Problems:

8. Describe the magnitude and direction of the net force acting on a 20kg aardvark that is traveling in perfect 3m radius circles at a constant speed of 1m/s. At the same time that the aardvark is circling, wind from the Northwest is exerting a 4N drag force on the aardvark. Rain is beating downward on the creature with a force of 2N. Two crows are pulling the animal southeastward with a force of 1N. The aardvark has a metal pacemaker which is being pulled in a direction 40° below Southward by the 3N force of a huge nearby magnet. Another animal is pulling the aardvark in some other direction with some other force.

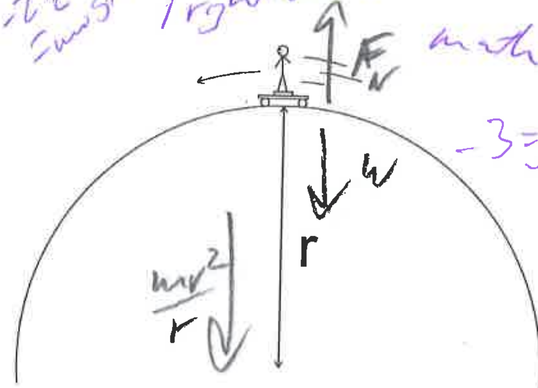
Net Force magnitude: 26.7N (3) Net Force Direction: (1) Toward the center

1/2 - Powers of 10
1/2 - units
1 - work
1 - right formula/diagram
1 right answer

$$\Sigma F = \frac{mv^2}{r} = \frac{20kg(2m/s)^2}{3m} = 26.7N$$

2 1/2 worst

9. A skateboarder stands on a bathroom scale on top of a skateboard as she travels over a hill at a constant speed. Her weight is 550N, and she is traveling a constant speed of 8m/s. If the scale reads 400N at the top of the hill, what is the radius of the hill's curve?



math 1/2

-3 = way off

550N/9.8 8m/s 400 550N

$$-\frac{mv^2}{r} = F_N - W$$

$r = 23.9m$

8.98 = -1 1/2

10. Two bowling balls of mass 7.0 kg each have a radius of 10.0 cm. If they are placed next to each other so they are touching, calculate the gravitational force between them. (5 pts)

$$\frac{G m_1 m_2}{r^2} = 8.17 \times 10^{-8} N$$

0.2

11. Use the data at the back of this quiz to find the orbital period of Mars, in Earth years.

$$\frac{T^2}{T^2} = \frac{r^3}{r^3}$$

$$\frac{T^2}{(1yr)^2} = \frac{(2.28\times10^{11})^3}{(1.4957\times10^{11})^3}$$

$T = 1.88$ Earth yr

12. Use the data at the back of this quiz to find the value of "g" at the **altitude** of a commercial passenger jet ~~(9,150m)~~?

$9\times10^6 m$

$$g = \frac{GM}{r^2} = G\frac{5.979\times10^{24} kg}{(8.3713\times10^6 m)^2} = 5.69 m/s^2$$

13. Explorers insert a geostationary satellite into a circular orbit around a newly discovered planet. The satellite has a period of 1.20×10^5 seconds and an orbital radius of 5.60×10^7m.

a. What is the velocity of the satellite?

b. What is the mass of the planet around which the satellite orbits?

$$V = \frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$$

$$V = \frac{3.519\times10^8 m}{1.2\times10^5 s} = 2.93\times10^3 m/s = \sqrt{\frac{Gm}{5.6\times10^7 m}}$$

$m = 7.22\times10^{24} kg$

1.5 eq/dims
2-correct work
0.5 units

1. a) $\alpha = \frac{\Delta \omega}{\Delta t} = \frac{\left(\frac{10\,rev}{s}\right)\left(\frac{2\pi\,rad}{rev}\right)}{1.4\,s} = 44.9\,rad/s^2$

b) $a = \alpha r = 44.9\,rad/s^2 \left(0.007\,m/rad\right) = 0.314\,m/s^2$

---

2) a) $\omega = \frac{v}{r} = \frac{4\,m/s}{0.04\,m} = 100\,rad/s$

c) $\omega^2 = \omega_0^2 + 2\alpha(\Delta\theta)$

$0 = (100\,rad/s)^2 + 2(-10\,rad/s^2)(\theta)$

$\theta = 500$ radians

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = (100\,rad/s)10s + \frac{1}{2}(-10\,rad/s^2)(10s)^2$

