Question 1

(a)

#VRML V2.0 utf8

(b)

# Everything after a hash character is a comment ...

Question 2

(a)
A long red cylinder is displayed. The axis of the cylinder is along vertical on the screen.

(b)
The Appearance defines the visual appearance of a VRML shape. The Material node defines surface characteristics including the transparency and lighting parameters. The Cylinder node defines the geometry of Cylinder, in terms of height and radius. The Shape node combines the Appearance and Cylinder nodes into a visible VRML shape.

(c)

Shape {
    appearance Appearance
    {
        material Material
        {
            diffuseColor 0.0 1.0 0.0
        }
    }
    geometry Sphere
    {
        radius 3.0
    }
}
Question 3

(a)
VRML files can be compressed with the gzip compression tool.
VRML supports the use of DEF, USE and PROTO in order to re-use frequently occurring nodes in the scene. This has the benefit of reducing the overall length of the VRML file.
VRML polygon-based shapes are represented as Indexed Face Sets. In this format each vertex is listed once, and faces using the vertex refer to it by a compact integer index, rather than it's 3D position.
VRML shapes such as Sphere, Cone and Cylinder are far more compact than a polygon-based description.

(b)
Indexed Face Sets can utilise the SOLID flag to reduce the number of faces drawn for each frame. This relies on the faces having consistent face-winding.
Collision detection is limited to collision between the user avatar and objects in the world. Collisions between other objects in the world are not detected.
The LOD (Level of Detail) node allows several representations of an object to be used according to the distance of the object from the viewer. Shapes far away need not be drawn in full detail.
The detail and realism of VRML worlds can be enhanced by the use of features such as background, texture and fog which are efficiently implemented in graphics hardware.
The Billboard node can be used to replace a distant complicated shape with a flat representation that always faces the viewer.
Question 4

(a)

Transform
{
    scale 0.5
}

(b)

Transform
{
    translation 2 0 0
}

(c)

Transform
{
    rotation 0 0 1 -1.571
}

(d)

Transform
{
    rotation 0 0 1 0.785
    translation 6 6 0
}

or

Transform
{
    rotation 0 0 1 -0.785
    translation 6 6 0
}
Question 5

(a)
A translation applied to the SUN node would affect the position of the sun, earth and moon. The whole solar system would move together.

(b)
With a rotation applied to the earth node, only earth-relative objects will rotate. In this case the earth and moon shapes, but not the sun.

(c)

PROTO Planet
[
  field SFFloat  rad  1.0
  field SFColor  col  1.0 1.0 1.0
]

{ Shape

  { appearance Appearance
    { material Material
      { diffuseColor USE col
      }
    }

    geometry Sphere
    { radius USE rad
    }
  }
}

(d)

DEF SUN Transform
{
  children

  [ Planet { rad 10.0 col 1.0 1.0 0.0 }]

  DEF EARTH Transform
  {
    children Planet { col 0.0 0.0 1.0 }
  }

  DEF MARS Transform
  {
    children Planet { col 0.5 0.5 0.5 }
  }
}

4
OrientationInterpolator
{
  key [ 0.000 0.333 0.666 1.000 ]
  keyValue [
    0 1 0 0.00  # 0/3 Pi
    0 1 0 2.09   # 2/3 Pi
    0 1 0 4.19   # 4/3 Pi
    0 1 0 6.28   # 6/3 Pi
  ]
}

Question 6

(a)
The three kinds of VRML light sources are point, directional and spot lights.
Point light sources emit light from a 3D position in all directions.
Directional light sources emit light in a direction from no particular position.
Spot light sources emit light in a cone shaped volume.

(b)
The VRML Material node defines surface lighting properties.
Transparency is the proportion of light transmitted through the surface.
Ambient light is the amount of background radiation in the world, reflected from other surfaces in the scene.
Emissive light is light emitted by the material, independent of light sources.
Diffuse light is reflected at the surface of an object in all directions.
Specular light is reflected directly from the light-source to the viewer, resulting in a bright spot on the object surface.

Question 7

(a)

IndexedLineSet
{
  coord Coordinate
  {
    point
    [
      -6 2 0,
      6 0 0,
      3 -2 0,
      -6 -2 0
    ]
  }
  coordIndex [ 0, 1, 2, 3, 4, 5, 6, 0 ]
}
IndexedFaceSet
{
  coord Coordinate
  {
    point 
    [ 
      -6 2 0,
      3 2 0,
      3 4 0,
      6 0 0,
      3 -4 0,
      3 -2 0,
      -6 -2 0
    ]
  }
  coordIndex [ 0, 1, 2, 3, 4, 5, 6 ]

  solid FALSE
  convex FALSE
}

(c)
The face in the indexed face set is not convex. Two of the interior angles of the polygon are greater than 180 degrees. It is possible to form a line between two points inside the arrow that passes outside of the face.

(d)
The solid field of the face set should be FALSE. Otherwise, the face will not be drawn when it is facing away from the viewer. There is no back-face for the arrow shape and culling of back-facing faces should be disabled.

**Question 8**

(a)
GIF, PNG, JPEG, MPEG.

(b)
PNG uses lossless compression, and supports transparency.
JPEG supports lossy compression.
MPEG supports animation. (movies)

(c)
By default VRML maps texture to the surface of shapes automatically. Texture coordinates allow complete control of the way texture is mapped. Texture coordinates are in an s, t coordinate system which can be transformed by means of 2D texture transformations.
Question 9

(a) WAV, MIDI.

(b) WAV is useful for digitised waveforms such as speech and sound effects. MIDI is a representation for musical compositions. MIDI files do not include digital waveforms, and are therefore compact.

(c) The AudioClip node defines the filename or url of an audio clip. It also includes control of looping and pitch.

The Sound node defines a sound emitter positioned in the 3D scene. Fields are included for controlling the intensity, direction and range. An AudioClip can be used for the source field of a Sound node.

THE END