

Centripetal acceleration and gravity in orbit

AP Physics 1 (algebra-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

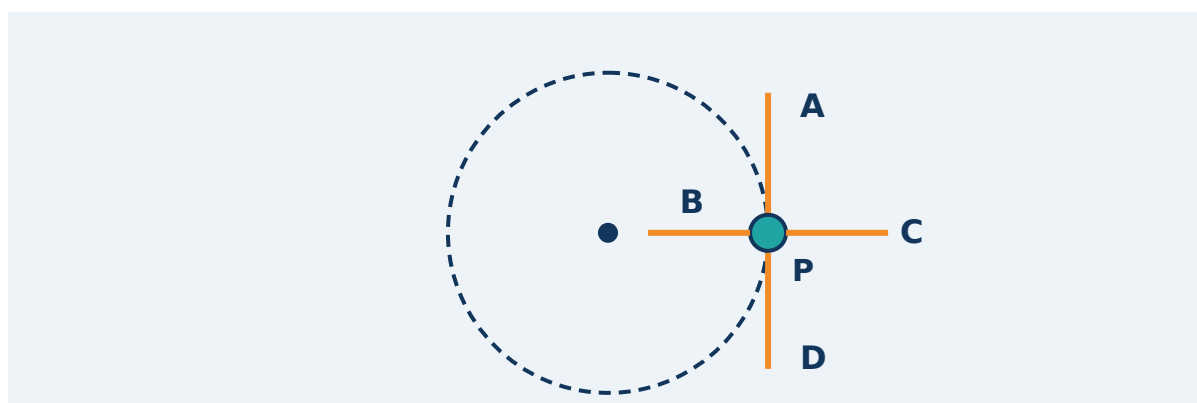
This test covers circular motion and gravitation at AP Physics 1 level. Use $g = 9.81 \text{ m/s}^2$ and $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$. Show all working for calculations and use full sentences in the written parts. Calculators are allowed.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 2

Time: 40 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Arrows at one point (2 marks)

The figure shows a puck at P. Choose from A, B, C or D.



Top view: a puck moves anticlockwise at constant speed. Arrows A to D start at P.

- Which arrow shows the direction of the velocity? (1 mark)
- Which arrow shows the direction of the acceleration? (1 mark)

Question 2 Control-line aircraft (3 marks)

A model aircraft of mass 0.50 kg flies in a horizontal circle of radius 8.0 m on a control line, taking 2.5 s per lap.

- Calculate its speed. (1 mark)
- Calculate its centripetal acceleration. (1 mark)
- Calculate the tension in the line, ignoring the weight. (1 mark)

Question 3 A heavier, bigger planet (2 marks)

Planet X has four times the mass of the Earth and twice its radius.

- Calculate g_X / g_{Earth} . (1 mark)
- Calculate the weight of a 60 kg student on planet X, using $g = 9.81 \text{ N/kg}$ for the Earth. (1 mark)

Question 4 Titan around Saturn (3 marks)

Titan orbits Saturn (mass $5.68 \times 10^{26} \text{ kg}$) at a radius of $1.22 \times 10^9 \text{ m}$. Use $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$.

- Calculate its orbital speed. (2 marks)
- Calculate its period in days. (1 mark)

Question 5 Vertical circle (3 marks)

A 0.30 kg ball on a string of length 0.80 m moves in a vertical circle. Use $g = 9.81 \text{ m/s}^2$.

- State Newton's second law along the line to the centre at the top. (1 mark)
- Calculate the tension at the top when the speed is 4.0 m/s. (1 mark)
- Calculate the tension at the bottom when the speed is 5.0 m/s. (1 mark)

Question 6 Outward force argument (3 marks)

A student writes: "The Moon does not fall into the Earth because the Earth's gravity is balanced by an outward force." Write a paragraph that evaluates this claim, using forces and acceleration.

Question 7 Two orbits compared (2 marks)

Satellite B orbits at twice the radius of satellite A around the same planet.

- Calculate v_B / v_A . (1 mark)
- Calculate T_B / T_A . (1 mark)

Question 8 Linear graph (2 marks)

A student measures the tension F for several periods T of a bung of mass m on radius r . State which quantities should be plotted to give a straight line, and what the gradient equals. Justify using the equation of motion.