<u>Physics Third Marking Period Review Sheet</u>

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<u>Chapter 7: Rotational Motion and the Law of Gravity</u>

- I can determine the angular position, $\Delta\theta$, in radians given by $\Delta\theta = \frac{\Delta s}{r}$ where Δs is arc length and r is radius.
- I can convert between degrees and radians using $\theta(rad) = \left(\frac{2\pi\ radians}{360^o}\right)\theta(\deg)$.
- I understand that counterclockwise (CCW) rotations are positive, and clockwise (CW) rotations are negative.
- I can clearly distinguish between the two types of velocities (angular velocity and tangential velocity) and three types of accelerations (angular acceleration, tangential acceleration, and centripetal acceleration) in rotational motion. See Table 1 for a comparison.
- Since velocity is a vector, I understand there are two ways that an acceleration can be produced: (1) changing the velocity's magnitude and (2) changing the velocity's direction. In centripetal acceleration, the velocity's ***direction*** changes.
- When a person drives a car in a circle at constant speed, I understand the car has a centripetal acceleration due to its changing direction, but it has no tangential acceleration due to its constant speed.

Table 1: Comparing Angular and Tangential Velocity and Angular, Tangential, and Centripetal Acceleration

Calculation	***Equations***	***Units, Comments***
Angular Velocity:	$\omega_{ave} = \frac{\Delta\theta}{\Delta t}$	• radians/s • Same value for horses A and B, side-by-side on a merry-go-round.
Tangential Velocity:	$v_t = r\omega$	• m/s • Different values for horses A and B, side-by-side on a merry-go-round.
Angular Acceleration:	$\alpha_{ave} = \frac{\Delta\omega}{\Delta t}$	• radians/s^2 • Same value for horses A and B, side-by-side on a merry-go-round.
Tangential Acceleration:	$a_t = r\alpha$	• m/s^2 • Different values for horses A and B, side-by-side on a merry-go-round.
Centripetal Acceleration:	$a_c = \frac{v_t^2}{r} = r\omega^2$	• m/s^2 • a_c is perpendicular to a_t with a_c directed toward the center of the circle and a_t tangent to it.

- I can determine centripetal force, F_C, which is the force that maintains circular motion, by using $F_c = ma_c = \frac{mv_t^2}{r} = mr\omega^2$
- I can determine the force due to gravity for objects in outer space using ***Newton's Law of Universal Gravitation***, which shows that the force of gravity between two point masses, m_1 and m_2, separated by a distance r is $F_g = G\frac{m_1 m_2}{r^2}$ where G is the universal gravitation constant, $G =$ 6.673 x 10^{-11} Nm^2/kg^2. ***Remember that r is the distance between the centers of the point masses.***
- In Newton's Law of Universal Gravitation, I notice that the force of gravity decreases with distance, r, as $\frac{1}{r^2}$. This is referred to as an ***inverse square dependence***.

<u>Chapter 8: Rotational Equilibrium and Dynamics</u>

- I understand that a tangential force, F, applied at a distance, d, from the axis of rotation produces a torque.
- I can calculate torque using $Torque = Force \bullet LeverArm$ or $\tau = Fd(\sin\theta)$.
- Given the description for a torque problem, I can find the lever arm in the diagram.
- I understand that counterclockwise torques are positive, and clockwise torques are negative.
- I understand that the rotational analog of force, $F = ma$, is torque, $\tau = I\alpha$, where $I =$ moment of inertia and $\alpha =$ angular acceleration.
- I understand that the conditions for an object in static equilibrium are that the net force and the net torque acting on the object must be zero: $F_{net} = 0$ and $\tau_{net} = 0$. Related problems often involve bridges, scaffolds, signs, and rods held by wires.
- I can solve problems involving static equilibrium:
  1. Construct a diagram showing all of the forces.
  2. Create an equation adding the forces together.
     - Remember to enter correct signs in your force equation. For example, upward forces are positive and downward forces are negative.
     - Since the object is not moving, set the force equation equal to zero. ($F_{net} = 0$)
  3. Create an equation adding the torques together.
     - If you are not sure what to do:
       - Start by writing the forces again leaving some space between them.
       - Multiply each force by an appropriate distance.
       - Each force and distance pair will have the same subscript.
     - Choose an axis of rotation in your diagram. It is helpful if your choice eliminates one of the two unknown forces. Then you can solve for the other force.
     - Remember to enter correct signs in your torque equation. Consider whether each force will create a counterclockwise or clockwise rotation resulting in a positive or negative torque.
     - Since the object is not moving, set the torque equation equal to zero. ($\tau_{net} = 0$)
  4. Substitute numbers in your torque equation and solve for the unknown force.
  5. Substitute the force you determined in the last step into the force equation and solve for the other unknown force.

