# 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 |
|---|---|---|
| 1 | 7 | |
| 2 | 5 | |
| 3 | 16 | |
| 4 | 10 | |
| 5 | 12 | |
| Total: | 50 | |

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**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.

A driver, Anoushka, is driving a car that moves along the road with constant acceleration $a$ $\text{ms}^{-2}$.

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

(i) the value of $u$

(ii) the value of $a$

**(7)**

**Question 1 continued**

**Question 1 continued**

**Question 1 continued**

**(Total for Question 1 is 7 marks)**

**2.** A particle $P$ travels along a straight line.
The displacement of $P$ from $O$ at time $t$ seconds is $x$ m, where $x = t^3 - 15t^2 + 62t$.

Find

(a) the initial velocity of $P$

**(3)**

(b) the value of $t$ for which $P$ has zero acceleration.

**(2)**

**Question 2 continued**

**Question 2 continued**

**Question 2 continued**

**(Total for Question 2 is 5 marks)**

**3.**

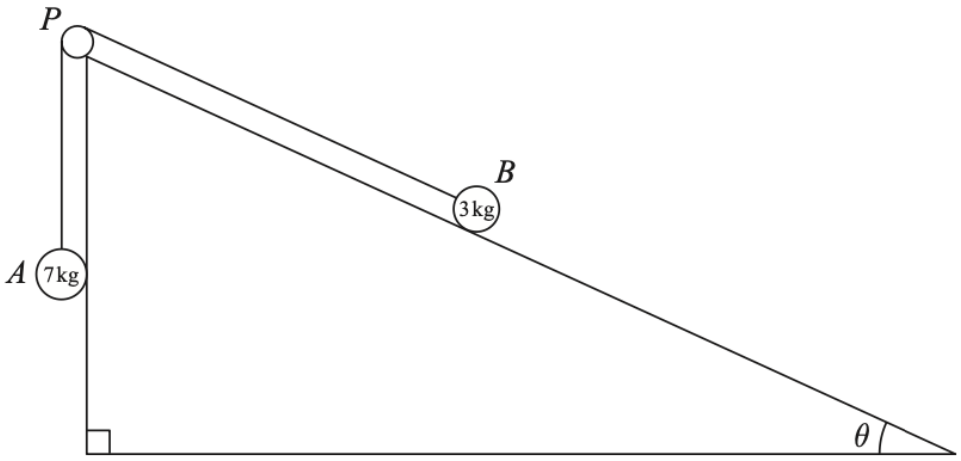


**Figure 1**

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 $\theta$ 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.

**(4)**

**Question 3 continued**

**Question 3 continued**

**Question 3 continued**

**(Total for Question 3 is 16 marks)**

**4.**

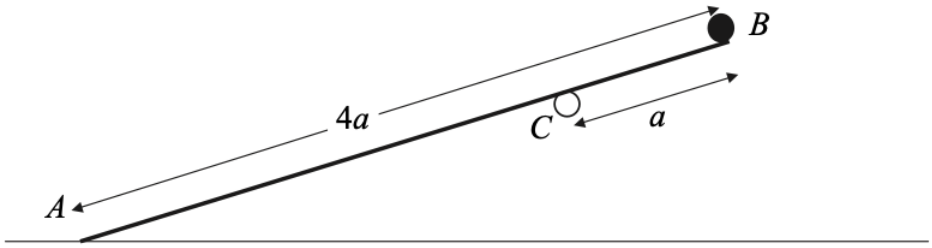


**Figure 2**

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 $\theta$ with the horizontal, where $\tan\theta = \frac{3}{4}$. The coefficient of friction between the plank and the ground is $\mu$. 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 $\frac{16}{5}\,mg$,

**(3)**

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

**(6)**

(c) State how you have used the information that the peg is smooth.

**(1)**

**Question 4 continued**

**Question 4 continued**

**Question 4 continued**

**(Total for Question 4 is 10 marks)**

**5.**

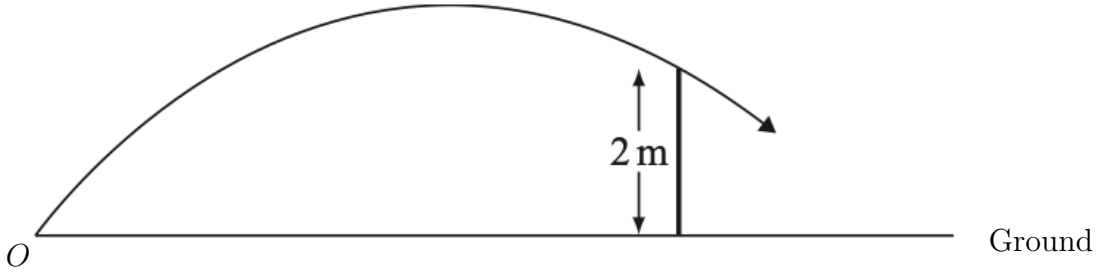


**Figure 3**

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 $u$ ms$^{-1}$ from point $O$ on the ground at an angle $\alpha$ 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 $\alpha = 45°$,

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

**(6)**

**Question 5 continued**

**Question 5 continued**

**Question 5 continued**

**(Total for Question 5 is 12 marks)**

**Total for paper is 50 marks**