1. What is the wavelength of 345 Hz sound in air if the speed of sound is 345 m/s?
   A. 0.1 meters
   B. 0.345 meters
   C. 1.0 meter
   D. 3.45 meters
   E. sound is not characterized by wavelength

C

2. Why is it difficult to localize sound under water?
   A. sound doesn't travel under water
   B. sound is heavily attenuated (suppressed) underwater
   C. our ears can't hear sound underwater
   D. sound speed is fast in water, throwing off our "calculation"
   E. sound doesn't have a localized source under water

D

3. Mid-range sound is about 1 kHz. What is the wavelength of mid-range sound? (c = 345 m/s)
   A. 0.1 m
   B. 0.345 m
   C. 1.0 m
   D. 3.45 m

B

4. About how big would you expect a midrange (about 1000 Hz) speaker to be?
   A. There are no physical restrictions on its size
   B. Less than 0.345 m across
   C. Greater than 0.345 m across
   D. Depends how much you pay: $$$→bigger
   E. It's mostly a matter of aesthetics/design

B

5. How do you differentiate a piano from a violin if both are playing the same note?
   A. The main wavelength of the two is different
   B. The main frequency of the two is different
   C. The amplitude of the sound wave is different
   D. The two look different on an oscilloscope
   E. The high-frequency content is different for the two

E, but D true

1. What is the binary number 1001 in decimal?
   A. 5
   B. 9
   C. 15
   D. 21
   E. 1,001

B

2. Convert 13 into binary (4 bits is all you need):
   A. 1011
   B. 1100
   C. 1101
   D. 1110
   E. 1111

C

3. What is one plus one in binary?
   A. 1
   B. 2
   C. 10
   D. 11
   E. 20

C

4. Add 1011 and 0011 in binary form. What do you get?
   A. 1000
   B. 1100
   C. 1110
   D. 1111
   E. 10000

C

5. When you wipe a CD, you may scratch it. Would you rather risk a radial scratch or a tangential scratch?
   A. Neither one is likely to have an effect
   B. Both will have the same effect
   C. The radial scratch is worse: affects many spirals
   D. The tangential scratch is worse: many bits in a row disrupted
   E. CDs cannot be scratched

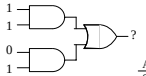
E

1. What logic table would you get out of a NAND gate with the inputs tied together?

A		B		C		D		NAND		
A	C	A	C	A	C	A	C	A	B	C
0	0	0	0	0	1	0	1	0	0	1
1	0	1	1	1	0	1	1	0	1	1
								1	0	1
								1	1	0

C

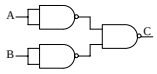
2. What is (1 AND 1) OR (0 AND 1)?
   A. 0
   B. 1
   C. indeterminate



AND			OR		
A	B	C	A	B	C
0	0	0	0	0	0
0	1	0	0	1	1
1	0	0	1	0	1
1	1	1	1	1	1

B

3. Which of the following functions does this contraption look like (using only NAND gates)?
   A. NAND
   B. AND
   C. OR
   D. NOR
   E. XOR



OR			AND			NAND		
A	B	C	A	B	C	A	B	C
0	0	0	0	0	0	0	0	1
0	1	1	0	1	0	0	1	1
1	0	1	1	0	0	1	0	1
1	1	1	1	1	1	1	1	0

C

4. How do TV remotes communicate with the TV?
   A. bursts of radio waves
   B. ultrasonic acoustic (sound) pulses
   C. bursts of infrared light
   D. via electrons/current flow
   E. by manipulating the electric field in the room

C

5. Why do you think the remotes avoid long sequences of ones or zeros (staccato nature)?
   A. this is the most efficient way to encode data
   B. this avoids confusion over blockages (shadows)
   C. this avoids confusion over natural sources (glints)
   D. all binary information is intrinsically this way
   E. it's an arbitrary choice with no real meaning

C or B

6. What do you think would happen if two remotes tried to access the same receiver at the same time? Keep in mind that to the receiver, it's all binary: it either sees a light or it doesn't.
   A. The signals would jumble together and confuse the receiver
   B. The receiver would be able to sort out who is who
   C. The receiver would store the second signal and process it later
   D. The receiver would block out the second one, listening only to the first

A

7. If each remote takes 100 ms to complete its transmission, roughly how many seconds would it take for 25 students to click in if you require less than 10% overlap rate?
   A. 2.5 seconds
   B. 25 seconds
   C. 50 seconds

B

1. TV remote controls use infrared light (LEDs). There is plenty of infrared light in sunlight. Why doesn't your TV do weird things when the sun hits it?
   A. because the sun isn't bright enough in infrared to do this
   B. because sunlight is constant—not flashing like the remote
   C. because the sun's spectrum is broader than the IR LED
   D. because even if flashing due to waving trees, it won't reproduce an understandable code