- I can describe all six ***simple machines:*** lever, inclined plane, wheel and axle, wedge, pulley(s), and screw. All machines are combinations or modifications of these six fundamental types of machines. For example, a bicycle is composed of three simple machines—a wheel and axle, a pulley, and a lever
- I can calculate a simple machine's mechanical advantage, MA, which is defined as $MA = \frac{F_{out}}{F_{in}} = \frac{d_{in}}{d_{out}}$. It is a number describing how much force or distance is multiplied by using a machine.
- I can determine a machine's efficiency, which is a measure of how well a machine works; $\%\ Efficiency$ is calculated using $\%\ Efficiency = \left(\frac{W_{out}}{W_{in}}\right)(100)$ where W_{out} is the work output and W_{in} is the work input.

Chapter 10: Heat

- I can compare and contrast heat and temperature. Heat is the energy transferred between objects because of a temperature difference. Heat depends on mass, specific heat, and change in temperature for a substance. (Recall $Q = mC\Delta T$.)
- Temperature is the degree of hotness or coldness for an object. I can convert temperatures between the Fahrenheit, Celsius, and Kelvin scales using the equations shown in Table 2.
- I can briefly describe the experiments used to determine absolute zero, which is the coldest temperature possible in the universe. Absolute zero (0 K, -273°C) is the temperature at which all atomic and molecular motion comes to a complete stop.

Table 2: Temperature Scales

Scale	***Melting Point for Water on Scale***	***Boiling Point for Water on Scale***	***Conversion***
Fahrenheit	32°F	212°F	$^oF = \left(\frac{9}{5}\right){}^oC + 32$
Celsius	0°C	100°C	$^oC = \frac{5}{9}\left({}^oF - 32\right)$
Kelvin	273 K	373 K	$T = {}^oC + 273.15$

- I understand that specific heat is defined as the heat capacity per unit mass as in $C = \frac{Q}{m\Delta T}$.
  - The units of specific heat are J/kg°C or J/kgK.
  - Note that specific heat is independent of the quantity of material in a given object.
  - Specific heats for several materials are given in Table 10-4 on p.372 in the text.
  - ***Note that specific heat not only depends on the substance but also on its state of matter—solid, liquid, or gas.***

- I can calculate heat energy by rearranging and using the equation for specific heat, $Q = mC_p\Delta T$, where C_p is the specific heat for a material at constant pressure (usually atmospheric pressure).
- When heat is ***gained*** by the system, I understand that Q is ***positive***, and when heat is ***lost*** from the system to the surroundings, I understand that Q is ***negative***.
- I can solve a common energy conservation (heat transfer) problem involving a hot metal added to room temperature water in a calorimeter (usually a Styrofoam cup) whereupon the system is allowed to reach its equilibrium temperature.
  - An overall equation for the system is $Q_{Metal} + Q_{Water} = 0$.
  - Next, Q_{Metal} is subtracted from both sides of the equation to give $Q_{Water} = -Q_{Metal}$. The object gaining heat is positive, and the object losing heat is negative.
  - Afterward, $Q = mC_p\Delta T$ is substituted into the equation for each object, and the problem is solved.
- ***I can sketch a heating curve for water, label the axes (temperature vs. heat), label the phases in the diagram (solid, liquid, and gas), label the phase changes (melting, vaporizing), and clearly show where the melting and boiling points are in relation to the curve.*** A heating curve for water is shown in Fig. 10-13 on p.376 in the text.
- I understand that latent heat, L, is the amount of heat per unit mass that must be added to, or removed from, a substance to convert it from one phase to another. Latent heats of fusion, L_f, and latent heats of vaporization, L_v, for several substances are shown in Table 10-6 on p. 379 in the text.
- I can solve a common heat transfer problem involving the heat needed to raise the temperature of ice from -15^{o}C to steam at 115^{o}C. Using the heating curve for water, the heat needed to increase the temperature of ice, liquid water, and steam can be calculated using $Q = mC_p\Delta T$ and the heat needed for melting and evaporating can be calculated using $Q = mL_f$ and $Q = mL_V$, respectively. Add the heats together, $Q_{Total} = Q_{Ice} + Q_{Melting} + Q_{Liquid\ Water} + Q_{Vaporizing} + Q_{Steam}$, to get the final answer.
- I can compare and contrast the three common mechanisms for heat exchange shown in Table 3.
- I can explain how a down sleeping bag helps to keep a person warmer at night. Insulating materials retain energy in cold climates. Air is an excellent insulator.
- I can explain how evaporation aids energy transfer in hot climates. For example, a fan helps a person to feel cooler because it helps the person's perspiration to evaporate more quickly. This removes energy from the person's skin reducing the skin's temperature.

