Interest Formulas from Business and Finance

Many of which are exponential in form

1) Definition of Quantities

P : Amount initially borrowed or deposited
A : Total amount gained or owed
r : Annual interest rate
r_{eff} : Effective annual interest rate
t : Time period in years for an investment
T : Time period in years for a loan
N : # of compounding periods per year
M : Monthly payment.
$e : e = \lim_{n\to\infty}\left[1+\frac{1}{n}\right]^n$

2) Simple Interest

1. Interest alone: $I = \Pr T$
2. Total repayment over T :
$$R = P + \Pr T = P(1+rT)$$
3. Monthly Payment over T :
$$M = \frac{P(1+rT)}{12T}$$

3) Simple Principle Growth and Decline

1. Compounded Growth: $A = P(1+\frac{r}{N})^{Nt}$
2. Continuous Growth: $A = Pe^{rt}$
3. Annual Inflation Rate r : $A = Pe^{-rt}$

4) Effective Interest Rates

1. N Compounding Periods per year:
$$r_{eff} = (1+\frac{r}{N})^N - 1$$
2. Continuous Interest: $r_{eff} = e^r - 1$
3. Known P, A, T : $r_{eff} = \sqrt[T]{\frac{A}{P}} - 1$

5) Continuous Interest IRA Growth Formulas

1. Annual Deposit D Evenly Metered Throughout the Year: $A = \frac{D}{r}(e^{rt} - 1)$

2. Annual Deposit D (evenly metered) Plus Initial Deposit P :
$$A = Pe^{rt} + \frac{D}{r}(e^{rt} - 1)$$

3. Replacement Formula: Continuous Interest to Compounded Interest

Replace e^{rt} with $(1+\frac{r}{N})^{Nt}$

6) Continuous Interest Mortgage Formulas

1. First Month's Interest: $I_{1st} = \frac{rP}{12}$
2. Monthly Payment: $M = \frac{\Pr e^{rT}}{12(e^{rT} - 1)}$
3. Total Repayment ($P + I$): $A = \frac{\Pr Te^{rT}}{e^{rT} - 1}$
4. Total Interest Repayment:
$$I = P\left[\frac{rTe^{rT}}{e^{rT} - 1} - 1\right]$$
5. Replacement Formula: Continuous Principle Reduction to Monthly Principle Reduction

Replace e^{rT} with $(1+\frac{r}{12})^{12T}$