# Physics Spring Semester Review Questions

This is an opportunity to see how much you know or remember about what we've covered so far in Physics. This is not graded, and the answers are on my website hut-lhansen.weebly.com. You may use this on the final.

## Unit 7 Review: Work, Energy, and Power

1. A father pulls his young daughter on a sled with a constant velocity on a level surface a distance of 10.0 m. If the total mass of the sled and the girl is 35 kg, and the coefficient of kinetic friction between the sled runners and the snow is 0.20, how much work does the father do? How much work is done by friction?

$W = F \cdot d = F_F \cdot d = \mu_K \cdot m \cdot g \cdot d = 0.20 \cdot 35\,kg \cdot 9.81\,m/s^2 \cdot 10.0\,m$

$= 686.7\,J \rightarrow \boxed{690\,J}$

$W_F = \boxed{-690\,J}$

2. If it takes 400. J of work to stretch a spring 8.00 cm, what is the spring constant?

$W_{spring} = \frac{1}{2} K x^2 \qquad \frac{2 \cdot W}{x^2} = K = \frac{2 \cdot 400\,J}{(0.08\,m)^2} = \boxed{1.25E5\ \frac{N}{m}}$

3. What work is necessary to slow a 13.8 m/s, 1.5 kg object to 2.4 m/s?

$W = \Delta K = \frac{1}{2} m v^2 - \frac{1}{2} m v^2 = \frac{1}{2}\,1.5\,kg \cdot (2.4\,m/s)^2 - \frac{1}{2}\,1.5\,kg \cdot (13.8\,m/s)^2$

$= -138.5\,J \rightarrow \boxed{-140\,J}$

4. What's the potential energy of a 16.5 kg object that's at a height 100.0 m above the ground?

$U_g = m \cdot g \cdot h = 16.5\,kg \cdot 9.81\,m/s^2 \cdot 100.0\,m = \boxed{16{,}200\,J}$

5. Disregarding all forms of friction, how much energy is required to propel a 240 gram toy rocket to a speed of 45 m/s at an elevation of 48.5 m?

240 gram = 0.24 kg

$E = K + U = \frac{1}{2} m \cdot v^2 + m \cdot g \cdot h$

$= \frac{1}{2}\,0.24\,kg \cdot 45\,m/s + 0.24\,kg \cdot 9.81\,m/s^2 \cdot 48.5\,m = \boxed{120\,J}$

6. A crane rated at 15.0 horsepower lifts 100.0 kg crates up from a platform, and puts them on an elevated deck 25.0 m above the starting position. How long will this crane take to raise one crate to the platform?

$15.0\,hp \times \frac{746\,W}{1\,hp} = 11{,}190\,W = \frac{11{,}190\,J}{1.0\,s} \qquad 24{,}525\,J \times \frac{1.0\,s}{11{,}190\,J}$

$U_g = m \cdot g \cdot h = 100.0\,kg \cdot 9.81\,m/s^2 \cdot 25.0\,m = 24{,}525\,J \qquad \boxed{= 2.19\,s}$

7. If it takes a 50.0 W motor15 seconds to raise a 30.0 kg box 2.0 m, what it the motor's efficiency?

$Power = \frac{Work}{Time} = \frac{m \cdot g \cdot h}{t} = \frac{30.0\,kg \cdot 9.81\,m/s^2 \cdot 2.0\,m}{15\,s} = 39.24\,W$

$\mathcal{E} = \frac{P_{out}}{P_{in}} = \frac{39.24\,W}{50.0\,W} = \boxed{78\%}$

# Unit 8 Review: Momentum, Impulse, Collisions

1. A 0.150-kg baseball travelling with a horizontal speed of 18.50 m/s is hit by a bat and then moves with a speed of 28.7 m/s in the opposite direction. What is the change in the ball's momentum?

