Short Problems:

1. We breed flies for increased heat tolerance. To quantify this, we put the flies in a "prostratometer" and slowly heat them until they can no longer cling to the sides of the bottle: call this the drop-off temperature T.
   (a) We start with flies with mean T=38 degrees. We select a subgroup with mean T=42 degrees to breed. The offspring of this subgroup have T=41 degrees. What is the heritability of T in this population under these circumstances? (Assume that T is appropriately measured in degrees; in practice this is probably the wrong scale.)
   (b) After 100 generations, we have flies with T=45, but improvement has stopped. Give two possible hypotheses for the failure of continued selection to produce a continued response.
   (c) Suggest an experiment which could distinguish between your hypotheses, and explain what you would expect if each were true.
   (d) For each of your hypotheses, what, if anything, would you recommend we try to restore response to selection and allow a higher T to be reached?
2. Consider a locus with complete dominance (the heterozygote is identical in phenotype to the dominant homozygote, while the recessive homozygote is different). Does such a locus contribute anything to V_A or is its whole contribution in V_D? Explain or give an example.
3. In Japan, heritability of male height is high, as in most human populations: tall fathers have tall sons on average.
   (a) When Japanese people settled in the US, there was a period where this heritability was much lower, even among families with no non-Japanese ancestry. Propose an explanation.
   (b) In general, would adding a proportion of intermarriage with Europeans be likely to increase or decrease the heritability of this trait? (If this question cannot be answered, explain why.)
4. The "Wilson Effect" is the observation that the heritability of IQ is low in children and increases until around age 18-20, after which it stabilises. (IQ here is defined as "the thing that IQ tests measure.") In other words, if we use your age-20 IQ to predict your child's age-20 IQ we will be more accurate than if we use your age-8 IQ to predict your child's age-8 IQ. Suggest an explanation for this.

Long Problem:

Consider an overdominant locus with the following fitnesses:

Genotype	Fitness
AA	0.9
Aa	1.0
aa	0.7

When the heterozygote is more fit than either homozygote, a (sufficiently large) random-mating population will move to the overdominant equilibrium for any starting value of pA except 0 or 1. A totally inbreeding population (f=1) has no equilibrium, because heterozygote advantage is useless when there are no heterozygotes. What about partial inbreeding?

Write a small program which calculates the change in allele frequencies each generation, for 1000 generations or so, as a function of starting pA, wAA, waa, and f. (If you do not wish to program, this can be done analytically by solving for zeros of the formula for change in allele frequency; I think the program is much easier....)

Consider the case of $wAA = 0.8$, $wAa = 1.0$, $waa = 0.9$.

1. Please attach the program to your homework or show your analytical calculation.

2. What is the theoretical equilibrium without inbreeding? (Test to see if your program actually finds it!)
3. We'll consider a pA value to be an equilibrium if the population reaches it whether starting above or below it. Are there values of f where there is an equilibrium, but at a different point than before?
4. Are there values of f (other than 1) where there appears to be no equilibrium (the frequency goes very close to 0 or 1)?
5. In words, how do you understand these results?