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| **Physics 20 Formula Sheet** |
| **Formula** | **Variables** | **Manipulations** |
| \*constant velocity\*$$v=\frac{Δd}{Δt}=\frac{d\_{f}-d\_{i}}{t\_{f}-t\_{i}}$$ | *v ,* d , t |  $∆d=v∆t$  | $$∆t=\frac{∆d}{v}$$ |
| $$a=\frac{Δv}{Δt}=\frac{v\_{f}-v\_{i}}{t\_{f}-t\_{i}}$$ | a , *v*f, *v*i , t | $∆v=a∆t$ $v\_{i}=v\_{f}-at$ $v\_{f}=v\_{i}+at$ $∆t=∆v/a$ |
| Uniform Acceleration | $$d=\left(\frac{v\_{f}+v\_{i}}{2}\right)t$$ | d , *v*f , *v*i , t | $$t=\frac{2d}{v\_{f}+v\_{i}}$$ | $$v\_{i}=\frac{2d}{t}-v\_{f}$$ | $$v\_{f}=\frac{2d}{t}-v\_{i}$$ |
| $$d= v\_{i}t+\frac{1}{2}at^{2}$$\*vertical motion\* | d , *v*i , t , a | $$v\_{i}=\frac{d-\frac{1}{2}at^{2}}{t}$$ | $$a=\frac{d-v\_{i}t}{\frac{1}{2}t^{2}}$$ | If *v*i = 0, $$t=\sqrt{\frac{2d}{a}}$$ |
| $$v\_{f}^{2}=v\_{i}^{2}+2ad$$ | d , *v*f , *v*i , a | $$v\_{i}=\sqrt{v\_{f}^{2}-2ad}$$ | $$d=\frac{v\_{f}^{2}-v\_{i}^{2}}{2a}$$ | $$a=\frac{v\_{f}^{2}-v\_{i}^{2}}{2d}$$ |
| Net Force$$F\_{NET}=ma$$ | Weight$$F\_{g}=mg$$ | F , m , a , g | $$m=\frac{F\_{NET}}{a}$$ | $$a=\frac{F\_{NET}}{m}$$ | $$m=\frac{F\_{g}}{g}$$ | $$g=\frac{F\_{g}}{m}$$ | $$F\_{N}=F\_{g}$$\*on a flat surface\* |
| $$F\_{f}=μF\_{N}$$ | Ff , µ , FN | $$μ=\frac{F\_{f}}{F\_{N}}$$ | $$F\_{N}=\frac{F\_{f}}{μ}$$ | $$F\_{N}=F\_{⊥}$$\*on an incline\* | $$F\_{f}=μF\_{⊥}=μF\_{g}cosθ$$\*on an incline\* |
| $$E\_{k}=\frac{1}{2}mv^{2}$$\*in motion\* | $$E\_{p}=mgh$$\*based on position\* | $E\_{k}$ , m , *v* | $E\_{p}$ , m , g , h | $$m=\frac{E\_{k}}{^{1}/\_{2}v^{2}}$$ | $$v=\sqrt{\frac{2E\_{k}}{m}}$$ | $$m=\frac{E\_{p}}{gh}$$ | $$h=\frac{E\_{p}}{mg}$$ | Top: ET = EpBottom: ET = EkMiddle: ET = Ep + Ek or $∆E\_{p}=∆E\_{k}$ |
| $$W=Fd$$ | $$W=Pt$$ | $$W=∆E$$ | W , F , d | W , P , t | $$F=\frac{W}{d}$$ | $$d=\frac{W}{F}$$ | $$P=\frac{W}{t}$$ | $$t=\frac{W}{P}$$ | $$P=\frac{∆E}{t}$$ | $$P=Fv$$ |
| $$W=∆E\_{k}+∆E\_{p}$$ |  For free falling objects, $E\_{PTOP}=E\_{kBOTTOM}$$$∴ v=\sqrt{2gh} h=\frac{v^{2}}{2g}$$ |
| **Circular Motion** | **Vertical Circles** | **Universal Gravity** |
| $$v=\frac{2πr}{T}$$$$a\_{c}=\frac{v^{2}}{r}$$$$F\_{c}=ma\_{c}$$$$F\_{c}=\frac{mv^{2}}{r}$$$$F\_{c}=\frac{4π^{2}rm}{T^{2}}$$$$Circumference=2πr$$ | $F\_{c}=F\_{T}+F\_{g}$ or$$F\_{c}=F\_{N}+F\_{g}$$If $F\_{T}$ or $ F\_{N}=0$, then:$$v=\sqrt{rg}$$ | **Kepler** | **Gravity Force** | **Orbital Period** |
| $$\frac{T\_{A}^{2}}{r\_{A}^{3}}=\frac{T\_{B}^{2}}{r\_{B}^{3}}$$ | $$F\_{g}=\frac{Gm\_{1}m\_{2}}{r^{2}}$$ | $$T=\sqrt{\frac{4π^{2}r^{3}}{Gm}}$$ |
