1. **Summations, 20 points** 5 parts, 4 points per part. 2 points for correct answer, 2 points for work/explanation.

   (a)
   $$\sum_{i=10}^{n}(7)^i = \sum_{i=0}^{n}(7)^i - \sum_{i=0}^{9}(7)^i = \frac{7^{n+1}-1}{7-1} - \frac{7^{9+1}-1}{7-1} = \frac{7^{n+1}-7^{10}}{6}$$

   (b)
   $$\sum_{i=0}^{\infty}\frac{6}{17^i} = 6\sum_{i=1}^{\infty}\left(\frac{1}{17}\right)^i = \frac{6}{1-\frac{1}{17}}$$

   (c)
   $$\sum_{i=1}^{n}\left(i^2+ni\right) = \sum_{i=1}^{n}i^2+\sum_{i=1}^{n}ni = \frac{n(n+1)(2n+1)}{6}+\frac{n^2(n+1)}{2} = \frac{n(n+1)(5n+1)}{6}$$

   (d) The harmonic series demonstrates logarithmic growth.
   $$\ln(315)-\ln(5)+\text{constant} = \ln(63)+\text{constant}$$

   (e)
   $$\sum_{i=0}^{\infty}\frac{i-1}{2^i} = -1+\frac{1}{2}\sum_{i=0}^{\infty}i(\frac{1}{2})^i = -1+\frac{1}{2}\cdot\frac{\frac{1}{2}}{\frac{1}{4}} = -1+1=0$$

2. **Exponents and logs, 20 points** 5 parts, 4 points per part. 2 points for correct answer, 2 points for work/explanation.

   (a) Using formula for sum of consecutive integers:
   $$x^{11}\cdot x^{12}\cdots x^n = x^{\sum_{i=11}^{n} i} = x^{\frac{n\cdot(n+1)}{2}-\frac{10\cdot 11}{2}} = x^{\frac{n\cdot(n+1)}{2}-55}$$

   (b) $\log_{99}(33\cdot 33\cdot 33\cdot 33\cdot 33) = 5\log_{99}(33)$ or $5\frac{\ln 99}{\ln 33}$

   (c) $44^{\log_{44}330} = 330$

   (d) $\log_x\left((3x)^x\right) = x\log_x(3x) = x\log_x 3 + x\log_x x = x\log_x 3 + x$

   (e) $\sum_{i=1}^{5^N}\log_{23} i = \log_{23}\left(\Pi_{i=1}^{5^N} i\right) = \log_{23}(5^N!)$ or $\frac{\ln(5^N!)}{\ln 23}$

3. **Combinatorics, 10 points** 2 parts, 5 points per part. 3 points for correct answer, 2 points for work/explanation.

   (a) There are 7 digits greater than or equal to 3. Now for each of the 6 decimal positions we have 7 digits to choose from. Therefore,
   $$7\cdot 7\cdot 7\cdot 7\cdot 7\cdot 7 = 7^6 = 117649$$

   (b) There are 52 different numbers between 17 and 68 (both inclusive). Therefore,
   $$\binom{52}{9} = 3679075400$$