ADVANCED Class.
FCC License Preparation
Element 4A

To go to an explanation press the Search button and select the required question designator.

A1A01:
Advanced class privileges cover almost the entire 80-meter band except for two 25 kHz sections at the bottom of each sub band. [97.301]

A1A02:
Advanced class privileges cover almost the entire 40-meter band except for a 25 kHz section at the bottom. [97.301]

A1A03:
Advanced class operators have privileges over the entire 20-meter band except for two 25 kHz sections at the bottom of each sub band. [97.301]

A1A04:
Advanced class operators have privileges over the entire 15-meter band except for two 25 kHz sections at the bottom of each sub band. [97.301]

A1A05:
When you have your CSCE for Advanced privileges you can go home and use these privileges on the air if you add the /AA to your existing call sign. [97.119]

A1A06:
In this case the Advanced operators' privileges are being exceeded. Therefore, the control operators call sign must be used. [97.119]

A1A07:
The Technician Plus privileges are being exceeded and so the Advanced class operator's call sign must be used. [97.119]

A1A08:
It must also be at least 40 dB below the main signal if the mean output power is greater than 5 watts.
[97.307]

A1A09:
It must also be less than 50 mW. [97.307]

A1A10:
The spurious emission requirements for VHF and UHF transmitters are more stringent than for HF equipment. [97.307]

A1A11:
The spurious emission requirements for VHF and UHF transmitters are more stringent than for HF equipment. [97.307]

A1B01:
The control link is often a radio link and the control operator may operate the link from a hand held transceiver. [97.3]

A1B02:
An example of automatic control is a repeater. [97.3]

A1B03:
Obviously a model plane needs to be manually supervised! [97.201]

A1B04:
Repeaters are the most common form of automatically controlled amateur stations. [97.205]

A1B05:
The correct option is almost a quotation from the FCC rules. The point is that the control operator is not doing the actual operating of the station. [97.3]

A1B06:
Although a control operator is responsible for an automatic station, he/she is not actually controlling it.
[97.3]

A1B07:
This is the only HF band that has repeaters. They are permitted only between 29.5 - 29.7 MHz. The input/output difference is 100 kHz with the output on the higher frequency. [97.205]

A1B08:
Most of the 6-meter band is available for repeater operation. [97.205]

A1B09:
There are two repeater sub-bands on the 2-meter band. [97.205]

A1B10:
All but the bottom 15 kHz is available for repeater use. [97.205]

A1B11:
Three sub-bands are available for repeater use on the 70 cm band.. [97.205]

A1B12:
Repeater operation is permitted in any part of the 23-cm band. The US national repeater plan for this band has the inputs from 1,270 - 1,276 and the corresponding outputs from 1,282 - 1,288 [97.301]

A1B13:
The purpose of this rule is to avoid a malfunctioning station permanently transmitting, possibly for days at a time. [97.213]

A1B14:
The control point could be a hand held transceiver used by the local repeater control operator. [97.3]

A1B15:
In the case of radio control the control link consists of a receiver at the remotely controlled station plus a transmitter at the control point. [97.3]

A1C01:
A licensed amateur may build or modify one of each type of power amplifier per calendar year for operation below 144 MHz without having to obtain FCC type acceptance. [97.315]

A1C02:
Type acceptance has to be granted for each model. [97.315]

A1C03:
Selling on to amateurs is permitted. [97.315]

A1C04:
In other words, if the amplifier cannot satisfy amateur radio emission standards then it will not gain type approval. [97.317]

A1C05:
The amplifier must not generate spurious emissions when in standby mode. [97.317]

A1C06:
The FCC is trying to make it difficult for illicit high power transmissions to be made on these frequencies.
[97.317]

A1C07:
At this drive level the amplifier will be working at close to its maximum output power. [97.317]

A1C08:
The aim is to prevent easy modification for illicit use. [97.317]

A1C09:
The aim is to prevent easy modification for illicit use. [97.317]

A1C10:
The aim is to prevent easy modification for illicit use. [97.317]

A1C11:
There should be no gain between these frequencies.   [97.317]

A1D01:
Spread spectrum modulation involves "scattering" a signal over a wide bandwidth during transmitting and "de-scattering" the signal during receiving. [97.3]

A1D02:
In direct sequence transmission the carrier is modulated by a high speed pseudo-random code. The same code sequence is used by the receiver to recover the signal. In frequency hopping a fixed number of predetermined frequencies are used. The carrier jumps from one to another in a predetermined sequence. This occurs at a relatively low speed. [97.311]

A1D03:
This is because the FCC has chosen to take a cautious approach to this relatively new type of amateur transmission. [97.311]

A1D04:
The important term here is "point to point."   [97.3]

A1D05:
The point to point communication is between the control operator and the repeater station. [97.3]

A1D06:
For a station to be an auxiliary station it must be a member of a group. [97.3]

A1D07:
The 70-cm sub-bands are satellite sub-bands. [97.201]

A1D08:
Any class except Novice can be in control of an auxiliary station. [97.201]

A1D09:
This limit is generally the maximum permitted for radio amateur identification purposes. [97.1191]

A1D10:
This is the same requirement as for normal amateur radio operation. [97.1191]

A1D11:
If it is a data transmission then the station identification can also be sent in digital form. [97.119]

A1E01:
An exact description of Line A can be found in the FCC Part 97 definitions [97.3] while the frequencies permitted North of Line A are stated in [97.303].

A1E02:
An exact description of Line A can be found in the FCC Part 97 definitions [97.3] while the frequencies permitted North of Line A are stated in [97.303].

A1E03:
The precise location is in FCC Part 97 definitions: [97.3]

A1E04:
The precise location is in FCC Part 97 definitions: [97.203]

A1E05:
This type of transmission involves safety of life or property and so it is permitted. [97.113]

A1E06:
The FCC rules do not permit you to run a business over the air. However, you are allowed to mention that you have radio equipment for sale if this is not done regularly. [97.113]

A1E07:
You may not accept payment for passing third-party messages over the air. [97.113]

A1E08:
A control operator may not accept payment for passing on third-party messages.   [97.113]

A1E09:
You can communicate with an employee so long as it is not for business purposes. [97.113]

A1E10:
Special rules apply near airports. [97.15]

A1E11:
Approval may be required for lower structures near airports. [97.15]

A1F01:
A holder of an Amateur License is assumed to have passed the examinations required for that license class. [97.505]

A1F02:
The code test is for a minimum of five (5) minutes. [97.503]

A1F03:
There are dozens of prosigns but these are the only ones required for examination purposes. [97.503]

A1F04:
This is the average size of a word in normal text. [97.507]

A1F05:
There is no lower age limit for obtaining an Amateur radio license, but there is a lower limit on VE age.
[97.509]

A1F06:
There are no exceptions to this rule. [97.509]

A1F07:
VEs must have no conflict of interest and they must be impartial. [97.509]

A1F08:
The principle of this rule is that VEs must have attained a higher level of amateur radio knowledge than the applicants. [97.509]

A1F09:
Volunteer examiners are volunteers! [97.509]

A1F10:
If your license is revoked you will never be allowed to be a VE again. [97.509]

A1F11:
If your license is revoked you will never be allowed to be a VE again. [97.509]

A1F12:
It is possible to go to an examination center, take and pass the examination and get on the air with your new privileges all in a few hours. [97.509]

A1F13:
This is a maximum and it would normally be much less than this. [97.509]

A1F14:
The FCC used to receive applications but it is now done by the coordinating VEC. [97.509]

A2A01:
The important word here is "printed." Facsimiles (Faxes) may be transmitted by telephone or by radio.

