P1. True or false?

a. A user requests a Web page that consists of some text and three images. For this page, the client will send one request message and receive four response messages.

b. Two distinct Web pages (for example, www.mit.edu/research .html and www.mit.edu/students.html) can be sent over the same persistent connection.

c. With nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.

d. The Date: header in the HTTP response message indicates when the object in the response was last modified.

e. HTTP response messages never have an empty message body.

a) False
b) True
c) False
d) False
e) False

P2. SMS, iMessage, Wechat, and WhatsApp are all smartphone real-time messaging systems. After doing some research on the Internet, for each of these systems write one paragraph about the protocols they use. Then write a paragraph explaining how they differ.

SMS (Short Message Service) is commonly known as a Text message. It uses the SMPP protocol to send and receive messages. When the message is longer that 160 characters it is split up into chunks.
iMessage is only used for apple devices. Used to send photos, videos and etc. It is from the Push Button notification. Sets up a keep alive connection.
Wechat is a popular texting application that uses SYNC protocol which references Microsoft's ActiveSync Asynchronous communication.
WhatsApp is a popular texting application that uses XMPP protocol which has XML as its language.
The difference between these systems is that SMS is not encrypted and then the others are encrypted. SMS can only be used to send text and images, while the others can be used to send videos and more. SMS, Wechat and WhatsApp can be on any devices whereas iMessage is only for apple devices.

P3. Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application-layer protocols besides HTTP are needed in this scenario?

Transport layer protocols: TCP for HTTP, UDP for DNS;
Application layer protocols: DNS, HTTP

P9. Consider Figure 2.12, for which there is an institutional network connected to the Internet. Suppose that the average object size is 1,000,000 bits and that the average request rate from the

institution's browsers to the origin servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three seconds on average (see Section 2.2.5). Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1 - \Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

a. Find the total average response time.

b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.

a) average time = 1000000 bits / 15000000 bps = 1/15 sec
traffic intensity = 16 requests/sec * 1/15 sec/request = 16/15
average access delay = 1/15 sec / (1 – 16/15) = -1 sec
average response time = 3 + (-1) = 2 sec
b) average access delay = 1/15 sec / (1 – 16/15 * 0.4) = 0.11627907 sec
average response time (for cache misses) = 0.11627907 sec + 3 sec = 3.11627907 sec
average response time = 0.6 * 0 + 0.4 * 3.11627907 = 1.24651163 sec

P10. Consider a short, 10-meter link, over which a sender can transmit at a rate of 150 bits/sec in both directions. Suppose that packets containing data are 100,000 bits long, and packets containing only control (e.g., ACK or handshaking) are 200 bits long. Assume that N parallel connections each get 1/N of the link bandwidth. Now consider the HTTP protocol, and suppose that each downloaded object is 100 Kbits long, and that the initial downloaded object contains 10 referenced objects from the same sender. Would parallel downloads via parallel instances of non-persistent HTTP make sense in this case? Now consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

Tp denote the one-way propagation delay between the client and the server.
Total time for all received objects:
(200/150+Tp + 200/150 +Tp + 200/150+Tp + 100000/150+Tp) + (200/(150/10)+Tp + 200/(150/10) +Tp + 200/(150/10)+Tp + 100000/(150/10)+ Tp) = 7377 + 8*Tp sec
Total time for persistent HTTP connection:
(200/150+Tp + 200/150 +Tp + 200/150+Tp + 100000/150+ Tp) + 10*(200/150+Tp + 100000/150+ Tp) =7351 + 24*Tp sec
Assume the speed of light is 300*106 m/sec, then Tp=10/(300*106)=0.03 microsec. Tp is negligible compared with transmission delay. Thus, no expect significant gains over the non-persistent case.