Answers are given in exact form when the exact form is fairly simple, and otherwise are given to 4 decimal places.

1. (a) 0.1 (b) 0.7 (c) 0.3 (d) 0.2 (e) 0.2,0.5,0.3 for $X = 1, 3, 4$ (f) 0.3,0.4,0.3 for $Y = 3, 4, 5$ (g) 0.8 (h) 0.7 (i) 2.9 and 4.0 (j) 10.9 (k) 1.09 and 1.0440 (l) 0.6 and 0.7746 (m) No (n) 0.4 and 0.4946

2. (a) 13/24 (b) 11/216 and 0 (c) 3/8 and 5/8 (d) 0 for $x < 0$, $(12x^2 - x^3)/216$ for $0 \le x \le 6$, 1 for $x > 6$ (e) 7/2 and 19 (f) 43/20 and 1.4663

3. (a) 1/27 (b) 2/27 (c) 16/27 (d) 28/81 (e) 16/81 (f) 0 (g) $(2x + 6)/27$ for $0 \le x \le 3$ (h) $(2y + 1)/6$ for $0 \le y \le 2$ (i) 5/3 and 11/9 (j) 7/2 and 16/9 (k) 2 (l) 13/18 and 0.8498 (m) 23/81 and 0.5329 (n) No (o) $-1/27$ and -0.0818

4. (a) -1 (b) 7 (c) 24 (d) 9 and 3 (e) 4 and 2 (f) 1 (g) 1/6 (h) 15

5. (a) $P(N_{0,1} < 2) = 0.9772$. (b) $P(-1 \le N_{0,1} \le 1) = 0.8413 - 0.1587 = 0.6826$. (c) $P(N_{0,1} > 1.5) = 1 - 0.9332 = 0.0668$. (d) $E(2X + 5) = 2\mu + 5 = 25$ (e) $\sigma(2X + 5) = 2\sigma = 4$.

6. (a) Distribution is binomial, $n = 1800$ and $p = 2/3$, so $P(Y = 1200) = \binom{1800}{1200} \cdot (\frac{2}{3})^{1200} \cdot (\frac{1}{3})^{600}$ and $P(1200 \le Y \le 1250) = \binom{1800}{1200} \cdot (\frac{2}{3})^{1200} \cdot (\frac{1}{3})^{600} + \binom{1800}{1202} \cdot (\frac{2}{3})^{1202} \cdot (\frac{1}{3})^{598} + \cdots + \binom{1800}{1250} \cdot (\frac{2}{3})^{1250} \cdot (\frac{1}{3})^{550}$.
(b) $E(Y) = np = 1200$ and $\sigma(Y) = \sqrt{np(1-p)} = 20$.
(c) Approximate by a normal distribution N with $\mu = 1200$ and $\sigma = 20$. With continuity correction, get $P(1199.5 \le N_{1200,20} \le 1250.5) = P(-0.025 \le N_{0,1} \le 2.525) \approx 0.5042$.

7. (a) Distribution is binomial, $n = 10$ and $p = 0.4$, so $P(\# \ge 2) = 1 - \binom{10}{0}0.6^{10} - \binom{10}{1}0.4^1 0.6^9 \approx 0.9476$.
(b) Distribution is binomial, $n = 100$ and $p = 0.8$, so $E(\text{pts}) = np = 80$ and $\sigma(\text{pts}) = \sqrt{np(1-p)} = 4$.
(c) Exp values, variances add for independent variables. Then $E(2\text{pt}) = 0.4 \cdot 2 = 0.8$, $E(3\text{pt}) = 0.2 \cdot 3 = 0.6$, $\text{var}(2\text{pt}) = 2^2 \cdot 0.4 \cdot 0.6 = 0.96$, $\text{var}(3\text{pt}) = 3^2 \cdot 0.2 \cdot 0.8 = 1.44$. So $E(\text{sum}) = 1.4$, $\text{var}(\text{sum}) = 2.4$, so $\sigma(\text{sum}) = \sqrt{2.4}$.
(d) Distribution will be approximately normal by central limit theorem. Mean is $1000 \cdot 0.8 + 2000 \cdot 0.8 + 500 \cdot 0.6 = 2700$ points, variance is $1000 \cdot 0.8 \cdot 0.2 + 2^2 \cdot 2000 \cdot 0.4 \cdot 0.6 + 3^2 \cdot 500 \cdot 0.2 \cdot 0.8 = 2800$ so $\sigma = \sqrt{2800} \approx 52.92$ points.

8. (a) Average A is normal with mean $\mu_A = 10.05$g and $\sigma_A = 0.10/\sqrt{10} = 0.0316$g
Average B is normal with mean $\mu_B = 10.05g$ and $\sigma_B = 0.10/\sqrt{25} = 0.02$g.
(b) 0.1586 (c) $1 - 0.8414^{10} = 0.8223$ (d) 100.5g and 0.3162g (e) 0.0569 (f) 0.00078
(g) Difference is normal with mean $\mu_{A-B} = \mu_A - \mu_B = 0$ and $\sigma_{A-B} = \sqrt{\sigma_A^2 + \sigma_B^2} = 0.0374$g (h) 0.0907

9. (a) 2/7 (b) 3.5min and 2.0207min (c) Approximately normal by central limit theorem with $\mu = 3.5$min and $\sigma = 0.2333$min (d) 0.3821 (e) 0.0196 using the normal approximation to the binomial (exact is 0.0120)

10. (a) Distribution is Poisson (it is counting rarely-occurring events) with parameter $\lambda = 3$, $p_X(n) = e^{-\lambda}\lambda^n/n!$
(b) $e^{-3} \approx 0.0498$ (c) 0.1847 (d) This is Poisson with average $\lambda = 3/7$ so prob. is $1 - e^{-3/7} \approx 0.3486$
(e) Poisson with average $\lambda = 90/7$ so prob. is $e^{-90/7}(90/7)^{15}/15! \approx 0.0865$

11. (a) Distribution is exponential (it is a memoryless wait time) with $\lambda = 1/30$, so $p_Y(y) = \lambda e^{-\lambda y}$ for $y \ge 0$
(b) $e^{-1} \approx 0.3689$ (c) $1 - e^{-1/3} \approx 0.2835$

12. (a) $0.98^{130} + \binom{130}{1}0.02^1 0.98^{129} = 0.2643$
(b) Parameter is the average number who like the course, which is $130 \cdot 2\% = 2.6$. The resulting probability estimate is $P(X = 0) + P(X = 1) = e^{-2.6} + 2.6e^{-2.6} \approx 0.2674$.
(c) Parameters are the mean and standard deviation, which are $np = 2.6$ and $\sqrt{np(1-p)} = 1.5962$. The continuity-corrected probability estimate is $P(-0.5 \le N \le 1.5) \approx 0.2193$.
(d) The Poisson is better since the normal approximation to the binomial is not especially good for np small. On the other hand, this is precisely the situation where the Poisson distribution is a good approximation.