A2A02:
At this rate it takes about 3.3 minutes to receive a FAX.

A2A03:
One frame is 3.3 minutes at 240 lines per minute.

A2A04:
The important word here is "printed." Facsimiles (Faxes) may be transmitted by telephone or by radio.

A2A05:
As a dot of light scans across the document the scattered light varies. These light variations are converted to voltage variations and sent to the FAX receiver.

A2A06:
In slow scan television the picture is received on a screen instead of being printed. It is common to send photographs by slow scan television (SSTV). Because the scan rate is relatively slow SSTV has a narrow bandwidth and can be used on the HF bands.

A2A07:
A slow scan television black and white picture can take tens of seconds for a single frame. Color pictures take longer.

A2A08:
The two frequencies used in SSTV transmissions are well within the 3 kHz passband of an SSB receiver. Shades of gray will be at intermediate frequencies.

A2A09:
The two frequencies used in SSTV transmissions are well within the 3 kHz passband of an SSB receiver. Shades of gray will be at intermediate frequencies.

A2A10:
The receiver is averaging over a number of frequencies. Interference will tend to cancel out and become background noise while the required signal will be additive.

A2A11:
The receive frequency will have to hop using the same pseudo random sequence.

A2A12:
This is lower than the rates used on telephone lines, but radio air time is free!

A3A01:
Sporadic-E propagation occurs mainly in summer at times of highest solar activity. Long distance skywave propagation becomes possible on the 6-meter band and at even higher frequencies.

A3A02:
Sporadic-E propagation occurs mainly in summer at times of highest solar activity. Long distance skywave propagation becomes possible on the 6-meter band and at even higher frequencies.

A3A03:
The equatorial regions are subject to higher solar flux and so more ionization will be present in the E-layer above these regions.

A3A04:
Sporadic-E propagation occurs mainly in summer at times of highest solar activity. Long distance skywave propagation becomes possible on the 6-meter band and at even higher frequencies.

A3A05:
The auroral curtains are constantly moving and of irregular shape so there will be multi-path reflections. The fluttery sound is due to these paths causing cancellations and additions of the signal.

A3A06:

The particles are emitted from disturbances on the surface of the sun. They take several days to reach earth and are then trapped by the earth's magnetic field. They are funneled down into the atmosphere near the North and South poles. When the solar particles strike the atmosphere it glows just like the gas in fluorescent tubes. This is what produces auroral displays.

A3A07:
This is where the auroral displays can be seen.

A3A08:
This is the height at which the atmosphere becomes dense enough to significantly interact with the solar particles to produce visible light.

A3A09:
Narrow band signals are the most tolerant to the rapid fading effects of auroral propagation

A3A10:
Propagation by tropospheric ducting is not a ground wave phenomenon.

A3A11:
The ground wave vertical polarization component is propagated more efficiently than the horizontal component.

A3B01:
The phase differences are caused because the signal is arriving at the receiver by several different paths.
It can be highly frequency dependent.

A3B02:
The phase differences are caused because the signal is arriving at the receiver by several different paths.
It can be highly frequency dependent.

A3B03:
The phase differences are caused because the signal is arriving at the receiver by several different paths. It can be highly frequency dependent. Therefore, wide band signals such as FM and double sideband are more affected.

A3B04:
Selective fading can be highly frequency dependent. Therefore, wide band signals such as FM and double sideband are more affected.

A3B05:
The bending is in a downward direction due to the change in air density with height. Because of this the radio path extends beyond the line of sight horizon. The extra path length is about 15%

A3B06:
The bending is in a downward direction due to the change in air density with height. Because of this the radio path extends beyond the line of sight horizon. The extra path length is about 15%

A3B07:
Low angle radiation gives a greater communication range. This is another reason to mount an antenna as high as possible.

A3B08:
So the best site for a Yagi is as high as possible on the side of a hill sloping in the direction most often used!

A3B09:
This is a sort of ducting effect that can happen at HF.

A3B10:
This assumes high powers and high gain antennas properly aligned.

A3B11:
Under normal conditions up to 500 miles is the best that can be expected for normal tropospheric propagation at VHF. When the range is greater than this extra effects are likely to be responsible, such as the tropospheric ducting effect.

A3B12:
There is a very slight heating effect on the air or particles. The loss of energy is not to be confused with losses in field strength due to the wave spreading out as it propagates.

A4A01:
A frequency standard is checked against more accurate frequency standards. The ultimate frequency standards are called "atomic clocks."

A4A02:
A frequency counter counts how many cycles occur in a given time. The frequency is calculated from this and then displayed.

A4A03:
A Lissajous pattern is always displayed when the two signals are roughly similar in amplitude and are simple multiples of each other. If there is a small discrepancy in one of the frequencies then the whole pattern will appear to slowly rotate.

Unknown frequency = (n2/n1) x known frequency

Where:
n1 is the loops along a vertical edge
n2 is the loops along a horizontal edge

A4A04:
A dip meter is useful for measuring resonant frequencies of tuned circuits. At resonance, power is "sucked out" of the dip meter oscillator by the circuit being tested. This can be seen on a meter.

A4A05:
A dip meter is useful for measuring resonant frequencies of tuned circuits. At resonance, power is "sucked out" of the dip meter oscillator by the circuit being tested. This can be seen on a meter.

A4A06:
A dip meter is useful for measuring resonant frequencies of tuned circuits. At resonance, power is "sucked out" of the dip meter oscillator by the circuit being tested. This can be seen on a meter.

A4A07:
Antenna traps are tuned circuits placed in a multi-band antenna system to isolate parts of the elements.

A4A08:
The coupling should be the smallest possible that gives a visible reading on the meter. It should be loosely coupled. If you over-couple the dip meter, you may affect the tuned circuit under test.

A4A09:
The coupling should be the smallest possible that gives a visible reading on the meter. It should be loosely coupled. If you over-couple the dip meter, you may affect the tuned circuit under test.

A4A10:
The coupling should be the smallest possible that gives a visible reading on the meter. It should be loosely coupled. If you over-couple the dip meter, you may affect the tuned circuit under test.

A4A11:
Apart from the cost of manufacturing it, the circuit will have less stray capacitance and inductance. It will also be smaller and more reliable. On the other hand, surface mounting of components does not lend itself to easy repair and modification.

