6091 Physics Formula and Definitions List for Sec 3

Measurement

Define physical quantity **A quantity that can be measured and consists of a numerical magnitude and unit.**
Explain the difference between vector and scalar quantities. **Vector quantities are quantities that have both magnitude and direction.** **Scalar quantities are quantities that have magnitude only.**

Kinematics

Distance (Scalar), Displacement (Vector)	Symbol: **s**
Define Displacement **distance travelled in a specified direction**	SI Unit **m**
Define Distance **total length of travel irrespective of the direction of motion**	Formula: **s = v x t** **(for constant v)**

*Speed (Scalar), Velocity (Vector)	Symbol: **u, v**
Define speed **the rate of change of distance** **OR distance travelled per unit time** Define velocity **as the rate of change of displacement** **OR distance travelled per unit time in a specified direction**	SI Unit **m/s**
Formula: $v = \frac{s}{t}$	

*Acceleration (Vector)	Symbol: **a**
Definition **rate of change of velocity**	SI Unit **m/s^2**
Formula $a = \frac{v-u}{t}$	

Write down the calculation method(s) for each of the quantities (e.g. distance, speed) under displacement-time (s-t) and speed-time (v-t) graphs.

	$s-t$	$v-t$
Distance / displacement	**Vertical axis**	**Area under graph**
Speed / velocity	**gradient**	**Vertical axis**
Acceleration		**gradient**
Difficult / not possible to determine	**acceleration**	

Dynamics

*Force (Vector)	Symbol: **F**
Definition **A force is a push or a pull that one object acts on another**	SI Unit **N (newton)**
Formula $F_{resultant} = ma$ **or** $F_{applied} - f = ma$	
One newton is defined as **the force which produces an acceleration of 1 ms^{-2} when it is applied to a mass of 1 kg.**	

Newton's First Law
State Newton's First Law **An object at rest will remain at rest and an object in motion will continue in motion at constant speed in a straight line in the absence of a resultant force acting on it.**

Friction
Define Friction **Friction is a force that resists the relative motion of objects that are in contact with each other.**
State the 2 factors which affect frictional force between 2 surfaces on a horizontal plane: 1) **nature of surfaces in contact** 2) **force pressing the surfaces together** Independent of: **area of contact**

Mass Weight Density

Mass (Scalar)		Symbol: **m**
Definition **amount of substance in a body**	Measuring instrument **beam balance, electronic balance**	SI Unit **kg**
*Weight (Vector)		Symbol: **W**
Definition **gravitational force acting upon a body**		SI Unit **N**
Formula **$W = mg$**		Measuring instrument **spring balance**

*Density (Scalar)	Symbol: **ρ**
Definition **mass per unit volume of a substance**	SI Unit **kg/m^3**
Formula $\rho = \frac{m}{v}$ **or** **density** $= \frac{\text{mass}}{\text{volume}}$	

Gravitational Field Strength (Vector)	Symbol: **g**	
Explain what is gravitational field **It is a region in which a mass experiences a gravitational force** Define gravitational field strength **It is the gravitational force per unit mass**		SI Unit **N/kg**
Acceleration due to gravity / Acceleration of free fall (Vector)	Symbol: **g**	SI Unit **m/s^2**

Inertia (Scalar)
Definition **It is the reluctance of the object to change its state of rest or motion in a straight line.**

Moment of force

*Moment (Vector)	
Definition **It is the product of the force and the perpendicular distance from the line of action of the force to the pivot**	SI Unit **Nm**
Formula **Moment = force x perpendicular distance from line of action of force to the pivot**	

Principle of Moment
State the Principle of Moment **When an object is in equilibrium, the sum of clockwise moments about any pivot is equal to the sum of anticlockwise moments about the same pivot**

Centre of Gravity
Definition **It is the point through which the entire weight of the object appears to act.**

Stability	
Definition **measure of a body's ability to maintain its original position**	
State the 2 conditions to make a body more stable: 1) **lowering its center of gravity** 2) **increasing the area of its base**	3 states of equilibrium: 1) **stable equilibrium** 2) **unstable equilibrium** 3) **neutral equilibrium**

Pressure

*Pressure (Scalar)	Symbol: **p**
Definition **It is the force acting per unit area.**	SI Unit **Pa or Nm^{-2}**
Formula Pressure: $p = \frac{F}{A}$ Liquid Pressure: $p = h \rho g$	**h = height in metres** **ρ = density in kg m^{-3}** **g = gravitational field strength in N kg^{-1}**
One pascal is defined as **the pressure exerted by a force of 1 newton on an area of 1 square metre.**	