$\theta = 500\,rad$

b) $\omega = \omega_0 + \alpha t$

$0 = 100\,rad/s + (-10\,rad/s^2)(t)$

$t = 10s$

If drew diagram, no more than -2.5

a) $\tau = rF = 1.2N(0.06m) = 0.072\,N\cdot m$

Fr[illegible] method -1/2

b) $\Theta = \omega_0 t + \frac{1}{2}\alpha t^2$

Ave V -1/2

$\frac{.4m}{0.06m/rad} = 0 + \frac{1}{2}\alpha(3s)^2$

$T = I\alpha$ -.2

$\alpha = 14.8\,rad/s^2$

0.74 rad/s² -1

useless diagram +1 or +1/2

or using ave V $\Delta\Theta$

c) $\tau = I\alpha$

$0.072\,N\cdot m = I(14.8\,rad/s^2)$

$I = 0.00486\,kgm^2$

---

4. a) $L = I\omega = \boxed{4.6\,kgm^2}\left[(0.6\,rev/s)\left(\frac{2\pi\,rad}{rev}\right)\right] = 17.3\,\frac{kgm^2}{s}$

2.76 = -1 K units -1/2 unit

b) $L_i = L_F$

$17.3\,\frac{kgm^2}{s} = I_F\left[(2\,rev/s)\left(\frac{2\pi\,rad}{rev}\right)\right]$

$I_F = 1.38\,kgm^2$

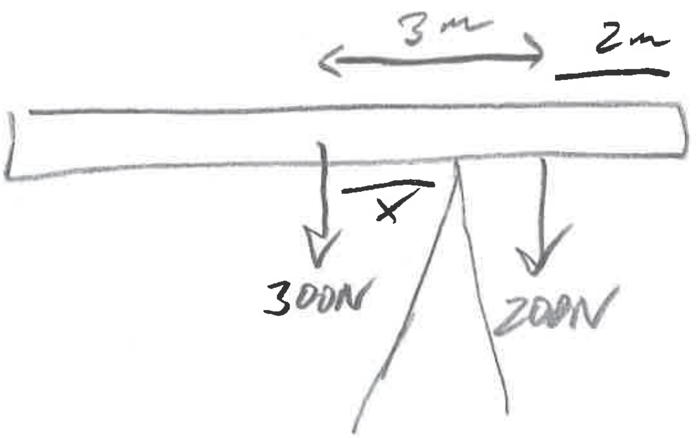
c) He tucks (Pulls together)

5. $$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2 + \frac{1}{2}\left(\frac{1}{2}\cancel{m}\cancel{r^2}\right)\left(\frac{v^2}{\cancel{r^2}}\right)$$

$$gh = \frac{3}{4}v^2$$

$$v = \sqrt{\frac{4gh}{3}} = 5.11\,m/s$$

6.



$$\tau_{ccw} = \tau_{cw}$$

$$300N(x) = 200N(3m - x)$$

$$300Nx = 600Nm - 200Nx$$

$$500Nx = 600Nm$$

$$x = 1.2m$$

Place fulcrum 1.2m to the right of the midpoint.

or 4.8m to left of right end

3 sources of torque

$-1\frac{1}{2}$

Ch 18 Test Problems

1. $$F_E = k\frac{q_1 q_2}{r^2} = \frac{8.99\times10^{9}\,\frac{Nm^2}{C^2}\left(40\times10^{-6}C\right)^2}{(0.22m)^2}$$

order of oom
mag = -1/2

$$= 2.97N$$

2. $$r = \sqrt{\frac{k q_1 q_2}{F_E}}$$

$$= \sqrt{\frac{8.99\times10^{9}\,\frac{Nm^2}{C^2}\left(25\times10^{-3}C\right)^2}{1N}} = 2{,}370\,m$$

3. $$F_E = Eq = 480\,N/C\left(-3.3\times10^{-6}C\right)$$

$$F_E = 1.58\times10^{-3}N$$ Leftward

4. $$E = \frac{kq}{r^2} \qquad q = \frac{Er^2}{k} = \frac{5.5\times10^{4}\,N/C\,(0.4m)^2}{8.99\times10^{9}\,\frac{Nm^2}{C^2}}$$

$$q = 9.79\times10^{-7}C$$

5.

