

PHYSICS VCE UNITS 3&4 DIAGNOSTIC TOPIC TESTS 2017

TEST 5: HOW FAST CAN THINGS GO? (II)

TOTAL 45 MARKS (45 MINUTES)

Student's Name: _____ Teacher's Name: _____

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

Use $g = 10 \text{ N kg}^{-1}$.

Question 1 (23 marks)

Two dodgem cars are moving toward each other as shown in Figure 1.

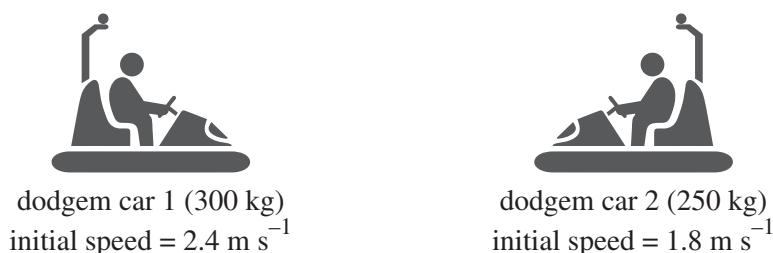


Figure 1

The dodgems collide and dodgem car 1 bounces back from its initial direction (to the left in the diagram) of motion at 1.0 m s^{-1} .

- a. Determine the total momentum of the two dodgem cars before the collision (magnitude and direction).

3 marks

Ns	left	right
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- b.** The total momentum of the dodgem cars is conserved.

Explain what this means and the assumption that exists when it is true.

2 marks

- c.** Determine the velocity of dodgem car 2 after the collision (magnitude and direction).

3 marks

m s^{-1}	left right
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- d.** Determine the impulse experienced by dodgem car 1.

2 marks

Ns

- e.** Determine the average force experienced by dodgem car 1 if the collision time was 0.100 seconds.

2 marks

N

- f. If instead the dodgem cars couple and move off together, determine their speed and direction, circling one of left or right.

3 marks

m s^{-1}	left	right
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The dodgem cars again move toward each other at the same velocities for a second time. The velocities before and after the collision are given in the table below.

	Dodgem car 1	Dodgem car 2
Velocities before collision	2.0 m s^{-1} right	2.0 m s^{-1} left
Velocities after collision	1.0 m s^{-1} left	1.6 m s^{-1} right

- g. Determine whether or not the collision is elastic or inelastic by providing calculations for this. Working must be shown. Explain any differences that you find in your calculations.

4 marks

- h.** The dodgem cars have a bumper to reduce the impact when they collide.

Explain, using physics principles, how the bumper reduces the impact during collisions in comparison to vehicles that have no bumper.

4 marks

Question 2 (5 marks)

A tow truck applies a horizontal force of 3000 N on a 1000 kg car for a period of three seconds over a distance of 10 m. Figure 2 shows the tow truck towing a vehicle.



Figure 2

- a. Calculate the work done by the tow truck over the 10 m distance.

2 marks

J

Figure 3 shows a graph of the force acting on a 500 kg satellite as a function of its distance from the Moon's centre.

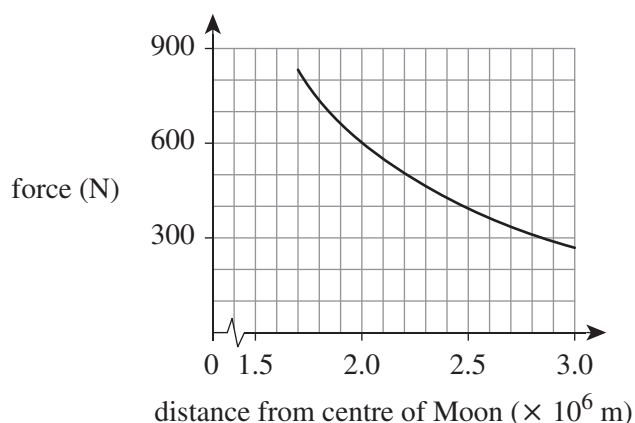


Figure 3

- b. Determine the work done by the satellite engines to move the satellite from its 2200 km position to 2500 km from the centre of the Moon.

3 marks

J

Question 3 (3 marks)

A high jumper is running at 8.0 m s^{-1} at the point at which she jumps to clear the high jump bar. Her centre of mass is 1.0 m above ground when she jumps. Her centre of mass is 2.15 m above ground when she clears the bar. This is shown in Figure 4.

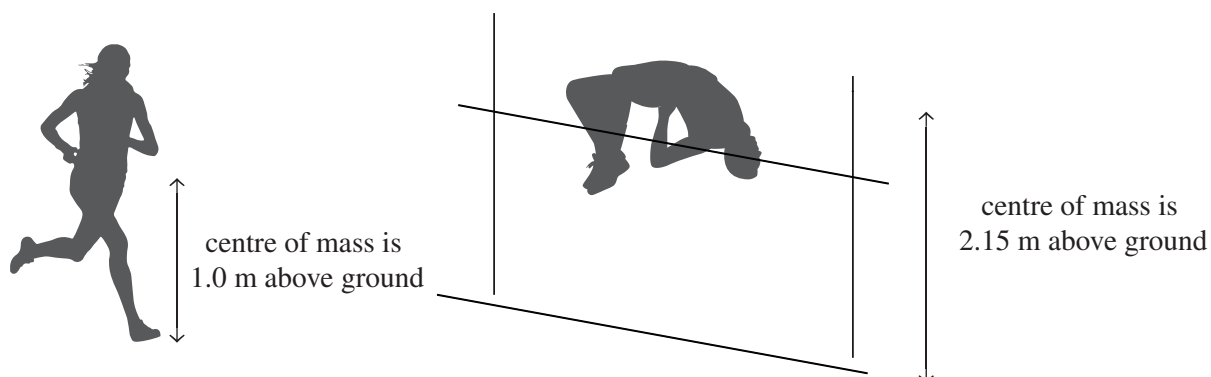


Figure 4

The mass of the high jumper is 65 kg .

Determine the speed of the high jumper at the height where she clears the bar. Ignore frictional forces.

m s^{-1}

Question 4 (14 marks)

A slingshot consists of a light leather cup containing a steel ball that is pulled back against a rubber band. It takes a force of 30 N to stretch the band by 10 cm. Such a slingshot is shown in Figure 5.

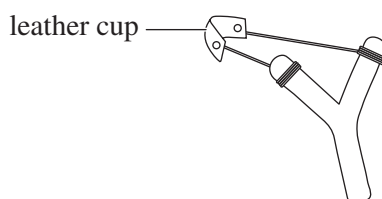


Figure 5

- a.** Show that the stiffness constant of the rubber band is 300 N m^{-1} . 2 marks

- b.** What is the average force needed to stretch the rubber band by 30 cm? 2 marks

N

- c.** Assuming that Hooke's law applies to the rubber band, what is the elastic potential energy stored in the band when it is stretched by 20 cm? 2 marks

J

- d.** What work is done by the hand that stretches the rubber band by 20 cm? 1 mark

J

A 30 g steel ball is placed in the leather cup of the slingshot. The leather cup is pulled back by 20 cm and fires the ball vertically into the air.

- e.** Calculate the release speed of the ball assuming that all of the energy stored in the rubber stretched by 20 cm is passed to the ball. 3 marks

m s^{-1}

- f.** What maximum height does the steel ball reach? 2 marks

m

- g.** In reality, the ball reaches a lesser height than the answer calculated in part **e**. Explain why. 2 marks
