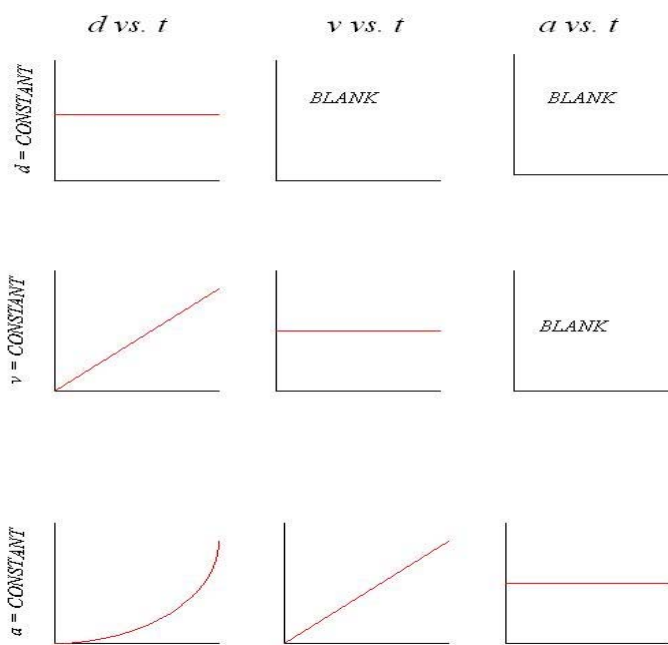


STUDY GUIDE FOURTH QUARTER QUIZ (Date = 05-17-07)

aka FUNDAMENTAL /CRITICAL RELATIONSHIPS / CONCEPTS OF INTRODUCTORY PHYSICS (to date)

Prior to utilizing this document the student should be fluent in all POD's & WOD's assigned to date. This recommendation notwithstanding, there may be problems on the quiz/test, which cover salient points of PSII, not directly highlighted herein.

1. **Scalar Quantities** – Those requiring only magnitude for sufficient description.
2. **Vector Quantities** – Those requiring magnitude and direction for sufficient description.
3. **Basic SI (System International) Units** are **Meters, Kilograms, Seconds** and fluency with the **Factor Label Method** of units conversion and solution arrangement. See reference links page for further information.
4. **Average Speed** (or *Velocity if direction is constant and distance equals displacement*) = $V_{AVG} = [\text{Total Distance}] / [\text{Total Time}] = [\Delta d / \Delta t]$ {*Not generally the average of the speeds or velocities.*}
5. **Velocity** = Speed with a specific direction = Rate of change of displacement = $V = [\Delta d / \Delta t]$. **Note also that the slope of a displacement (or position) versus time graph is equivalent to the associated velocity for the involved object.**
6. **Acceleration** = a = Rate of change of Velocity = $\Delta V / \Delta t = (V_f - V_i) / \Delta t$ (*From this one can rearrange to get $V_f = V_i + a(\Delta t)$ or when $V_i = 0$ then $V_f = a(\Delta t)$ assuming a is constant.) **Note also that the slope of a velocity versus time graph is equivalent to the associated acceleration for the involved object.***
7. When **acceleration is constant**, average Velocity = $V_{AVG} = [V_f + V_i] / 2$
8. Position/Displacement, Velocity & Acceleration Graphs as follows:



9. **The area under a velocity versus time graph is equivalent to the displacement of the object.**

10. Newton's Three Laws of Motion are:

- I. All bodies will stay in motion (*at constant velocity*) or at rest, unless acted upon by an outside force - *aka* the **Law of Inertia**.
- II. The acceleration of an object is directly proportional to the Force applied and inversely proportional to its Mass - *aka* $F = ma$.
- III. For every action force there is an equal and opposite reaction force – *aka* a **force pair**. Each of these forces, of the force pair, acts on a different object.