$\Delta p = p_2 - p_1 = mV_2 - mV_1 = 0.150\,kg \cdot 28.7\,m/s - 0.150\,kg(-18.50\,m/s)$

$= 7.08\ kg\,m/s$

2. A semi with a total mass of 3500 kg traveling at 1.50 km/h hits a loading dock and comes to a stop in 0.24 s. What is the magnitude of the average force exerted on the truck by the dock?

$P_2 = 0\,kg \cdot m/s$

$F_{avg} \cdot \Delta t = \Delta p$

$1.50\frac{km}{h} \times \frac{1\,h}{3600\,s} \times \frac{1000\,m}{1\,km} = 0.417\,m/s$

$F_{avg} = \frac{\Delta p}{\Delta t} = \frac{3500\,kg \cdot 0.417\,m/s}{0.24\,s} = 6100\,N$

3. To get off a frozen, frictionless lake, a 55.0-kg person takes off his 0.250-kg shoe and throws it horizontally, directly away from the shore with a speed of 13.0 m/s. If the person is 10.00 m from the shore, how long does she take to reach it?

Conservation of Momentum

$p_{shoe} = p_{person} \rightarrow 0.250\,kg \cdot 13.0\,m/s = 55.0\,kg \cdot ?\,m/s$

$?\,m/s = 0.0591\,m/s$

$d = r \cdot t$

$t = \frac{d}{r} = \frac{10.00\,m}{0.0591\,m/s} = 169\,s$ (2.82 min)

4. A 4.4-kg ball with a velocity of 4.5 m/s in the + x-direction collides head-on elastically with a 2.0-kg ball traveling 0.4 m/s in the – x-direction. What are the velocities of the balls after the collision?

4.4 kg = Ball 1

2.0 kg = Ball 2

$V_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)V_{1_0} + \left(\frac{2m_2}{m_1+m_2}\right)V_{2_0} = \left(\frac{4.4\,kg - 2.0\,kg}{4.4\,kg + 2.0\,kg}\right)4.5\,m/s + \left(\frac{2 \cdot 2.0\,kg}{4.4\,kg + 2.0\,kg}\right)(-0.4\,m/s) = 1.44\,m/s$

$V_2 = \left(\frac{2m_1}{m_1+m_2}\right)V_{1_0} - \left(\frac{m_1 - m_2}{m_1+m_2}\right)V_{2_0} = \left(\frac{2 \cdot 4.4\,kg}{4.4\,kg + 2.0\,kg}\right)4.5\,m/s - \left(\frac{4.4\,kg - 2.0\,kg}{4.4\,kg + 2.0\,kg}\right)(-0.4\,m/s) = 6.33\,m/s$

5. A dropped rubber ball hits the floor with a speed of 8.0 m/s and rebounds to a height of 1.25 m. What percentage of the initial kinetic energy was lost in the collision? (Hint: Refer to Unit 7.3 notes).

① $V_2 \rightarrow$ Kinetic energy at the bounce = Potential energy at top of apex.

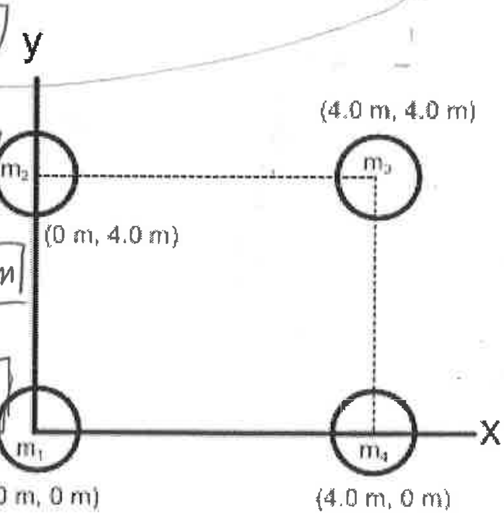
$\frac{1}{2}mV^2 = m \cdot g \cdot h$

$V = \sqrt{9.81\,m/s^2 \cdot 2 \cdot 1.25\,m} = 4.95\,m/s$

② $\frac{K_2}{K_1} = \frac{\frac{1}{2} m \cdot V_2^2}{\frac{1}{2} m \cdot V_1^2} = \frac{V_2^2}{V_1^2} = \frac{(4.95\,m/s)^2}{(8.00\,m/s)^2} = 38\%$ left

62% Lost

6. Locate the center of mass of the system shown in the figure if $m_1$ = 31.0 kg, $m_2$ = 25.0 kg, $m_3$ = 3.0 kg, and $m_4$ = 14.0 kg.




