Name	Date started	Target end date

GCE AS / A LEVEL — APPLIED MATHEMATICS A QUESTION PACK

0980-01 (Legacy M1) · New spec Unit 2 Topic 7 · AS unit, 25% of A-level, 75 marks, 1h 45min paper

REVISE
.wales

MATHEMATICS — APPLIED A · CONNECTED PARTICLES - SMOOTH PULLEYS

Connected Particles over Smooth Pulleys

Smooth-pulley / smooth-peg connected-particle questions from the legacy WJEC M1 papers (2011-2017). Friction-on-incline variants now live in Unit 4 - this pack stays strictly on the AS Unit 2 spec

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 hours 9 minutes

*Derived from the legacy M1 paper's pace of **~1.25 min/mark** (55 marks over 6 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains questions from the legacy WJEC M1 papers (2008 modular spec) that map onto new-spec AS Unit 2 Topic 7 (2.2.8).

Questions are ordered chronologically.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — method marks are awarded for clear setup.

A calculator is allowed (except where specified by individual questions). The WJEC Formula Booklet and statistical tables may be referred to. Take $g = 9.8\,\mathrm{ms}^{-2}$ for mechanics.

For Examiner's use only

Q	Source	Max	Mark
1	Jun 11 Q5	7	
2	Jan 12 Q5	8	
3	Jun 12 Q4	7	

Q	Source	Max	Mark
4	Jan 13 Q8	7	
5	Jun 16 Q2	13	
6	Jun 17 Q5	13	
Total		**55**	

Connected Particles over Smooth Pulleys — what the new spec asks

WJEC GCE AS / A Level Mathematics (from 2017) · Unit 2: Applied Mathematics A · Topic 2.2.8.

Connected particles - setup 2.2.8

- Tension T is the same throughout a light inextensible string.
- Smooth peg / pulley: string changes direction without losing tension.
- Connected particles share the same magnitude of acceleration a.

Building the equations 2.2.8

- Draw a free-body diagram for each particle.
- Apply $F = ma$ along the direction of motion for each.
- Solve the simultaneous equations for T and a.

Crib sheet »

Connected Particles - Smooth Pulleys in one page

Quick-reference notes — revisit before each section. Don't use during questions.

Setup

Two particles connected by a light inextensible string over a smooth pulley / peg.

Tension T same throughout; acceleration magnitude a same for both.

Free-body diagrams

For each particle: list weight, tension, normal (if on a surface).

Then write $F = ma$ along the direction of motion.

Smooth horizontal table

Table-particle: $T = m_1 a$ horizontally.

Hanging particle: $m_2 g - T = m_2 a$.

Add: $a = \dfrac{m_2 g}{m_1 + m_2}$.

Smooth incline pulley

Particle on slope angle α: $T - m_1 g \sin\alpha = m_1 a$ (up the slope).

Hanging particle: $m_2 g - T = m_2 a$.

Two hanging masses

Larger mass m_2 moves down: $m_2 g - T = m_2 a$.

Smaller mass m_1 moves up: $T - m_1 g = m_1 a$.

Add: $a = \dfrac{(m_2 - m_1) g}{m_1 + m_2}$.

After-string-breaks / motion

Use SUVAT with the acceleration just computed.

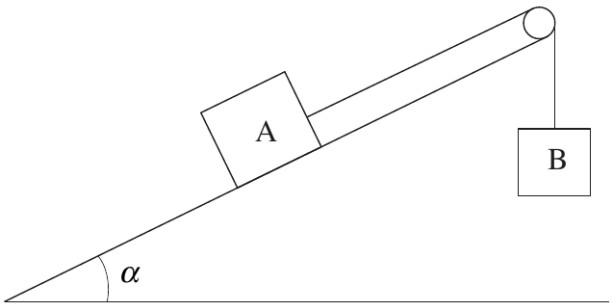
If string goes slack: each particle then under its own forces only (gravity, surface contact).

SECTION T7

Connected Particles over Smooth Pulleys

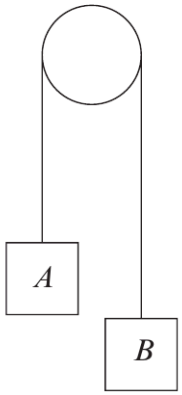
Questions 1–6 · 55 marks

5. The diagram shows a particle A, on a smooth inclined plane, joined by a light inextensible string passing over a smooth pulley to a particle B, which hangs freely. The plane is inclined at an angle α to the horizontal, where $\sin \alpha = \frac{5}{13}$. The masses of A and B are 13 kg and 15 kg respectively. The string is in the same vertical plane as a line of greatest slope of the plane.



