EXAM REVIEW

HESI A2 Cheat Sheet

PHYSICS

Motion	**Types of Motion** ‣ ***Translational*** – An object moves along a path in any of the three dimensions. ‣ ***Rotational*** – An object moves along a circular path around a fixed axis. ‣ ***Linear*** – The body moves in a single direction along a single dimension. ‣ ***Periodic*** – Motion that repeats itself after certain intervals of time. ‣ ***Simple Harmonic*** – A simple pendulum where a restoring force acts in the direction opposite to the direction of motion of the object. This restoring force is proportional to the displacement of the object from the mean position. ‣ ***Projectile*** – Motion which has a horizontal displacement as well as vertical displacement. ‣ ***Oscillatory*** – Repetitive in nature within a time frame. If it is mechanical it is called vibration. **Newton's Laws of Motion** ‣ ***First Law*** - Any object will remain in its existing state of motion or rest unless a net external force acts on it. ‣ ***Second Law*** - The greater the mass of an object, the greater the force required to accelerate the object. It is represented by the equation $F = ma$. ‣ ***Third Law*** - For every action, there is an equal and opposite reaction.
Acceleration	The average acceleration is the rate at which velocity changes. ***Formula:*** $a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$
Friction	Friction is a force that opposes relative motion between systems in contact. ‣ **magnitude of static friction:** $f_s \leq \mu_s \cdot N$ ‣ **magnitude of kinetic friction:** $f_k = \mu_k N$
Rotation	**Average angular acceleration:** $\bar{\alpha} = \frac{\Delta \omega}{\Delta t}$ **Rotational and Linear Variables - Relationships** ‣ magnitude of angular displacement: $\theta = \frac{s}{r}$ ‣ magnitude of angular velocity: $\omega = \frac{v}{r}$ ‣ magnitude of angular acceleration: $\alpha = \frac{a}{r}$

	Kinematics of rotational motion: the relationships between the angle of **rotation**, angular velocity, angular acceleration, and time. Extend this definition to any system of particles by adding up the kinetic energies of all the constituent particles: $K = \sum \frac{1}{2}mv^2$.
Uniform circular motion	An object undergoing **uniform circular motion** is always accelerating, even though the magnitude of its velocity is constant. **Centripetal acceleration** - For an object traveling at speed *v* in a circular path with radius *r*, the magnitude of centripetal acceleration is: $a_c = \frac{v^2}{r}$.
Kinetic Energy	The kinetic energy of a particle is one-half the product of the particle's mass and the square of its speed. ***Formula:*** $K = \frac{1}{2}mv^2$
Potential Energy	‣ A scalar function of position that can be defined for any conservative force in a way that makes it easy to calculate the work done by that force over any path. Calculating the work done by a conservative function along an arbitrary path by taking the difference in potential energy evaluated at the two endpoints: $W = U(\vec{r}_B) - U(\vec{r}_A)$
Linear momentum	Linear momentum is defined as **the product of a system's mass multiplied by its velocity:** *p = mv.* **!** Momentum is directly proportional to the object's mass and also its velocity. Thus the greater an object's mass or the greater its velocity, the greater its momentum. **In the context of Newton's second law of motion** - The net external force equals the change in momentum of a system divided by the time over which it changes. ***Formula:*** $\vec{F}_{net} = \frac{\Delta\vec{p}}{\Delta t}$ **Impulse - Change in momentum** ‣ the average net external force multiplied by the time this force acts: $\Delta\vec{p} = \vec{F}_{\text{avg, net}} \cdot \Delta t$
Universal Gravitation	Objects with mass feel an attractive force that is proportional to their masses and inversely proportional to the square of the distance. ***Formula:*** $F = G\frac{Mm}{r^2}$
Waves	‣ **Transverse waves:** oscillations occurring perpendicular (or right-angled) to the direction of energy transfer. *Wave propagation speed:* $v = \lambda f$ ‣ **Longitudinal waves:** the movement of the medium is in the same direction as the motion of the wave.

! Water waves comprise both transverse and longitudinal waves.

Characteristics:

- **Amplitude:** half of the distance measured from crest to trough.
- **Wavelength:** the spatial period of the wave (from crest to crest or trough to trough).
- **Frequency:** the number of cycles per unit of time (the number of crests that pass a fixed point per unit of time).
- **Velocity:** the rate at which the phase of the wave propagates in space.

Energy Transportation

Waves carry energy along an axis defined to be the direction of propagation.

! Electromagnetic waves can be imagined as self-propagating transverse oscillating waves of electric and magnetic fields.

Relation of waves: $v = f\lambda$

Sound waves are **mechanical waves**, meaning, they require a medium to travel through.

- Longitudinal in air and water.
- Can be both longitudinal and transverse in solids.

Electricity and Magnetism

The electric force is created by **electric charges.**

- charged particles: protons (+1) and electrons (-1)

Coulomb's Law: $F = k_e \cdot \frac{|q_1 \cdot q_2|}{r^2}$

Electric Dipole Moment: $\vec{p} = q\vec{d}$

- The direction of the dipole moment is that it points from the negative charge to the positive charge.

The effect that a uniform electric field has on a dipole - Each individual charge feels a new force from the field, but the charges are equal in magnitude, and the forces act in opposite directions, so the net force on it is zero.

Torque on a dipole: $\vec{\tau} = \vec{p} \times \vec{E}$

Potential energy charge for a rotating dipole: $U = -\vec{p} \cdot \vec{E} = -pE\cos(\theta)$

Electric field of a dipole: $\vec{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3}$