BEACHWOOD SCIENCE OLYMPIAD INVITATIONAL - WIFI LAB C

DIRECTIONS: Each team can use a 3-ring binder along with 2 non-graphable and non-programming calculators. You are allowed to separate the test, but staple it back in order before you turn it in. Please show all your work on any calculations for full credit.

School Name #: _____ Team #: _____

Names:_____ Score: _____/96

Best of luck >:D

Section A: Multiple Choice (2 points each)

1) What is the maximum range in bandwidth (in kHz) allocated to every FM station?

A. 150
B. 200
C. 250
D. 300
E. 350

2) What is the maximum range in bandwidth (in kHz) allocated to every AM station?

A. 1
B. 5
C. 10
D. 15
E. 20

3) The band of electromagnetic waves with frequencies between 30 MHz and 300 MHz is called what?

A. EHF
B. VHF
C. HF
D. MF
E. VLF

4) The band of electromagnetic waves with wavelengths between 10,000 and 100,000 kilometers is called what?

A. ELF
B. VLF
C. LF
D. MF
E. VHF

5) In what period was the SMA connector developed?

A. 1950s
B. 1960s
C. 1970s
D. 1980s

6) What is the impedance of an SMA connector in ohms?

A. 10
B. 25
C. 50
D. 100
E. 1000

7) **(TIEBREAKER)** Order the following microwave bands from longest to shortest:

A. L, Ku, X, S, P, C, Ka, K
B. Ku, Ka, L, S, X, C, P, K
C. P, C, L, S, X, Ku, Ka, K
D. P, L, S, C, X, Ku, K, Ka
E. None of the above

8) What is the wavelength range of the X-band?

A. 3.8-7.5 cm
B. 2.4-3.8 cm
C. 1.7-2.4 cm
D. 1.1-1.7 cm
E. 0.75-1.1 cm

9) What is an antenna with a perfectly indirectional radiation pattern called?

A. Yagi-uda
B. Patch
C. Isotropic
D. Polytropic
E. Dipole

10) Which of the following is not an element of a Yagi-Uda antenna?

A. Director
B. Driven
C. Parasitic
D. Frontal
E. Reflector

11) What is the impedance of free space?

A. 377 Ω
B. 272 Ω
C. 681 Ω
D. 882 Ω
E. 113 Ω

12) In what medium would light travel the fastest?

A. Water 10°C (RI 1.33)
B. Water 100°C (RI 1.32)
C. Cedar Oil (RI 1.52)
D. Diamond (RI 2.42)
E. Propane (RI 1.34)

13) From the previous question, if light were to hit all of these mediums, which of these would have the lowest critical?

A. Water 10°C (RI 1.33)
B. Water 100°C (RI 1.32)
C. Cedar Oil (RI 1.52)
D. Diamond (RI 2.42)
E. Propane (RI 1.34)

14) In electromagnetic waves, what is the angle between the magnetic field and the electric field?

A. 30°
B. 45°
C. 60°
D. 75°
E. 90°

15) Fraunhofer radiation is also known as:

A. Far Field
B. Close Field
C. Near Field
D. Short Field
E. Mid Field

16) The image on the right is the helical antenna used on the amazing GOES-16 Satellite, what type of polarized wave does this antenna generate?

A. 90° Offset
B. 45° Offset
C. Vertically Polarized
D. Stratically Polarized
E. Circularly polarized

17) What does dBd measure?

A. Decibels relative to a monopole antenna.
B. Decibels relative to an isotropic antenna
C. Decibels relative to the Doss constant
D. Decibels relative to a dipole antenna
E. Decibels relative to a double antenna

18) Light with a wavelength of of 420 nm would be:

A. Near IR
B. Violet
C. Green
D. UV
E. Microwave

19) Who made the first antenna?

A. Ernest Rutherford
B. Kai Zheng
C. Werner Heisenberg
D. Heinrich Hertz
E. Robert Downey

20) Which super common antenna uses multiple elements to get a high directivity with low bandwidth?