B and D

2. How does energy get from the sun to us on earth?
   A. the solar wind carries heat
   B. the vacuum of space conducts heat
   C. electromagnetic radiation (light, IR, etc.) carries it
   D. We place an order, and one month later, it's delivered

C

3. What is the wavelength of a radio wave at 300 MHz (3×10^8 Hz)?
   A. 1 mm
   B. 1 m
   C. 100 m
   D. 1 km
   E. 100 km

B

4. What is the ideal length for an FM radio antenna (100 MHz: 10^8 Hz)?
   A. 0.25 meters
   B. 0.75 meters
   C. 3 meters
   D. 5 meters
   E. length is irrelevant

B

5. Why can't you fit more stations into the FM radio band?
   A. It's strictly regulatory: you could fit many more
   B. It's a matter of bandwidth: less space means poorer sound quality
   C. It would be impossible to build radios to separate out stations any closer together than 200 kHz
   D. Nobody would *want* any more stations: most are bad anyway

B

1. If I place a sphere in an electric field that points to the right, how will charges distribute themselves on the sphere?
   A. electrons go right, leaving positive on left
   B. electrons go left, leaving positive on right
   C. electrons go up, leaving positive on bottom
   D. electrons go down, leaving positive on top

B

2. Why does the mesh cage block radio waves but not light, if both are electromagnetic radiation?
   A. light and radio are not that similar
   B. photons of light are small enough to make it through
   C. the mesh only blocks polarized sources of radiation
   D. the electric field for light oscillates too quickly for electrons to redistribute around holes
   E. light can't be thought of as oscillating electric fields

D

3. Is the frequency of 1 GHz (10^9 Hz) considered to be a microwave frequency?
   A. No: nowhere close
   B. Yes: it's in the right range
   C. Yes, but just barely
   D. No, but just barely not

B

4. If I put a positively charged rod near a stream of water, do the oxygens or hydrogens tend to orient toward the rod?
   A. the oxygens do, since they're more negative
   B. the hydrogens do since they're more positive
   C. neither: water molecules don't care
   D. both happen equally

A

5. If a positively charged rod attracts the stream of water, what will a negative rod do?
   A. repel the stream
   B. still attract the stream
   C. it will have no effect

B

6. How long would it take a 1000 W microwave to heat a 0.1 kg hot dog by 80 °C if it's heat capacity is 2000 J/kg/°C?
   A. 5 seconds
   B. 8 seconds
   C. 16 seconds
   D. 60 seconds

C

1. TV tubes are called "Cathode Ray Tubes". What are the "rays"?
   A. photons
   B. protons
   C. electrons
   D. Charles
   E. gamma rays

C

2. Why are the primary colors red, green, and blue, and not magenta, yellow, and cyan?
   A. Because we're mixing light, not pigments
   B. Because this mixing is additive, not subtractive
   C. Because our eyes have cones responding to the colors red, green, and blue
   D. Because white light includes red, green, and blue
   E. Dr. Murphy will tell us in a future lecture

A, B

3. What is the charge on the CRT anode?
   A. Positive
   B. neutral
   C. negative
   D. $3.95

A

4. HDTV has about 700 lines/frame. The frame rate remains about 30 fps. What is the horizontal scan frequency?
   A. 30 Hz
   B. 700 Hz
   C. 15,750 Hz
   D. 21,000 Hz
   E. zero Hz

D

5. One form of HDTV is 30 fps, non-interlaced. What is the vertical scan frequency?
   A. 30 Hz
   B. 700 Hz
   C. 15,750 Hz
   D. 21,000 Hz
   E. zero Hz

A

1. How low must a mirror go if you want to see your feet?
   A. all the way to the floor
   B. to half your height
   C. to half the distance from feet to eyes
   D. probably around your knees
   E. level with your eyes

C; B is close

2. What do you see from underwater looking up at the sky?
   A. You don't see out: only a reflection of the floor
   B. You see part of the sky, but not all the way to the horizon
   C. You see all of the sky, filling the entire vertical view
   D. You see all of the sky, but confined to a smaller circle
   E. You see the sky in a circle, and outside of this see a reflection of the floor

D and E

3. Do the sides of aquariums that look like mirrors to you also look like mirrors to the fish inside?
   A. Yes: every bit as much
   B. Yes, but not straight ahead: only to the sides
   C. No: nowhere does it look like a mirror
   D. They see a partial reflection, like a half-mirror

B

4. If you want to spear a fish underwater, how should you aim?
   A. Aim higher than where you see the fish
   B. Aim right at where you see the fish
   C. Aim lower than where you see the fish
   D. It doesn't matter: you're gonna miss anyway

C

5. If you want to shoot a fish with a laser gun, how should you aim?
   A. Aim above where you see the fish
   B. Aim right at where you see the fish
   C. Aim below where you see the fish
   D. Doesn't matter: laser guns don't exist

