1. a) $\phi = \{x/A, y/A, z/B\}$

b) One doesn't exist as
y must be $G(A,B)$
but then y cannot be $G(x,x)$

c) $\phi = \{x/B, y/A\}$

d) $\phi = \{y/John, x/John\}$

e) One doesn't exist
otherwise x would have to
be Father(y) and y 7.

2. a)

1. $\forall x \; Food(x) \Rightarrow Likes(John, x)$
2. $Food(Apples)$
3. $Food(Chicken)$
4. $\forall x \; (\exists y \; Eats(y,x) \wedge \neg(Killed(x,y)))$
$\Rightarrow Food(x)$
5. $\forall x \; (\exists y \; Killed(y,x))$
$\Rightarrow \neg(Alive(x))$
6. $Eats(Bill, Peanuts) \wedge Alive(Bill)$
7. $\forall x \; Eats(Bill, x) \Rightarrow Eats(Alice, x)$

b)

1. $\neg Food(x) \vee Likes(John, x)$
2. $Food(Apples)$
3. $Food(Chicken)$
4. $\neg Eats(F(x), x) \vee Killed(x, F(x))$
$\vee Food(x)$
5. $\neg Killed(G(x), x) \vee \neg Alive(x)$
6. a) $Eats(Bill, Peanuts)$
b) $Alive(Bill)$
7. $\neg Eats(Bill, x) \vee Eats(Sue, x)$

c) Resolving 6a with 4 we get
after unifying Bill with $F(x)$
and Peanuts with x

8. $Killed(Peanuts, Bill)$
$\vee Food(Peanuts)$

Resolving 6b) with 5, we get
after unification of x with Bill
we get 9. $\neg Killed(G(Bill), Bill)$

Resolving 9 with 8 and
unifying Peanuts with $G(Bill)$
we get 10. $Food(Peanuts)$

Finally resolving 10 with 1 and
unifying x with Peanuts we get
11. $Likes(John, Peanuts)$

which proves that John likes peanuts

d) Resolving 7 with 6a
unifying x with Peanuts
we get 12 $Eats(Sue, Peanuts)$

This is the only clause that relates
alice to a food she eats that can
be derived from this KB
$\therefore$ Ans. Peanuts

e) With any of the other statements we cannot infer anything that Sue eats.
(If we make the closed world assumption i.e. everything not in Knowledge Base is false this means Sue eats nothing)

3

1. No
2. Yes
3. This tells us that the given graph needs at least 4 colors for a valid coloring.

i.e. it is 4-colorable but not 3-colorable

RSAT returns a satisfying assignment for the satisfiable instance, this assignment can be parsed into a coloring

assignment: -1 -2 -3 4

-5 -6 7 -8

-9 10 -11 -12

-13 -14 15 -16

17 -18 -19 -20

-21 22 -23 -24

25 -26 -27 -28

which translates to the following colouring

Node 1 - 4
Node 2 - 3
Node 3 - 2
Node 4 - 3
Node 5 - 1
Node 6 - 2
Node 7 - 1

4. 8 colors are needed at minimum to color graph 2