

Possibly Useful Information: $g = 9.80 \frac{\text{m}}{\text{s}^2}$, $G = 6.67 \times 10^{-11} \frac{\text{N}\cdot\text{m}}{\text{kg}^2}$,

For Steel: $\rho = 8050 \frac{\text{kg}}{\text{m}^3}$, $Y = 20 \times 10^{10} \text{Pa}$, $S = 8.4 \times 10^{10} \text{Pa}$, $B = 6 \times 10^{10} \text{Pa}$

For Air (1atm, 20°C): $\rho = 1.203 \frac{\text{kg}}{\text{m}^3}$, $v_{\text{sound}} = 343 \frac{\text{m}}{\text{s}}$, $B = 1.42 \times 10^5 \text{Pa}$

Problem 1 Short answer - Which of the following could be used to find the mass of Jupiter? Answer yes or no.

_____ (i) The speed and period of Europa, one of Jupiter's moons.

_____ (ii) The radius and speed of Jupiter's orbit about the sun.

Problem 2 (8 points each)

(a) A simple pendulum has a period of 8s on earth. What is the period of this pendulum on a planet with 5 times the earth's mass and twice its radius?

(b) A particle moves in simple harmonic motion with a frequency of 0.60 Hz and an amplitude of 10 cm. What are the speed and acceleration of the particle when it is at a point 6 cm from the equilibrium position?

(c) A 3.3-m long steel wire has a 2.2-mm diameter. By how much does the wire stretch when a 55-kg mass is hung from it?

Problem 3

(a) A 200 kg spherical mass is at the origin, an 800 kg spherical mass is at (3m,0) and a 500 kg mass is at (0,2m). What is the magnitude of the net force on the 200 kg mass? (7 points)

(b) If the 800 kg and 500 kg masses in part (a) are fixed in place then what is the smallest speed that the 200 kg mass must be given to escape the gravitational pull of the other two masses? (7 points)

Problem 4 The pressure amplitude of a 450-Hz sound wave in air is 9.5 Pa.

(a) What is the displacement amplitude?

(b) What is its intensity?

(c) What is its sound level in dB?

Problem 5

(a) A wave of the form: $y(x,t) = (0.040\text{m})\sin[(300\text{s}^{-1})t + (5\text{m}^{-1})x]$ travels down a string with a linear density of $3 \times 10^{-3}\text{kg/m}$. What is the maximum speed of a point on the string as the wave passes and what is the tension in the string? There are two answers.

(b) A uniform disk with a 2m radius swings without friction about a nail through a hole 30cm from the rim. What is the period of small oscillations?

(c) A piece of space debris of mass m has a speed of v_0 at a height of h above a spherical planet of mass M and radius R . What is its speed when it crashes into the planet? You may not assume that h is small compared to R . Ignore air resistance.

(d) Neptune has a mass that is 17.2 times that of the earth and orbits the sun every 165 years. What is its distance from the sun in AU, where 1 AU is the earth-sun distance?