A4B01:
This is the older style of mechanical meter with jeweled movement and "hair spring."

A4B02:
Accuracy and linearity of the time base are relevant to frequency measurements. Linearity and bandwidth of the deflection amplifiers are relevant to amplitude measurements and maximum operating frequency.

A4B03:
As these parameters improve, the cost increases

A4B04:
Frequency counter time bases are usually derived from crystals in temperature controlled ovens. Sometimes there is a facility for feeding an external frequency standard into the frequency counter.

A4B05:
This is the one important limit on accuracy. Frequency counter time bases are usually derived from crystals in temperature controlled ovens. Sometimes there is a facility for feeding an external frequency standard into the frequency counter.

A4B06:
One (1) p.p.m. means one (1) part per million. This is simply the frequency divided by 1,000,000.

In the question this comes to 146,520,000 / 1,000,000 = 146.52 Hz

A4B07:
0.1 p.p.m. means 0.1 parts per million.   This is simply the frequency divided by 10,000,000.

In the question this comes to 146,520,000 / 10,000,000 = 14.652 Hz

A4B08:
Ten (10) p.p.m. means ten (10) parts per million. This is simply the frequency divided by 100,000.

In the question this comes to 146,520,000 / 100,000 = 1,465.20 Hz

A4B09:
One (1) p.p.m. means one (1) part per million. This is simply the frequency divided by 1,000,000.

In the question this comes to 432,100,000 / 1,000,000 = 432.1 Hz

A4B10:
0.1 p.p.m. means 0.1 parts per million. This is simply the frequency divided by 10,000,000.

In the question this comes to 432,100,000 / 10,00,000 = 43.21 Hz

A4B11:
Ten (10) p.p.m. means ten (10) parts per million. This is simply the frequency divided by 100,000.

In the question this comes to 432,100,000 / 100,000 = 4,321 Hz

A4C01:
The local oscillator is modulated by the strong signals and this modulation is then superimposed on the required signal.

A4C02:
Receiver desensitization is a potential problem with repeaters. High quality filters on the repeater input are used to reduce it. Careful shielding of your receiver and transmitter also help.

A4C03:
Receiver desensitization is a potential problem with repeaters. High quality filters on the repeater input are used to reduce it. Careful shielding of your receiver and transmitter also help.

A4C04:
Receiver desensitization is a potential problem with repeaters. High quality filters on the receiver input are used to reduce it. Careful shielding of your receiver and transmitter shielding also help.

A4C05:
This is a consequence of the way that FM discriminators work.

A4C06:
This is a consequence of the way that FM discriminators work.

A4C07:
This is a consequence of the way that FM discriminators work.

A4C08:
Most of the internal noise comes from the first active device at the receiver front end.

A4C09:
The noise due to thermal movement at the receiver input is p = KTB watts.

Where:
K=1.37 E - 23 (Boltzmanns constant)
T = absolute temperature in degrees Kelvin.
B = bandwidth in Hz

Giving p = 1.9923 E-18 watts = -177 dB0 = -147 dBm

At a bandwidth of 500 Hz a receiver has a minimum theoretical noise floor of -147 dBm. The active device at the front end will contribute some noise, in this question this noise is 8 dBm. So the noise power is -147 + 8 = -139 dBm.

A signal of -139 dB level could just be detected. This is the bottom end of the dynamic range. The top end (for 1 dB blocking) is given as -20 dBm. Therefore, the blocking dynamic range is 139 - 20 = 119 dB.

A4C10:
One way to obtain a good image rejection ratio is to have good RF selectivity before the mixer so those image frequencies at (IF frequency x 2) away from the required signal are suppressed. If the chosen IF frequency is high then it will be easier for the RF filters to reject image frequencies since they will be farther away from the required signal. So correct answers would be RF filter selectivity and IF filter frequency. However, RF filter selectivity is not presented as an option and so this leaves option D, IF filter.

A4C11:
The noise due to thermal movement on a receiver input is p = KTB watts.

Where:
K=1.37 E - 23 (Boltzmanns constant).
T = absolute temperature in degrees Kelvin.
B = bandwidth in Hz

Let's assume a bandwidth of 500 Hz and a temperature of 20 degrees Centigrade that is 290 degrees Kelvin..

This gives p = 1.37 E -23 x 290 x 500 = 1.9923 E-18 watts = -177 dB0

dB0 is a power level relative to 1 watt. We usually use dBm that is a power level relative to 1 mw.

Power level in dBm = Power level in dB0 + 30

-177 dB0 = -147 +30 = -147 dBm

At a bandwidth of 500 Hz a receiver has a minimum theoretical noise floor of -147 dBm.
The minimum discernible signal will be above the theoretical noise floor of 147 dBm (at 500 Hz bandwidth). Typical figures quoted by manufacturers are around 145 dBm for VHF receivers.

A4D01:
"Inter" means "between". The products due to mixing between two frequencies are intermodulation products.

A4D02:
"Inter" means "between". The products due to mixing between two frequencies are intermodulation products. This question is checking for knowledge that transmitter power amplifiers are capable of acting as mixers if strong external signals are applied to their outputs. Solid state power amplifiers are particularly prone to this effect.

A4D03:
A power amplifier can produce cross modulation products if several strong signals are present at the output. This can be a problem at radio sites with several transmitters sharing a common tower with antennas close together. Isolators are directional devices that prevent unwanted signals going down the feedline to the power amplifier. They also attenuate the forward signal to some extent.

A4D04:
Immunity to cross modulation is an important factor in receiver performance.

A4D05:
Immunity to cross modulation is an important factor in receiver performance.

A4D06:
The best place for filtering to reduce cross modulation is before the first active device in the receiver.

A4D07:
Intermodulation and cross modulation occur due to non linearity in the early stages of a receiver. The strong signals modulate the weaker ones. To correct this condition, either eliminate the strong unwanted signals with filters or improve the linearity of the RF stages of the receiver.

A4D08:

Intermodulation and cross modulation occur due to non linearity in the early stages of a receiver. The strong signals modulate the weaker ones. To correct this condition, either eliminate the strong unwanted signals with filters or improve the linearity of the RF stages of the receiver.

A4D09:
The difference between the two frequencies given is 0.18 MHz and so the other interfering signal could be at 146.52 - 0.18 = 146.34 MHz.

If the interfering signal were at 146.61 MHz then there would be a difference of:
146.61 - 146.52 = 0.09 MHz.
This could produce an intermodulation product at 146.61+0.09 = 146.70 MHz

A4D10:
The high pass filter would allow the VHF television transmissions but would block the lower frequency HF amateur transmissions.

A4D11:
Intermodulation requires a none linear device. In this case the none linear device is an over modulated SSB transmitter and the intermodulation products are derived from the frequencies present in the speech waveform.