11. Force = (mass) x (acceleration), especially $\Sigma F = (m)(a) \Rightarrow$ *aka* Newton's Second Law of Motion. It says that the sum of the forces on any object (*i.e. the net force*) is equal to the mass times the acceleration of the object (in Newtons) – where *one* Newton = an acceleration of *one* [Meter / s²] times a mass of *one* [Kilogram]. Forces can act in compression (*i.e. a "push"*) or in tension (*i.e. a "pull"*). For purposes of PSII the tension force in tension members such as ropes, strings, cables and chains may usually be assumed to remain constant throughout the tension member.

12. **Weight Force** = (mass) x (acceleration of gravity) = (m) (g) = (m) | (-9.81 meters/s²) | in Newtons.

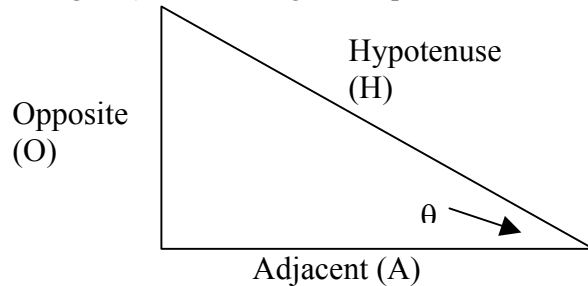
13. **Newton's Law of Gravitation:** Force between two objects is proportional to the product of their masses and inversely proportional to the square of the distance between them.

14. **Kinematics** (*a.k.a. Equations of Motion for Constant a*) **Summary** - The following equations, for motion of an object (*that has an initial velocity of zero*) in *one direction* are provided below; where "V" represents velocity, "a" represents a constant acceleration, "**delta D**" represents the total displacement, "**delta t**" represents the change in time, subscript "i" represents the associated initial parameter, "f" represents the associated final parameter, subscript "**AVG**" means average – all in that *one direction*.

$V_{AVG} = [\text{Total Distance} / \text{Total Time}]$ $V_{AVG} = [V_f + V_i] / 2 \text{ (for constant "a")}$ $a = [\Delta V / \Delta t] = (V_f - V_i) / \Delta t$ $V_f = V_i + (a)(\Delta t)$ $\Delta D = V_i (\Delta t) + (1/2)(a)(\Delta t)^2$ $V_f^2 = V_i^2 + 2 (a) (\Delta D)$

15. **Right Triangle Trigonometry for “Vector” Analysis** (i.e. for the below pictured Right “Vector” Triangle) the following information applies:

OPPOSITE, ADJACENT, HYPOTENUSE – Sides of a right triangle in relationship to one of the acute angles (e.g. θ in degrees) of that triangle as depicted in the below figure;



In this regard the following information applies: $\sin(\theta) = O/H$, $\cos(\theta) = A/H$, $\tan(\theta) = O/A$ & $\sin^{-1}(O/H) = \theta$, $\cos^{-1}(A/H) = \theta$, $\tan^{-1}(O/A) = \theta$.

16. **Work** = Force_{||} x Displacement = [F_{||}] [Δd] (Where the Force is in parallel with the direction of the displacement.) The units of Work are **Joules**. Where one Joule is the Work done by a Force of One Newton through a distance of One Meter.
17. **Energy is the ability to do Work**. The units of Energy & Work are **Joules**.
18. **Potential Energy** due to height = (m)(g)(Δh). **Kinetic Energy** due to velocity = ½(m)(V²).
19. **Power** = [Work / Δt] = [Energy / Δt]. **Units of Power** are Joules per Second or **Watts**. Alternatively Power times time equals Energy.
20. **Conservation of Energy**: Energy output of any given process cannot exceed the energy input to that process. Efficiency (η) of any machine or process = (Work Out)/(Work In) x 100% = (Energy Out)/(Energy In) x 100%, and is always less than “100%” unless an ideal machine or process is involved.
21. Coefficient of Friction (*unit-less*) = μ (*mu*) = F_f/F_N = Friction Force divided by the Normal Force which is generally less than “1”. There are distinct differences between the “Static” Coefficient of Friction and the “Dynamic” Coefficient of Friction for any given combinations of surfaces in that the “Static” Coefficient is usually larger.
22. Vector Delineation via Magnitude and Direction – Please refer to associated document link on this “Study Guides” pull-down tab page.
23. Momentum = P = (m) (V) = mass times velocity. In the absence of external forces momentum of a system is conserved, e.g. P_i (*Initial Momentum before a collision*) = P_f (*Final Momentum after a collision*).
24. Impulse, Change in Momentum: (Force)(Δt) = m (ΔV) = ΔP.
25. Hooke’s Law or Force due to a Spring: F_s = -(k)(x), where “F_s” is the force due to the spring due to its tension (*stretch*) or compression, “k” is the Spring characteristic in Newtons per Meter and “x” is the displacement (*stretch or compression*) of the Spring.