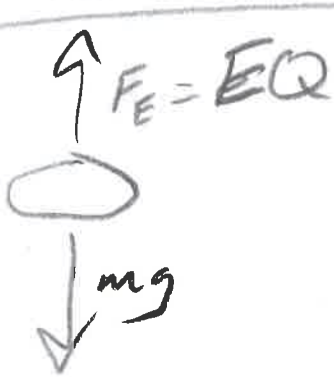
$$V = V_0 + at \qquad F_e = Eq$$

$$a = \frac{F_e}{m} \qquad \frac{-V_0}{a} = t$$

$$t = \frac{(-V_0)}{\frac{Eq}{m}} = \frac{-V_0 m}{Eq} = \frac{(2\times10^{6}\,m/s)(1.67\times10^{-27}\,kg)}{(5\times10^{4}\,N/C)(1.6\times10^{-19}\,C)}$$

$$t = 4.18\times10^{-7}\,s$$

6.



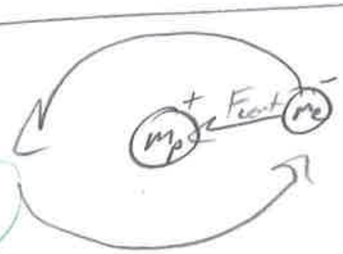
−1 − No converting to C

$$eQ = mg$$

$$m = \frac{EQ}{g} = \frac{(3.6\times10^{4}\,e)(1.6\times10^{-19}\,C/e)(150\,N/C)}{9.8\,m/s^2}$$

$$m = 8.82\times10^{-14}\,kg$$

7.



$$F_{cent} = F_E$$

$$\frac{m_e v^2}{\cancel{r}} = \frac{kQq}{r^{\cancel{2}}}$$

$$V = \sqrt{\frac{kQq}{r m_e}}$$

Something wrong, no work ↓ −4

$$\sqrt{\frac{kQ}{rm}} \;(-1)$$

$$V = \sqrt{\frac{2qEr}{m}}$$

$$V = \sqrt{\frac{k\, q_{proton}\, q_{electron}}{r m_e}} = \sqrt{\frac{k q_e^2}{r_{me}}} = q_e\sqrt{\frac{k}{r_{me}}}$$

−1 used $\frac{mv^2}{r} = qE$

b.

$V = V_0 + at$ $\quad$ $v = at$ $\quad$ $a = \frac{F}{m}$

$V_0 = 0$

$p = mv = mat$

$p = m\left(\frac{F}{m}\right)t = Ft$

$F = qE$

$p = qEt$

$qEt\left(\frac{m}{m}\right)$ ok

$qEt + mv_0$ ok

III. Problems: 1 — units 1/4 Answer 1/2 2 units 1/2 Answer 1 Formula 1/2

1. You have a 30-m-long piece of silver wire having a radius of 0.15 mm? (ρ_{Ag} = 1.59 x 10^{-8} Ω·m)

   A. What is the resistance of this wire?

2 $$R = \frac{1.59\times10^{-8}(30m)}{\pi(1.5\times10^{-3}m)^2} = 6.75\times10^{-2}\Omega$$

   B. How much current will flow through the wire if there is a 9 V potential difference between the ends (i.e. if it is hooked up to a 12.0 V battery)?

2 $$I = \frac{V}{R} = \frac{9V}{6.75\times10^{-2}\Omega} = 133A$$

2. A cordless drill operates at a current of 7A.

   A. How many Coulombs of charge pass through the drill in one hour of use?

2 $$I = \frac{\Delta Q}{\Delta t} \qquad 7A = \frac{\Delta Q}{3600s} \qquad \Delta Q = 25,200C$$

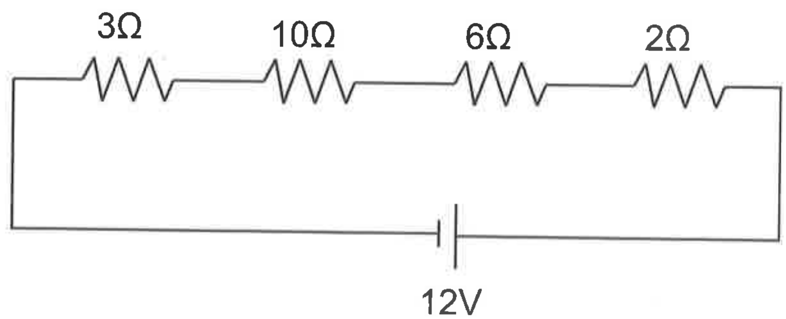
   B. How many electrons pass through the drill during that hour?