A5A01:
At resonance the circulating currents and resulting voltages can be much larger than the applied voltage of current.   Think of a child's swing that has built up much energy from a series of small pushes.

A5A02:
At resonance XL = XC and the circuit appears resistive to the AC current.

A5A03:
At resonance XL = XC and the circuit appears resistive to the AC current.

A5A04:
At resonance XL = XC and the circuit appears resistive to the AC current.

A5A05:
The impedance of a series L-C circuit is at a minimum at resonance and the circuit appears resistive because no reactance is present.

A5A06:
The inductor capacitor combination will present a very high impedance at resonance. Therefore, the parallel resistor will determine the total circuit impedance.

A5A07:
The impedance of a series L-C circuit is at a minimum at resonance and the circuit appears resistive.

A5A08:
Be careful here. The impedance of the circuit is at a maximum and little current will flow through it. However, the circulating current between L and C will be at a maximum.

A5A09:
The circulating current will be at a maximum, but the current flowing across the circuit will be at a minimum.

A5A10:
The current will be in phase because a resonant circuit is resistive.

A5A11:
The current will be in phase because a resonant circuit is resistive.

A5B01:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / (2 x pi x square root (L x C))

We get 1 / (2 x 3.14 x square root (50E-6 x 40E-12))
= 3,560,617 Hz = 3.56 MHz

A5B02:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (40E-6 x 200E-12)]
= 1,780,308 Hz = 1.78 MHz

A5B03:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (50E-6 x 10E-12)]
= 7,121,235 Hz = 7.21 MHz

A5B04:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (25E-6 x 10E-12)]
= 1,007,094 Hz = 10.1 MHz

A5B05:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (3E-6 x 40E-12)]
= 14,536,161 Hz = 14.5 MHz

A5B06:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (4E-6 x 20E-12)]
= 17,803,088 Hz = 17.8 MHz

A5B07:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (8E-6 x 7E-12)]
= 21,278,761 Hz = 27.3 MHz

A5B08:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (3E-6 x 15E-12)]
= 23,737,451 Hz = 23.7 MHz

A5B09:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (4E-6 x 8E-12)]
= 28,149,155 Hz = 28.1 MHz

A5B10:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / (2 x 3.14 x square root (1E-6 x 9E-12))
= 53,078,556 Hz = 53.1 MHz

A5B11:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain C

C = [(1/(2 x pi x Fr))squared] / L

Giving:

C = [(1/(2 x 3.14 x 14.25E6))squared] / 44E-6

We get C = 4.39E-11 Farads = 43 picofarads.

A5C01:
Use an approximate value for pi of 3.14

Use the formula Fr = 1 / [2 x pi x square root (L x C)]

We get 1 / [2 x 3.14 x square root (1E-6 x 10E-12)]
= 50,354,739 Hz = 50.3 MHz

A5C02:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (2E-6 x 15E-12)]
= 29,072,322 Hz = 29.1 MHz.

A5C03:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (5E-6 x 9E-12)]
= 23,737,745 Hz = 23.7 MHz.

A5C04:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (2E-6 x 30E-12)]
= 20,557,723 Hz = 20.5 MHz.

A5C05:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (15E-6 x 5E-12)]
= 18,386,951 Hz = 23.7 MHz.

A5C06:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (3E-6 x 40E-12)]
= 14,536,161 Hz = 14.5 MHz.

A5C07:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (40E-6 x 6E-12)]
= 10,278,618 Hz = 10.3 MHz.

A5C08:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (10E-6 x 50E-12)]
= 7,121,235 Hz = 7.12 MHz.

A5C09:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (200E-6 x 10E-12)]
= 3,560,617 Hz = 3.56 MHz.

A5C10:
Use an approximate value for pi of 3.14.

Use the formula Fr = 1 / [2 x pi x square root (L x C)].

We get 1 / [2 x 3.14 x square root (90E-6 x 100E-12)]
= 1,678,491 Hz = 1.68 MHz.

A5C11:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain L.

L = [(1/(2 x pi x Fr)) squared] / C.

Giving:

L = [(1/(2 x 3.14 x 14.25E6) squared] / 44E-12.

We get L = 2.8E-6 Henrys = 2.8 microhenrys.

A5D01:
The rapidly changing fields in a conductor carrying RF cause the current to flow mostly in the outer parts. Metal tubing would be just as good a conductor as solid wire at RF frequencies. If low RF resistance is important then wire is sometimes silver plated because silver is a better electrical conductor than copper.

A5D02:
The rapidly changing fields in a conductor carrying RF cause the current to flow mostly in the outer parts. Metal tubing would be just as good a conductor as solid wire at RF frequencies. If low resistance is important then wire is sometimes silver plated because silver is a better electrical conductor than copper.

A5D03:
This is called the skin effect. The rapidly changing fields in a conductor carrying RF cause the current to flow mostly in the outer parts. Metal tubing would be just as good a conductor as solid wire at RF frequencies. If low resistance is important then wire is sometimes silver plated because silver is a better electrical conductor than copper.

A5D04:
The rapidly changing fields in a conductor carrying RF cause the current to flow mostly in the outer parts. Metal tubing would be just as good a conductor as solid wire at RF frequencies. If low resistance is important then wire is sometimes silver plated because silver is a better electrical conductor than copper.

A5D05:
The skin effect results in an increase in resistance because the effective conductor area is less. The rapidly changing fields in a conductor carrying RF cause the current to flow mostly in the outer parts. Metal tubing would be just as good a conductor as solid wire at RF frequencies. If low resistance is important then wire is sometimes silver plated because silver is a better electrical conductor than copper.

A5D06:
The electrostatic field is in the insulator between the two electrodes. This insulator may be air, plastic film or even a vacuum in certain specialized capacitors.

A5D07:
The Joule is a measure of total energy. It is equivalent to a watt of power flowing for a second.

A5D08:
A magnetic field can be used to store energy.

A5D09:
The left hand rule:
Grip a conductor with your left hand. Straighten out your thumb. If your thumb points in the direction of the electron flow, then your fingers will point in the direction of the resulting magnetic field.

A5D10:
Double the current and the magnetic field becomes twice as strong.

A5D11:
Potential energy is "frozen" energy ready to be released.   It has the potential to do work.

A5E01:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 1.8E6/95 = 18947 Hz = 18.9 kHz.

A5E02:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 3.6E6/218 = 16,513 Hz = 16.5 kHz.

A5E03:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 7.1E6/150 = 47,333 Hz = 47.3 kHz.

A5E04:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 12.8E6/218 = 58,715 Hz = 58.7 kHz.

A5E05:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 14.25E6 / 150 = 95,000 Hz = 95 kHz.

A5E06:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 21.15E6 / 95 = 222,631 Hz = 222.6 kHz.

A5E07:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 10.1E6 / 225 = 44,888 Hz = 44.9 kHz.

A5E08:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 18.1E6 / 195 = 92,8205 Hz = 92.8 kHz.