$x = \frac{\sum x_i m_i}{M} = \frac{4.0\,m \cdot 3.0\,kg + 4.0\,m \cdot 14.0\,kg}{31.0\,kg + 25.0\,kg + 3.0\,kg + 14.0\,kg} = \frac{68\,m \cdot kg}{73\,kg}$

$x = 0.93\,m$

$y = \frac{\sum y_i m_i}{M} = \frac{4.0\,m \cdot 25.0\,kg + 4.0\,m \cdot 14.0\,kg}{73\,kg} = 2.14\,m$

# Unit 9 Review: Rotational Motion and Equilibrium

1. A rope goes over a circular pulley with a radius of 6.5 cm. If the pulley makes 4.0 revolutions without the rope slipping, what length of rope passes over the pulley?

Circumference $= 2 \cdot \pi \cdot r = 2 \cdot 3.14 \cdot 6.5cm$

$= 40.84 \frac{cm}{revolution} \times 4.0 \text{ revolutions} = 163.4 cm \rightarrow$ **160cm**

2. A bowling ball with a radius of 15.3 cm travels down the lane so that its center of mass is moving at 3.6 m/s. The robotic bowler estimates that it makes 3.5 complete revolutions in 1.2 seconds. Is it rolling without slipping? Prove your answer (to 2 sig figs).

$3.5 rev \times \frac{2\pi \, rad}{rev} = 22 \, rad$

Does Linear Distance Equal Circumferencial Distance?

$d = r \cdot t = 3.6 m/s \cdot 1.2 s = 4.32m$

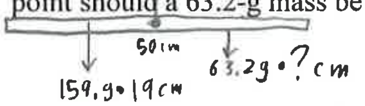
$S = r \cdot \theta = 0.153m \cdot 22 rad = 3.4m$

**Slipping**

3. A. The drain plug on a car's engine has been tightened to a torque of 18.6 m•N. If a 0.35 m long wrench is used to change the oil, what is the minimum force needed to loosen the plug?

$\tau = r_\perp \cdot F \qquad F = \frac{\tau}{r_\perp} = \frac{18.6 m \cdot N}{0.35 m} =$ **53.1N**

4. A uniform meterstick pivoted at its center has a 159.-g mass suspended at the 31.0-cm position. At what point should a 63.2-g mass be suspended to put the system in equilibrium?




$\frac{159.g \cdot 19cm}{63.2g} = 47.8cm + 50cm =$ **97.8cm**

5. What net torque is required to give a uniform 20.0-kg solid cube with a side length of 13.2 cm of 0.35 m an angular acceleration of 10.0 rad/s around its center of mass?

$\tau = I \cdot \alpha \qquad I_{cube} = \frac{m s^2}{6} = \frac{20.0kg \cdot (0.132m)^2}{6} = 0.0581 kgm^2$

$S = 0.132m$

$\tau = 0.0581 kgm^2 \cdot 10.0 rad/s$ **$= 0.581 \frac{kg \, m^2}{s}$**

6. A fixed, 0.15 kg solid disk pulley with a radius of 0.75 m is acted upon by a net torque of 6.4 m•N. What is the angular acceleration of the pulley?

$I = \frac{mr^2}{2} = \frac{0.15kg \cdot (0.75m)^2}{2} = 0.0422 \, kg \cdot m^2$

$\tau = I \cdot \alpha$

$\alpha = \frac{\tau}{I} = \frac{6.4 \, m \cdot N}{0.0422 \, kgm^2}$ **$= 151 m/s^2$**

7. A wheel spinning at 144 rpm comes to rest after 850 rotations. What was the magnitude of deceleration during that time?

