Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Further Mechanics

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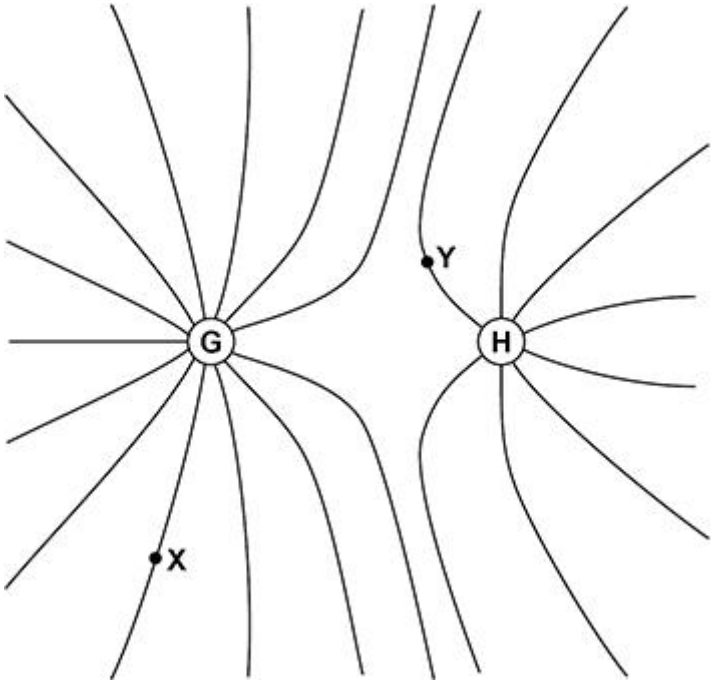
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

The lines in **Figure 1** show the shape of the gravitational field around two stars **G** and **H**.

Figure 1



(a) Compare, with reference to **Figure 1**, the masses of **G** and **H**.

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(2)

(b) **X** and **Y** are two points in the field.

Annotate **Figure 1** to show the field direction at **X** and the field direction at **Y**.

(1)

(c) A spherical asteroid **P** has a mass of 2.0×10^{20} kg.

The gravitational field strength at its surface is 0.40 N kg^{-1}.

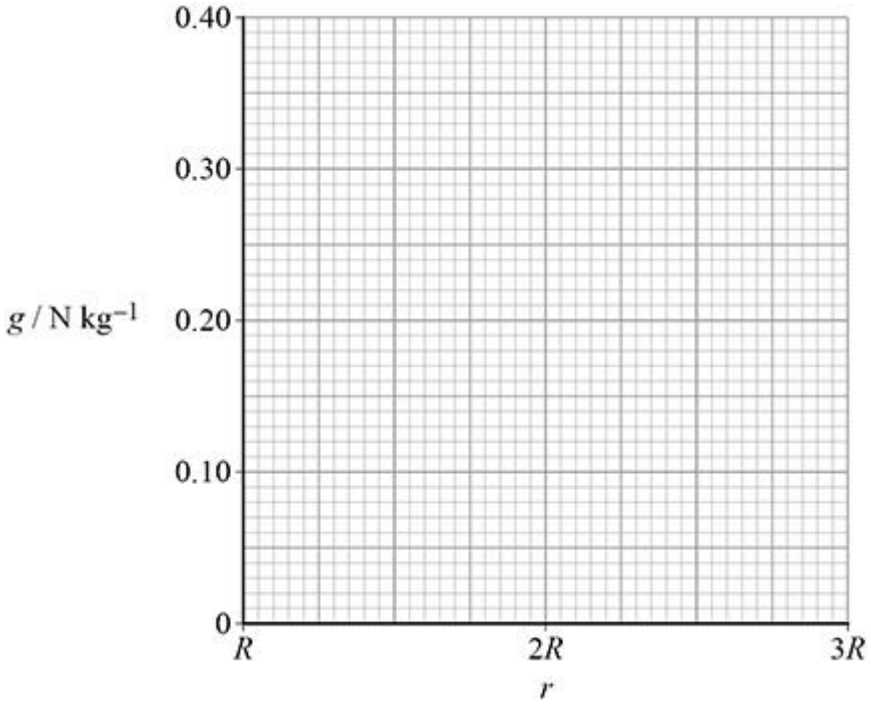
Calculate the radius R of **P**.

R = _____ m

(1)

(d) Sketch, on **Figure 2**, the variation of the gravitational field strength g with distance r. The distance r is measured from the centre of **P**.

Figure 2



(1)

(e) Explain what is represented by the area under the graph between $r = R$ and $r = 2R$ on **Figure 2**.

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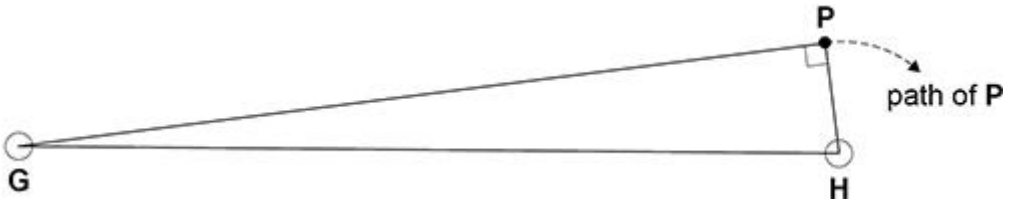
(2)

Asteroid **P** approaches the two stars **G** and **H**.
Figure 3 shows one position of **P** close to **H**.

Figure 3



(f) The gravitational force on **P** from **G** is 6.38×10^{12} N.
The mass of **H** is 3.00×10^{25} kg and the mass of **P** is 2.00×10^{20} kg.
The distance **HP** is 1.50×10^{11} m.