A5E09:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 3.7E6 / 118 = 31,355 Hz = 31.4 kHz.

A5E10:
For half power bandwidth use the formula:

B = Fr/Q Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

We have:
B = 14.25E6 / 187 = 76,203 Hz = 76.2 kHz.

A5E11:
For half power bandwidth use the formula:

$B = Fr/Q$ Hz.

Where "Fr" is the resonant frequency and "Q" is the "quality" (or goodness) of the circuit.

A5F01:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X.

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 14.128E6 x 2.7E-6 = 239.55 ohms.

So Q = 18E3 / 239.55 = 75.1

A5F02:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X.

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 14.128E6 x 4.7E-6 = 417 ohms.

So Q = 18E3 / 417 = 43.1

A5F03:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X.

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 4.468E6 x 47E-6 = 1316 ohms.

So Q = 180 / 1316 = 0.136

A5F04:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 14.225E6 x 3.5E-6 = 312.6 ohms.

So Q = 10E3 / 312.6 = 31.9

A5F05:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 7.125E6 x 8.2E-6 = 366.9 ohms.

So Q = 1000 / 366.9 = 2.73

A5F06:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 7.125E6 x 10.1E-6 = 451.9 ohms.

So Q = 100 / 451.9 = 0.221

A5F07:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 7.125E6 x 12.6E-6 = 563 ohms.

So Q = 22E3 / 563 = 39

A5F08:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 3.625E6 x 3E-6 = 68.295 ohms.

So Q = 2.2E3 / 68.295 = 32.2

A5F09:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 3.625E6 x 42E-6 = 956.1 ohms.

So Q = 220 / 956.1 = 0.23

A5F10:
For the Q of a parallel R-L-C circuit we use the formula:

Q = Rp / X

Where:
X is the reactance of the inductor or capacitor at resonance.
R is the resistance in parallel with the tuned circuit.

In this circuit the inductive reactance is obtained from:
Xl = 2 x pi x Fr x L = 2 x 3.14 x 3.625E6 x 43E-6 = 978.895 ohms.

So Q = 1.8E3 / 978.895 = 1.84

A5F11:
Since $Q = Rp / X$ then reducing "Rp" will reduce "Q".

A5G01:
To calculate phase angle we use:

Tan (Phase angle) = X / R.

Where X = total reactance = Xl - Xc.
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (100-25) / 100 = 0.75
So Phase angle = 36.9 degrees
Xl - Xc is positive so the voltage leads the current.

A5G02:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (50-25) / 100 = 0.25
So Phase angle = 14 degrees
Xl - Xc is positive so the voltage leads the current.

A5G03:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (250-500) / 1000 = -0.25
So Phase angle = 14 degrees
Xl - Xc is negative so the voltage lags the current.

A5G04:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (100-75) / 100 = 0.25
So Phase angle = 14 degrees
Xl - Xc is positive so the voltage leads the current.

A5G05:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions.   The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (25-50) / 100 = -.25
So Phase angle = 14 degrees
Xl - Xc is negative so the voltage lags the current.

A5G06:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (50-75) / 100 = -.25
So Phase angle = 14 degrees
Xl - Xc is negative so the voltage lags the current.

A5G07:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (75-75) / 100 = -.25
So Phase angle = 14 degrees
Xl - Xc is negative so the voltage lags the current.

A5G08:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (500-250) / 1000 = 0.25
So Phase angle = 14.04 degrees
Xl - Xc is negative so the voltage leads the current.

A5G09:
To calculate phase angle we use:

Tan (Phase angle) = X / R

Where:
X = total reactance = Xl - Xc
R = total series resistance.

If X is negative then the circuit is capacitive and the voltage lags the current.
If X is positive then the circuit is inductive and the voltage leads the current.

To obtain Phase angle from Tan (Phase angle) you need a set of trigonometry tables or a calculator that supports inverse trig functions. The Tan (Phase angle) function can usually be accessed using the sequence INV TAN after entering a number.

In the question we have:
Tan (Phase angle) = (Xl - Xc) / R = (75-50) / 100 = 0.25
So Phase angle = 14 degrees
Xl - Xc is negative so the voltage leads the current.

A5G10:
In a pure capacitor, the voltage lags the current by 90 degrees.

A5G11:
In a pure inductor, the voltage leads the current by 90 degrees.

A5H01:
This is the power that is being transferred to and from a reactive component, but is not dissipated.

A5H02:
This is the power that is being transferred from and to a reactive component, but is not dissipated.

A5H03:
It is returned to the rest of the circuit and can not be dissipated in the reactive components.

A5H04:
The apparent power is the product of the current times the voltage as measured with a meter. The true power will be less than this.

A5H05:
Power factor can be obtained from cos (phase angle)
We have power factor = cos (60) = 0.5

A5H06:
Power factor can be obtained from cos (phase angle)
We have power factor = cos (45) = 0.707

A5H07:
Power factor can be obtained from cos (phase angle)
We have power factor = cos (30) = 0.866

A5H08:

True power = apparent power x power factor
And so true power = current x voltage x power factor

We get 4 x 100 x 0.2 = 80 watts.

A5H09:

The apparent power is given by voltage x current.

True power = apparent power x power factor

This gives 5 x 200 x 0.6 = 600 watts.

A5H10:
In this question apparent power means current x voltage.

So, true power = apparent power x power factor.

We get 500 x 0.71 = 355 watts.

A5H11:
Power factor = cos (phase angle) and this will always be equal to or less than one (1). Therefore, in a reactive circuit the true power will be less than (voltage times current).

A5I01:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 4 -2 -1 + 6 = -1 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question, we have antilog (-1 /10) = 0.794

So effective radiated power = 0.794 x 50 = 39.7 watts.

A5I02:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 5 -3 -1 + 7 = -2 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(-2 /10) = 0.63

So effective radiated power = 0.63 x 50 = 31.5 watts.

A5I03:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 4 + 10 = 6 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(6 /10) = 3.98

So effective radiated power = 3.98 x 75 = 299 watts.

A5I04:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 5 -3 -1 + 6 = -3 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(-3 /10) = 0.501

So effective radiated power = 0.501 x 75 = 37.6 watts.

A5I05:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 1 + 6 = 5 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(5 /10) = 3.16

So effective radiated power = 3.16 x 100 = 316 watts.

A5I06:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 5 -3 -1 + 10 = 1 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(1 /10) = 1.26

So effective radiated power = 1.26 x 100 = 126 watts.

A5I07:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 5 -3 -1 + 6 = -3 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(-3 /10) = 0.501

So effective radiated power = 0.501 x 120 = 60 watts.

A5I08:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 2 - 2.2 + 7 = 2.8 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(2.8 /10) = 1.905

So effective radiated power = 1.905 x 150 = 286 watts.

A5I09:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 4 -3.2 - 0.8+ 6 = 2 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(2 /10) = 1.585

So effective radiated power = 1.585 x 200 = 317 watts.