26. Mechanical Advantage (M.A.) of a simple machine = F_o/F_i = Output Force divided by the Input Force. For pulleys of the type studied in PSII the M.A. is equivalent to the number of tension members connected to the load.
27. Lever Torque: $(F_i)(L_i) = (F_o)(L_o)$. Input Force times Input Lever Length = Output Force times Output Lever Length, where both forces are perpendicular to their respective lever arms. As such, the Mechanical Advantage of a Lever = $(L_i)/(L_o)$. The point about which a lever rotates is called the fulcrum. For situations of equilibrium (“Statics”) the sum of the Torques about any point of rotation (*i.e. pivot or fulcrum*) equals zero [$\Sigma T's = 0$] or the *Clockwise (CW) Torques* equal the *Counter-Clockwise (CCW) Torques*.
28. Fundamental Characteristic of Electric Charges: Like Charges Repel & Unlike Charges Attract.
29. Ohm’s Law: $V = (I)(R)$. Voltage = Current x Resistance. Voltage (*in Volts*) is an amount of Joules of Energy needed to move 1 Coulomb of charge through an electrical load. Current is an amount of Coulombs per Second (*a.k.a. Amperes*) traveling in a conductor. Conductors are those materials (*such as metals – Copper, Aluminum, Iron Alloys, etc.*) which carry current with little difficulty. Insulators are those materials (*such as dry wood, glass, rubber & plastics*) that greatly resist the conduction of current. Mechanical (fluid system) analogies are: Voltage => Pressure & Current = Fluid Flow. The student should be able to identify (*or sketch*) schematic representations of batteries, ammeters, voltmeters, wires & AC voltage sources - *and* - parallel or series circuits consisting of same.
30. KVL: Kirchoff’s Voltage Law => The Sum of the Voltage Increases minus the Sum of the Voltage Drops around any single circuit loop equals zero. Series circuits are those circuits where circuit elements (*such as resistors*) are “in series” with the voltage source (*e.g. batteries*).
31. KCL: Kirchoff’s Current Law => The Sum of the Current Inputs to any given current node (*junction*) is equivalent to the Sum of the Current Outputs of that node. Parallel circuits are those circuits where circuit elements (*such as resistors*) are “in parallel” with the voltage source (*e.g. batteries*). All house-hold circuits are wired in parallel with the utility voltage source.
32. Resistances in Series add algebraically as: $R_T = R_1 + R_2 + R_3$, etc.. Resistance is measured in Ohms (Ω , where One Ohm = One Volt per One Amp).
33. Resistances in Parallel add algebraically as: $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$, etc.. Resistance is measured in Ohms (Ω , where One Ohm = One Volt per One Amp).
34. Electrical Power, $P = (V)(I)$: Power in Watts = (Voltage) x (Current).
35. Fundamental Characteristic of Magnets: Like Poles Repel & Unlike Poles Attract. Changing the poles, from North to South, or vice-versa, can be changed in Electro-Magnets, by changing the current direction in the Electro-Magnet. In electric motors this is done via the commutator.
36. Turns Ratio of a Transformer and therefore the Step-Up or Step-Down Voltage Ratio of that Transformer = V_s/V_p = AC Voltage of Secondary Side of Transformer divided by the AC Voltage of the Primary Side of the Transformer.