Hydraulic Press
State the 2 properties of liquids that helps transmit pressure in a hydraulic system: 1) **liquids are incompressible** 2) **if pressure is applied to an enclosed liquid, the pressure is evenly transmitted to all parts of the liquid**
Formula Conservation of volume Conservation of Energy $\frac{F_1}{A_1} = \frac{F_2}{A_2}$ **or** $d_1A_1 = d_2A_2$ **or** $F_1d_1 = F_2d_2$

Atmospheric Pressure	Symbol: p_0 **or** p_{atm}
Definition **the weight of air that exerts pressure on the surface of the Earth**	Units **Pa or cmHg or mmHg**

Work, Energy and Power

*Work Done (Scalar)	Symbol: **W**
Definition **Work done is defined as the product of the force and the distance moved in the direction of the force**.	SI Unit **J (joule)**
Formula **W = F x s**	
One joule is defined as **the work done by a force of one newton which moves an object through a distance of one metre in the direction of the force.**	

Energy (Scalar)	Symbol: **E**
Definition Energy: **the capacity to do work** Kinetic Energy: **energy possessed by objects in motion** Gravitational Potential Energy: **energy which an object possesses because of it position relative to the ground**	SI Unit **J**
Formula KE = $\frac{1}{2}mv^2$ GPE = **mgh**	
State the Principle of Conservation of Energy **Energy cannot be created or destroyed but only converted from one form to another; the total energy in an isolated system remains constant.**	

*Power (Scalar)	Symbol: **P**
Definition **rate of doing work**	SI Unit **W (watt)**
Formula **power = $\frac{\text{work}}{\text{time}}$ = $\frac{\text{change in energy}}{\text{time}}$ = force x velocity** **(condition: constant force applied on object moving at constant velocity)**	
One watt is defined as **the power delivered when one joule of work is done in one second or one joule of energy is converted in one second.**	

Efficiency
Definition **the percentage of useful work output ÷ total work input**
Formula $$Efficiency = \frac{useful\ energy\ output}{total\ energy\ input} \times 100\%$$

Kinetic Model of Matter

Explain what is the kinetic model of matter **The kinetic model of matter states that all matter is made up of a large number of tiny particles which are in continuous random motion.**		
Explain what is meant by Brownian Motion **It is the haphazard movement of microscopic particles suspended in a fluid (liquid or gas) due to the uneven bombardment of the suspended particles by the unseen, fast-moving fluid molecules.**		
At constant volume, **$p \propto T$**	At constant temperature, **$p \propto \frac{1}{V}$**	At constant pressure, **$V \propto T$**

Temperature

Explain what is meant by thermometric substances **Thermometric substances are substances that have physical properties that vary linearly and continuously with temperature**	
Explain what is ice point **The temperature of pure melting ice at standard atmospheric pressure**	
Explain what is steam point **The temperature at which pure boiling water changes into steam at standard atmospheric pressure**	
Explain what is internal energy **The combination of total KE and PE of the molecules in the body**	
How to convert °C to K **$T = \theta + 273$**	Formula for thermometers **$\theta = \frac{L_\theta - L_0}{L_{100} - L_0} \times 100\ °C$ or $\frac{R_\theta - R_0}{R_{100} - R_0} \times 100\ °C$ or $\varepsilon = k\Delta\Theta$**

	Resistance thermometer	Liquid-in-glass thermometer	Thermocouple
Thermometric property	**Electrical resistance of metal wire**	**Volume of fixed mass of liquid**	**Electromotive force**
Advantages	**1) Accurate** **2) High sensitivity** **3) Measure wide range of temperatures**	**1) Portable** **2) Independent of other equipment** **3) Cheap and affordable**	**1) Measure wide range of temperatures** **2) Measure temperature at a point** **3) Measure temperatures that change rapidly**

Transfer of Thermal Energy

Flow of thermal energy **Region of higher temperature to region of lower temperature**	
Explain what is conduction **The process by which thermal energy is transmitted through a medium from one particle to another without any flow of medium.**	
Explain what is convection **The process by which thermal energy is transmitted from one place to another by the movement of heated gas or liquid due to a difference in density.**	
Explain what is radiation **The process by which thermal energy is transmitted by electromagnetic waves.**	Rate of radiation affected by: **Surface temperature** **Surface colour and texture** **Surface area**

