Oscialltions &SHM

1. A particle under SHM has displacement of 0.4m at the velocity 0.3m/s and a displacement 0.3m at the velocity 0.4m/s. Calculate the amplitude and frequency of the oscillation.
   [hint: $V=\omega\sqrt{a^2-y^2}$] **0.5m; 1/2π Hz**
2. A partice describing SHM makes 100complete oscillations per minute and its maximum speed is 5 m/sec. What is the length of its path and its maximum acceleration? Find the velocity when the particle is half wave between its mean position and the extreme position.
   [hint: $\omega=2\pi n; V_{max}=a\omega; a_{max}=a\omega^2; V=\omega\sqrt{a^2-y^2};$]
   2a = 0.48m; 52.6m/s^2; 4.352m/s
3. A particle executing SHM is represented by $y=10\sin(10t-\frac{\pi}{6})$ where y is expressed in metre, t in sec and phase angle in radian. Calculate (a) frequency (b) time period (c) the maximum displacement (d) the maximum velocity (e) the maximum acceleration (f) displacement , velocity and acceleration at time t=0
   (a) 1.6Hz (b) 0.63s (c) 10m (d) 100m/s (e) -1000m/s^2 (f) -5m; 86.6m/s; 500m/s^2
4. A body of mass 4.9kg hangs from a spring and oscillates with a period of 0.6s. How much will the spring shorten when the body is removed
   [hint: $T=2\pi\sqrt{\frac{m}{k}}; f=kx$] **0.089m**
5. A horizontal spring block system of mass M executes simple harmonic motion. When the block is passing through its equilibrium position, an object of mass m is put on it and the two move together. Find the new amplitude and the frequency of vibratio
   $A'=A\sqrt{\frac{M}{M+m}}; f'=\frac{1}{2\pi}\sqrt{\frac{K}{M+m}}$
6. Two tuning forks A and B when sounded together produces 3 beats/sec. When A is field and sounded, the no. Of beats per second decreases. If frequency of B is 480Hz, find the frequency of A **477Hz**
7. what is the change in the time period of a simple pendulum if its length changes by 1%
   [hint: $\frac{dT}{T}=\frac{1}{2}\frac{dl}{l}$] **0.5%**
8. when the length of simple pendulum is increased by 21% what is the change in its timeperiod?
   [hint: $\frac{T_2}{T_1}=\sqrt{\frac{l_2}{l_1}}$] **increase in time period is 10%**
9. A seconds pendulum is taken into a mine of depth 640m and oscillated. What is its timeperiod?(Radius of the earth is 6400km)
   [hint: $\frac{T_1}{T_2}=\sqrt{\frac{g_2}{g_1}}=\sqrt{\frac{g(1-\frac{d}{R})}{g}}$] **2.0001sec**
10. A clock regulated by a seconds pendulum keeps correct time. During summer the length of the pendulum increases to 1.01m. How much will the clock gain or lose in one day?
    [hint: $\frac{dT}{T}=\frac{1}{2}\frac{dl}{l}$ and the gain or loss of time per day = no. Of osciallations in one day X change in time for one oscillation] **752.9s(Time period increases with increasing length)**
11. A particle is executing SHM with an amplitude of 0.2m. At what distance from the mean position the PE of the particle will be equal to its KE **0.1414m**
12. A sphere is hung with a wire. A 30degree rotation of the sphere about the wire generates a

restoring torque of 4.6Nm. If the moment of inertia of the sphere about the wire is 0.082 kgm^2. Deduce the frequency of angular oscillations.

