W-05

**YEAR 12 PHYSICS**

**TEST 2: CIRCULAR MOTION, GRAVITATION**

**NAME:**  **TOTAL:** 

1. A fairground ride called the Gravitron has people standing vertically against the walls of a drum that

rotates about its vertical axis.

**diameter = 4.00 m**

axis of rotation

As the machine gains speed, the people feel themselves pushed against the walls.

Ultimately it goes fast enough so that, when the floor is allowed to drop away, the people remain against the wall and don't fall.

(a) Explain why the people feel a force from the wall pushing on their backs.

(2)

(b) In which direction is this force?

(1)

(c) What must be the period of rotation of the drum if the people are to experience a force from the

wall equal to ***0.600 of their weight***?

(3)

2. Mars has the following characteristics.

Mass: 6.37 x 1023 kg Radius: 3.43 x 106 m Period of rotation: 8.85 x 104 s

It can be considered perfectly spherical in shape.

Scientists in America have spent years studying the atmosphere and geology of this planet, with a view to going there one day. Assume an astronaut of 80.0 kg, carrying a combined mass for his suit of 235 kg, is on the surface.

(a) Calculate the ***apparent weight*** of the astronaut if he is standing on the equator.

(Hint: Remember that the planet is spinning.)

(4)

(b) How would this value change if the calculation were done at one of the geographical poles of

the spin axis? Explain your answer using a calculation.

(2)

(c) What ***period of rotation*** is required for the astronaut to be "flung off" the surface of Mars at the equator?

(3)

3. The moon Io is seen to revolve around Jupiter in a time of 18.6 hours at a radius of orbit measured to

be 3.65 x 105 km. Io has a mass of 3.90 x 1022 kg.

(a) Use this information to calculate the mass of Jupiter.

(4)

(b) A probe sent to scan Io orbits at a height of 1.10 x 102 km above its surface in a pole-to-pole

direction. The mass of the probe is 589 kg. Io has a mass of 3.90 x 1022 kg and a radius of

5.30 x 106 m.

(i) Determine the acceleration due to gravity acting on the probe.

(3)

(ii) Calculate the ***total energy*** of the probe as it orbits at this height above the moon.

(4)

(c) Unfortunately the probe encounters a severe micrometeor shower that knocks it into an

elliptical orbit. Describe the changes in energy as the probe maintains this orbit. You may wish

to label the diagram below.

(2)

4. A small child of mass 20.0 kg is playing on a maypole in a park. She runs quickly and lifts up her feet, causing the rope she is holding to form a 20.0° angle to the vertical as she revolves around the pole. The distance along the rope from the top to her centre of gravity is 4.00 m.

(a) Calculate the tension that exists in the rope.

4.00 m

20.0°

(3)

(b) Determine the speed with which the girl orbits the maypole at this point.

(3)

5. No matter which situation is considered (runner, bike rider, skateboarder, surfer), the person must lean over as he or she goes around a curve on ***level ground***.

Using a clear diagram, explain why the person must lean.

(2)