Table 3: Mechanisms of Heat Exchange

Mechanism	***Description***
Conduction	Heat exchanges between materials that are in contact with each other.
Convection	Heat exchanges due to mixing. Convection currents occur because of temperature differences in liquids and gases.
Radiation	Heat exchanges due to electromagnetic radiation, such as infrared rays and light.

<u>Chapter 12: Vibrations and Waves</u>

- I can explain simple harmonic motion, which is a periodic motion that repeats after a definite length of time. The period is the time required for a motion to repeat (one "cycle"), and the frequency is the number of oscillations (cycles) per unit time.
- I can convert between period and frequency. Period, T, and frequency, f, are related to each other by $f = \frac{1}{T}$ and $T = \frac{1}{f}$. Rapid motion has a ***short*** period and a ***large*** frequency.
- Classic examples of simple harmonic motion (SHM) include the oscillation of a mass attached to a spring and the periodic motion of a pendulum.
  - I can predict when relative velocity, acceleration, and force are zero or at a maximum for these systems. See Table 4.
  - I can calculate the period for each type of system. See Table 5 for additional information.

Table 4: Relative Velocity, Acceleration, and Restoring Force at Various Positions for a Spring-Mass System or Pendulum in SHM

Quantity	***Maximum Displacement Left***	***Equilibrium Position***	***Maximum Displacement Right***
Velocity, v	$v = 0$	$v = v_{\max}$	$v = 0$
Acceleration, a	$a = a_{\max}$	$a = 0$	$a = a_{\max}$
Restoring Force, F_x	$F = kx = F_{\max}$	$F = kx = 0$ since $x =$ change in distance from the equilibrium position.	$F = kx = F_{\max}$

Table 5: Periods for Oscillating Objects

Period Type	***Equation***	***Comments***
Period of a Simple Pendulum with a Small Amplitude: (<15°)	$T = 2\pi\sqrt{\frac{L}{g}}$	For a pendulum with an amplitude less than 15°, the period is independent of the amplitude and the mass.
Period of a Mass on a Spring:	$T = 2\pi\sqrt{\frac{m}{k}}$	When a spring obeys Hooke's Law, the period is independent of the amplitude.
Period's Relationship to Frequency:	$T = \frac{1}{f}$	Also remember $f = \frac{1}{T}$

- I can distinguish between wavelength, frequency, and amplitude and use $v = f\lambda$ to perform related calculations.
  - Wavelength is the distance a wave travels during one cycle.
  - Frequency is the number of cycles per second; it has units of 1/s = s^{-1} = Hz.
  - Amplitude is the wave height (maximum displacement from the equilibrium position).
- I can explain the difference between transverse and longitudinal waves, sketch them, and give examples of each.
  - Transverse waves—particle movement is perpendicular to the direction of wave motion. Ex. Electromagnetic radiation, which includes gamma rays, X-rays, ultraviolet light, visible light, infrared, microwaves, and radio waves.
  - Longitudinal waves—particle movement is parallel to the direction of wave motion. Ex. Sound, earthquake tremors.
- I can distinguish between a pulse wave and a periodic wave.
- I can explain the difference between constructive and destructive interference.
  - Constructive interference results in larger wave amplitudes.
  - Destructive interference results in smaller wave amplitudes.
- I can explain the difference between reflection from fixed and free boundaries.
  - Wave inversion occurs when waves are reflected from a fixed boundary.
  - No wave inversion occurs when waves are reflected from a free boundary.
- I can determine the number of nodes and antinodes for a standing wave.

