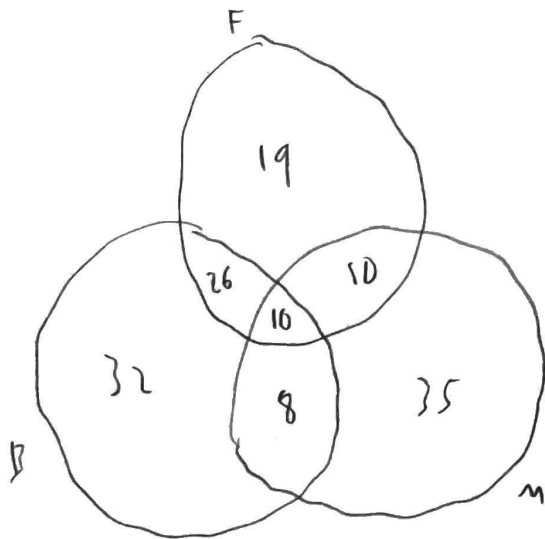


3.



61 at least any

1. 8
2. 93
3. 61

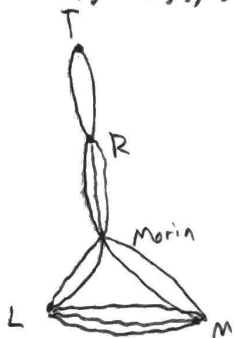
4d. P1. Total possible combination of answers: $5^3 = 125$
 If there are only 125 possible answer sheets, if there are over 125 students, it is guaranteed to have at least 2 identical sheets. $130 > 125$
 P2. We can attempt to avoid 5 consecutive numbers by using 4 consecutive and skipping the 5th.

55 numbers, 11 sets of 5

11 sets of 4 numbers = 44

Since you can only choose 44 numbers max and have no 5 be consecutive, choosing a 45th number is guaranteed to fill in a consecutive number gap and create a set of 5 consecutive numbers. Thus, if there are at least 45 houses, 5 of them will be numbered consecutively

5c.

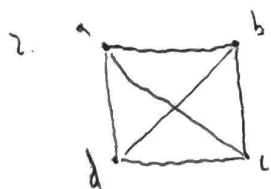
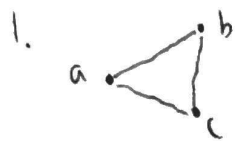


$$2 \cdot 3 \cdot (2 \cdot 3 + 2) = 48 \text{ routes}$$

Can take 48 routes to Morder and 47 routes back

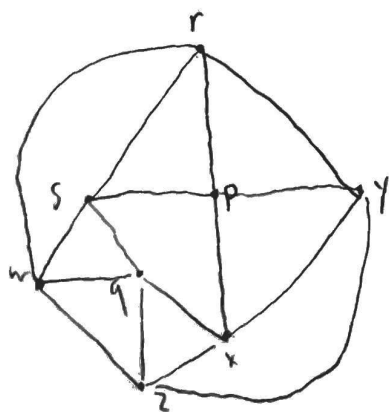
$$48 + 47 = \boxed{95 \text{ ways}}$$

6. Hamiltonian contains each vertex once, twice for Euler
 Euler visits each edge once



- 7a.
1. True
 2. False
 3. False
 4. True

8b.



9. 8

10. Since every cycle must have at least 3 edges, each face is bounded by at least 3 edges.
Each edge belongs to at most 2 cycles, so $2e \geq 3f$

$$2e \geq 3(e - v + 2)$$

$$2e \geq 3e - 3v + 6$$

$$3v \geq e + 6$$

$$3(12) \geq 31 + 6$$

$$36 \geq 37, \text{ not true}$$

cannot be planar