

QQQ – Further Mechanics 2 – Chapter 5 – Dynamics (Version 2)

Total Marks: 23

(23 = Platinum, 21 = Gold, 18 = Silver, 16 = Bronze)

1. A spacecraft S of mass m moves in a straight line towards the centre of the earth. The earth is modelled as a fixed sphere of radius R . When S is at a distance x from the centre of the earth, the force exerted by the earth on S is directed towards the centre of the earth and has magnitude $\frac{k}{x^2}$, where k is a constant.

(a) Show that $k = mgR^2$. (2)

Given that S starts from rest when its distance from the centre of the earth is $2R$, and that air resistance can be ignored,

(b) find the speed of S as it crashes into the surface of the earth. (7)

(Total 9 marks)

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2. Throughout this question, use $g = 10 \text{ m s}^{-2}$

A light elastic string has natural length 1.25 m and modulus of elasticity 25 N.

A particle P of mass 0.5 kg is attached to one end of the string. The other end of the string is attached to a fixed point A . Particle P hangs freely in equilibrium with P vertically below A

The particle is then pulled vertically down to a point B and released from rest.

(a) Show that, while the string is taut, P moves with simple harmonic motion with period $\frac{\pi}{\sqrt{10}}$ seconds. (6)

The maximum kinetic energy of P during the subsequent motion is 2.5 J.

(b) Show that $AB = 2 \text{ m}$ (3)

The particle returns to B for the first time T seconds after it was released from rest at B

(c) Find the value of T (5)

(Total 14 marks)

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