Calculate the magnitude of the acceleration of **P**.

magnitude of acceleration = _____ m s^{-2}

(4)

(g) Explain why **P** cannot have a circular orbit around **H**.

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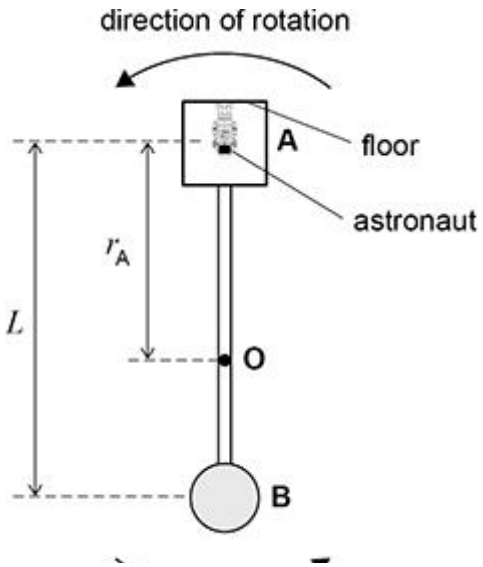
(1)

(Total 12 marks)

Q2.

Figure 1 shows a rotating spacecraft that is proposed to carry astronauts to Mars.

Figure 1



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**.

(a) 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.

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(2)

(b) 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)

(c) 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.

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(2)

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

When loaded,

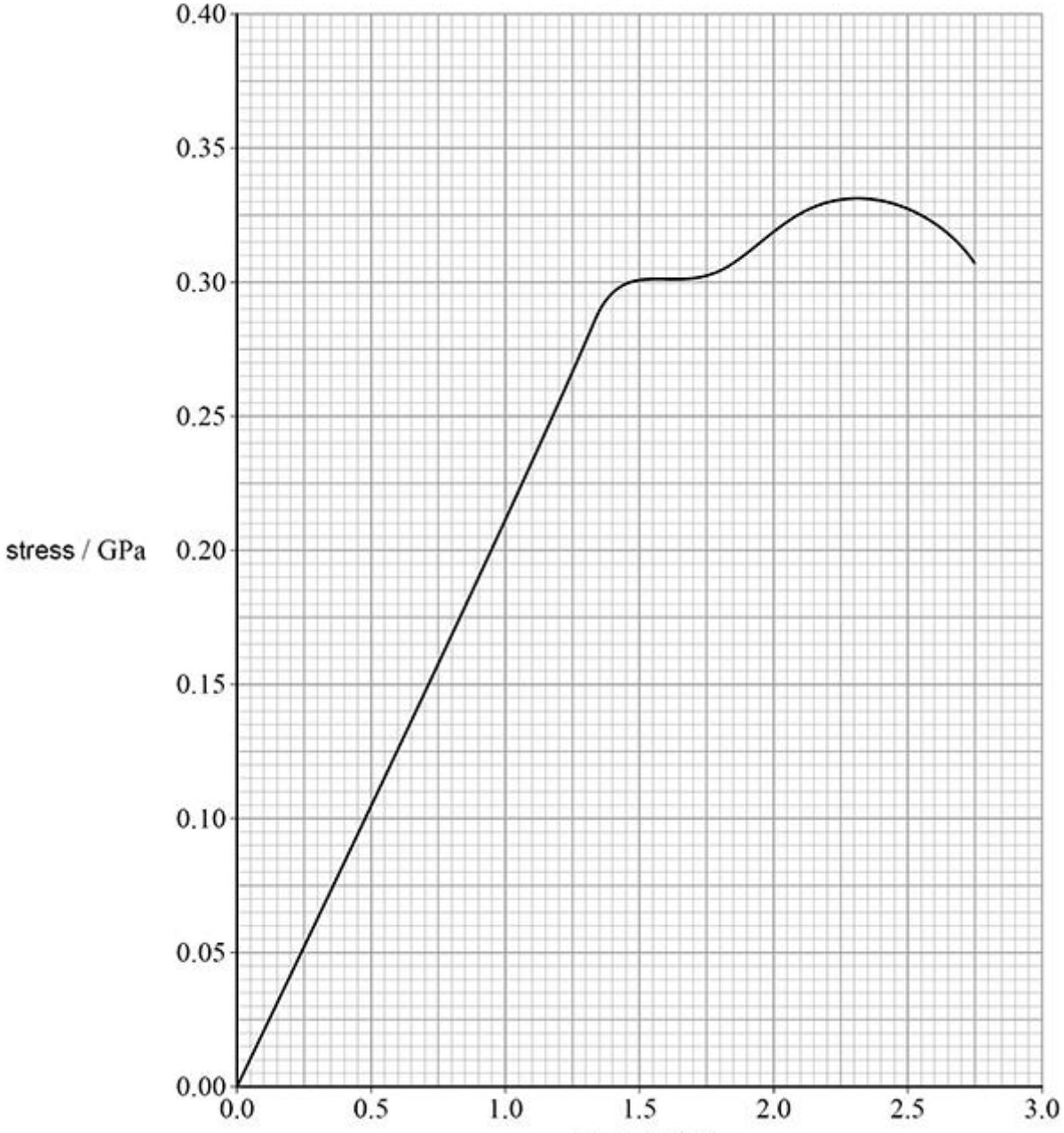
$m_A = 1.32 \times 10^6$ kg

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

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

Figure 2 shows a stress–strain curve for the metal used for the rigid rod.

Figure 2



(d) Suggest a suitable diameter for the rod.
Justify your answer.

diameter = _____ m

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(5)

(Total 11 marks)