A5I10:
First we need to calculate the total loss between the transmitter and the antenna. Remember that antenna gain is given in dBd
- 2 - 2.8 -1.2 + 7 = 1 dB.

To convert to a power ratio we divide decibels by 10 and take the antilog of the result. For this question we have antilog(1 /10) = 1.259

So effective radiated power = 1.259 x 200 = 252 watts.

A5I11:
Effective radiated power can be greater than the actual output power of the transmitter.

A5J01:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (8,000 x 8,000) / (8,000 + 8,000) = 4,000 ohms = 4 kilohms. The equivalent series voltage is 8 x 8,000 / (8,000 + 8,000) = 4 volts.

A5J02:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (8,000 x 16,000) / (8,000 + 16,000) = 5,300 ohms = 5.3 kilohms. The equivalent series voltage is 8 x 8,000 / (8,000 + 16,000) = 2.6 volts.

A5J03:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (16,000 x 8,000) / (16,000 + 8,000) = 5,300 ohms = 5.3 kilohms. The equivalent series voltage is 8 x 16,000 / (16,000 + 8,000) = 5.3 volts.

A5J04:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (10,000 x 10,000) / (10,000 + 10,000) = 5,000 ohms = 5 kilohms. The equivalent series voltage is 10 x 10,000 / (10,000 + 10,000) = 5 volts.

A5J05:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (10,000 x 20,000) / (10,000 + 20,000) = 6,666 ohms = 6.67 kilohms. The equivalent series voltage is 10 x 10,000 / (10,000 + 20,000) = 3.33 volts.

A5J06:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (10,000 x 20,000) / (10,000 + 20,000) = 6,666 ohms = 6.67 kilohms. The equivalent series voltage is 10 x 20,000 / (10,000 + 20,000) = 6.66 volts.

A5J07:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (10,000 x 10,000) / (10,000 + 10,000) = 5,000 ohms = 5 kilohms. The equivalent series voltage is 12 x 10,000 / (10,000 + 10,000) = 6 volts.

A5J08:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (10,000 x 20,000) / (10,000 + 20,000) = 6,666 ohms = 6.7 kilohms. The equivalent series voltage is 12 x 10,000 / (10,000 + 20,000) = 4 volts.

A5J09:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (20,000 x 10,000) / (20,000 + 10,000) = 6,666 ohms = 6.7 kilohms. The equivalent series voltage is 12 x 20,000 / (20,000 + 10,000) = 8 volts.

A5J10:
This problem requires the use of Thevenin's Theorem. The equivalent series resistance is (20,000 x 20,000) / (20,000 + 20,000) = 10,000 ohms = 10 kilohms. The equivalent series voltage is 12 x 20,000 / (20,000 + 20,000) = 6 volts.

A5J11:
Thevenin's Theorem states:
A two terminal complex circuit containing any number of resistors and voltage sources can be replaced by a single series resistor and voltage source.

A6A01:

Germanium is a gray, brittle, metallic element. It is purified to 1 part in 10E10. Then, special impurities are added (doping) to make it a useful semiconductor.

Silicon makes up 25% of the earth's crust. It has a gray metallic sheen and is generally prepared from sand.

A6A02:
Semiconductor devices depend on the movement of charge carriers (holes and electrons) one factor limiting the maximum frequency that can be used is the mobility of the charge carriers. Gallium arsenide is a semiconductor compound that has highly mobile charge carriers.

A6A03:
The Antimony atoms contribute electrons.

A6A04:
Gallium is an acceptor of electrons. The resulting holes are positive charge carriers.

A6A05:
The free electrons are contributed by a donor impurity.   Antimony is a donor element.

A6A06:
The Arsenic atoms contribute electrons.

A6A07:
Indium is an acceptor of electrons. The resulting holes are positive charge carriers.

A6A08:
The charge carriers in P-type semiconductors are holes.   Holes are regions of positive charge.

A6A09:
The charge carriers in P-type semiconductors are holes.   Holes are regions of positive charge.

A6A10:
The charge carriers in N-type semiconductors are electrons. Electrons are carriers of negative charge.

A6A11:
The free electrons are contributed by a donor impurity. Antimony is a donor element.

A6A12:
For example indium is an acceptor of electrons. The resulting holes are positive charge carriers.

A6B01:
The constant voltage characteristic of Zener diodes is exploited in voltage regulation. The Zener effect occurs during reverse biasing of the diode junction.

A6B02:
The elongated "Z" in the symbol is a clue to the correct option.

A6B03:
Over part of the voltage/current characteristic, the voltage decreases as the current increases. This is a negative resistance region.

A6B04:
Over part of the voltage/current characteristic, the voltage decreases as the current increases. This is a negative resistance region. A circuit containing negative resistance is capable of exhibiting a power gain.

A6B05:
A tunnel diode cannot rectify. It has bi-directional properties. The symbol shows two diodes pointing in opposite directions.

A6B06:
Varactors are often employed to vary the resonant frequency of tuned circuits. The capacitance across the junction varies as the reverse bias voltage changes.

A6B07:
Can you see a capacitor symbol and a diode symbol combined in the varactor symbol?   A varactor diode is used as a voltage controlled capacitor.

A6B08:
Hot carrier diodes have low noise figures, good conversion efficiency, good dynamic range and excellent high frequency characteristics.

A6B09:
If the maximum junction temperature is exceeded then the junction will be destroyed. To limit the maximum temperature many high power semiconductor devices have heat sinks.

A6B10:
If these ratings are exceeded the junction will heat up beyond the maximum temperature.

A6B11:
In junction diodes the junction is fabricated using the standard semiconductor techniques of doping and etching. In point contact diodes a small conductor is placed in contact with the surface of a semiconductor and the junction is a small area around the contact.

A6B12:
Point contact diodes have low capacitance and are therefore suitable for high frequency applications.

A6B13:
A diode is a directional component. Its symbol looks like an arrow pointing at a line. The arrow points in the direction of conduction.

A6B14:
A pin diode is used as an RF switch by appearing as a capacitor or a high impedance depending on the bias conditions.

A6B15:
The symbol looks like an ordinary diode except that arrows representing rays of light are added.

A6B16:
This is because LED junctions glow when they are forward biased. Appreciable current flow occurs through the junction and it lights up.

A6C01:
Inductor cores increase the inductance by decreasing the "resistance" of the magnetic circuit.

A6C02:
Some core materials are designed for high permeability. Low frequency inductors use laminated iron cores. Mid range and RF inductors use ferrite materials. High frequency inductors are air cored.

A6C03:
Ferrite is a ceramic material containing iron compounds. It is mechanically superior to powdered iron toroids but powdered iron toroids are more temperature stable.

A6C04:
Ferrite is a ceramic material containing iron compounds. It is mechanically superior to powdered iron toroids but powdered iron toroids are more temperature stable.

A6C05:
The permeability of ferrite materials is generally higher.

