Vibrations & Waves Problem Set Answers

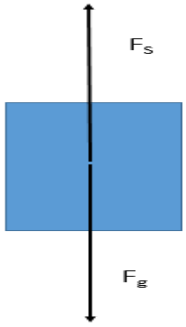
1. Periodic, so it repeats, and the force and acceleration back to the equilibrium position increase as the displacement increases.
2. No, the acceleration is not constant. The acceleration is greatest at the greatest displacements, and the acceleration is zero when it is passing through the equilibrium position.
3. The pendulum bob has gravitational potential energy that converts to kinetic as it moves toward the equilibrium position. The kinetic energy converts back to gravitational potential as it moves to the other amplitude.
4. $\Sigma F = F_s - F_g = 0$

   $F_s = F_g$

   $kx = mg$

   $k(.03m) = (0.4kg)(9.8\,{}^{m}/_{s^2})$

   $k = 130.7\,{}^{N}/_{m}$



5. Two times; once each way in the oscillation
6. If the length is doubled, the period of oscillation would be $\sqrt{2}$ times greater
7. If the clock is running slow, that means the period of oscillation is too slow. Therefore, you should decrease the length of the pendulum to make the clock run on time.
8. $f = 0.16Hz$

   $T = \frac{1}{f} = \frac{1}{0.16Hz} = 6.25s$

   $T = 2\pi\sqrt{\frac{l}{g}}$

   $6.25s = 2\pi\sqrt{\frac{l}{9.8\,{}^{m}/_{s^2}}}$

   $l = 9.71m$

9. a) $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1.5kg}{180\,{}^{N}/_{m}}} = 0.57s$

   b) $f = \frac{1}{T} = \frac{1}{0.57s} = 1.74Hz$

10. Transverse waves vibrate perpendicular to the direction of motion, while longitudinal waves vibrate in the same direction as the direction of the wave's motion.
11. $v = \lambda f$

    $3.0x10^{8}\,{}^{m}/_{s} = \lambda(9.0\,\mathrm{x}\,10^{9}\,Hz)$

    $\lambda = 0.033m$

12. Constructive has twice the amplitude, both crests and troughs; destructive has no amplitude at all
13. Zero
14. $\lambda = \frac{2L}{n}$, so a, b, and d work

15. $v = \lambda f$

$3.0x10^{8}\,{}^{m}\!/_{s} = (5.2x10^{-7}m)\,f$

$f = 5.77x10^{14}Hz$

$T = \frac{1}{f}$

$T = \frac{1}{5.77x10^{14}Hz} = 1.73x10^{-15}s$

16. $f = 2Hz$

$\lambda = 0.15m$

$v = \lambda f$

$v = (0.15m)(2Hz) = 0.3\,{}^{m}\!/_{s}$

17. $v = \frac{\Delta x}{t}$

$343\,{}^{m}\!/_{s} = \frac{\Delta x}{1.3s}$

$\Delta x = 446m$

18. $\lambda = 1.20m$

$f = \frac{8crests}{12s} = 0.67Hz$

$v = \lambda f$

$v = (1.20m)(0.67Hz) = 0.8\,{}^{m}\!/_{s}$

19. The clock will read 9:47 AM