

Angular velocity, centripetal force and circular paths

Physics grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

The model answers show full working and the final result in bold. Marks are given for the correct method as well as the answer, so show each step. Check whether you converted rpm to rad/s and whether the net force points to the centre.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.6

Question 1 Centripetal acceleration (2 marks)

The acceleration is directed **towards the centre** of the circle. The direction of the velocity changes continuously, and velocity is a vector, so there is an acceleration.

Marking: 1 mark for direction; 1 mark for the change of velocity direction.

Question 2 Rotating disc (3 marks)

- a. $\omega = 480 \times 2\pi \div 60 = \mathbf{50.3 \text{ rad/s}}$.
- b. $v = r \omega = 0.060 \times 50.27 = \mathbf{3.0 \text{ m/s}}$.
- c. $a = \omega^2 r = 50.27^2 \times 0.060 = \mathbf{152 \text{ m/s}^2}$.

Marking: 1 mark for each part.

Question 3 Work done (2 marks)

The force is always at right angles to the velocity, so the displacement along the force is zero. With **no work done**, the kinetic energy and speed remain constant.

Marking: 1 mark for perpendicular to velocity; 1 mark for no work so constant kinetic energy.

Question 4 Car on a flat bend (3 marks)

- a. $\mu m g = m v^2 \div r$, so $v = \sqrt{(\mu g r)} = \sqrt{(0.60 \times 9.81 \times 50)} = \mathbf{17 \text{ m/s}}$.
- b. **Equal**, because the mass cancels.

Marking: (a) 1 mark for the equation, 1 for the result; (b) 1 mark.

Question 5 Ball in a vertical circle (3 marks)

- a. $T - m g = m v^2 \div r$, so $T = 0.40 \times 9.81 + 0.40 \times 36 \div 0.90 = 3.92 + 16.0 = \mathbf{19.9 \text{ N}}$.
- b. At the limit $T = 0$, so $v = \sqrt{(g r)} = \sqrt{(9.81 \times 0.90)} = \mathbf{3.0 \text{ m/s}}$.

Marking: (a) 1 mark for the equation, 1 for the result; (b) 1 mark.

Question 6 Banked road (3 marks)

- a. The horizontal component of the normal reaction, $N \sin \theta$.
- b. $\tan \theta = v^2 \div (r g)$, so $v = \sqrt{(150 \times 9.81 \times \tan 8.0^\circ)} = \sqrt{(1471.5 \times 0.1405)} = \mathbf{14 \text{ m/s}}$.

Marking: (a) 1 mark; (b) 1 mark for the formula, 1 for the result.

Question 7 Mud from a tyre (2 marks)

The adhesion that gave the mud a centripetal force is no longer enough, so the mud gets **no resultant force**. By Newton's first law it moves in a straight line along the tangent at the speed it had at that instant.

Marking: 1 mark for insufficient centripetal force; 1 mark for tangent motion by Newton's first law.

Question 8 Scaling (2 marks)

- a. $F = m v^2 \div r$, so doubling v gives **four times** the force.
- b. F is proportional to $1/r$, so halving r gives **twice** the force.

Marking: 1 mark each.