

Physics Brainstorm Fille

Print it out and learn it by heart!

Atoms

If the outer shell of an atom is full the element is inert. An atom with three free electron is called trivalent Catalysts can speed up or slow down reaction The splitting of a chemical compound is called analysis. Molecules of a same compound are held together by cohesive force. Oxygen has a valency of 2 The further from the nucleus the shells are the farther the shells get to each other. The number of protons determines the element identity An isotope of an element will have more neutrons, same atomic number it has a different mass number A positive ion has missing electrons The isotope of a carbon atom C₁₄ to C₁₂ will have same number of protons Heat of fusion turns a solid into liquid A liquid expands more than a solid Atomic number (number. of protons) and Mass number (number. of neutrons and protons)

Statics

Two equal and opposite couples will have a resultant of 0 Young's modulus is about stress per strain A quadrature component of a vector is 90 deg to the original The addition of vectors to produce a single vector is called resultant A force of 10 million Newton is expressed numerically as 10,000kN The SI unit of energy is joule, and pressure is N per sq.m (pascal) and momentum is kg.m per sec A Slug is a unit of mass The height of water required to produce a head pressure of 1 bar is 10.19m A gauge indicates 15psig, so absolute pressure is 30 PSIA. Permanent deformation of a material under load is said to be strained The force, which opposes twisting moment, is torsion Load divided by cross sectional area gives stress. Stress is given by force per unit area A force perpendicular to a beam produces shear stress

Kinetics

Speeds **Indicated Airspeed** IAS = dynamic air pressure of air against a vehicle = $\frac{1}{2}\rho V^2 = \text{Dynamic Pressure}$ The Kinetic Energy of a mass of 2 metric tones with a velocity of 2m per s is 4kJ The specific gravity of a substance is defined as the density of the body divided by the density of water As an object slides down a slope its kinetic energy increases and potential energy decreases

Dynamics

The extension of a spring can be determined using Hooke's law Yield point is at which the object doesn't return to its original form even after the load is released A regulator controls the pressure output of a pump within the specific limits Precession in a gyro is proportional to the magnitude of the torque applied A space gyro is free to rotate in all three axes A gyroscope suffers apparent wander due to earth's rotation

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Fluid dynamics

Combined Boyle's and Charles' Law Equation

$$\frac{P_1 \cdot V_1}{K_1} = \frac{P_2 \cdot V_2}{K_2}$$

Gas Laws Boyle's Law = P₁ x V₁ = P₂ x V₂

V= Volume , P= Pressure

Charles' Law = $\frac{V_1}{K_1} = \frac{V_2}{K_2}$ V= Volume , K= Constant — Volume increases by 1 per 273 per every deg C

Atmosphere consists of 78% Nitrogen, 21% Oxygen, 1% other gases

Troposphere is where temperature decreases with altitude (1.98 deg C per 1000ft) and where the weather takes place.

Lapse Rate ISA International Standard Atmosphere = Temperature decreases 1.98 deg C per 1000ft Temperature Unit conversion F = 9C per 5+32 C = 5 per 9(F-32) K=C+273

Temperature Variation in the Troposphere is above the Equator -80 deg C , above 45 deg N per S -56 deg C , above the poles -45 deg C

At Sealevel the atmosphere pressure is normally 950 - 1050 mb or hpa (1013 hpa is standard)hpa = hecto pascal = **Static Pressure**. With increase in altitude atmospheric pressure drops e.g. at 30,000ft the pressure is 300.9 hpa = Pressure Altitude = the ISA pressure given for a certain altitude (also density altitude). In reality this varies with the ambient temperature. Density = $\frac{Mass}{Volume}$ in kilogram per cubic meter .

Factors affecting density when considering a gas are

$$\text{Density} = \frac{Pressure}{GasConstant \cdot Absolutetemperature}$$

The greater the humidity, the lower the air — humidity decreases the total pressure

Bernoulli's law deals with kinetic and potential energy and pressure Relative density is density of medium per density of water Sublimation is the transfer of state from solid to gas 1 bar is 760mm of mercury, is 29.92 inches of mercury, 14,69 PSI Dew point is the temp. at which condensation occur Pitot pressure is the impact pressure caused by air; static pressure is present in undisturbed air The cut out relives pump from load A compressor increases potential energy From 36,000

ft on the temperature remains at 56 deg C Solids cannot transmit pressure Convection does not occur in solids A venturi has minimum cross sectional area in the center

