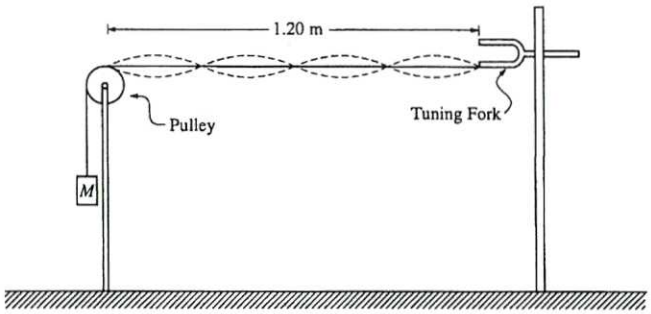
Oscillation & Waves Exam Review

Directions – Complete the following problems to help prepare you for the upcoming test.



5. (10 points)

To demonstrate standing waves, one end of a string is attached to a tuning fork with frequency 120 Hz. The other end of the string passes over a pulley and is connected to a suspended mass M as shown in the figure above. The value of M is such that the standing wave pattern has four "loops." The length of the string from the tuning fork to the point where the string touches the top of the pulley is 1.20 m. The linear density of the string is 1.0×10^{-4} kg/m, and remains constant throughout the experiment. μ

a. Determine the wavelength of the standing wave.

$L = 2\lambda$

$\lambda = \frac{L}{2} = \frac{1.20m}{2} = .60m$

b. Determine the speed of transverse waves along the string.

$V = f\lambda = (120Hz)(.60m) = 72\ m/s$

c. The speed of waves along the string increases with increasing tension in the string. Indicate whether the value of M should be increased or decreased in order to double the number of loops in the standing wave pattern. Justify your answer.

$V = \sqrt{\frac{F_t}{\mu}}$ $\quad f\lambda = \sqrt{\frac{F_t}{\mu}}$

$V = f\lambda$ $\quad \lambda = \frac{1}{f}\sqrt{\frac{mg}{\mu}}$ (same → f, same ← μ)

To double the loops, the wavelength must decrease. The tension would need to decrease so the mass would need to decrease

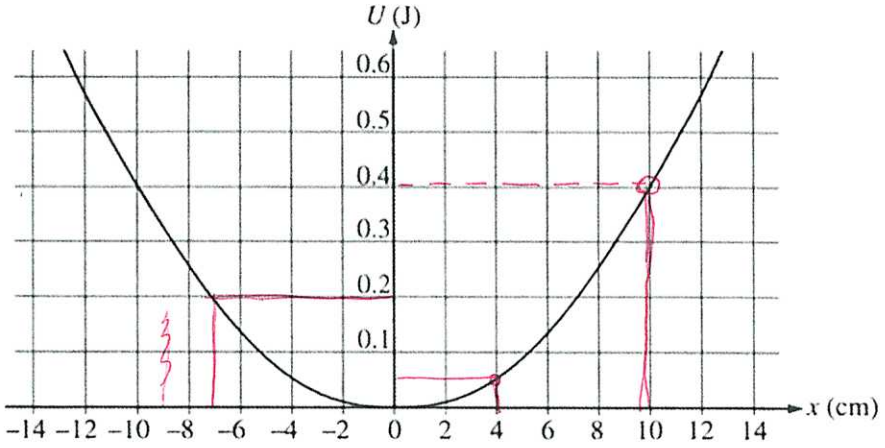
d. If a point on the string at an antipode moves a total vertical distance of 4 cm during one complete cycle, what is the amplitude of the standing wave?

up one
down two
up one

distance is 4x amplitude

$d = 4A$

$A = \frac{d}{4} = \frac{4cm}{4} = 1cm$



2. (15 points)

A 3.0 kg object subject to a restoring force F is undergoing simple harmonic motion with a small amplitude. The potential energy U of the object as a function of distance x from its equilibrium position is shown above. This particular object has a total energy E of 0.4 J.

(a) What is the object's potential energy when its displacement is +4 cm from its equilibrium position? .05 J (Read from graph)

(b) What is the farthest the object moves along the x-axis in the positive direction? Explain your reasoning.

b) 10 cm The total energy is .4J and U_g cannot exceed that. maximum displacement occurs when $K=0$ and $U_g = E_T = .4J$

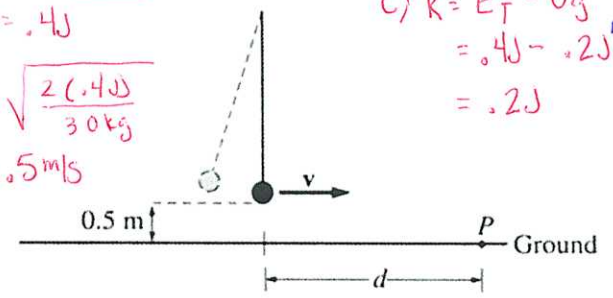
(c) Determine the object's kinetic energy when its displacement is –7 cm.

c) $K = E_T - U_g$ ← from graph
$= .4J - .2J$
$= .2J$

(d) What is the object's speed at $x = 0$?

d) $U_g = 0J$ $K = E_T = .4J$

$v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2(.4J)}{3.0kg}}$
$= .5 m/s$



Note: Figure not drawn to scale.

(e) Suppose the object undergoes this motion because it is the bob of a simple pendulum as shown above. If the object breaks loose from the string at the instant the pendulum reaches its lowest point and hits the ground at point P shown, what is the horizontal distance d that it travels?

$v_{0x} = .5 m/s$ $a_x = 0 m/s^2$
$v_{0y} = 0 m/s$ $a_y = -9.81 m/s^2$

① $t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2(.5m)}{9.81 m/s^2}} = .3s$

② $x = v_{0x} t = (.5 m/s)(.3s) = .15 m$
$= .2 m$