

Classical Mechanics Problem 1: Central Potential
Solution

a) Integrals of motion for a central potential $V(r)$:

$$\begin{aligned} \text{Angular Momentum} \quad L &= r v_\phi = r^2 \dot{\phi} \\ \text{Energy per unit mass} \quad E &= \frac{1}{2} (\dot{r}^2 + v_\phi^2) + V(r) = \frac{1}{2} \dot{r}^2 + V_{\text{eff}}(r) \end{aligned}$$

where v_ϕ is the tangential velocity and V_{eff} is defined as

$$V_{\text{eff}}(r) = V(r) + \frac{L^2}{2r^2}$$

If the orbit is circular, the distance of the test body from the origin is invariant: $\dot{r} = 0$, which implies that the body is always at the equilibrium-distance:

$$\frac{dV_{\text{eff}}}{dr} = 0 \quad \Rightarrow \quad \frac{dV}{dr} = \frac{L^2}{r^3} = \frac{v_\phi^2}{r} = r \dot{\phi}^2$$

then

$$\dot{\phi} = \omega_\phi = \frac{L}{r^2} = \left(\frac{1}{r} \frac{dV}{dr} \right)^{1/2}$$

so for the period we get

$$\boxed{T_\phi = \frac{2\pi}{\omega_\phi} = 2\pi \left(\frac{1}{r} \frac{dV}{dr} \right)^{-1/2}}$$

b) Write the orbit as in the statement of the problem:

$$r(t) = r_0 + \epsilon(t) \quad \text{with} \quad \frac{dV_{\text{eff}}}{dr}(r_0) = 0 \quad \text{and} \quad \epsilon^2 \ll r_0^2.$$

The energy per unit mass is now $E = \frac{1}{2} \dot{\epsilon}^2 + V_{\text{eff}}(r_0 + \epsilon)$, and since ϵ is small we may Taylor-expand the potential as

$$V_{\text{eff}}(r_0 + \epsilon) = V_{\text{eff}}(r_0) + \underbrace{\frac{dV_{\text{eff}}}{dr}(r_0)}_{=0} \epsilon + \frac{1}{2} \frac{d^2 V_{\text{eff}}}{dr^2}(r_0) \epsilon^2 + \mathcal{O}(\epsilon^3)$$

so then

$$E - V_{\text{eff}}(r_0) = \frac{1}{2} \dot{\epsilon}^2 + \frac{1}{2} \frac{d^2 V_{\text{eff}}}{dr^2}(r_0) \epsilon^2 + \mathcal{O}(\epsilon^3) = \text{const.}$$

In the above equation we readily recognize the equation of the simple harmonic oscillator with

$$\boxed{\omega_\epsilon = \left(\frac{d^2 V_{\text{eff}}}{dr^2} \right)_{r=r_0}^{1/2}}$$

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web solution 1 the two half reactions balanced as if in acidic solution $2\text{CN}^- + \text{Au} + \text{CN}^- + 2\text{e}^- + 2\text{H}^+ + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + 2\text{H}_2\text{O}$ make electrons equal convert to basic solution $4\text{CN}^- + 2\text{Au} + 2\text{CN}^- + 2\text{e}^-$ multiplied by a factor of 2 $2\text{e}^- + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + 2\text{OH}^-$ the final answer

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web we can balance it for charge by adding two electrons to the right side of the equation so that the net charge on each side is 0 oxidation $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$ now that the oxidation half reaction is balanced it tells us that two electrons are produced for every atom of nickel oxidized but where do those electrons go

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web balancing redox reactions in acidic solution problems 1 10 problem 1 $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} + \text{Cr}^{3+} + \text{Fe}^{3+}$ solution 1 balanced half reactions $6\text{e}^- + 14\text{H}^+ + \text{Cr}_2\text{O}_7^{2-} \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$ 2 equalize the electrons $6\text{e}^- + 14\text{H}^+ + \text{Cr}_2\text{O}_7^{2-} \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ $6\text{Fe}^{2+} \rightarrow 6\text{Fe}^{3+} + 6\text{e}^-$ multiplied by a factor of 6

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web aug 29 2023 some points to remember when balancing redox reactions the equation is separated into two half equations one for oxidation and one for reduction the equation is balanced by adjusting coefficients and adding H_2O H^+ and e^- in this order balance the atoms in the equation apart from O and H

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web in the redox equation below that occurs in our stomach which of the following pairs identifies the reducing and oxidizing agents respectively $\text{C}_6\text{H}_8\text{O}_6$ $2\text{H}_2\text{NO}_2$ $\text{C}_6\text{H}_6\text{O}_6$ $2\text{H}_2\text{O}_2$ NO choose 1 answer $\text{C}_6\text{H}_8\text{O}_6$ and NO_2 a $\text{C}_6\text{H}_8\text{O}_6$ and NO_2 b NO_2 and $\text{C}_6\text{H}_8\text{O}_6$ c $\text{C}_6\text{H}_8\text{O}_6$ and H_2O_2 d $\text{C}_6\text{H}_8\text{O}_6$ and H_2O_2