2 $$25,200C\left(\frac{1e}{1.6\times10^{-19}C}\right) = 1.58\times10^{23}e$$

3. A. Calculate the total equivalent resistance of this circuit.

   21Ω

2



   B. Calculate the current flowing through this circuit.

2 $$I = \frac{V}{R} = \frac{12V}{21\Omega} = 0.571A$$

4. Bob spends 20 hours annually operating his hairdryer on a 120V circuit. Bob's hairdryer draws 12.5A of current. If Bob's electricity costs $0.15 per kilowatt-hour, what is the total cost of the electricity that he uses to run his hairdryer?

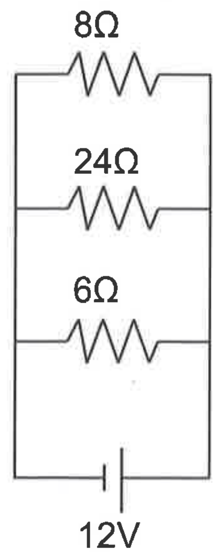
2 $P = IV = 12A(120V) = 1{,}500W = 1.5kW$

$\frac{w}{h} = -1$ $(20\,\text{hours})(1.5kW) = 30\,kW\cdot h$

$(30\,kW\cdot h)\left(\frac{\$0.15}{kW\cdot h}\right) = \$4.50$

5. A. Calculate the total equivalent resistance of this circuit.

2 $\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{24} + \frac{1}{6} = \frac{8}{24} = \frac{1}{3}$ $R_{eq} = 3\Omega$



B. Calculate the total current flowing through this circuit.

2 $I = \frac{V}{R} = \frac{12V}{3\Omega} = 4A$

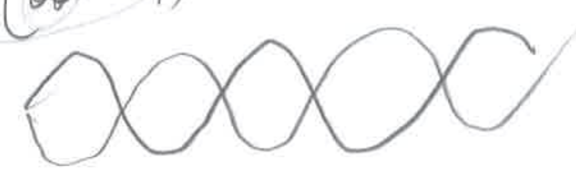
C. Calculate the current flowing through the 24-Ω resistor.

