YEAR 12 PHYSICS

Motion Topic Test 2 2016

Circular Motion & Gravity

Name: _____

Teacher: _____

TIME ALLOWED FOR THIS PAPER

Working time for paper: Fifty five (55) minutes

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER
TO BE PROVIDED BY THE SUPERVISOR
Question/Answer Booklet
Physics Formulae and Constants Sheet

TO BE PROVIDED BY THE CANDIDATE
Standard Items: Pens, pencil, eraser, correction fluid and ruler
Special Items: Drawing instruments, templates and calculators satisfying the conditions set by the Curriculum Council.

IMPORTANT NOTE TO CANDIDATES
No other items may be taken into the examination room.
It is your responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you hand it to the supervisor BEFORE reading any further.

INSTRUCTIONS TO CANDIDATES
Write your answers in the spaces provided beneath each question. The value of each question (out of 50) is shown following each question.
Calculators satisfying the conditions set by the Curriculum Council may be used to evaluate numerical answers.
Answers to questions involving calculations should be evaluated and given in decimal form. Quote the final answer to no more than three significant figures. Despite an incorrect final result, credit may be obtained for method and working, provided these are clearly and legibly set out.
Questions containing specific instructions to **show working** should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; correct answers which do not show full working will not be awarded full marks.

Questions containing the instruction **estimate** may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained.

Marks Allotted: 50 marks Time 55 mins

Useful Data:
Assume that the acceleration due to gravity at the Earth's surface is $9.80 ms^{-2}$ and the effects of air resistance can be ignored for calculations. See data sheet for planetary data.

1. An athlete of mass 65.0 kg sprints around a circular bend of radius 25.0 m on an indoor synthetic athletics track, at a speed of 8.50 m/s.

(a) Draw vectors on the sketch at right to show the forces acting on the athlete as she sprints around the circular bend. Show the resultant force acting on the athlete with a dashed line. (ignore forces acting in the forward and backwards direction)

[3 marks]

(b) Calculate the centripetal force acting on the athlete as she runs around the bend at a speed of 8.50 m/s. [2 marks]

(c) Calculate the ideal angle of banking required for this bend so that the athlete would not need any sideways friction force. [2 marks]

2. A roller coaster carriage passes upside down through a vertical loop of radius 6.00 m. The speed of the carriage at the top of the loop is 8.00 m/s. A 65.0 kg woman sits in the carriage.

(a) Draw a sketch showing the two forces acting on the woman as the carriage passes upside down through the top of the loop. [2 marks]

(b) Calculate the resultant force on the woman at the top of the loop. [2 marks]

(c) Calculate the magnitude of the reaction force of the seat acting on the upside down woman at the top of the loop. [2 marks]

(d) Briefly explain why the upside down woman stays in her seat when the carriage passes through the top of the loop at this speed. [3 marks]

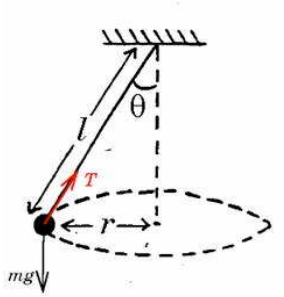
(e) At what minimum speed can the carriage pass through the top of the loop (so that the woman would momentarily feel weightless)? [2 marks]

(f) Why is the situation described in part (e) above only apparent weightlessness and not true weightlessness? [3 marks]

3. Given that the acceleration due to gravity at the surface of Venus is 91% of what it is on Earth and that Venus's radius is 95% that of the Earth, determine the mass of Venus. [3 marks]

4. A mass of 75.0 grams is swung in a horizontal circle of radius 20.0 cm. The length of the string holding the mass is 101 cm and the period of this conical pendulum is measured to be 2.00 s. Calculate:

(a) the tangential speed of the mass. [2 marks]



(b) the centripetal force required. [2 marks]

(c) the tension in the string. [3 marks]

5. The following table gives information about the four large moons of Jupiter.

Moon	Mass (x10 ^{22}kg)	Period around Jupiter (days)	Orbital radius around Jupiter (x 10^3km)
Io	8.9	1.77	422
Europa	4.9	3.55	671
Ganymede	15	7.16	1070
Callisto	11	16.7	1883

(a) Kepler's 3rd Law for satellites orbiting a parent body of mass **M** can be written as

$$r^3/T^2 = GM/4\pi^2$$

Derive this expression for an orbiting satellite. [3 marks]

(b) Demonstrate that this relationship holds true for the moons of Jupiter, using data given above for any two of the moons. [3 marks]

(c) Use the data for **Io** to determine the mass of Jupiter. [3 marks]

(d) Explain how you could use the data in the table above to draw a straight line graph (relating orbital radius and period) and how this graph could be used to find a more accurate value for Jupiter's mass. [3 marks]

(e) Calculate the magnitude of Jupiter's gravitational field strength at the orbital distance of **Callisto** and again at the orbital distance of **Io.** [4 marks]

(f) Sketch a graph of gravitational field strength versus distance from Jupiter from Io's orbit to Callisto's orbit. **(put suitable scales on the axes)** [3 marks]

END OF TEST