Section A - Multiple Choice

1. C
2. A
3. D
4. B
5. A
6. D
7. D
8. D
9. A
10. A
11. B
12. B
13. D
14. A
15. E
16. E (small angle approximation doesn't hold)
17. E
18. A
19. C
20. D

Section B – Problems

1. (a) $\omega = 105$ rad/s
   (b) $x(t) = 0.06\text{m} \sin(105t + 0.524)$
   (c) $x = -0.06$ m
   (d) $a = 658$ m/s^2
   (e) $k = 43.9$kN/m

2. (a) $T = 5.3$ s
   (b) $v = 0.237$ m/s
   (c) $g = 2.81$ m/s^2
   (d) $E = 0.0422$ J

3A (a) $y(x,t) = .25\sin(\frac{\pi}{3}x + 40\pi t)$

   (b) $\frac{\lambda}{2} = 3cm$

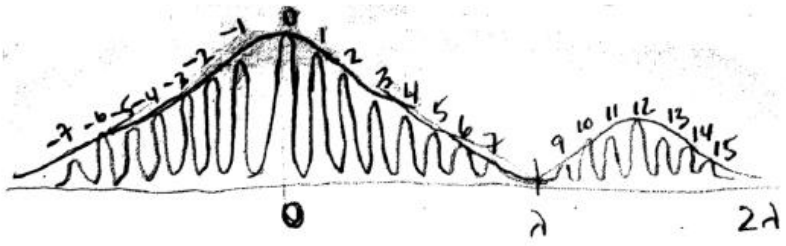
3B $\lambda_1 = 1.05$ m, $\lambda_2 = 0.740$ m

3C a) 9 b) 9.54 dB

4. (a) $f_{beat} = 9.2$ kHz
   (b) $L_{open\text{-}closed} = 0.425$m, $L_{open\text{-}open} = 0.567$m

5. (a) thickness = 470.5nm
   (b) $\lambda = 1.15$m

6A (a) 15 bright fringes in central diffraction maximum
(b) $I/I_{max} = 5.78\text{x}10^{-5}$ (this answer is extremely sensitive to rounding)
(c)



6B (a) 513
(b) 3

7A (a) $\phi = 5.05$ eV
(b) $\lambda = 169$ nm
(c) 1.19E17 photons

7B $\frac{I}{I_0} = 0.390$

8A (a) $E_3 = 6.7\text{x}10^{-17}$ J
(b) $\lambda = 0.060$ nm

8B (a) $n = 4$, $n = 2$
(b) $\lambda = 487$ nm

9 a) $Q = \frac{kA\Delta T}{x} = \frac{0.45(12)(25)(7)}{0.25} = 3780\ W$

b) $Q = \sigma\varepsilon A(T_1^4 - T_2^4) \rightarrow T_2 = \left(T_1^4 - \frac{Q}{\varepsilon\sigma A}\right)^{0.25} = 11.4°C$

c) $\lambda_{max}T = 2.898 \times 10^{-3} \rightarrow \lambda_{max} = 10.06\ \mu m$

10A
a) ${}^{209}_{83}Bi$: 7.85 MeV/nucleon; ${}^{211}_{83}Bi$: 7.83 MeV/nucleon. The binding energy per nucleon is smaller for the less stable nucleon.
b) ${}^{211}_{83}Bi \rightarrow {}^{207}_{81}Tl + {}^{4}_{2}He$
c) ${}^{215}_{83}Bi \rightarrow {}^{215}_{84}Po + e^- + \overline{\nu}$
d) $4.28\text{x}10^{-12}$m

10B t=0.251 billion years