$\times \frac{2\pi \, rad}{rotation} \times \frac{1 minute}{60s} = 15.072 \, rad/s = \omega_0$

$850 rot \times \frac{2\pi \, rad}{rotation} = 5341 rad = \theta$

Sandbag $\omega^2 = \omega_0^2 + 2\alpha(\Delta\theta) \qquad \omega = 0 \, rad/s$

$\frac{\omega^2 - \omega_0^2}{2 \Delta\theta} = \frac{0 - (15.072 rad/s)^2}{2 \cdot 5341 rad}$ **$= -0.021 \, rad/s^2$**

8. A constant retarding torque of 12 N•m stops a rolling wheel of diameter 0.80 m in a distance of 15 m. How much work is done by the torque?

$r = 0.40m$

$S = 15m$

$\theta = \frac{S}{r} = \frac{15m}{0.40m} = 37.5 \, rad$

$W = \tau \cdot \theta = 12 N \cdot m \cdot 37.5 rad$ **$= -450J$**

9. A. An ice skater spinning with outstretched arms has an angular speed of 4.0 rad/s. She tucks her arms in, decreasing her moment of inertia by 15.5 %. What is the resulting angular speed?

$\omega_0 = 4.0 \, rad/s$

$I_0 = 1 unit$

$I = 0.85 units$

$\omega = ?$

$\frac{\omega_0 \cdot I_0}{I} = \omega = \frac{4.0 rad/s \cdot 1}{0.85 units} =$ **4.7 rad/s**

# Unit 10 Review: Electrostatics

1. What is the net charge of an object that has 1.8 billion excess electrons?

$$1.8E9e^- \cdot \frac{1.602E-19C}{1e^-} = 2.88E-10C \rightarrow \boxed{2.9E-10C}$$

2. A rubber rod rubbed with fur acquires a charge of -4.8 E -9 C. What is the charge on the fur, and how much mass is transferred to or from the rod?

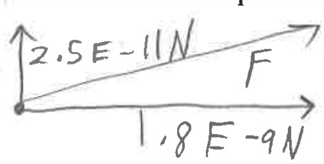
Fur= + 4.8E-9C

$$-4.8E-9C \times \frac{1e^-}{-1.602E-19C} \times \frac{9.109E-31kg}{1e^-} = \boxed{2.73E-11kg \text{ to the rod}}$$

3. What is the force between the following charges, spaced 0.63 m apart: -1.85 E -6 C and +13.2 E -4 C?

$$F_e = K\frac{Q_1 Q_2}{r^2} = \frac{8.9E9\frac{Nm^2}{C^2} \cdot (-1.85E-6C)(13.2E-4C)}{(0.63m)^2} \boxed{= -54.8N}$$

4. An electron is acted on by two electric forces, one of 2.5 E -11 N acting upward and a second of 1.8 E -9 N acting to the right. What is the magnitude and direction of the electric field at the electron's location? Hint: This is a vector addition problem.

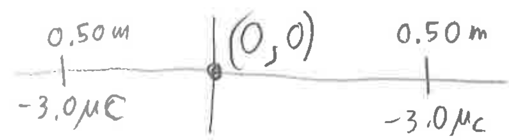



$$F = \sqrt{(2.5E-11N)^2+(1.8E-9N)^2} \boxed{= 1.8E-9N}$$

$$\Theta = \tan^{-1}\left(\frac{2.5E-11N}{1.8E-9N}\right) = 0.7957 \boxed{\rightarrow 0.80^\circ}$$

5. Two charges, -3.0 µC and -3.0 µC, are located at (-0.50 m, 0) and (0.50 m, 0), respectively. Find the location of the point where the electric field is zero.

