MATHSAURUS

AS Mathematics Exam Questions by Topic
Chapter 20c: Pulleys

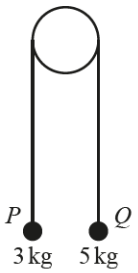
These questions are taken from the Specimen Exam materials and the real 2018 papers for the new syllabus AS and A-level mathematics courses and arranged by chapter of the textbooks by Goldie et al (available here: `https://amzn.to/39umfr5` and `https://amzn.to/3hE8kBL`). There are a mixture of questions from OCR A, OCR B (MEI), Edexcel and AQA. Although the style of questions varies a little across the exam boards the content of the syllabus is almost identical so these are suitable for students preparing for any exam board.

Free problem sets for all other chapters, as well as video solutions, full past papers and other content for GCSE and A-level maths can be found at:

`https://mathsaurus.com/`

OCR A AS 2018 Paper 2 Question 10:

10 Particles P and Q, of masses 3 kg and 5 kg respectively, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. The system is held at rest with the string taut. The hanging parts of the string are vertical and P and Q are above a horizontal plane (see diagram).



(i) Find the tension in the string immediately after the particles are released. **[4]**

After descending 2.5 m, Q strikes the plane and is immediately brought to rest. It is given that P does not reach the pulley in the subsequent motion.

(ii) Find the distance travelled by P between the instant when Q strikes the plane and the instant when the string becomes taut again. **[4]**

Edexcel AS Sample Paper 2 Question 9:

9.

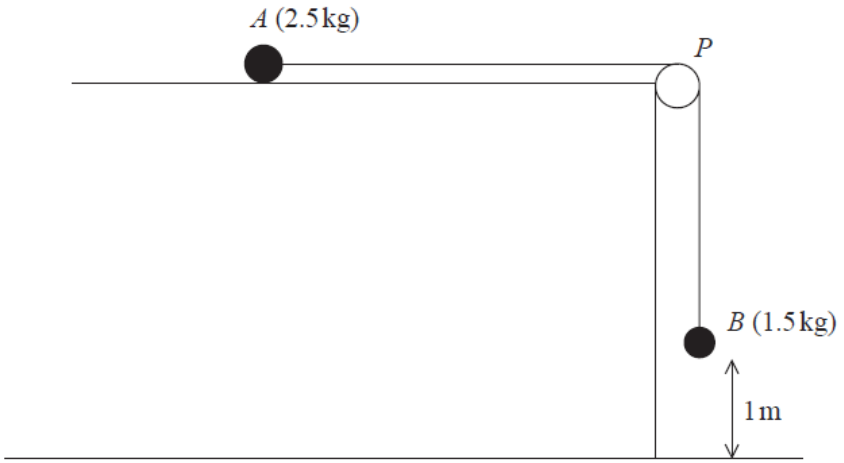


Figure 2

A small ball A of mass 2.5 kg is held at rest on a rough horizontal table.

The ball is attached to one end of a string.

The string passes over a pulley P which is fixed at the edge of the table. The other end of the string is attached to a small ball B of mass 1.5 kg hanging freely, vertically below P and with B at a height of 1 m above the horizontal floor.

The system is release from rest, with the string taut, as shown in Figure 2.

The resistance to the motion of A from the rough table is modelled as having constant magnitude 12.7 N. Ball B reaches the floor before ball A reaches the pulley.

The balls are modelled as particles, the string is modelled as being light and inextensible, the pulley is modelled as being small and smooth and the acceleration due to gravity, g, is modelled as being $9.8\,\text{m s}^{-2}$.

(a) (i) Write down an equation of motion for A.

(ii) Write down an equation of motion for B.

(4)

(b) Hence find the acceleration of B.

(2)

(c) Using the model, find the time it takes, from release, for B to reach the floor.

(2)

(d) Suggest two improvements that could be made in the model.

(2)

OCR B MEI AS 2018 Paper 1 Question 4:

4 Fig. 4 shows a block of mass $4m$ kg and a particle of mass m kg connected by a light inextensible string passing over a smooth pulley. The block is on a horizontal table, and the particle hangs freely. The part of the string between the pulley and the block is horizontal. The block slides towards the pulley and the particle descends. In this motion, the friction force between the table and the block is $\frac{1}{2}mg$ N.