| $$r=\sqrt{\frac{Gm\_{1}m\_{2}}{F\_{g}}}$$ | $$m=\frac{4π^{2}r^{3}}{T^{2}G}$$ |
| $$m\_{1}=\frac{F\_{g}r^{2}}{Gm\_{2}}$$ | $$r=\sqrt[3]{\frac{T^{2}Gm}{4π^{2}}}$$ |
| **Horizontal Circles** | **Gravity Fields** | **Orbital Velocity** | **Constants** |
| $F\_{c}=F\_{T}$ oron a flat road: $F\_{c}=F\_{f}$\*on a banked curve\*$$F\_{c}=F\_{f}+F\_{∥}$$ $tanθ=\frac{v^{2}}{rg}$ | Test Object: $$g=\frac{F\_{g}}{m}$$Source Object:$$g=\frac{Gm}{r^{2}}$$ | $$v=\sqrt{\frac{Gm}{r}}$$$$r=\frac{Gm}{v^{2}}$$ | $$r\_{EARTH}=6.37 ×10^{6}m$$$$m\_{EARTH}=5.98×10^{24}kg$$$$G=6.67×10^{-11}\frac{Nm^{2}}{kg^{2}}$$$$g\_{EARTH}=-9.81 ^{m}/\_{s^{2}}$$ |
| **Projectile Motion**$$v\_{x}$$ | **Conservation of Energy** | **Energy of SHM** |
| $$d\_{x}$$$$v\_{x}$$$$v\_{y}$$$$v\_{T}$$ | $$d\_{x}=v\_{x}t$$$$t\_{\frac{1}{2}}=\sqrt{\frac{2d\_{y}}{g}}$$ | $$∆E\_{p}=∆E\_{k}$$$$E\_{T}=E\_{p}+E\_{k}$$ | $$mg\left(h\_{f}-h\_{i}\right)=\frac{1}{2}m\left(v\_{f}^{2}-v\_{i}^{2}\right)$$$$E\_{T}=E\_{pmax}=E\_{kmax}$$ | $$E\_{T}=E\_{p}+E\_{k}$$$$E\_{T}=\frac{1}{2}kx^{2}+\frac{1}{2}mv^{2}$$ |
| If $∆d\_{y}=0,$$$t\_{full}=\frac{-2v\_{y}}{g}$$ | **Waves** | **Springs** |
| $$T=\frac{1}{f}$$ | $$f=\frac{1}{T}$$ | $$F\_{R}=kx$$ | $$T=2π\sqrt{\frac{m}{k}}$$ |
| **Sound** | $$v=λf$$ | $$λ=\frac{v}{f}$$ | $$f=\frac{v}{λ}$$ | $$m=\left(\frac{T^{2}}{4π^{2}}\right)k$$ | $$k=\frac{4π^{2}m}{T^{2}}$$ |
| $$v=\left(331+0.6T\right)$$T = temperature |
| speed of sound in 0ºC air = 331 m/s | **Stretched Strings & Air Columns** | **Pendulums** |
| 1st Open Harmonic (and strings): $L=\frac{λ}{2}$1st Closed Harmonic: $L=\frac{λ}{4}$ | $$T=2π\sqrt{\frac{L}{g}}$$ | $$L=\frac{T^{2}g}{\left(2π\right)^{2}}$$ | $$g=\frac{\left(2π\right)^{2}L}{T^{2}}$$ |
| \*or use conservation of energy to find velocity, height, or energy\* |
| **Harmonics** | **Doppler Effect** |
| Open columns and strings:$$f\_{n}=\frac{nv}{2L}$$ | Closed columns:$$f\_{n}=\frac{nv}{4L}$$ | $$f^{'}=f\_{o}\left(\frac{v\pm v\_{o}}{v\pm v\_{s}}\right)$$ |
| **Trigonometry** | **Shortcuts**$$÷3.6$$ |
| $$\sin(θ=\frac{opposite}{hypoteneuse})$$$$\cos(θ=\frac{adjacent}{hypoteneuse})$$$$\tan(θ=\frac{opposite}{adjacent})$$ | ABC$$c^{2}=a^{2}+b^{2}$$ | $$×3.6$$km/h m/s |
| $$×1000$$kg g |
| 1nm = 1 x 10-9 m$$÷1000$$ |
| **Plane Forces** | **Direction** |
| $F\_{N}=$Normal Force $F\_{f}=$ Force of Friction $F\_{∥}=$ Parallel Force $F\_{g}=$ Gravitational Force $F\_{⊥}=$ Perpendicular Force $F\_{A}=$ Applied Force$$F\_{N}$$$$F\_{f}$$$$F\_{g}$$$$F\_{⊥}$$$$F\_{∥}$$$$F\_{∥}$$ | 90º0º (360º)180º270ºNESW |