NAME: KEY

Assessment: *Oscillations*

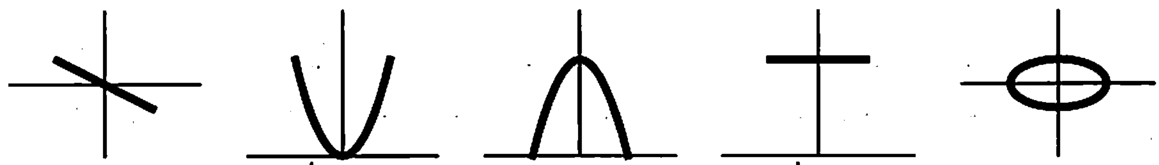
Multiple Choice: *Choose the letter of the best answer. 3 points each.*

87 total

2013

1. B Two pendulums have the same period of oscillation, but one is on the earth and the other is on the moon. Which pendulum is longer?
   a. the one on the moon. b. the one on the earth.
   c. they are the same length. d. can't tell which one is longer.

2. A Which of the following graphs would best represent acceleration vs position for an object undergoing simple harmonic motion?



a. b. c. d. e.

3. C A certain mass is hanging from a spring and oscillating with a period T and amplitude A. If the amplitude were doubled, then which of the following would be true?
   I. The period would also double.
   II. The energy of the system would also double. ×
   III. The maximum speed of the mass would also double. ✓
   a. I only. b. II only. c. III only. d. I & III only. e. all are true.

Problems 4 to 6 refer to the following:
The velocity of a 2 kg object is given by the function **v = 4 sin (3t)**, where v is in m/s and t in seconds.

$4 = A \cdot 3$

4. A What is the amplitude of the motion?
   a. $\frac{4}{3}$ m. b. $2\sqrt{3}$ m. c. $4\sqrt{3}$ m. d. 6 m. e. 12 m.

5. D What is the period of the motion?
   a. $\frac{3}{4}\pi$ s. b. $\frac{4}{3}\pi$ s. c. 4π s. d. $\frac{2}{3}\pi$ s. e. $\frac{2}{\sqrt{3}}\pi$ s.

6. B What is the total mechanical energy of the motion? $\frac{1}{2}(2)(4)^2$
   a. 36 J. b. 16 J. c. 12 J. d. 9 J.
   D e. can't tell because you need to know the spring constant.

7. D A simple pendulum of length L and mass M has frequency f. To double its frequency you should
   a. increase its length to 4L. b. increase its length to 2L.
   c. decrease its length to L/2. d. decrease its length to L/4. $\frac{T}{2}$
   e. decrease its mass to < M/4.

8. B A block attached to a spring oscillates in simple harmonic motion along the x axis. The limits of its motion are x = 10 cm and x = 50 cm and it goes from one of these extremes to the other in 0.25 s. Its amplitude and frequency are:
   a. 40 cm, 2 Hz. b. 20 cm, 2 Hz. c. 40 cm, 2 Hz. d. 25 cm, 4 Hz. e. 20 cm, 4 Hz.

A = 20 cm
T = .5 s
↳ f = 2 Hz

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9. __A__ A simple pendulum is set swinging with an initial amplitude and frequency. Because of air resistance
   a. the frequency will remain constant, but the amplitude will slowly decrease. ✓
   b. the frequency will slowly decrease, but the amplitude will remain constant.
   c. both the frequency and amplitude will slowly decrease.
   d. the frequency will slowly increase, but the amplitude will slowly decrease.
   e. both the frequency and amplitude will remain constant.

Problems 10 and 11 refer to the following:
A 3 kg mass is attached to a spring on a horizontal frictionless table. It is oscillating with a period of 0.75 seconds.

$.75 = 2\pi\sqrt{\frac{3}{K}}$ $K = 211$

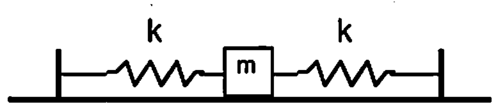
10. __E__ What is the spring constant of the spring?
   a. 5.3 N/m. b. 12.6 N/m. c. 14.5 N/m. d. 40 N/m. e. 210 N/m.

11. __C__ If the table is then inclined at an angle of 30°, what is the new period of oscillation?
   a. 0.38 s. b. 0.65 s. c. 0.75 s. d. 0.87 s. e. 1.50 s.

12. __A__ A uniform rod of length L is hanging and oscillating about one of its ends. What is the period of the motion?
   a. $2\pi\sqrt{\frac{2L}{3g}}$. b. $2\pi\sqrt{\frac{L}{3g}}$.

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

   c. can't tell because you need to know the mass of the rod.
   d. can't tell because you need to know the amplitude of the motion.
   e. can't tell because you need to know both the mass and the amplitude.



$-kx - kx = ma$

$a = \frac{-2k}{m}x$

13. __C__ A mass on a frictionless table is attached to two identical springs as shown above. What is the period of oscillation for this system?
   a. $2\pi\sqrt{\frac{m}{k}}$. b. $2\pi\sqrt{\frac{2m}{k}}$. c. $2\pi\sqrt{\frac{m}{2k}}$. d. $2\pi\sqrt{\frac{4m}{k}}$. e. $4\pi\sqrt{\frac{m}{k}}$.