2 $I = \frac{V}{R} = \frac{12V}{24\Omega} = 0.5A$

D. Calculate the power dissipated as heat through the 24-Ω resistor.

2 $P = IV = (0.5A)(12V) = 6W$

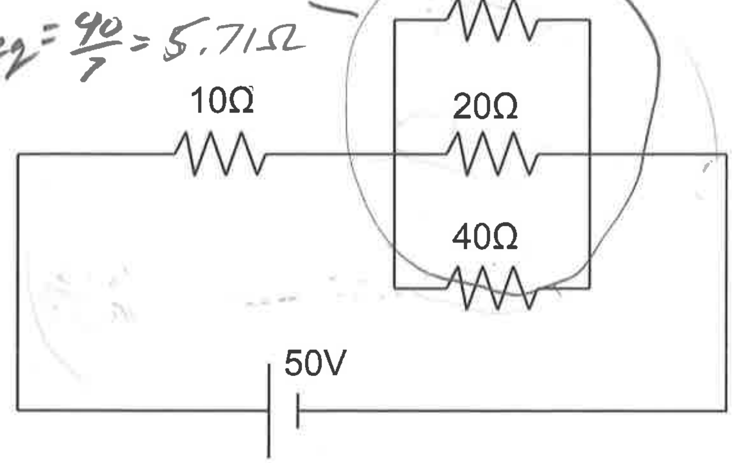
$A\cos(\omega t + \varphi)$



6. A. Calculate the total equivalent resistance of this circuit.

$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40} = \frac{7}{40}$

$R_{eq} = \frac{40}{7} = 5.71\Omega$



$R_{eq} = 10\Omega + 5.71\Omega$
$= 15.71\Omega$

2

B. Calculate the total current flowing through this circuit.

$I = \frac{V}{R} = \frac{50V}{15.71\Omega} = 3.18A$

4

C. Calculate the potential difference across the 10-Ω resistor.

$V = IR_{branch} = 3.18A(10\Omega) = 31.8V$

4

D. Calculate the current flowing through the 20.0-Ω resistor.

$I = \frac{V_{branch}}{R} = \frac{18.2V}{20\Omega} = 0.91A$

2

$2.5A = -1$

E. Calculate the total power dissipated as heat in this circuit.

$P = IV = (3.18A)(50V) = 159W$

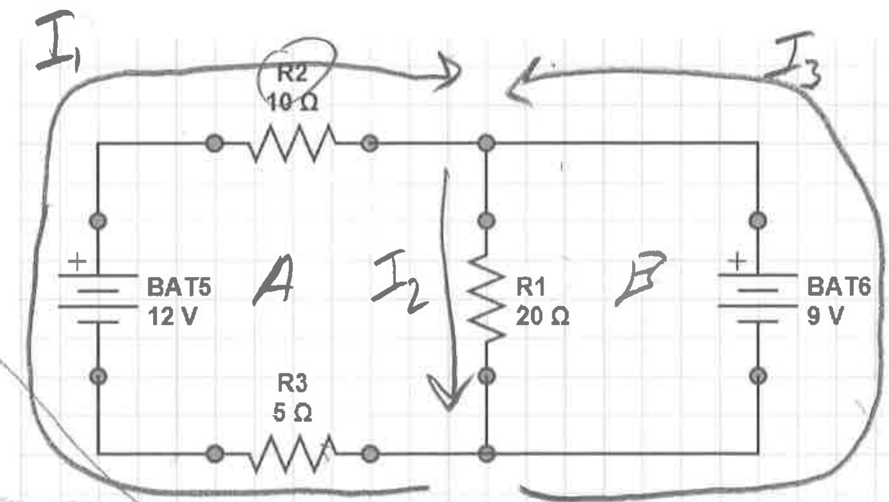
2

7. For each of the items below, choose the correct direction of current flow (conventional current) and give the magnitude of the current.

6

1 for each

Item	Magnitude of Current (A)	Direction of Current In Diagram Below (circle one)	
Resistor ~~R2~~ R1	0.45	~~Leftward~~ up	~~Rightward~~ down
Resistor R3	0.2	Leftward	Rightward
BAT6	0.25	Upward	Downward



Junction:

$I_1 + I_3 = I_2$

Loop A (cw)

$12V - 10I_1 - 20I_2 - 5I_1 = 0$

$12V - 15I_1 - 20I_2 = 0$

$12V - 15I_1 - 20(0.45A) = 0$

$3V = 15I_1$

$I_1 = 0.2A$

Loop B (ccw)

$9V - 20I_2 = 0$

$9V = 20I_2$

$\boxed{I_2} = \frac{9}{20} = 0.45A$

$I_3 = I_2 - I_1$

$= 0.45A - 0.2A$

$I_3 = 0.25A$

III. Problems:

34 54

1 equation
$1\frac{1}{2}$ answer + work
$\frac{1}{2}$ units

1. A bat finds a moth by sending a sound pulse through the air and listening for the echo. If the distance between the moth and the bat is 15m, how long after it makes a sound does the bat hear its echo? (Assume that the speed of sound is 340m/s)

3

$d = vt$

$30m = 340m/s(t)$

$t = 0.088s$

2. When the island of Krakatoa erupted in 1883, the sound was reportedly heard as far as 4,800km away. Assuming a constant air temperature of 28°C, how long did it take the sound to travel this distance?

3

$V_{sound} = 331.4 + 0.6(28°C) = 348.2 m/s$

$d = vt = (3.8h)\left(\frac{3600s}{h}\right) 348.2 m/s = 4,763 km$

3. Calculate the speed of sound on a day when sound with a frequency of 440Hz frequency has a wavelength of 0.79 m.

$V = \lambda f = 0.79m(440Hz) = 347.6 m/s$

3

4. You're standing motionless in the water at the beach. You are 30m from the water's edge. A wave hits you every ~~15~~ 5 seconds. After the waves pass you, it takes them 3 seconds to travel to the water's edge. Find...

a. The frequency of the waves. $T = 15s$ $f = \frac{1}{T} = \frac{1}{5s} = 0.2 Hz$

2

b. The speed of the waves. $V = \frac{28m}{7s} = 4 m/s$

2

c. The wavelength of the waves $\lambda = \frac{V}{f} = \frac{4 m/s}{\frac{1}{\cancel{15}5s}} = 80m$

2

15

5. The velocity of a standing wave in a guitar string is 300m/s. If the vibrating string length is 0.63m, what is its fundamental frequency?