B

6. Why is corneal surgery (and contact lenses) so effective without messing with the eye's lens?
   A. Because the lens adjusts to the cornea
   B. Because most of the refraction happens at the air/cornea interface
   C. Because the eye otherwise would be distorted by the surgery
   D. Because the cornea heals fastest

B

7. What would fish goggles be like:
   A. Just like ours: holding a pocket of air
   B. Much like ours, but holding a pocket of water
   C. Fish can see fine out of water
   D. They would be bulbous and full of air
   E. They would be bulbous and full of water

B

1. Why do you get brown/black when you mix lots of paints together?
   A. each additional paint absorbs yet more light
   B. brown is a natural color that tends to emerge
   C. the chemicals mix and change to make brown
   D. for the same reason that dirt is brown
   E. this only happens with cheap paints

A

2. How might blue sky and orange sunsets be related?
   A. There's no good reason why they would be
   B. Air pollution is responsible for both
   C. The air is subtracting orange light from the sun
   D. The air is subtracting blue light from the sun
   E. It's just the way things are…

D

3. What color(s) will a red shirt absorb?
   A. red
   B. green
   C. blue
   D. green and blue
   E. red and blue

D

4. Why isn't pink in the spectrum?
   A. pink is not an actual color
   B. pink requires red plus some white
   C. pink is mostly red, with some green and blue mixed in
   D. pink has a wavelength, it's just beyond the "visible" range

B or C

5. Magenta paint absorbs green well. If you wanted to make magenta via *additive* sources, what light(s) would you use?
   A. red
   B. green
   C. blue
   D. red and green
   E. red and blue

E

6. Some parking garages use low pressure sodium vapor lamps (very orange), casting a single wavelength (589 nm). What does a blue shirt look like in this light?
   A. still blue
   B. a blueish-orange
   C. magenta
   D. black
   E. nothing has color in this light

D

1. Why is the lather from blue soap still white?
   A. a chemical reaction changes the nature of the soap
   B. the water dilutes the blue
   C. the lather has many reflective surfaces
   D. the walls of the bubbles are so thin they're clear
   E. never happened

C and D

2. Using $[(n_1 - n_2)/(n_1 + n_2)]^2$, what is the reflection fraction of glass vs. air at n=1.5?
   A. 0.02
   B. 0.04
   C. 0.08
   D. 0.20
   E. huh?

B

3. In what direction would you look to find a rainbow in the evening?
   A. north
   B. south
   C. east
   D. west
   E. could be anywhere

C

4. Why don't you tend to see rainbows in the middle of the day?
   A. We're mostly indoors then, and simply don't notice
   B. The rain/sun conditions are rarely met during mid-day
   C. They happen all the time, if we were only more observant
   D. The sun is too high in the sky; rainbow is toward ground
   E. It's too bright to notice them during mid-day

D

1. GoldenEye: What's wrong with this picture
   A. any plane a runner can catch up to isn't serious about taking off
   B. Bond got a late start going off the cliff
   C. The plane (with engine on) will go faster than Bond will fall
   D. Bond wasn't in a full-dive to minimize area
   E. The building blew up at the end (of course)

all

2. Speed: What's wrong with this picture?
   A. The gap is level
   B. The gap is too long: several bus-lengths
   C. The bus lurches upward on "take-off"
   D. The bus falls *down* onto the other side (originally at the same level)
   E. There *is* no spoon!

all

3. Two Towers: What's wrong with this picture?
   A. Gandalf gets a late start
   B. Gandalf catches up to his sword
   C. Gandalf falls faster than the balrog at first, but later same speed
   D. All those swats, and still falling straight without hitting wall!
   E. Stupid balrog has wings: what—he forgot?!

all

4. If you want to make a 3D movie in full color, what sort of glasses do you need to use?
   A. blue for left, red for right
   B. red for left, blue for right
   C. blue/red in either order
   D. polarized: vertical vs. horizontal
   E. polarized: 45° left-ward vs. 45° rightward

E or D

5. Ozone takes out 90% of UVB when sun is straight overhead. What effective SPF does ozone have if the sun is at 30° vs. straight up, and thus travels through *twice* as much ozone?
   A. SPF 2
   B. SPF 5
   C. SPF 10
   D. SPF 20

C

1. What's a fool-proof way to know whether a light is based on exciting atomic transitions (like neon, fluorescent) or on thermal incandescence (hot filament)?
   A. if it's colored, it's not incandescent
   B. if it looks white, it's incandescent
   C. the shape of the light tells you
   D. look at it with a spectrograph: lines means atomic

D is best

2. Which would produce greater tides: our own moon or a moon twice as massive twice as far from earth?
   A. Our own moon produces larger tides
   B. They would both produce the same tidal effect
   C. The alternate moon would produce a bigger tide
   D. There *is* no moon

A