



Cambridge International Examinations

Cambridge International Advanced Level

| CANDIDATE NAME | | | |
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| CENTRE NUMBER | | CANDIDATE NUMBER | |
| MATHEMATICS | | | 9709/53 |
| Paper 5 Mechanics | 2 (M2) | Octo | ber/November 2017 |
| | | | 1 hour 15 minutes |
| Candidates answer | on the Question Paper. | | |
| Additional Materials: | List of Formulae (MF9) | | |

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer all the questions.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use 10 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

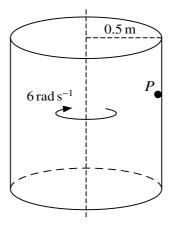
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 50.

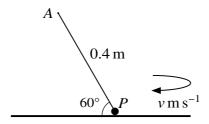


International Examinations



A hollow cylinder with a rough inner surface has radius $0.5\,\mathrm{m}$. A particle P of mass $0.4\,\mathrm{kg}$ is in contact with the inner surface of the cylinder. The particle and cylinder rotate together with angular speed 6 rad s⁻¹ about the vertical axis of the cylinder, so that the particle moves in a horizontal circle (see diagram). Given that P is about to slip downwards, find the coefficient of friction between P and the surface of the cylinder. [4]

| of the ball. | | | | | | | |
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One end of a light inextensible string of length 0.4 m is attached to a fixed point A which is above a smooth horizontal surface. A particle P of mass 0.6 kg is attached to the other end of the string. P moves in a circle on the surface with constant speed $v \, \text{m s}^{-1}$, with the string taut and making an angle of 60° with the horizontal (see diagram).

| Given that $v = 0.5$, calculate the magnitude of the force that the surface exerts on P . | [4] |
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- A particle P is projected with speed $25 \,\mathrm{m\,s^{-1}}$ at an angle of 30° above the horizontal from a point O on horizontal ground. At time t s after projection the horizontal and vertically upwards displacements of P from O are x m and y m respectively.
 - (i) Express x and y in terms of t and hence show that the equation of the trajectory of P is

| $y = \frac{x}{\sqrt{3}} - \frac{4x^2}{375}.$ | [4] |
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One end of a light elastic string of natural length 0.8 m and modulus of elasticity 24 N is attached to

| Calcul | ate the spee | ed of the pa | rticle at th | e position | where it is | moving wit | h zero acc | eleratio |
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| (i) Show | v that the height of the cylinder is 0.3 m. | |
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| nemisphe | bject is made by cutting the cylinder in half and removing the half re. The cut is perpendicular to the axis of symmetry, so the new ore and a cylinder half the height of the original cylinder. | |
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| held | new object is placed with its hemispherical part on a rough horizontal surface. The new object is in equilibrium by a force of magnitude PN acting along its axis of symmetry, which is inclined 0° to the horizontal. |
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| (iii) | Find P . [3 |
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| 7 | hori: plan | article P of mass $0.2 \mathrm{kg}$ is released from rest at a point O on a rough plane inclined at 60° to the zontal, and travels down a line of greatest slope. The coefficient of friction between P and the e is 0.3 . A force of magnitude $0.6x \mathrm{N}$ acts on P in the direction PO , where x m is the displacement from O . |
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| | (i) | Show that $v \frac{dv}{dx} = 5\sqrt{3} - 1.5 - 3x$, where $v \text{ m s}^{-1}$ is the velocity of P at a displacement $x \text{ m}$ from O . |
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| | (ii) | Find the value of x for which P reaches its maximum velocity, and calculate this maximum velocity. [4] |
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| (iii) | Calculate the magnitude of the acceleration of P immediately after it has first come to instantaneous rest. [4] |
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