$\lambda = 2L = 2(0.63m) = 1.26m$

3

$f = \frac{v}{\lambda} = \frac{300 m/s}{1.26 m} = 238 Hz$

476Hz
= -1

6. An overheated bicyclist traveling at a rate of 15m/s approaches a stationary ice cream truck that is playing *Pop Goes The Weasel.* When the ice cream truck loudspeaker plays a note with a frequency of 600Hz, what frequency is heard by the approaching bicyclist?

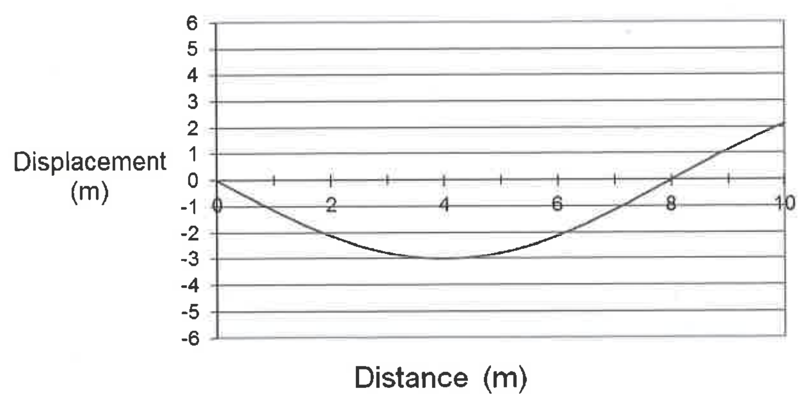
3

Frequency increases

$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right) = 600Hz\left(\frac{340 m/s + 15 m/s}{340 m/s}\right) = 626 Hz$

$v_s = 0$

7. Given that the velocity of the wave shown on the right is 90.0 m/s, find each of the following.



2 A. λ = 16m

2 B. f = 5.63 Hz

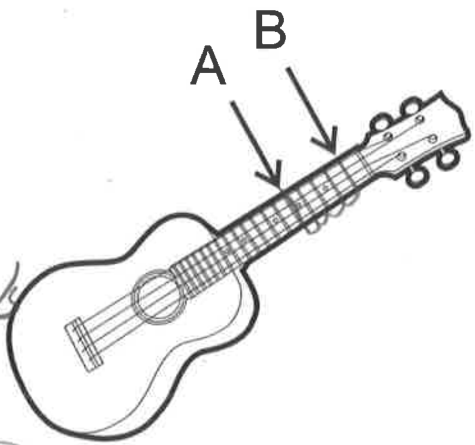
2 C. T = 0.178 s

2 D. A = 3m

2 E. ω = 35.3 rad/s

16

8. On a hot summer afternoon, a student listens to a passing stock car and hears a Doppler shift. The student recreates the shift by playing two notes on the ukulele to the right. The air temperature is 33°C.



What was the velocity of the car?

$V_{sound} = 331.4 + 33(0.6) = 351.2\,m/s$

3

$V_{sound} = 351.2\,m/s\left(\dfrac{2^{4/12} - 1}{2^{4/12} + 1}\right) = 40.4\,m/s$

<u>Equations:</u>

$f = \dfrac{1}{T}$ $\qquad$ $v = \lambda f$ $\qquad$ $y = A\cos(\omega t + \phi)$

$V_{sound\ in\ air} = 331.4 + 0.6T_C$ $\qquad$ $d = vt$ $\qquad$ $\omega = 2\pi f$

$$f_o = f_s \frac{v \pm v_o}{v \pm v_s}$$

$$v_{source} = v_{sound}\left(\frac{2^{\frac{\Delta Pitch}{12}} - 1}{2^{\frac{\Delta Pitch}{12}} + 1}\right)$$

3