37. Heat input for any given substance is given by the relationship:

$$Q = (m)(c)(\Delta T)$$

Where: Q = Heat Input (+) or Loss (-) in Joules, m = mass in Kilograms, c = Specific Heat in Joules per °C per Kilogram (*a characteristic of the substance*) & ΔT = the temperature change in °C that the substance experiences. Note that alternate units of grams and/or °K (*Kelvin*) can also be utilized (*remember FLM!*).

38. Period of Harmonic Motion = T in Seconds per Cycle. Frequency of Harmonic Motion = $f = [1/T]$ in Cycles per Second. One Cycle per Second = One Hertz (*hz*).

39. Speed of a Wave (v), for either a *Transverse* or *Longitudinal* wave, which is considered constant for a given type of wave in a given medium, equals the Wavelength λ times the Frequency (f) of the wave. $v = \lambda f$

40. Speed of electromagnetic waves in space = c , the speed of light = 3×10^8 M/Sec. The speed of light is believed to be the maximum speed attainable by anything and is additionally believed to be constant for all frames of reference.

41. The waves of the electromagnetic wave spectrum, from **Low Energy, Low Frequency, Long Wavelength** to **High Energy, High Frequency, Short Wavelength** are **Radio, Microwave, Infrared, Visible, Uv, X-ray & Gamma**.

42. The waves of the visible portion of the electromagnetic wave spectrum, from **Low Energy Low Frequency, High Wavelength** to **High Energy, High Frequency, Low Wavelength**, are **Red, Orange, Yellow, Green, Blue & Violet**.

43. Transverse waves are those waves wherein the physical motion of the involved physical material is perpendicular to the direction of the energy flow.

44. Longitudinal waves involve the movement of both the energy and the physical material (*partially/temporarily*) in the same direction.

45. The student should be able to define/sketch the Amplitude, Wavelength, Crests, and Troughs of a transverse wave and the Wavelength, Compressions & Rarefactions of a Longitudinal Wave.

46. The student should be able understand when waves are “In Phase” or “Out of Phase” and the concepts of Constructive and Destructive interference between waves.

47. Sound Waves are Longitudinal. Also, because of the relationship between the subjective sensation of **Loudness** and the physically measurable quantity **Intensity** (*Power per unit area*), physicists specify sound **Loudness** levels on a logarithmic scale. The unit on this scale is a Bel (*after Alexander Graham Bell*) or more commonly a Decibel ($dB = 0.1$ Bel). **The Loudness level β (in dB) of any sound is defined in terms of its (Power/Area) Intensity I , as follows:**

$$\beta \text{ (in dB)} = 10 \log [I/I_0]$$

Where I_0 is the **Intensity** of a reference level usually the taken to be the threshold of hearing which is $1 \times 10^{-12} \text{ W/M}^2$.

48. For any given vibratory activity, the student should be able to define “Natural Frequency”, “Resonance” & “Harmonics”. Further, given a “Harmonic” frequency, or any integer multiple thereof, the student should be able identify/calculate any other desired harmonic.
49. It is believed (*by many scientists*) that the main cause of “Global Warming” is excess production of CO_2 due to combustion of “Fossil Fuels” – which tends to cause a “Green-House” affect. All things “organic” will eventually decompose to CO_2 – via the combustion reaction $\text{CH}_x + \text{O}_2 \Rightarrow \text{CO}_2 + \text{H}_2\text{O}$ - the problem is that stores of ancient organics (*Fossil Fuels – oil, gas, & coal*) are now being added to the atmospheric mix.
50. The “Ozone Layer”, in the upper atmosphere, protects Earth life from certain harmful energies of the Sun. The “Ozone Layer” can be damaged by a chemical reaction with Chlorofluorocarbons (*CFC's*), which for many years were used as refrigerants and spray can propellants. Existing damage to the Ozone Layer has come to be known as the “Ozone-Hole”.