Year 13 Pre-Mock Applied (Mechanics) Set 01

- Advised to print in "A3-booklets", this will allow all questions to be on the left hand side.
- You can also print in A4, double-sided, and two staples on the left
- If instead you print in 2-in-1 settings, first print the second page up to the last page, then print the cover page separately (to allow all questions on the left)

This exam paper has 5 questions, for a total of 50 marks.

| Question | Marks | Score |
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| Total: | 50 | |

Andrew Chan

Last updated: 17th February 2023

| 1. | Three posts P , Q and R , are fixed in that order at the side of a straight horizontal road. The distance from P to Q is 45 m and the distance from Q to R is 120 m. |
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| | A driver, Anoushka, is driving a car that moves along the road with constant acceleration a ms ⁻² . |
| | The speed of the car, as it passes P, is $u \text{ ms}^{-1}$. The car passes Q two seconds after passing P, and the car passes R four seconds after passing Q. |
| | Find |
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| 2. | A particle P travels along a straight line. The displacement of P from O at time t seconds is x m, where $x = t^3 - 15t^2 + 62t$. | |
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| | (b) the value of t for which P has zero acceleration. | (-) |
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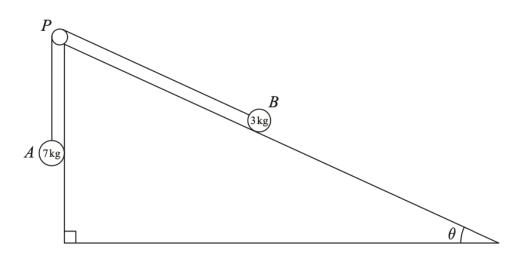


Figure 1

Two particles A and B, of mass 7 kg and 3 kg respectively, are attached to the ends of a light inextensible string. Initially B is held at rest on a rough fixed plane inclined at angle θ to the horizontal, where $\tan \theta = \frac{5}{12}$. The part of the string from B to P is parallel to a line of greatest slope of the plane.

The string passes over a small smooth pulley, P, fixed at the top of the plane. The particle A hangs freely below P, as shown in Figure 1. The coefficient of friction between B and the plane is $\frac{2}{3}$.

The particles are released from rest with the string taut and B moves up the plane.

(a) Find the magnitude of the acceleration of B immediately after release.

(10)

(b) Find the speed of B when it has moved 1 m up the plane.

(2)

When B has moved 1 m up the plane the string breaks. Given that in the subsequent motion B does not reach P,

(c) find the time between the instants when the string breaks and when B comes to instantaneous rest.

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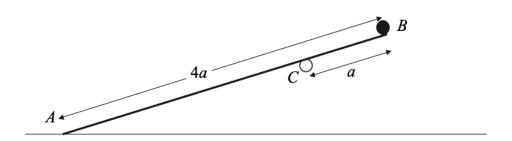


Figure 2

A wooden plank AB has mass 4m and length 4a. The end A of the plank lies on rough horizontal ground. A small stone of mass m is attached to the plank at B. The plank is resting on a small smooth horizontal peg C, where BC = a, as shown in Figure 2.

The plank is in equilibrium making an angle θ with the horizontal, where $\tan \theta = \frac{3}{4}$. The coefficient of friction between the plank and the ground is μ . The plank is modelled as a uniform rod lying in a vertical plane perpendicular to the peg, and the stone as a particle.

Show that

| (a) | the reaction | of the peg on | the plank has | magnitude | $\frac{16}{5}$ mg, | |
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| | | | | | | (3) |

(b)
$$\mu \ge \frac{48}{61}$$
. (6)

| (c) State how you have used the information that the peg is smooth. | |
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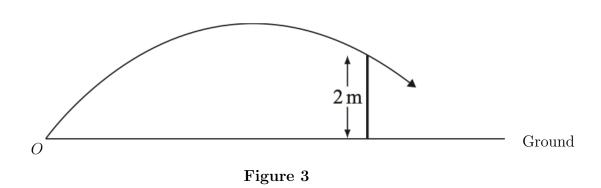
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| | (Total for Question 4 is 10 marks) |



A child, Kasope, is playing cricket on a horizontal ground. She hits the ball towards a fence 10 m away. The ball moves in a vertical plane which is perpendicular to the fence. The ball just passes over the top of the fence, which is 2 m above the ground, as shown in Figure 3.

The ball is modelled as a particle projected with initial speed $u \text{ ms}^{-1}$ from point O on the ground at an angle α to the ground.

(a) By writing down expressions for the horizontal and vertical distances, from O of the ball t seconds after it was hit, show that

$$2 = 10\tan\alpha - \frac{50g}{u^2\cos^2\alpha}$$

.

(6)

Given that $\alpha = 45^{\circ}$,

(b) find the speed of the ball as it passes over the fence.

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