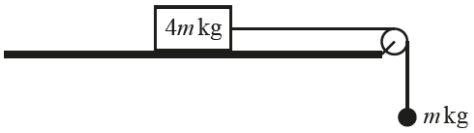


Fig. 4

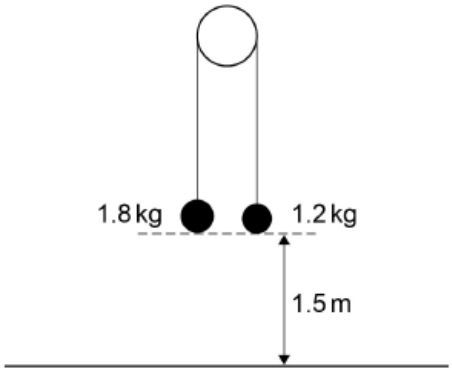
Find expressions for

- the acceleration of the system,
- the tension in the string. **[4]**

AQA AS 2018 Paper 1 Question 14:

14 **In this question use $g = 9.81\,\text{m s}^{-2}$**

Two particles, of mass 1.8 kg and 1.2 kg, are connected by a light, inextensible string over a smooth peg.



14 (a) Initially the particles are held at rest 1.5 m above horizontal ground and the string between them is taut.

The particles are released from rest.

Find the time taken for the 1.8 kg particle to reach the ground.

[5 marks]

14 (b) State one assumption you have made in answering part **(a)**.

[1 mark]

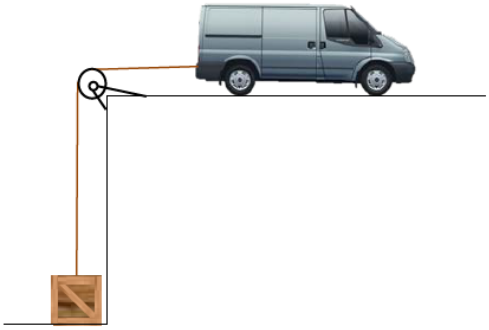
AQA AS Sample Paper 1 Question 17:

17 **In this question use $g = 9.8$ m s^{-2}.**

A van of mass 1300 kg and a crate of mass 300 kg are connected by a light inextensible rope.

The rope passes over a light smooth pulley, as shown in the diagram.

The rope between the pulley and the van is horizontal.



Initially, the van is at rest and the crate rests on the lower level. The rope is taut.

The van moves away from the pulley to lift the crate from the lower level.

The van's engine produces a constant driving force of 5000 N.

A constant resistance force of magnitude 780 N acts on the van.

Assume there is no resistance force acting on the crate.

17 (a) (i) Draw a diagram to show the forces acting on the crate while it is being lifted.

[1 mark]

17 (a) (ii) Draw a diagram to show the forces acting on the van while the crate is being lifted.

[1 mark]

17 (b) Show that the acceleration of the van is 0.80 m s^{-2}

[4 marks]

17 (c) Find the tension in the rope.

[2 marks]

17 (d) Suggest how the assumption of a constant resistance force could be refined to produce a better model.

[1 mark]

Edexcel AS 2018 Paper 2 Question 9:

9.

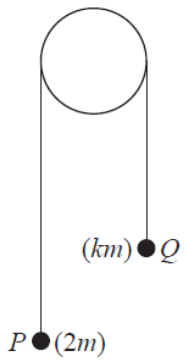


Figure 1

Two small balls, P and Q, have masses $2m$ and km respectively, where $k < 2$.
The balls are attached to the ends of a string that passes over a fixed pulley.
The system is held at rest with the string taut and the hanging parts of the string vertical, as shown in Figure 1.

The system is released from rest and, in the subsequent motion, P moves downwards with an acceleration of magnitude $\frac{5g}{7}$

The balls are modelled as particles moving freely.
The string is modelled as being light and inextensible.
The pulley is modelled as being small and smooth.

Using the model,

(a) find, in terms of m and g, the tension in the string,

(3)

(b) explain why the acceleration of Q also has magnitude $\frac{5g}{7}$

(1)

(c) find the value of k.

(4)

(d) Identify one limitation of the model that will affect the accuracy of your answer to part (c).

(1)