Chapter 13: Sound

- I understand that sound waves are longitudinal waves.
- I can distinguish between compression and rarefaction. Suppose the prong of a tuning fork moves to the right. On the right side, the higher air pressure results in compression. On the left side, the lower air pressure results in rarefaction.
- I understand that frequency determines pitch.
- I understand that ultrasonic waves can produce images.
- I can predict the relative speed of sound through two different mediums. For example, sound travels faster through water (1450 m/s at 20^oC) than through air (343 m/s at 20^oC).
- I can explain how the Doppler Effect changes the pitch when a car passes you on the road. Relative motion creates a change in frequency, which results in a change in pitch.
- I can calculate the intensity of a spherical wave using $Intensity = \frac{P}{4\pi r^2}$ where P is the power in Watts, r is the distance from the source to the receiver in meters, and the intensity has units of W/m^2.
- Relative intensity is measured in decibels, dB. Note that the decibel scale is logarithmic.
- I can determine an increase in loudness and sound intensity. There is a 2^n increase in loudness and a 10^n increase in sound intensity where n = a 10 dB increase in sound.
- I understand that vibrations at the natural frequency produce resonance. Structural resonance caused the Tacoma Narrows suspension bridge to collapse in 1940 only four months after it had opened.

Equations Available on Physics Third Marking Period Test

$\Delta\theta = \frac{\Delta s}{r}$

$\omega_{ave} = \frac{\Delta\theta}{\Delta t}$

$\alpha_{ave} = \frac{\Delta\omega}{\Delta t}$

$G =$ 6.673 x 10^{-11} Nm^2/kg^2

$v_t = r\omega$

$a_t = r\alpha$

$F_g = G\frac{m_1 m_2}{r^2}$

$F_c = ma_c = \frac{mv_t^2}{r} = mr\omega^2$

$a_c = \frac{v_t^2}{r} = r\omega^2$

$Torque = Force \bullet LeverArm$

$\tau = Fd(\sin\theta)$

$\tau = I\alpha$

Conditions for Static Equilibrium: $F_{net} = 0$ $\quad \tau_{net} = 0$

$MA = \frac{F_{out}}{F_{in}} = \frac{d_{in}}{d_{out}}$

$\%\ Efficiency = \left(\frac{W_{out}}{W_{in}}\right)(100)$

$W = Fd\cos\theta$

${}^oF = \left(\frac{9}{5}\right){}^oC + 32$

${}^oC = \frac{5}{9}\left({}^oF - 32\right)$

$T = {}^oC + 273.15$

$C = \frac{Q}{m\Delta T}$

$Q = mC\Delta T$

$Q = mL$

$Q_{Hot\ Object} + Q_{Water} = 0$

$Q_{Total} = Q_{Ice} + Q_{Melting} + Q_{Liquid\ Water} + Q_{Vaporizing} + Q_{Steam}$

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

$T = 2\pi\sqrt{\frac{m}{k}}$

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

$v = f\lambda$

$E = hf$

$E = \frac{hc}{\lambda}$

$F = kx$

h = 6.63 x 10^{-34} Js

c = 3.00 x 10^8 m/s

$Intensity = \frac{P}{4\pi r^2}$

There is a 2^n increase in loudness and a 10^n increase in sound intensity where n = a 10 dB increase in sound.

- This list of equations will be provided on the test.
- You are not allowed to use note cards, review sheets, textbooks, or any other aids during the test.
- You may use a calculator. However, you are not allowed to use any other electronic devices (*i*-Pods, *i*-Phones, smart phones, netbooks, laptop computers etc.) until the last person is finished with the test.
- Calculator sharing is not allowed.
- It is to your advantage to check your work.
- All test materials including scratch paper must be returned at the end of the test.