14. __A__ An object is said to be resonating when
   a. it is being forced to oscillate at its natural frequency resulting in large amplitudes.
   b. it is really loud.
   c. it is undergoing simple harmonic motion with really large amplitudes.
   d. it is undergoing simple harmonic motion with its natural frequency.
   e. none of the above are correct.

15. __E__ In simple harmonic motion:
   a. the velocity is greatest at the maximum displacement.
   b. the period depends on the amplitude.
   c. the acceleration is constant.
   d. the acceleration is greatest at zero displacement.
   e. the acceleration is greatest at the maximum displacement.

1@8 = 8
2@12 = 24
2@6 = 12
44

15@3 = 45
~~1@8 = 8~~
2@12 = 24
2@6

total

total 87

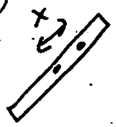
Assessment: *Oscillations*

Problem Solving: Show all work.

16. A uniform thin rod of length L is suspended from a point that is a distance x from the center of the rod.

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

6 a. What is the period of oscillation of the rod?

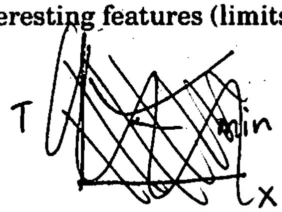


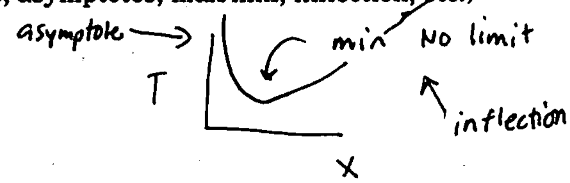
$I = \frac{1}{12}ML^2 + Mx^2$ $\quad T = 2\pi\sqrt{\frac{I}{rmg}} = 2\pi\sqrt{\frac{\frac{1}{12}ML^2 + Mx^2}{xMg}} = 2\pi\sqrt{\frac{\frac{L^2}{12} + x^2}{xg}}$

$r = \frac{L}{2}$ -3 $\quad$ "r" = x

$= 2\pi\sqrt{\frac{L^2}{12xg} + \frac{x}{g}}$

6 b. What would a sketch of Period vs x look like? You don't need numbers, but do point out any interesting features (limits, asymptotes, max/min, inflection, ~~etc.~~)





17. Find, but don't solve, the equation of motion for a particle of mass m that is experiencing two forces on it: a force that is proportional by a factor of P to its position and always directed to the origin and a force that is proportional by a factor of Q and opposite to its velocity.

signs -2 6

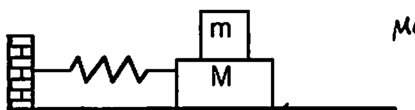
-3 if "solve"

$\Sigma F = ma = -Px - Qv$

$m\ddot{x} = -Px - Q\dot{x} \rightarrow \boxed{\ddot{x} = -\frac{P}{m}x - \frac{Q}{m}\dot{x}}$

18. A 2 kg mass is on top of a 3 kg mass, which is on a frictionless table. The 3 kg mass is attached to a spring of constant 60 N/m. The 2 kg mass always stays on top of the 3 kg mass without sliding, and the maximum speed the masses ever have is 2.3 m/s. What is the minimum coefficient of friction between the blocks?

12



Max A $\rightarrow$ $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$\frac{1}{2}(60)x^2 = \frac{1}{2}(3+2)(2.3)^2$

$30x^2 = 13.23$

$x^2 = .44$

$\underline{x = .66}$

on m:

$\Sigma F = ma$

$\mu mg = ma$

$\mu = \frac{a}{g}$

$\left(\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{60}{5}} = \sqrt{12} = 3.46\right)$

$\Sigma F = ma$

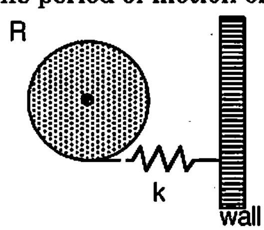
$(.66)(60) = (5)a$

$\underline{a = 7.97\ m/s^2}$

$\mu = \frac{7.97}{10} = .797$

19. A spring, with spring constant k, is attached to a wall and to the edge of a uniform disk of mass M and radius R. The disk is otherwise free to rotate about its center. Derive an expression for the period of motion of the resulting small oscillations.

12



$\tau = kx$ -3

$mg\sin\theta$ -4

x

no - -3

$\Sigma\tau = I\alpha$

$-Rkx = \frac{1}{2}MR^2\alpha$

Since $x \approx R\theta$

$-Rk(R\theta) = \frac{1}{2}MR^2\ddot{\theta}$

$-k\theta = \frac{1}{2}M\ddot{\theta}$

$\ddot{\theta} = -\frac{2k}{M}\theta$

SHM!

$\therefore \omega^2 = \frac{2k}{M}$

$\therefore T = 2\pi\sqrt{\frac{M}{2k}}$