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Thermodynamics

The specific heat capacity of a gas heated at constant pressure will be more than at constant volume Combined gas law uses Kelvin temperature scale Temperature is a measure of amount of vibration of particles In a heat pump condenser losses heat. Heat transfer from a hot body to a cold body is termed as conduction A process where volume does not change is isochoric, and where pressure does not change is isobaric Isothermic is where temp. remains constant $1\text{J} = 0.239\text{ calories}$ If pressure on a liquid is increased, while the temp. is held constant, the volume will remain same A thermistor is used when the temperature of the source has insufficient heat for thermocouple operation Compressing the air in an accumulator can restore hydraulic pressure Heat is defined as energy in transit A cylinder filled with water to half a meter will exert a pressure of 4900 Pa 2 hydraulic jacks having different diameters have the same amount of fluid entering at the same pressure the extension will be at different rates. A mass of 10kg placed 2 m per s. away from a pivot will have a moment of 196 Nm 1 degree C rise will cause 1.8 degree F rise Adiabatic compression is when no heat is lost or gained. $1\text{ CHU} = 1400\text{ft lbs.}$ $1\text{ HP} = 33000\text{ft lbs per min}$ or 550ft lbs per sec $1\text{ Watt} = 1\text{ j per sec}$ The heat required to change a liquid to gas is called latent heat of vaporisation The most common refrigerants are ammonia, freon, water, and dry ice The specific heat capacity of a gas heated at constant pressure, when compared to the specific heat capacity of a gas heated at constant volume is more A good refrigerant has high condensing pressure, low evaporating temperature Latent heat is the heat required to change the state of a body 1 calorie is equal to 4J 1 BTU equals 1055 joules Particles vibrating in air tend to give off heat The intensity of the radiated heat is inversely proportional to the square of the distance from the source of heat. As a block of ice is melted to 4 deg C its volume decreases

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Optics

A mirror absorbs a certain percentage of light In a flat surfaced mirror the angle of reflection is equal to the angle of incidence Refractive index is the speed of light in air per speed of light in that medium Speed of light is 300,000km per s Light travels $9.46 \times 10^{15}\text{m}$ in a

year. The focal point of a mirror is half the radius A graded index fiber optic cable has a variable refractive index across its cross sectional area If a ray of light enters a fiber optic cable with a refractive index of 1.5, the speed of the ray is 200,000 Km per sec The ratio between angle of incidence and angle of refraction The width of a multimode fiber optic cable is 100 μm Photons in a semiconductor are stimulated to produce excess photons to be emitted this is a laser diode Light rays change speed when entering a medium with different refractive index Converging lens can focus light rays because it is spherical Multi mode is used in fiber optic flying control system. A fiber optic cable is attenuated at 29dB per metre is allowed for power gain Fiber optic receiver is a photodiode Fiber optic cables are capable of transmitting light at $1.99 \times 10^8\text{ m per s}$ Step index fibers suffer from dispersion Attenuated pulses have their sizes and shape restored by regenerators Attenuation in fiber optic cables is caused by absorption and scattering Convex lens image is real A material with a gradually varying refractive index is called graded index Attenuation in a fiber optic cable is caused by absorption and scattering In a fiber optic flying system which requires power- transmitter The fiber optic cable is chosen by matching the diameter to the wavelength

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Wave Motion and Sound

Two tones of the same frequency will be heard as a beat of two tones The period of frequency of 4Hz is 0.25sec A dot rotates around the circumference of a circle, if the vertical position of this dot is plotted on a graph with respect to time the result is a sinusoidal waveform Two frequencies of the same wavelength and amplitude are moving half a wavelength out of phase with each other then nothing can be heard A time period of 10microseconds is equal to a frequency of 100kHz An approaching fire engine increases pitch, as it passes us it decreases in pitch, this is called doppler effect! Quality of sound depends on the frequency and harmonics of the waves being produced 10 microseconds is equal to a frequency of 100 kHz If a wave traveling to a point meets a wave traveling from that point of equal frequency a standing wave is formed The speed of sound in air at 0deg C is 331m per s 1^{st} harmonic is the fundamental frequency The first overtone of a sound wave is the 2^{nd} harmonic The fundamental frequency, which is 4 times the wavelength, is 2^{nd} harmonic

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Principles of Airflow

Dynamic pressure at 400kts is about 4 psi (1013.25 hpa = 14.69 psi)

Moving air passes and airfoil quicker than a cube, therefore the shape is very important. In a venturi or on an airfoil $A_1 \cdot V_1 = A_2 \cdot V_2$, which means the mass of air being at the leading edge is meeting again at the trailing edge. Therefore it must flow faster over the curved area and therefore reduces its pressure, which gives the lift on the airfoil.

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Reduced air density above 10,000 ft affects the human body and leads to hypoxia, lack of judgement to sleepiness or collapse according to altitude.

The greater the **humidity**, the lower the air — humidity decreases the total pressure

Performance Ceilings **Service Ceiling** is the altitude where the rate of climb of an aircraft falls below 100 ft per minute

Absolute Ceiling is the altitude where the rate of climb of an aircraft falls to zero

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Speeds

Indicated Airspeed IAS = dynamic air pressure of air against a vehicle = $\frac{1}{2}\rho V^2 = \text{Dynamic Pressure}$

Rectified Airspeed RAS is IAS corrected for instrument position errors

Equivalent Airspeed EAS = Rectified Air Speed corrected for compressibility (as subtracted quantity)

True Airspeed TAS = the Equivalent Air Speed corrected for Density

Calibrated Air Speed CAS for mean sea level compressibility corrected indicators also corrected for instrument and position errors

Mach Number is the ratio of TAS to the local speed of sound

Bernoulli's Principle: When a gas is accelerated, its pressure decreases.

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All three axes of rotation intersect at the center of gravity; thus the aircraft manoeuvres around the CG.