#1

a) A_i = polymeric nanoparticle obtained on i-th selection

$$P(A_2^c) = P(A_1^c)\,P(A_2^c \mid A_1^c) + P(A_1)\,P(A_2^c \mid A_1)$$

$$= \left[\frac{20}{100}\right]\left[\frac{19}{99}\right] + \left[\frac{80}{100}\right]\left[\frac{20}{99}\right]$$

$$\boxed{P(A_2^c) = 0.2}$$

b) If the 1st NP is metal, the probability that second & third are metal:

P = P (2nd & 3rd are metal | first is metal)

$$= \left[\frac{19}{99}\right]\left[\frac{18}{98}\right]$$

$$\boxed{P \approx 0.035}$$

c)

P = P (2nd & 3rd are metal, if replaceable)

$$= \left[\frac{20}{100}\right]^2$$

$$\boxed{P \approx 0.04}$$

Q2

Assume there are n hard drives.
0 fail:
$P1 = {}^{30}C_{30} * {}^{n}C_{0} * (0.999)^{30}$

1 fail in one day:
$P2 = {}^{30}C_{1} * {}^{n}C_{1} * (0.001) * (0.999)^{29}$

2 fail in one day:
$P3 = {}^{30}C_{1} * {}^{n}C_{2} * (0.001)^{2} * (0.999)^{29}$

2 fail in two days:
$P4 = {}^{30}C_{2} * {}^{n}C_{2} * (0.001)^{2} * (0.999)^{28}$

Data-loss probability = 1 – (P1+P2+P3+P4)

Q3

(1) Consider these two groups are indistinguishable:
Combinations of (6 boys + 4 girls, 6 boys + 4 girls):
$a = [({}^{12}C_{6} * {}^{6}C_{6})/2!] * [({}^{8}C_{4} * {}^{8}C_{4})/2!] * 2!$

Combinations of (5 boys + 5 girls, 7 boys + 3 girls):
$b = [({}^{12}C_{5} * {}^{7}C_{7})] * [({}^{8}C_{5} * {}^{3}C_{3})]$

All combinations:
$c = [{}^{20}C_{10} * {}^{10}C_{10}]/2!$

Probability that at least one of the groups have more girls than boys = 1 – (a/c + b/c) = ~0.170

(2) Consider these two groups are distinguishable:
Combinations of (6 boys + 4 girls, 6 boys + 4 girls):
$a = [({}^{12}C_{6} * {}^{6}C_{6})/2!] * [({}^{8}C_{4} * {}^{8}C_{4})/2!] * 2! * 2!$

Combinations of (5 boys + 5 girls, 7 boys + 3 girls):
$b = [({}^{12}C_{5} * {}^{7}C_{7})] * [({}^{8}C_{5} * {}^{3}C_{3})] * 2!$

All combinations:
$c = [{}^{20}C_{10} * {}^{10}C_{10}]$

Probability that at least one of the groups have more girls than boys = 1 – (a/c + b/c) = ~0.170