Same charges,



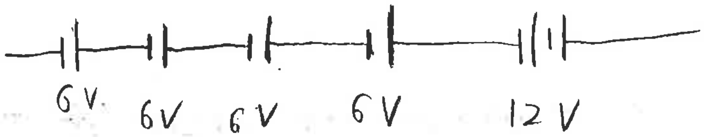

at the origin, (0,0)

6. What is the force between two -1.5 E 8 C and +1.2 E 13 C charges spaced 186.63 m apart?

$$F_e = K\frac{Q_1 Q_2}{r^2} = \frac{8.9E9\frac{N\cdot m^2}{C^2}(-1.5E8C)(+1.2E13C)}{(186.63m)^2} \boxed{= -4.6E26N}$$

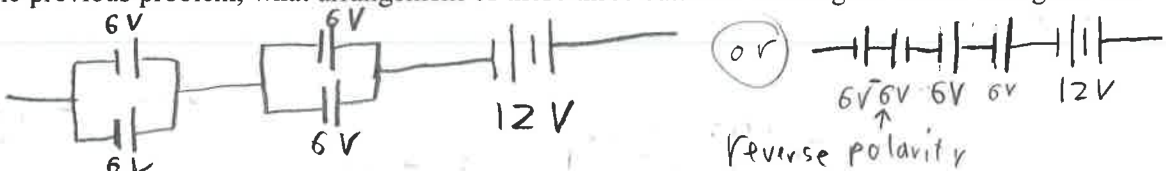
# Unit 11 Review: Basic Electric Circuits

1. Four 6-V batteries and one 12-V battery are connected in series. What is the voltage across the whole arrangement?




$V_{series} = 36\,V$

2. For the previous problem, what arrangement of these three batteries would give a total voltage of 24-V?




3. A net charge of 2.4 C passes through the cross sectional area of a wire in 38.0 minutes. What is the current in the wire?

$I = \frac{\Delta Q}{\Delta t} = \frac{2.4C}{38.0min} = \frac{2.4C}{2280s} = 1.05E{-3}A$

4. A battery labeled supplies 0.90 A to a 6.00-Ω resistor. What is the voltage of the battery?

$V = I \cdot R = 0.90A \cdot 6.00\Omega = 5.4V$

5. The wire in a heating element of an electric stove burner has a 0.55-m effective length and a 2.0 E -6 m² cross sectional area. If the wire is made of iron and operates at 480 °C, what is its resistance?

$R = \rho\left(\frac{L}{A}\right) ; R = \rho_0(1+\alpha\Delta T)\frac{L}{A} = 10E{-8}\,\Omega\cdot m(1 + 6.51E{-3}/°C \cdot 480°C)\frac{0.55m}{2.0E{-6}m^2} = 0.113\,\Omega$

6. The current in a refrigerator with a resistance of 10.0 Ω is 9.0 A. What is the power delivered to the refrigerator?

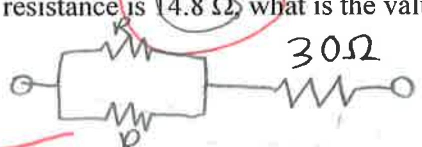
$P = I^2R = (9.0A)^2 \cdot 10.0\Omega = 810W$

?

7. Two identical resistors (R) are connected in parallel and then wired in series to a 30-Ω resistor. If the total equivalent resistance is 14.8 Ω, what is the value of R?

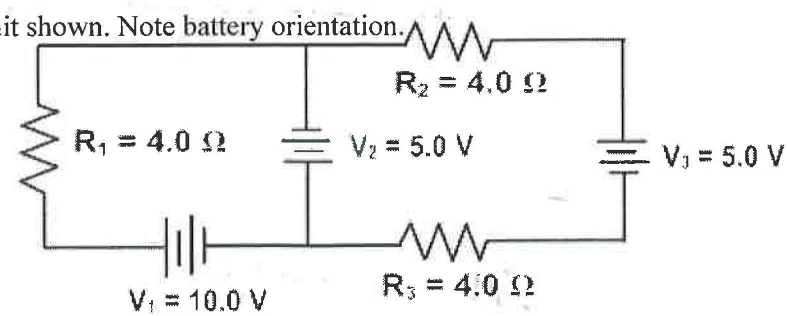
Too small

Error




8. Find the current in each resistor in the circuit shown. Note battery orientation.

Dont Do



# Unit 12 Review: Mechanical Waves and Sound

1. A aquatic wave has a speed of 1500 m/s. What is its wavelength of a 1000 Hz tone?

$v = \lambda \cdot f \quad \lambda = \frac{v}{f} = \frac{1500\,m/s}{1000/s} = 1.5\,m$

