Christ Church Grammar School

Science Department
Year 12 2020

ATAR PHYSICS
UNIT 3: MOTION AND FORCES
TEST 2 2020

Teacher: JRM HKR
(Please circle)

Time allowed for this paper
Working time for paper: 50 minutes.

NAME: _____

Instructions to candidates:

- You must include **all** working to be awarded full marks for a question. Answers should be expressed to 3 significant figures unless otherwise indicated.
- Marks may be deducted if diagrams are not drawn neatly with a ruler and to scale (if specified).
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

Mark:	/ 51
=	%

Question 1 **(3 marks)**

Two 2.00 kg crystal balls are 1.00 m apart. Calculate the net force between the crystal balls.

Question 2 **(3 marks)**

Astronauts orbiting in a satellite 300.0 km above the surface of the Earth experience weightlessness which can lead to a range of health problems – including early onset osteoporosis (a reduction in bone density). Explain why the astronauts, who are still within the Earth's gravitational field, experience weightlessness.

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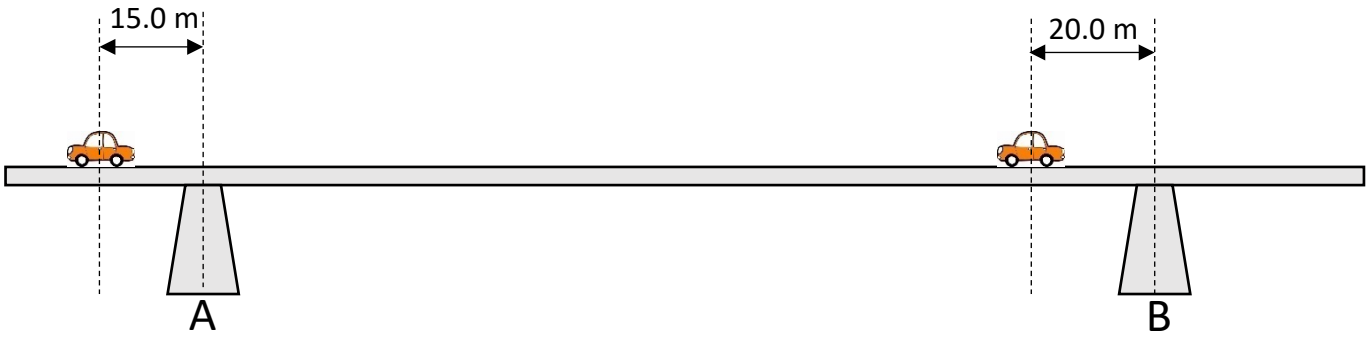
Question 3 **(7 marks)**

The uniform bridge shown in the diagram below is 120.0 m long and has a weight of 20.0 kN. The support pillars (A and B) are 70.0 m apart.



(a) Calculate the magnitude of the force that pillar A exerts on the bridge when two 8.00 kN cars are located at the positions shown.

(4 marks)

(b) Calculate the magnitude of the force that pillar B exerts on the bridge when the two cars are located at the positions shown. (If you could not complete part (a), use $F_A = 20.0$ kN)

(3 marks)

Question 4 **(8 marks)**

Uranus has a moon, Umbriel, whose mean orbital radius is 2.67×10^8 m and whose period is 3.58×10^5 s.

(a) Calculate the mass of Uranus. Include a full derivation of Kepler's Third Law in your response.

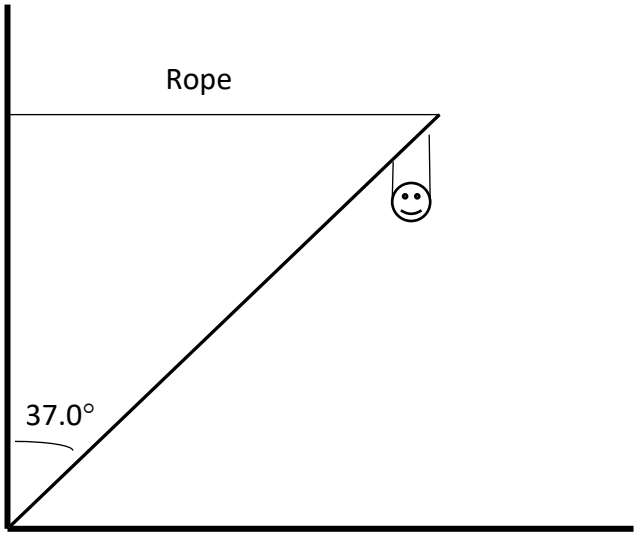
(6 marks)

(b) Calculate the period of another of Uranus's moons, Oberon, whose mean orbital radius is 5.86×10^8 m.

(2 marks)

Question 5 **(17 marks)**

The base of a non-uniform ladder rests against a wall and is held in place by a rope, as shown in the diagram below. The ladder is 7.00 m long and has a mass of 10.2 kg. Its centre of gravity is 0.400 of its length from the base. A 150.0 N child hangs from the ladder 0.200 of its length from the top.



(a) Calculate the magnitude of the tension in the rope

(5 marks)

(b) Calculate the force exerted on the base of the ladder. (If you could not complete part (a) use T = 110 N.)

(6 marks)

(c) Explain, making reference to any appropriate formulae, how the horizontal and vertical components of the force on the base of the ladder would change as the child moves back down the ladder towards the base.

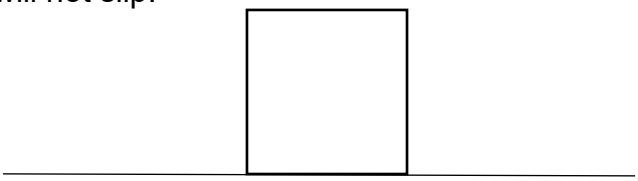
(6 marks)

Question 6 **(4 marks)**

Mars has a mass of 0.107 M_{Earth} and a radius of 0.533 R_{Earth}. Calculate the acceleration due to gravity on the surface of Mars.

Question 7 **(4 marks)**

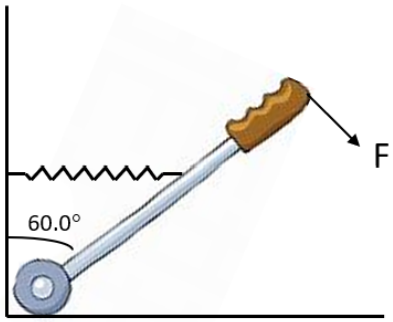
A square box of uniform mass and side length 20.0 cm and mass 15.0 kg sits on a table, as shown in the diagram below. It can be assumed that there is a sufficiently large static friction force between the box and table, that the box will not slip.



Calculate the minimum horizontal force that must be applied to the box to make it start to tip to the left.

Question 8 **(5 marks)**

A person is pulling down on a 1.20 m long lever of negligible mass that is connected to the wall by a spring, as shown in the diagram below. In the diagram, the hand exerts a 200.0 N force, perpendicularly, at the end of the lever. The spring, which is connected to the midpoint of the lever, pulls back with a horizontal force of 80.0 N. Calculate the net torque acting on the lever about the pivot.



END OF TEST