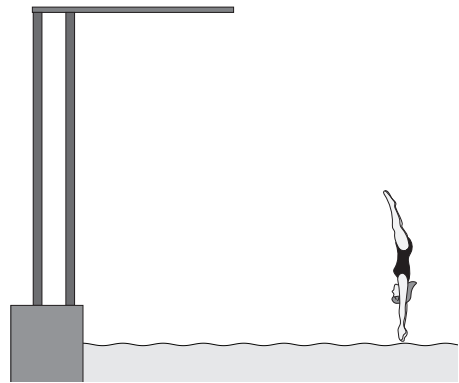
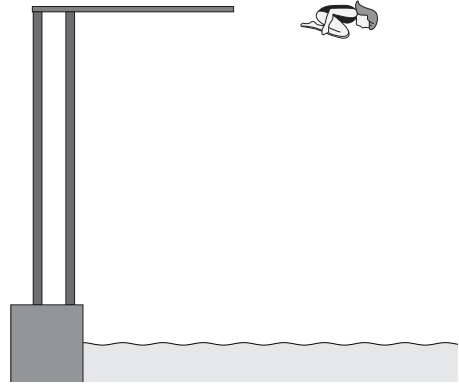
- (b) Just before entering the water, she straightens her body, thereby changing her rotational inertia.

Explain what effect this will have on her rotational motion.

Comment on her:

- angular velocity
- rotational kinetic energy.

You may ignore effects of friction while she is in the air.



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- (c) It takes Sandra 0.280 s to straighten her body just before entering the water. Her rotational inertia becomes 4.80 kg m^2 .

Calculate her angular deceleration during this time.

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- (d) One day, Sandra observes Tapu practising somersaults from the diving board. Tapu does 2.00 complete somersaults in 1.25 seconds.

Calculate Tapu's average angular velocity while executing the somersaults.

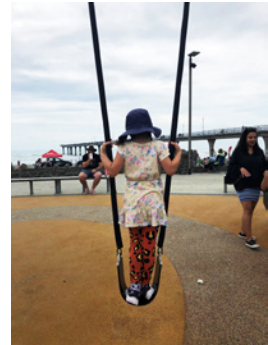
QUESTION THREE: IN THE PLAYGROUND

- (a) Serena sits on a rigid swing that is 3.00 m long.

Show that the period of the swing is 3.50 s.

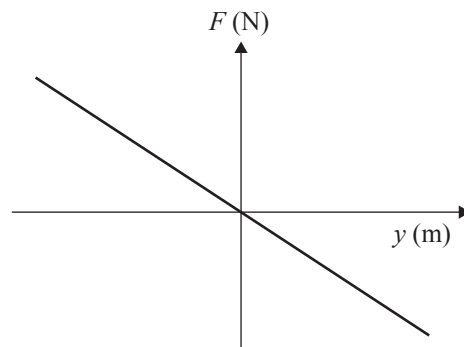


- (b) Explain, giving reasons, how the period of the swing will be affected if Serena stands up on the swing while it is swinging freely.



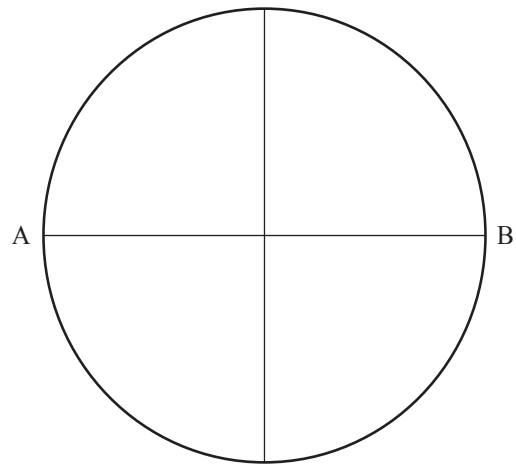
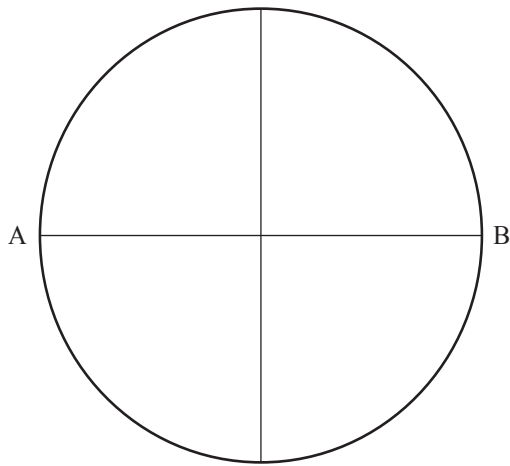
- (c) The graph below is that of the restoring force, F , on Serena, against y , which is the horizontal displacement of Serena from her equilibrium position.

Explain how the information in the graph below shows that the swing is an example of SHM.



- (d) Serena swings from end A to end B with an amplitude of 1.50 m and a period of 3.50 s.

Using the reference circles below or otherwise, calculate the velocity of Serena and the swing when she is 0.500 m from end B.



SPARE DIAGRAM

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

