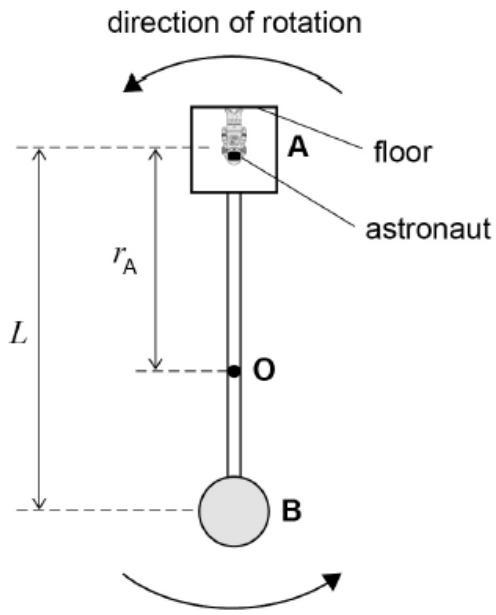
Periodic motion – A2 Physics P1

1. No.04

0 4 **Figure 6** shows a rotating spacecraft that is proposed to carry astronauts to Mars.

Figure 6



The spacecraft consists of two parts **A** and **B** connected by a rigid cylindrical rod. When the spacecraft is travelling, **A** and **B** rotate at a constant angular speed about their common centre of mass **O**.

L is the distance between the centre of mass of **A** and the centre of mass of **B**.
r_A is the distance from **O** to the centre of mass of **A**.

0 4 . 1 As the spacecraft rotates, a force that imitates the effect of gravity acts on an astronaut who is in contact with the floor.

Explain why.

[2 marks]

0 4 . 2 The forces exerted on **A** and **B** by the connecting rod have the same magnitude.

m_A is the mass of **A**
m_B is the mass of **B**

Show, by considering the centripetal forces acting on **A** and **B**, that r_A is given by

$$r_A = \frac{m_B L}{m_A + m_B}$$

[2 marks]

0 4 . 3 In this spacecraft $m_A < m_B$.

Deduce whether the centre of mass of **A** or the centre of mass of **B** rotates with a greater linear speed.

[2 marks]

The astronauts live in **A** and the cargo is stored in **B**.

When loaded,

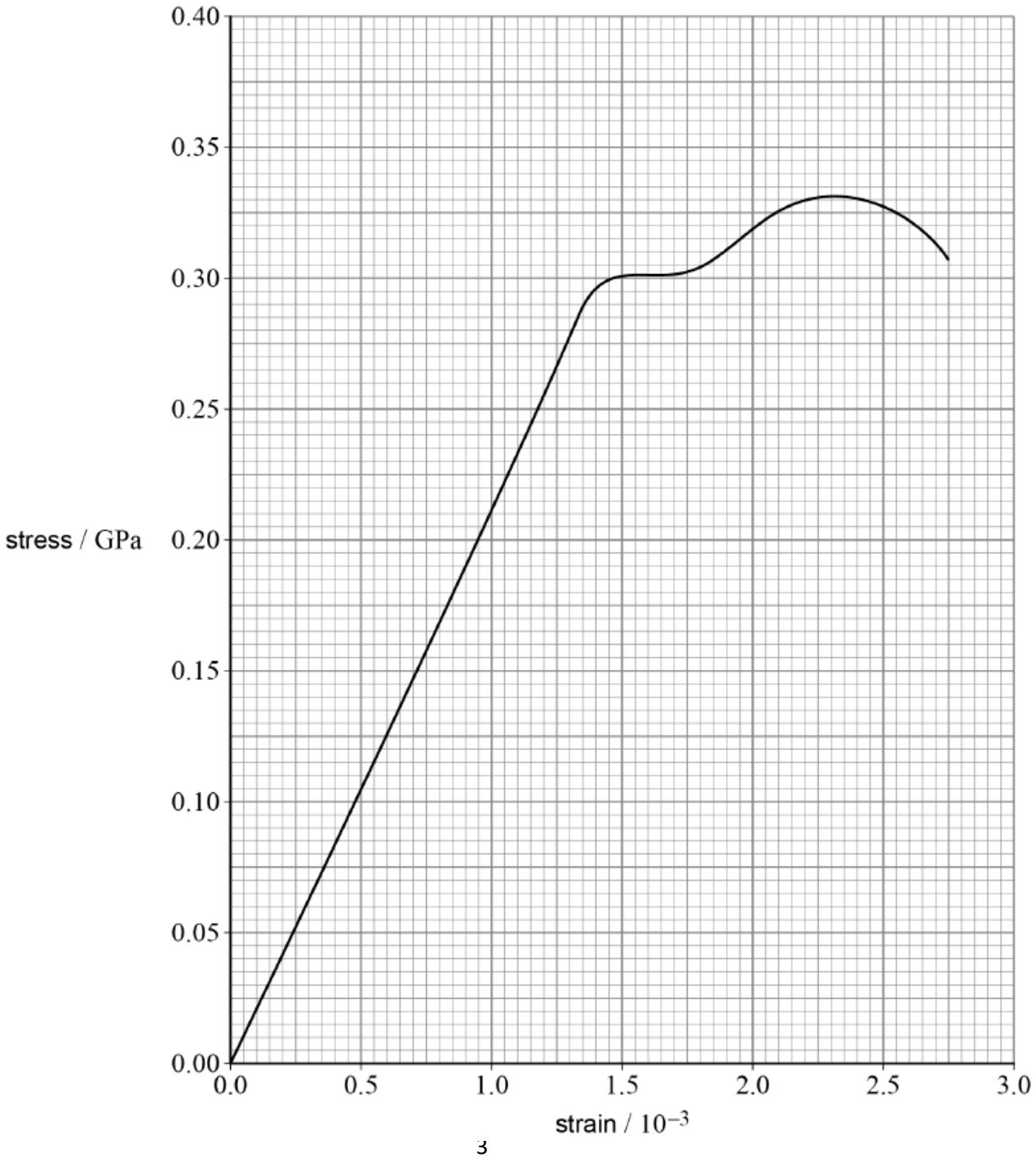
$m_A = 1.32 \times 10^6$ kg

$m_B = 3.30 \times 10^6$ kg.

The spacecraft imitates the gravity of Mars where $g = 3.7$ m s^{-2}.

Figure 7 shows a stress–strain curve for the metal used for the rigid rod.

Figure 7



0 4 . 4 Suggest a suitable diameter for the rod.
Justify your answer.

[5 marks]

diameter = _____ m

_____

_____

_____

_____

_____

2. No.30

A simple pendulum and a mass–spring system each have a time period T on the Earth.

They are taken to the surface of a planet where the acceleration due to gravity is $\frac{g}{4}$.

What are the time periods of the pendulum and the mass–spring system on this planet?

[1 mark

	Simple pendulum	Mass–spring system	
A	$\frac{T}{2}$	T	⬭
B	$2T$	T	⬭
C	$\frac{T}{2}$	$2T$	⬭
D	$2T$	$2T$	⬭

3. No.31

A particle of mass m is oscillating with simple harmonic motion.
The period of the oscillation is T and the amplitude is A.

What is the maximum kinetic energy of the particle?

[1 mark]

A $\frac{mA^2}{2T^2}$ ⬭

B $\frac{\pi^2 mA^2}{2T^2}$ ⬭

C $\frac{2mA^2}{T^2}$ ⬭

D $\frac{2\pi^2 mA^2}{T^2}$ ⬭