A6C06:
For this application we need the highest possible inductance so that the choke will present a high impedance to the RFI.   A high permeability will help achieve this.

A6C07:
Ferrite has a high permeability. Therefore, ferrite beads increase the inductance of any wire passing through them. The extra reactance due to this inductance helps to prevent parasitic oscillations.

A6C08:
This useful property is exploited in power supplies in audio equipment. The external magnetic field of a toroidal power transformer is very small and unlikely to affect the rest of the circuit.

A6C09:
Bifilar wound transformers are used when the maximum possible coupling is desired.

A6C10:
The formula to obtain the number of turns required on a toroidal core is:
N= 1000 x square root (L/A)
A is the inductance index
N is the number of turns
L is inductance in mH
For this question:
N = 1000 x square root (1/523) = 43

A6C11:
The formula to obtain the number of turns required on a toroidal core is:
N= 1000 x square root (L/A)
A is the inductance index
N is the number of turns
L is inductance in mH
For this question:
N = 1000 x square root (5/40) = 35

A6D01:
Memorize these three names.

A6D02:
The difference between collector and emitter current is the base current.

A6D03:
This parameter, together with other circuit parameters determines the gain of a transistor amplifier stage,

A6D04:
The alpha cut off frequency is defined as the frequency at which the gain is 0.707 times the gain at 1000 Hz in grounded base mode.

A6D05:
The direction of the arrow is what determines the type of transistor.   Memorize this symbol.

A6D06:
The direction of the arrow is what determines the type of transistor.   Memorize this symbol.

A6D07:
The alpha cut off frequency is defined as the frequency at which the gain is 0.707 times the gain at 1000 Hz in grounded base mode.

A6D08:
The beta cut off frequency is defined as the frequency at which the gain is 0.707 times the gain at 1000 Hz in grounded emitter mode.

A6D09:
The transition region is electrically equivalent to the dielectric of a capacitor. The thickness (and therefore the junction capacitance) will vary with junction voltage.

A6D10:
A transistor being used as a switch and in the conducting state is saturated.

A6D11:
For a transistor that is being used as a switch and in the non-conducting state, it is said to be "cut off."

A6D12:
A unijunction transistor has two connected bases and an emitter. If you compare the symbol with the normal transistor symbol you will see how this symbol is derived.

A6D13:
A common application for unijunction transistors is in relaxation oscillator circuits.

A6E01:
An SCR is a semiconductor device that is non conducting until a trigger pulse arrives at the gate. The device then switches on and remains on until the supply is interrupted. SCRs are used in over voltage crowbar circuits.

A6E02:
An SCR is a semiconductor device that is non conducting until a trigger pulse arrives at the gate. The device then switches on and remains on until the supply is interrupted. SCRs are used in over voltage crowbar circuits.

A6E03:
It has a maximum forward current and a peak inverse voltage.

A6E04:
An SCR is a semiconductor device that is non conducting until a trigger pulse arrives at the gate. The device then switches on and remains on until the supply is interrupted. SCRs are used in over voltage crowbar circuits.

A6E05:
The symbol for a silicon controlled rectifier is like a normal rectifier with its anode and cathode connections. The extra controlling connection is called the gate.

A6E06:
A TRIAC can be used to control an AC circuit. The use of TRIACs has revolutionized the control of AC machinery. A typical domestic application is in lighting dimmer switches.

A6E07:
A TRIAC can be used to control an AC circuit. The use of TRIACs has revolutionized the control of AC machinery. A typical domestic application is in lighting dimmer switches.

A6E08:
A TRIAC is equivalent to two SCRs connected in parallel. One is forward biased and the other one is reverse biased. You can see the two SCRs in the schematic symbol.

A6E09:
An unconnected neon lamp can be used to detect strong RF fields.

A6E10:
Once a neon lamp is "struck" its resistance drops to a low level and the current through it must be limited.

A6E11:
The large circle represents the glass envelope and the two small circles are the electrodes. The dot indicates that the envelope is gas filled.

A6F01:
This is about the minimum bandwidth for reasonable quality speech signals.

A6F02:
Each sideband is about 2 kHz wide, but the sidebands lie on each side of the carrier position and a little distance away from it. So the whole signal occupies about 6 kHz.

A6F03:
Most receivers for radio amateur use have this type of filter for receiving SSB transmissions.

A6F04:
It is a minority of radio amateurs who make their own crystal filters.

A6F05:
The crystal frequency spacing affects the bandwidth as well as the frequency response in the passband.

A6F06:
This deformation can be used to generate sound as in piezoelectric alarm transducers.

A6F07:
A discrete device, such as the MFR901 bipolar transistor, gives worthwhile noise figures. They are about 2.5 dB at a power gain of about 10 dB. However, the MSA-0135 MMIC has a higher gain/bandwidth product. It also has good stability at 1,296 MHz.

A6F08:
The use of MMICs has made the construction of low noise microwave receivers much easier.

A6F09:
The device sits in a small hole separating the input and output enclosures. The ground leads are soldered to the sides of the hole. Meanwhile, the input and output leads are soldered to copper or silver strips. The strips function as input and output tuned circuits.

A6F10:

The device sits in a small hole separating the input and output enclosures. The ground leads are soldered to the sides of the hole. Meanwhile, the input and output leads are soldered to copper or silver strips. The strips function as input and output tuned circuits.

A6F11:

This is the power supply to the device. The RF choke will typically be 8 turns of thin wire close wound with an air core of about 0.1 inches.

A7A01:
Class A and Class B amplifiers are linear amplifiers. They are the only types suitable for amplifying SSB signals. Class A amplifiers have the best linearity, but are the least efficient. They have only about 20% efficiency.

A7A02:
Class A and Class B amplifiers are linear amplifiers. They are the only types suitable for amplifying SSB signals. Class A amplifiers have the best linearity, but are the least efficient. The average DC input current is constant regardless of the input drive.

A7A03:
Class AB amplifiers are biased so that they are a compromise between class A and Class B amplifiers.

A7A04:
In a class B amplifier only half of the input signal cycle appears at the output. Under zero drive conditions little or no current is drawn from the power supply. Class B amplifiers are often run in pairs. Each one will be one working for half of the signal cycle.

A7A05:
A Class C amplifier is non-linear. It is also more efficient than the other amplifier classes. It has a typical efficiency of 80%. The amplifier device is biased in the zero current condition. In a no drive condition, there is no current drawn from the power supply. When driven, the output of a Class C amplifier is a series of short pulses. The pulses are less than half of the signal cycle.

A7A06:
A Class C amplifier is non-linear. It is also more efficient than the other amplifier classes. It has a typical efficiency of 80%. The amplifier device is biased in the zero current condition. In a no drive condition, there is no current drawn from the power supply. When driven, the output of a Class C amplifier is a series of short pulses. The pulses are less than half of the signal cycle.

A7A07:
The saturation point is where no additional output occurs when the drive is increased.

