NAME: KEY

Assessment 7: *Oscillations*

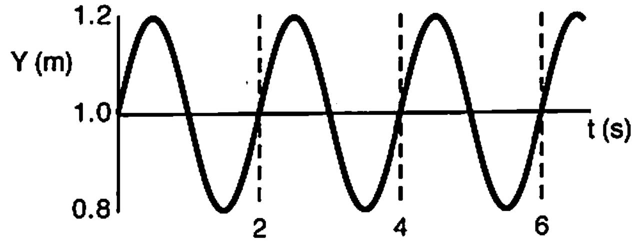
Multiple Choice: *Choose the letter of the best answer. 3 points each.*

2012

1. A A rod of mass M and length L is free to oscillate about its end point, and is hanging straight down in its equilibrium position. What is the frequency of small oscillation if the rod is displaced

a. $\frac{1}{2\pi}\sqrt{\frac{3g}{2L}}$ b. $\frac{1}{2\pi}\sqrt{\frac{3g}{L}}$ c. $\frac{1}{2\pi}\sqrt{\frac{2L}{3g}}$ d. $\frac{1}{2\pi}\sqrt{\frac{L}{3g}}$ e. $\frac{1}{2\pi}\sqrt{\frac{3L}{2g}}$

Questions 2 and 3 refer to the following position vs time graph.



2. E What is the amplitude of the simple harmonic motion?
a. 0.8 m. b. 1.2 m. c. 1.0 m. d. 2.0 m. e. 0.2 m.

3. B What is the period of the motion?
a. 6 s. b. 2 s. c. π s. d. π/2 s. e. π/3 s.

Questions 4 and 5 refer to the following velocity vs time function.

$$v = 4\sin(\pi t + \frac{\pi}{2})$$

4. D What is the amplitude of the simple harmonic motion?
a. 2π. b. 4π. c. π/2. d. 4/π. e. 4.

5. A What is the maximum acceleration of the simple harmonic motion?
a. 4π. b. 2π. c. $2\pi^2$. d. $4\pi^2$. e. $\pi^2/2$.

6. E A mass "m" is attached to a spring with spring constant "k" on a frictionless incline with base angle "θ". What is the period of the resulting simple harmonic motion?

a. $2\pi\sin\theta\sqrt{\frac{m}{k}}$ b. $2\pi\sqrt{\frac{m\sin\theta}{k}}$ c. $\frac{2\pi}{\sin\theta}\sqrt{\frac{m}{k}}$ d. $2\pi\sqrt{\frac{m}{k\sin\theta}}$ e. $2\pi\sqrt{\frac{m}{k}}$

7. D If you double the length of a pendulum, what will happen to its frequency?
   a. The frequency will also double.
   b. The frequency will be cut in half.
   c. The frequency will increase by a factor of $\sqrt{2}$.
   d. The frequency will decrease by a factor of $\sqrt{2}$.
   e. The frequency will increase by a factor of 4.

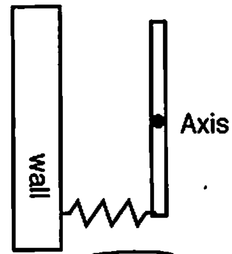
8. B In simple harmonic motion, the magnitude of the acceleration is
   a. constant.
   b. proportional to the displacement.
   c. inversely proportional to the displacement.
   d. greatest when the velocity is greatest.
   e. never greater than g.

50+24 = 74
(25)

Assessment 7: *Oscillations*

Problem Solving: *Show all work. 10 points each.*

9. A uniform rod of mass "m" and length "L" is free to oscillate about its center of mass. It is attached to a wall via a spring at the very end of the rod. Derive an expression for the periods of small oscillations about its equilibrium position (shown.)



$\Sigma \tau = I\alpha$

$-\frac{L}{2}kx = \frac{1}{12}mL^2\alpha$

$x = \frac{L}{2}\theta$

$-\frac{L}{2}k\frac{L}{2}\theta = \frac{1}{12}mL^2\alpha$

$-\frac{L^2}{4}k\theta = \frac{1}{12}mL^2\ddot{\theta}$

$\ddot{\theta} = -\frac{3k}{m}\theta$

$\omega^2 = \frac{3k}{m}$

$\therefore T = \frac{2\pi}{\omega} = \boxed{2\pi\sqrt{\frac{m}{3k}}}$

-2 $I = \frac{1}{3}$

10. A 0.5 kg mass is oscillating with a frequency of 4 Hz. It has a maximum acceleration of 7 m/s². What is its maximum speed?

$T = \frac{1}{4}$ sec $= \frac{2\pi}{\omega}$

$\omega = 8\pi$

$\rightarrow \frac{1}{4} = 2\pi\sqrt{\frac{.5}{k}}$ $k = 316$ $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$A\omega^2 = 7$

$A(8\pi)^2 = 7$

$A = \frac{7}{(8\pi)^2} = (.011)$

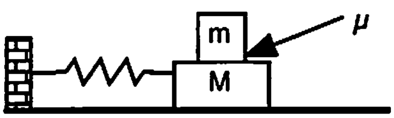
$V = A\omega$

$= \frac{7}{(8\pi)^2}\cdot 8\pi$

$= \frac{7}{8\pi} = \boxed{.028 \text{ m/s}}$

-4 $\omega = 4$

11. A 0.5 kg mass is on a 2.0 kg mass that is attached to a spring of spring constant 300 N/m. The coefficient of friction between the two masses is 0.35. What is the maximum speed the system could have if the little mass does not slip on the big mass? The table is frictionless.



$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{300}{2.5}} = \sqrt{120} = 10.95$

$\mu mg = ma$

$a = \mu g$ (= 3.5)

$a = A\omega^2$

$\mu g = A\left(\sqrt{\frac{k}{m}}\right)^2$

$A = \mu g\left(\sqrt{\frac{m}{k}}\right)^2 =$

$a = A\omega^2$

$3.5 = A(120)$

$A = .029$

$V = A\omega = (.029)(10.95)$

$\boxed{.32 \text{ m/s}}$

-4 $\mu mg = kx$

12. A certain spring stretches 3 cm when a mass M is hung from it. What is the natural frequency of this mass spring system?

$mg = kx$

$Mg = k(.03)$

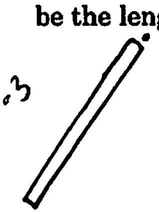
$k = \frac{Mg}{.03}$

$f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{\omega}{2\pi}$

$f = \frac{1}{2\pi}\sqrt{\frac{Mg}{(.03)M}} = \frac{1}{2\pi}\sqrt{\frac{g}{.03}} = \boxed{2.91 \text{ Hz}}$

-4 $mgh = \frac{1}{2}kx^2$

13. A uniform thin rod of length L and mass M is oscillating about one of its end points. What would be the length of a simple pendulum that has the same period as this rod?



$T = 2\pi\sqrt{\frac{I}{rmg}}$

$= 2\pi\sqrt{\frac{\frac{1}{3}ML^2}{\frac{L}{2}Mg}}$

$= 2\pi\sqrt{\frac{2}{3}\frac{L}{g}}$

$2\pi\sqrt{\frac{2L}{3g}} = 2\pi\sqrt{\frac{L'}{g}}$

$\frac{2L}{3g} = \frac{L'}{g}$

$\boxed{L' = \frac{2}{3}L}$

* use answer from #1

-3 $r = L$ I wrong: -3