[hint: $\tau = C\theta ; \nu = \frac{1}{2\pi}\sqrt{\frac{C}{I}}$] **1.65Hz**

13. Starting from the origin, a body oscillates simple harmonically with a period of 2s. After what time, will its KE be 75% of the TE **1/6 s**
14. Two masses m_1 and m_2 are suspended together by a massless spring of spring constant K. When the masses are in equilibrium, m_1 is removed without disturbing the system. Calculate the amplitude and angular frequency of m_2 $\omega = \sqrt{\frac{k}{m_2}}$
15. You are riding in an automobile of mass 3000kg. Assuming that you are examining the oscillation characteristics of its suspension system of four parallel springs. The suspension sags 15cm when the entire automobile is placed on it. Also, the amplitude of oscillation decreases by 50% during one complete oscillation. Estimate the values of (a) the spring constant K (b) the damping constant for the spring and the shock absorber systme of one wheel, assuming that each wheel supports 750kg. Take g = 10 m/s^2
    Note: When the springs are connected parallel in a system $K = k_1 + k_2 + k_3 + ... + k_n$.
    when the springs are connected in series of system $\frac{1}{K} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + ... + \frac{1}{k_n}$.
    [hint: Mg = 4kx ; $x = Ae^{\frac{-bt}{2m}}$ $where\, m = \frac{M}{4}$; $T = 2\pi\sqrt{\frac{M}{4k}}$] **5 x 10^4 N/m ; 1350.5kg/s**
16. An observer standing at a sea cost observer 54 waves reaching the coast per minute. If the wavelength of the waves is 10m. Find the velocity of the waves **9 m/s**
17. Calculate the speed of sound in oxygen from the follwoing data. The mass of 22.4 litre of oxygen at STP(T = 273K and P = 1.0x10^5 N/m^2) is 32g, the molecular heat capacity of oxygen at constant volume is C_v = 2.5R and that at constant pressure is C_p = 3.5R
    [hint: $V = \sqrt{\frac{\gamma P}{\rho}}$] **313m/s**
18. Find the speed of transverse waves in a copper wire having a cross-sectional area of $1mm^2$ under the tension produced by 1kgwt. The relative density of copper is 8.93
    [hint: $V = \sqrt{\frac{T}{\mu}}$ $where\, \mu = mass/length = \rho\, x\, area$] **33.13m/s**
19. Determine the speed of sound in a liquid of density 8000kg/m^3. Given bulk modulus = 2x$10^9$$N/m^2$.
    [hint: $V = \sqrt{\frac{bulk\ modulus}{\rho}}$] **500m/s**
20. Calculate the velocity of longitudinal waves in hydrogen at NTP(γ = 1.4 ,R=8.3J/(molK), T = 273K and M = 2x10^{-3} kg/mol)
    [hint: $V = \sqrt{\frac{\gamma R T}{M}}$] **1259.42m/s**
21. At what temperature will the velocity of sound in H_2 be twice as much as that at 27^0C.
    [hint: $\frac{V_t}{V_{27}} = \sqrt{\frac{273+t}{273+27}}$] **927^0C**
22. For the plane waves, in air, of frequency 1000Hz and displacement amplitude 0.2x10^{-7}m, deduce (a) the velocity amplitude (b) the intensity. Given ρ = 1.3 kg/m^3 ,v = 340m/s

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[hint: $v_0 = a\omega$ and $I = \frac{1}{2}\rho a^2 \omega^2 V$] **1.257×10^{-4} m/s; 3.5×10^{-6} W/m^2**

23. A sinusoidal wave travelling along a string is $y(x,t) = 0.00327 \sin(72.1x - 2.72t)$ all the numerical constants in this equation are in SI units. Calculate the amplitude, wavelength, period, frequency and speed of the wave.
3.27mm ; 8.72cm; 2.31s; 0.433Hz; 3.77cm/s
24. A wire of length 1.5m under tension emits a fundamental note of frequency 20Hz (a) what would be its fundamental frequency if the length is increased by half under the same tension? (b) How much should the length shortened so that the frequency is increased three fold.
[hint: $\upsilon \alpha 1/l$] **80Hz; 0.5m**
25. A sonometer wire made of silver alloy of density 10.8g/cm^3 and of diameter 0.25mm is kept in a state of tension by handing a load W at its end. When the distance between the bridges of the sonometer is 30cm, it gives out a vibration whose fundamental frequency is 300Hz. What is the changed value of the frequency in each of the following cases. (a) the distance between the bridges is increased to 90cm (b) the load is increased to 9W (c) the wire is replaced by a wire of steel of diameter 1mm (d) the wire is replaced by a wire of the same diameter(i.e 0.25mm) but made of aluminium of density 2.7 g/cm^3
[hint: $\nu = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$] **100Hz; 900Hz; 75Hz; 600Hz**
26. find the fundamental, first overtone and second overtone frequencies of an open organ pipe of lenght 20cm. Speed of sound in air is 340m/s
[hint: $\nu_n = n\frac{v}{2l}$] **850Hz; 1700Hz; 2550Hz**
27. If the velocity of sound in air at 0^0C be 332m/s. Find the shortest length in an open pipe that will be thrown into resonant vibrations by a tuning form of frequency 256Hz when the temperature of air is 50^0C.
[hint: $V \alpha \sqrt{T}$; $\nu = \frac{V_{50}}{2l}$] **0.71cm**
28. A closed organ pipe can vibrate at a minimum frequency of 500Hz. Find the length of the tube speed of sound in air is 340 m/s
[hint: $\nu_n = n\frac{V}{4l}$] **17cm**
29. The second overtone of an open pipe has the same frequency as the first overtone of a closed pipe 2m long. Calculate the length of the open pipe. **4M**
30. Two tuning forks A and B when excited simultaneously produce 4 beats per second. The first fork A is in resonance with a closed organ pipe of length 16cm while the second is in resonance with an open organ pipe of length 32.5cm. Fin their frequencies.
260Hz; 256Hz
31. The noise level in a class room in absence of the teacher is 50dB when 50 students are present, assuming that on the average each student outputs same sound energy per second. What will be the noise level if the no. Of students is increased to 100?
[hint: $L = 10\log_{10}\frac{I_2}{I_1}$] **53.01dB**
32. If the sound level in a room is increased from 50dB to 60dB, by what factor is the pressure amplitude increases.

[hint: $\frac{I_2}{I_1}=(\frac{p_2}{p_1})^2$] $\sqrt{10}$