1. (30 pts.) 1 pt per node (10) and link (14), only -2 if missing nodes/arc for Ontology triple
2. **(10 pts.)** -4 if one of two answers completely wrong. -1 for intersect w/ person, -1 for wrong syntax for owl:Nothing

```
<owlClass rdf:about="#Man" />
  <rdfs:subClassOf>
    <owl:Class>
      <owl:complementOf rdf:resource="#Woman" />
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>

<owlClass rdf:about="http://www.w3.org/2002/07/owl#Nothing" />
  <owl:intersectionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#Man" />
    <owl:Class rdf:about="#Woman" />
  </owl:intersectionOf>
</owl:Class>
```

3. **(10 pts.)** We assume the default namespace is scipub.rdf and that the standard xsd entity has been defined. -2 if answer implies that all instances have both properties

```
<owl:Class>
  <owl:intersectionOf rdf:parseType="Collection">
    <owl:Class rdf:about="PublishedWork" />
    <owl:Restriction>
      <owl:onProperty rdf:resource="publishedLoc" />
      <owl:minCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:minCardinality>
    </owl:Restriction>
  </owl:intersectionOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="publishedBy" />
      <owl:minCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:minCardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>
```

Also acceptable is a solution where PublishedWork is equivalent to the complement of at least one publishedLoc unioned with at least one publishedBy.

4. **(15 pts.)** All of these require a property chain axiom. -2 if order of props reversed, -7 if no property chains in solution, -1 for syntax error

```
:venue owl:propertyChainAxiom (:partOfEvent :confName) .
:confLocation owl:propertyChainAxiom (:partOfEvent :location) .
:publishedYear owl:propertyChainAxiom (:partOfEvent :year) .
```
5. (20 pts. total, 5pts. each)

a) Note using owl:equivalentClass with owl:unionOf is redundant → -1

```
: A owl:unionOf ( : B
  [ owl:intersectionOf (: C : D) ]
). 
```

b) 

```
: A rdfs:subClassOf [ 
  a owl:Restriction ; 
  owl:onProperty [owl:inverseOf : P] ; 
  owl:someValuesFrom : C
].
```

c) Note, we need to use owl:oneOf (:a) to represent the \{a\}, -2 for hasValue

```
[ owl:complementOf : A ]
  rdfs:subClassOf 
  [ owl:intersectionOf 
    ( : B
      [ a owl:Restriction ; 
        owl:onProperty : P ; 
        owl:allValuesFrom 
          [ owl:oneOf ( : a ) ]
      ]
    )
  ].
```

d) 

```
[ a owl:Restriction ; 
  owl:onProperty : P ; 
  owl:someValuesFrom [ 
    owl:unionOf ( : B : C )
  ]
]
  owl:equivalentClass 
  [ 
    a owl:Restriction ; 
    owl:onProperty : R ; 
    owl:maxCardinality 2
  ].
```
6. **(15 pts., 5 pts. each)** This problem can be solved by using the semantic conditions and the interpretations to construct interpretations of class expressions.

a) $I_3$

$I_1: \{b\} \not\subset \emptyset$

$I_2: \{b,d\} \not\subset \{a,b\}$

$I_3: \{a,b\} \subseteq \{a,b,c,d\}$

b) $I_1$ and $I_3$

-2 for just $I_1$ due to misunderstanding of $\forall$ semantics

<table>
<thead>
<tr>
<th></th>
<th>$(A)^I$</th>
<th>$(B)^I$</th>
<th>$(\forall P.C)^I$</th>
<th>$(B \cap \forall P.C)^I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>${}$</td>
<td>${a,b}$</td>
<td>${a,b,c,d}$</td>
<td>${a,b}$</td>
</tr>
<tr>
<td>$I_2$</td>
<td>${a}$</td>
<td>${a}$</td>
<td>${b,c,d}$</td>
<td>$\emptyset$</td>
</tr>
<tr>
<td>$I_3$</td>
<td>${b,c}$</td>
<td>${b,c,d}$</td>
<td>${a,b,c,d}$</td>
<td>${b,c,d}$</td>
</tr>
</tbody>
</table>

Note, remember that $\forall P.C$ is trivially satisfied for any instance $x$ that does not have any values for $p$

c) $I_1$ and $I_2$

<table>
<thead>
<tr>
<th></th>
<th>$(D)^I$</th>
<th>$(A)^I$</th>
<th>$(\exists P.C)^I$</th>
<th>$(A \cup \exists P.C)^I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>${}$</td>
<td>${}$</td>
<td>${}$</td>
<td>${}$</td>
</tr>
<tr>
<td>$I_2$</td>
<td>${a,b}$</td>
<td>${a}$</td>
<td>${a,b}$</td>
<td>${a,b}$</td>
</tr>
<tr>
<td>$I_3$</td>
<td>${a,b,c,d}$</td>
<td>${b,c}$</td>
<td>${b,d}$</td>
<td>${b,c,d}$</td>
</tr>
</tbody>
</table>