A. Patch Antenna
B. Loop Antenna
C. Yagi Uda Antenna
D. Dipole Antenna
E. Helical Antenna

Section B: Written Response

1) What do AM and FM stand for? (2 points)

Amplitude Modulation and Frequency Modulation (1 point each)

2) In North America, what is the range of frequencies in KHz allocated to AM radio? (2 points)

540 kHz to 1700 kHz

3) In North America, what is the range of frequencies in MHz allocated to FM radio? (2 points)

88.0 MHz to 108.0 MHz

4) KDKA (1020 kHz) is a radio station licensed to Pittsburgh, Pennsylvania, United States? What is the wavelength of the carrier radio wave in meters? (3 points)

294m (accept 288-300m)

5) **[TIEBREAKER]** To the nearest 5 MHz, what is the center frequency of the GMRS band? (2 points)

465 MHz (accept 460-470MHz)

6) A radio wave traveling at 3.0×10^8 m/s in the air has a wavelength of 150 cm.
What is its frequency? (2 points)
200MHz

7) An EM wave with a wavelength of 15.0 mm is traveling through the air.
What is its frequency in GHz (2 points)

20 GHz

8) An electromagnetic wave propagating through a certain medium has a wavelength of 1.5 m and a frequency of 150 MHz. What is the speed of light in the medium? (3 points)

$2.25*10^8$ m/s

9) SMA (as in SMA connector) is short for what? (2 points)

SubMiniature version A

10) A certain antenna has a gain of 8.51 dBi. What is its gain in dBd? (2 points)

6.37 dBd (accept 6.35-6.39)

11) What is the main practical difference between 2.4GHz and 5GHz WiFi bands? (2 points)

The 2.4GHz has a slower transmission rate but a longer transmission range, and 5GHz

has a faster transmission rate but a shorter transmission range.

12) What is the difference between directivity and gain? (4 points)

Directivity measures how focused the radiation pattern of the antenna is compared to isotropic antennas. Gain the measurement of how much power is transmitted in the direction of peak radiation. (2 points for correctly describing one)

13) **(TIEBREAKER)** Photon G-16 is traveling through a medium with a refractive index of 1.6. Given that its wavelength is 0.12m, how much energy in Electron-Volts (eV) does this photon have? (4 points)

Correct answer: $6.456*10^{-6}$ eV (accept 6.056 to 6.856)
only 2 points if they have $1.03433421*10^{-24}$ J (accept 1.0 to 1.06)

14) If an antenna has a directivity of 6.9 dBi and a gain of 4.06 dBd, what is the antenna efficiency? (3 points)

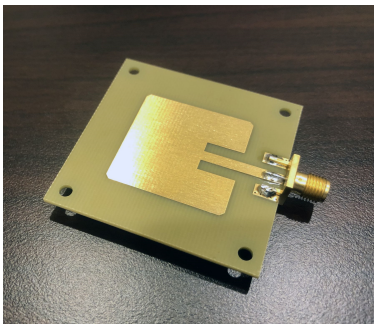
90% (accept 89% to 91%)

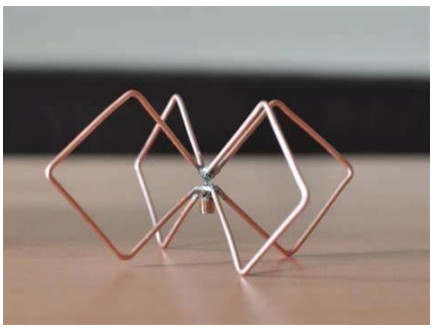
15) The Antenna TPX has a gain of 5dBi and an efficiency of 70%. If the antenna is fed with 140W, how much power (W) does it emit? (3 points)

100W

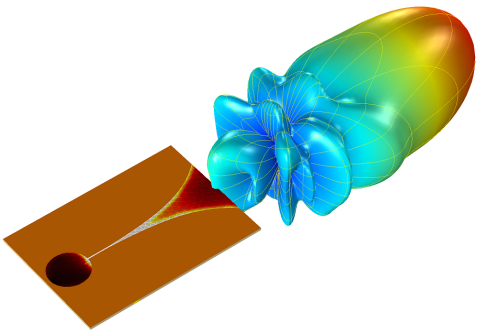
Section C: Antenna Identification (ID the following Antennas)

(2 points each)

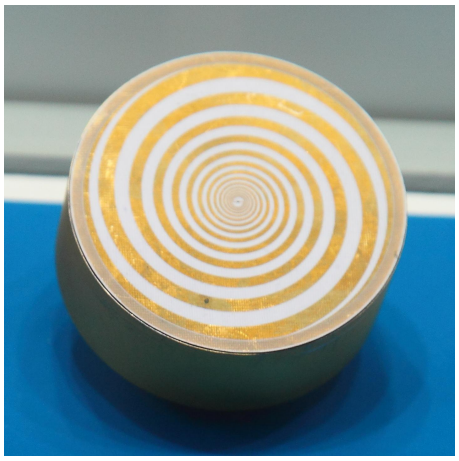




Dipole Antenna **Patch Antenna** **Biquad Antenna**



Yagi Uda Antenna **Helical Antenna** **Vivaldi Antenna**



Spiral Antenna **Parabolic Reflector/Dish Antenna** **Loop Antenna**