2. A surfer trying to catch a wave estimates the distance between wave crests is about 7.2 m, and that the arrival time between waves is 9.4 s. What is the approximate speed of the waves?

$v = \lambda \cdot f = \lambda \cdot \frac{1}{T} = 7.2\,m \cdot \frac{1}{9.4\,s} = \quad \frac{m}{s}$

3. If the frequency of the third harmonic of a vibrating string is 750 Hz, what is the frequency of the first harmonic? How about the fifth harmonic?

$f_3 = \frac{750\,Hz}{3} \quad f_1 = 250\,Hz \qquad f_5 = 250\,Hz \cdot 5 = 1250\,Hz$

4. What is the speed of sound in air at 55.0 °C?

$v_{sound_{air}} = 331\,m/s + 0.6 \cdot 55\,°C = 364\,\frac{m}{s}$

5. What is the linear mass density of a length of string under a tension of 19.00 N, if it makes a 1240 Hz note (its fundamental frequency) when plucked?

Need Length of String: $f_1 = \frac{1}{2 \cdot L}\sqrt{\frac{F_T}{\mu}}$

6. Particles approximately 3.2 E -4 cm in diameter are to be scrubbed loose from machine parts in an aqueous ultrasonic cleaning bath. Above what frequency should the bath be operated to produce wavelengths of this size and smaller?

$v_{H_2O} = 1500\,m/s \qquad v = \lambda \cdot f \quad f = \frac{v}{\lambda} = \frac{1500\,m/s}{3.2E-6\,m} = 470\,MHz$

7. Calculate the intensity generated by a 1.48-W point sound at a location 2.5 m and 8.0 m from it.

$I = \frac{P}{A} = \frac{1.48\,W}{4\pi \cdot (2.5\,m)^2} = \qquad I = \frac{1.48\,W}{4\pi (8.0\,m)^2} = 1.84\,W/m^2$

8. Find the intensity level in decibels for sounds with an intensity of (a) 5.6 E -2 W/m².

$dB = 10 \cdot \log\left(\frac{I}{I_0}\right) = 10 \cdot \log\left(\frac{5.6E-2\,W/m^2}{1.0E-12\,W/m^2}\right) = 107\,dB$

9. What is the frequency heard by a person driving 45 km/h directly toward a factory whistle (f = 650 Hz) if the air temperature is 13.5°C? = 339 m/s

$45\,\frac{km}{h} \times \frac{1000\,m}{1\,km} \times \frac{1\,h}{3600\,s} = 12.5\,m/s$

Moving observer: $f_o = \left(\frac{V + V_o}{V}\right) f_s = \left(\frac{339\,m/s + 12.5\,m/s}{339\,m/s}\right) 650\,Hz = 673\,Hz$

10. A closed organ pipe has a fundamental frequency of 418 Hz at 25°C. What is the fundamental frequency of the pipe at 0 °C? What if it were an open organ?

→ $V_s = 346\,m/s$ (25°C); → $V_s = 331\,m/s$ (0 °C)

$f_n = \frac{m\,V}{4\,L}$

$L = \frac{m \cdot V}{4 \cdot f_n} = \frac{1 \cdot 346\,m/s}{4 \cdot 418\,Hz} = 0.207\,m$

$f_1 = \frac{1 \cdot 331\,m/s}{4 \cdot 0.207\,m} = 400\,Hz$

Open: Double $f_{closed}$

25°C: 836 Hz

0°C: 800 Hz