1. (a) stream paradigm message paradigm

<table>
<thead>
<tr>
<th>Connection-Oriented</th>
<th>Connectionless</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-to-one Communication</td>
<td>Many-to-many Communication</td>
</tr>
<tr>
<td>Sequence of Individual Bytes</td>
<td>Sequence of Individual Messages</td>
</tr>
<tr>
<td>Arbitrary Length Transfer</td>
<td>Each Message Limited to 64 Kbytes</td>
</tr>
<tr>
<td>Used by Most Applications</td>
<td>Used Mainly for Multimedia Applications</td>
</tr>
<tr>
<td>Built on TCP Protocol</td>
<td>Built on UDP Protocol</td>
</tr>
</tbody>
</table>

(b) (i) \((\text{name} \mid \text{EMPTY})\) and (ii) \((\text{name}, \text{name*})\)

(c) Unicode and UTF-8. Such characters can be included by using character entity references which refer to the numeric value of the character in the Unicode encoding. The syntax is \(\&\text{#value};\) or \(\&\#xvalue;\), where value is the numeric value in decimal or hexadecimal, respectively.

2. (a) Base64 encoding is used to encode 8-bit binary data as ASCII characters.

(b) Form input data is sent to the server as \(\text{name}=\text{value}\) pairs, where \(\text{name}\) is the value of the name attribute of a form input control, and \(\text{value}\) is the value of the corresponding value attribute or is entered by the user. The \(\text{name}=\text{value}\) pairs are separated by & characters. For GET, the \(\text{name}=\text{value}\) pairs form the URI query string, while for POST, the \(\text{name}=\text{value}\) pairs form the message body. With CGI, the data is made available through environment variables such as \QUERY\_STRING\, while in PHP built-in associative arrays such as \$_GET\ are used.

(c) TCP implements a congestion control algorithm based on the perceived congestion by the sender: if it perceives little congestion, it increases its send rate; if it perceives there is congestion, it reduces its send rate.

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(d) DHCP enables a computer to obtain an IP address automatically when it connects to a network. DHCP also allows a host to learn additional information, such as its subnet mask, the address of its first-hop router (often called the default gateway), and its local DNS server. The four steps are: the client sends a discover message to find a server. A server sends an offer message with an IP address. The client sends a request message with the IP address. The server replies with an ACK.

(6 marks)

3. (a) The Address Resolution Protocol (ARP) translates between addresses on LANs, which are MAC addresses, to addresses at the network layer, which are, e.g., IP addresses. ARP takes an IP address on the same LAN and returns the corresponding MAC address.

Each node (host or router) has an ARP table in memory, containing mappings between IP addresses and MAC addresses. If an IP address is not in the table, it sends an ARP query packet to the broadcast MAC address FF-FF-FF-FF-FF-FF. The packet contains the desired IP address and the MAC address of the sender. The one node with the matching IP address sends a response ARP packet with its MAC address.

(8 marks)

(b) <xsl:template match="recipes">
    <h1>Recipes with chocolate</h1>
    <xsl:for-each select="recipe[ingredient[description='chocolate']]">
        <h2><xsl:value-of select="name"/></h2>
        <table>
            <xsl:for-each select="ingredient">
                <tr>
                    <td><xsl:value-of select="quantity"/></td>
                    <td><xsl:value-of select="description"/></td>
                </tr>
            </xsl:for-each>
        </table>
        <p><xsl:value-of select="method"/></p>
    </xsl:for-each>
</xsl:template>

(12 marks)
4. (a) i. `<!ELEMENT results (event)* >`  
`<!ELEMENT event (name, athlete+) >`  
`<!ELEMENT athlete (name, country, position? ) >`  
`<!ELEMENT name (#PCDATA) >`  
`<!ELEMENT country (#PCDATA) >`  
`<!ELEMENT position (#PCDATA) >`  
`<!ATTLIST position medal (gold|silver|bronze) #IMPLIED >`  

(8 marks)

ii. `count(//athlete[country='Great Britain']/position[@medal='gold'])`  

(5 marks)

(b) The Maximum Transmission Unit (MTU) specifies the maximum amount of data that a frame can carry. Different networks may have different MTUs, so that a datagram arriving at a router may have to be fragmented before being forwarded. The fragments of a datagram are routed independently of one another but all have the same identification field so that IP can reassemble the original datagram.

(7 marks)

5. (a) Namespace definitions can be overridden by associating a different namespace with the same prefix or default within the scope of an existing definition, i.e, in one of the descendant elements of the element where the namespace was defined. Overriding namespaces makes it more difficult for a human reader to work out which namespaces elements belong to.

(7 marks)

(b) *Network Address Translation* (NAT) addresses the problem that every IP-capable device needs an IP address but these cannot all be allocated statically or contiguously for subnets. NAT uses the blocks of IP addresses reserved for private networks. A NAT router replaces the IP address and port number used by a local machine in outgoing datagrams by its own address and an arbitrary port number. The association between the port number and address of the local machine and the port number used by the NAT router is recorded in a table. This is also used to translate and correctly forward incoming datagrams.

Criticisms of NAT include: (1) port numbers should be used for addressing processes, not hosts, (2) routers are supposed to process packets only up to layer 3, (3) NAT violates end-to-end principle: hosts should be communicating directly, (4) IPv6 should be used to solve problem of shortage of addresses.

(13 marks)
6. (a) HTML is an SGML vocabulary where a DTD can specify that start and/or end
tags are optional, whereas XHTML is an XML vocabulary where every element
is required to have a start and end tag.

(b) One could send the requests via a server which is in the same domain as the
page containing the Javascript code. The requested URL could be sent to a PHP
script running on the server which simply retrieves the resource and passes it
back to the page.

(c) RAC parity arranges the bits of each dataword conceptually into rows and
columns, and then adds a parity bit for each row and column. For example,
a 12-bit word might be arranged into 3 rows and 4 columns as shown below,
where the parity bits for each row are in the last column and the parity bits for
each column are in the last row (assuming even parity).

| 1 0 1 1 | 1 |
| 0 0 1 0 | 1 |
| 1 0 1 0 | 0 |
| 0 0 1 1 | 0 |

Now assume that the bit shown below is flipped:

| 1 0 1 1 | 1 |
| 0 [1] 1 0 | 1 |
| 1 0 1 0 | 0 |
| 0 0 1 1 | 0 |

RAC parity determines the row and column of the flipped bit by seeing where
the parity is odd rather than even. RAC parity cannot correct all two-bit errors.
If the errors occur in the same row or same column, the parity of that row or
column will be unchanged.

7. (a) Using an internal DTD requires the same DTD to be included in each document
of the given type. If the DTD needs to be modified, every copy would need to
be updated. An external DTD allows there to be only one copy of the DTD,
making for smaller documents and updates that are less likely to be inconsistent.

(b) The element to be deleted would have to be identified, perhaps by using the
getElementById method if the element had an id attribute. Then the removeChild
method could be invoked on the parent of the identified element, with a reference
to the element passed as an argument.
(c) The notation “/12” means that 12 bits are used for the network prefix and therefore 20 bits are used for the host suffix. Since only 4 bits of the second byte are used for host addresses, these range from 1000 (16) to 1111 (31). Hence the smallest and largest addresses are 172.16.0.0 and 172.31.255.255. Not all addresses can be allocated to individual machines because 172.16.0.0 is used to identify the network, while 172.31.255.255 is used for broadcast on the network. (8 marks)