Initially, the particles are held at rest with the string taut. The system is released. Calculate the magnitude of the acceleration of the particle A and the tension in the string. [7]

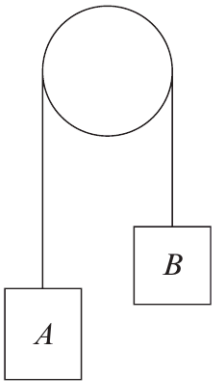
5. The diagram shows two objects A and B, of mass 5 kg and 9 kg respectively, connected by a light inextensible string passing over a smooth peg. Initially, the objects are held at rest. The system is then released.



(a) Find the magnitude of the acceleration of A and the tension in the string. [7]

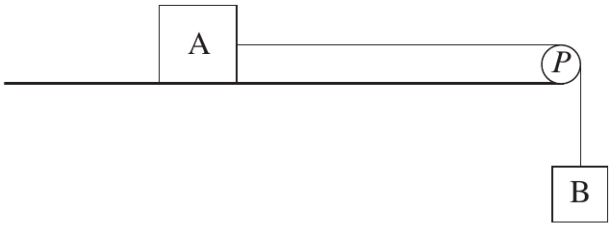
(b) What assumption did the word "light", underlined in the first sentence, enable you to make in your solution? [1]

4. Two particles A and B are connected by a light inextensible string which passes over a smooth fixed pulley. Particle A has mass 3 kg and particle B has mass M kg. Initially, the particles are held at rest with the string just taut and the hanging parts of the string vertical, as shown in the diagram.



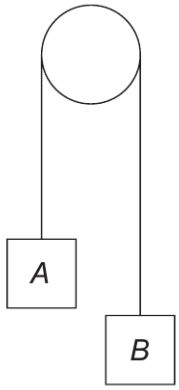
The system is then released from rest and particle B moves downwards with acceleration $0{\cdot}4g\,\text{ms}^{-2}$, where g is the acceleration due to gravity.
Calculate the tension in the string and the value of M. [7]

8. The diagram shows a body A, of mass 5 kg, lying on a smooth horizontal table. It is connected to another body B, of mass 9 kg, by a light inextensible string, which passes over a smooth light pulley P fixed at the edge of the table so that B hangs freely.



Initially, the system is held at rest with the string taut. A horizontal force of magnitude 126 N is then applied to A in the direction PA so that B is raised. Find the magnitude of the acceleration of A and the tension in the string. [7]

2. The diagram shows two objects, *A* and *B*, of mass 2 kg and 5 kg respectively, connected by a light inextensible string passing over a smooth fixed pulley. Initially, the objects are held at rest with the string taut. The system is then released.

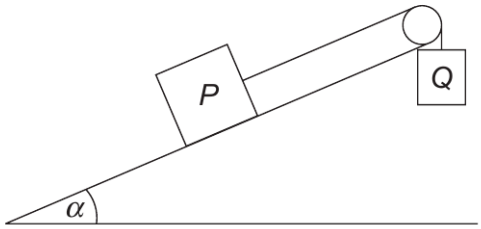


(a) Find the magnitude of the acceleration of *A* and the tension in the string. [7]

(b) Before the object *A* reaches the pulley and 2 seconds after the system is released, the string breaks.

(i) Find the speed of *A* when the string breaks.
(ii) Given that *A* does not reach the pulley in the subsequent motion and that *A* is 18·9 m above the ground when the string breaks, determine the time taken for *A* to reach the ground. [6]

5. Two particles P and Q, of masses 6 kg and 4 kg respectively, are connected by a light inextensible string of length 2 m. The string passes over a light smooth pulley fixed at the top of a smooth plane which is inclined at an angle α to the horizontal where $\sin\alpha = \frac{3}{5}$.



Initially, the particles are held at rest with the string just taut, with particle P lying on the plane and particle Q hanging just over the pulley. The particles are then released.

(a) Find the magnitude of the acceleration of the particles and the tension in the string. [6]

(b) Given that particle Q is initially 1·5 m above the ground, determine the speed with which particle Q hits the ground. [3]

(c) Given that particle P does not reach the top of the plane, calculate the time that elapses between Q reaching the ground and the string becoming taut again. Give your answer correct to 2 decimal places. [4]

END OF CONNECTED PARTICLES - SMOOTH PULLEYS PACK

Source: WJEC M1 (2008 modular spec) · 2011–2017
Curated for WJEC Maths 2017 spec AS Unit 2 — Topic 7 (2.2.8)