Homework #3: Chapters 7 and 8

1.

S	F	S ⇒ S	S ⇒ F	(S ⇒ F) ⇒ (¬S ⇒ ¬F)	S ∨ F ∨ ¬F
T	T	T	T	T T T	T
T	F	T	F	F T T	T
F	T	T	T	T F F	T
F	F	T	T	T T T	T
		Valid	Satis.	Satisfiable	Valid

B	D	B ∨ D ∨ (B ⇒ D)
T	T	T T T
T	F	T T F
F	T	T T T
F	F	F T T
		Valid

2.

a)

			Sentences in the KB *(bold rows are where KB is true)*			Grey elements are models where KB is false		
P	Q	R	Q ⇒ P	P ⇒ ¬Q	Q ∨ R	¬Q	P ⇒ R	P ∨ Q
T	T	T	T	F	T			
T	T	F	T	F	T			
T	F	T	**T**	**T**	**T**	T	T	T
T	F	F	T	T	F			
F	T	T	F	T	T			
F	T	F	F	T	T			
F	F	T	**T**	**T**	**T**	T	T	F
F	F	F	T	T	F			

b) Yes, KB $\models \neg Q$. In both models in which the KB is true (indicated in the table), $\neg Q$ is also true.

c) Yes, the KB does entail $P \Rightarrow R$. In both models in which the KB is true (indicated in the table), $P \Rightarrow R$ is also true.

d) No, the KB does not entail $P \vee Q$. The KB is true in the model (P=F,Q=F,R=T), but $P \vee Q$ is not.

3.

a) Some students took French in Spring 2001.
$\exists x\ Student(x) \wedge TakesCourse(x,F,S)$

b) Every student who takes French passes it.
$\forall x,y\ \ Student(x) \wedge TakesCourse(x,F,y)\ \Rightarrow Passes(x,F)$

c) Only one student took Greek in Spring 2001.
$\exists x\ Student(x) \wedge TakesCourse(x,G,S) \wedge \neg\exists y\ (\ TakesCourse(y,G,S) \wedge x\neq y\ )$

d) The best score in Greek is always higher than the best score in French.
$\forall s1,s2\ (\ BestScore(s1,G) \wedge BestScore(s2,F)\ ) \Rightarrow GreaterThan(s1,s2)$

e) Every person who buys a policy is smart.
$\forall x,y\ (\ Person(x) \wedge Policy(y) \wedge Buys(x,y)\ ) \Rightarrow Smart(x)$

f) No person buys an expensive policy.
$\forall x,y\ (\ Person(x) \wedge Policy(y) \wedge Expensive(y)\ ) \Rightarrow \neg Buys(x,y)$

g) There is an agent who sells policies only to people who are not insured.
$\exists x\ Agent(x) \wedge (\forall y,z\ Policy(y) \wedge Person(z) \wedge Sells(x,y,z) \Rightarrow \neg Insured(z))$

or

$\exists x\ Agent(x) \wedge (\forall y,z\ Policy(y) \wedge Sells(x,y,z) \Rightarrow Person(z) \wedge \neg Insured(z))$

h) There is a barber who shaves all men in town who do not shave themselves.
$\exists x\ Barber(x) \wedge (\forall y\ LocalMan(y) \wedge \neg Shaves(y,y)\ ) \Rightarrow Shaves(x,y))$

i) A person born in the UK, each of whose parents is a UK citizen or a UK resident, is a UK citizen by birth.
$\forall x \exists y,z\ (\ Person(x) \wedge BornIn(x,UK) \wedge Parent(x,y) \wedge Parent(x,z) \wedge \mathrm{y}\neq\mathrm{z} \wedge$
$(CitizenOf(y,UK) \vee ResidentOf(y,UK)) \wedge$
$(CitizenOf(z,UK) \vee ResidentOf(z,UK))\ ) \Rightarrow CitizenByBirth(x,UK)$

or

$\forall x\ Person(x) \wedge BornIn(x,UK) \wedge (\forall y\ Parent(x,y) \Rightarrow (CitizenOf(y,UK) \vee$
$ResidentOf(y,UK))) \Rightarrow CitizenByBirth(x,UK)$

j) A person born outside the UK, one of whose parents is a UK citizen by birth, is a UK citizen by descent.
$\forall x\ Person(x) \wedge \neg BornIn(x,UK) \wedge (\exists y\ Parent(x,y) \wedge CitizenByBirth(y,UK)\ ) \Rightarrow$
$CitizenByDescent(x,UK)$

4. *[10 pts.]* Do exercise 8.16 from the book (p. 270). Your axiom should be consistent with those defined on pages 258-260. You may also use any predicates already defined for the Wumpus world.

   Wumpus is a constant symbol, and *In(Wumpus, Location)* is a binary predicate. Axioms required for reasoning about the wumpus's location:

   $\forall s,t\ At(Agent,s,t) \wedge Stench(t) \Rightarrow Smelly(s)$

   $\forall s\ Smelly(s) \Leftrightarrow (\exists r\ Adjacent(r,s) \wedge In(Wumpus,r))$

   $\exists r\ In(Wumpus,r) \wedge (\forall s\ r \neq s \Rightarrow \neg In(Wumpus,s))$