Light

Reflection
1st Law of reflection: **The angle of reflection is equal to the angle of incidence.**
2nd Law of reflection: **The incident ray, the reflected ray and the normal at the point of incidence all lie on the same plane.**
Angle of incidence: **The angle between the incident ray and the normal.** Angle of reflection: **The angle between the reflected ray and the normal.** Normal: **The line that is perpendicular to the reflecting surface or boundary between 2 media.**
Characteristics of image formed by plane mirror **1. Same size as object, 2. Laterally inverted** **3. Upright, 4. Virtual** **5. The distance of the image from the mirror = distance of object from the mirror**

Refraction		
Angle of refraction: **The angle between the refracted ray and the normal.**		
1st Law of Refraction: **For two given media, the ratio of $\frac{\sin i}{\sin r}$ is a constant, where i is the angle of incidence and r is the angle of refraction.** **Note: i must be in the optically less dense medium**		
2nd Law of Refraction: **The incident ray, the refracted ray and the normal at the point of incidence all lie on the same plane.**		
Explain what is meant by refractive index of a medium **The refractive index of a medium is the ratio of the speed of light in vacuum to the speed of light in that medium** Write out the 3 formulas for calculating refractive index:		
1) $n = \frac{\sin i}{\sin r}$ **Note: i must be in the optically less dense medium**	2) $n = \frac{\text{real depth}}{\text{apparent depth}}$	3) $n = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}} = \frac{c}{v}$

Critical Angle	Symbol: **c**
Definition **It is the angle of incidence in the optically denser medium for which the angle of refraction in the optically less dense medium is 90°.**	
Formula $n = \frac{1}{\sin c}$	

Total internal reflection
State the 2 conditions for total internal reflection to occur: 1) **light is travelling from an optically denser to an optically less dense medium** 2) **the angle of incidence is greater than the critical angle**

Lens	
Focal length **distance between its optical centre and principal focus (or focal point)**	Symbol **f**

Waves & Sound

Wave motion
Explain what is meant by wave motion **It is vibration/oscillation which transfers energy from one point to another without a transfer of medium.**

Wavefront
Explain what is meant by a wavefront **It is an imaginary line on a wave that joins all points which have the same phase of vibration.**

*Period (Scalar)	Symbol: **T**
Definition **time taken to generate one complete wave / time taken for the crest or any given point on the wave to move a distance of one wavelength**	SI Unit **s**

*Frequency (Scalar)	Symbol: **f**
Definition **the number of crests or troughs that pass through a point per second / the number of vibrations/oscillations or complete waves generated per second**	SI Unit **Hz (hertz)**
Formula $f = \frac{1}{T}$	

Amplitude (Scalar)	Symbol: **A**
Definition **the maximum displacement from the rest position or equilibrium position**	SI Unit **m**

*Wavelength (Scalar)	Symbol: λ
Definition **the horizontal distance between two successive crests or trough or points that are in phase**	SI Unit **m**

Formula for speed of a wave:
$v = f\lambda$

What is the difference between a transverse wave and a longitudinal wave?
A transverse wave travels in a direction perpendicular to the direction of vibration of the particles while a longitudinal wave travels in a direction parallel to the direction of vibration of the particles.

Sound & Ultrasound & Echoes	
Explain what is a sound wave **A sound wave is a longitudinal wave which transfers energy from one point to another through a series of compressions and rarefactions.** What is meant by ultrasound **Ultrasound is a sound wave which has a frequency higher than 20 kHz (or frequency above the upper limit of human audible range).**	
What is meant by an echo **An echo is a sound reflected from a surface.**	Formula for echoes $v = \frac{2d}{t}$
Relationship	
Frequency **Higher frequency = higher pitch**	Loudness **Higher amplitude = louder note**

Electromagnetic Waves						
State 3 common properties of electromagnetic waves. **1) EM waves are transverse waves.** **2) EM waves can travel through vacuum (do not require a medium to travel).** **3) EM waves travel at the speed of 3.0 x 10^8 m/s in vacuum.**						
Lowest Frequency Longest Wavelength						Highest Frequency Shortest Wavelength
Radio Waves	**Microwaves**	**Infrared Waves**	**Visible light** **ROYGBIV**	**Ultraviolet Waves**	**X- Rays**	**Gamma Rays**