A7A08:
This is fairly straightforward. The RF power out could be measured with an oscilloscope and a dummy load. The DC power in is calculated as (amplifier current times amplifier voltage).

A7A09:
Neutralization is the application of a small amount of negative feedback to cancel out the positive feedback that can occur within a power amplifier active device. The trick is to make sure that the cancellation is maintained over a range of signal frequencies and amplifier operating conditions.

A7A10:
As the procedure is carried out, the RF output power increases.

A7A11:
The even-order harmonics cancel out if the two halves of the push-pull amplifier are evenly matched.

A7A12:
Intermodulation products will be generated by a none linear amplifier resulting in distortion and broadening of the signal.

A7B01:
Neutralization is the application of a small amount of negative feedback. This cancels out the positive feedback that can occur. Positive feedback is usually caused by the interelectrode capacitance of the power amplifier tube. The trick is to make sure that the cancellation is maintained over a range of signal frequencies and amplifier operating conditions.

A7B02:
Energy is stored in an L-C circuit. An analogy is a flywheel that stores energy.

A7B03:
A higher tank Q will result in high current losses within the tank coil.   A lower tank Q will result in greater harmonic output.

A7B04:
The emitter is at ground potential for ac due to C3. The input signal is applied across base and emitter. The output signal appears across collector and emitter. The emitter is common to both input and output.

A7B05:
The resistors form a "potential divider". This biases the transistor into the required operating region.

A7B06:
C1 allows the AC signal to get to the transistor. However, it prevents DC from the previous stage from affecting the bias.

A7B07:
C3 keeps the emitter at ground potential as far as AC signals are concerned.

A7B08:
A DC voltage exists across R3. It raises the emitter voltage relative to the base voltage. R3 contributes toward the transistor bias.

A7B09:
Because of C1, the collector is at ground potential for AC. The input signal is applied across base and collector (by way of ground and C1). The output signal appears across collector and emitter. The collector is common to both input and output.

A7B10:
As the emitter current varies the voltage across R will vary and this voltage is available as an output.

A7B11:
C1 connects the AC potential of the power rail to ground. This allows the collector to function as the common electrode..

A7B12:
The AC signal across R is passed to the next stage by C2. This prevents DC from disturbing the bias conditions of the next stage.

A7B13:
A circuit like this is used in most electronics equipment. Sometimes the components are fabricated as a single device (except for the capacitors). An alternative type of regulator, called a switching regulator, is more efficient. However, it is much more complex to design and build.

A7B14:
D1 is a Zener diode. The voltage drop across it is constant over a range of current.

A7B15:
A Zener diode on its own can function as a shunt regulator but the current range of such a regulator is limited to the constant voltage portion of the Zener diode current versus voltage characteristic.

A7B16:
Direct current is obtained from alternating current using rectifiers. Rectifiers give a pulsing DC output. C1 filters these pulses, leaving a steady DC voltage. In a practical circuit, C1 will be an electrolytic capacitor.

A7B17:

We need the current through D1 to be as steady as possible since the voltage across it is used as a reference by Q1. C1 reduces any hum that may be present on the input to the regulator.

A7B18:
Along with C3, there will also be a number of decoupling capacitors. They will be distributed around the load circuit.

A7B19:
The value should be such as to supply current to D1 that is on the constant voltage part of its current versus voltage characteristic.

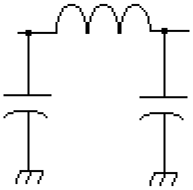
A7B20:
Having a constant current portion in the regulator load helps the voltage regulation.

A7C01:
A pi network is often used for coupling a transmitter RF amplifier to the antenna feedline.

A7C02:
The plate impedance of a tube amplifier could be as high as 8,000 ohms. The pi network couples this to the 50 ohm impedance feedline.

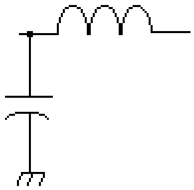
A7C03:
In a schematic diagram, the components of a pi-network form the Greek letter "pi".

A pi network:



A7C04:
In a schematic diagram of an L-network, the components form an inverted letter "L". The capacitor forms the vertical leg and the inductor forms the horizontal leg.

An L network:



A7C05:
A pi network gives a greater impedance transformation range than an L-network.

A7C06:
This is a pi-network with an L-network on the output (antenna) side.

A7C07:
The capacitors are in series with the signal and present a smaller reactance at higher frequencies. The inductor is a low reactance at low frequencies and is in parallel with the signal. Both of these effects combine to make the T-filter a high pass filter.

A7C08:
The extra section aids in harmonic suppression. If a 14 MHz signal has a significant harmonic on 28 MHz then this will be efficiently radiated by a 14/21/28 MHz multiband antenna.

A7C09:
The extra section aids in harmonic suppression. If a 14 MHz signal has a significant harmonic on 28 MHz then this will be efficiently radiated by a 14/21/28 MHz multiband antenna.

A7C10:
They are generally called tank circuits. Another important function is harmonic suppression.

A7C11:
Ideally a load should be resistive and of the correct resistance. A matching network can achieve both of these requirements.

A7D01:
All three filters are widely used in amateur radio.

A7D02:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain C

Where Fr is the resonant frequency
L is inductance in Henrys
C is capacitance in Farads.

C = [(1/(2 x pi x Fr)) squared] / L

If we take "Fr" as 3.5 MHz for the 80-meter band then:

C = [(1/(2 x 3.14 x 3.5E6)) squared] / 20E-6

We get C = 1.03E-10 Farads = 100 picofarads.

A7D03:
We have to re arrange the following formula to obtain L:
Fr = 1 / [2 x pi x square root (L x C)]

Where Fr is the resonant frequency
L is inductance in Henrys
C is capacitance in Farads

L = [(1 / (2 x pi x Fr))squared] / C

If we take Fr as 7.0 MHz for the 40-meter band then:

L = [(1 / (2 x 3.14 x 7.0E6))squared] / 100E-12

We get L = 5.1E-6 henrys = 5 microhenrys.

A7D04:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain C

Where Fr is the resonant frequency
L is inductance in Henrys
C is capacitance in Farads

C = [(1/(2 x pi x Fr)) squared] / L

If we take Fr as 14 MHz for the 20-meter band then:

C = [(1/(2 x 3.14 x 14E6)) squared] / 2E-6

We get C = 6.4-11 Farads = 64 picofarads.

A7D05:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain L

Where Fr is the resonant frequency
L is inductance in Henrys
C is capacitance in Farads

L = [(1/(2 x pi x Fr)) squared] / C

If we take Fr as 21 MHz for the 15-meter band then:

L = [(1/(2 x 3.14 x 21E6))squared] / 15E-12

We get L = 3.8E-6 henrys = 4 microhenrys.

A7D06:
We have to re arrange the formula:
Fr = 1 / [2 x pi x square root (L x C)] to obtain C

Where Fr is the resonant frequency
L is inductance in Henrys
C is capacitance in Farads

C = [(1/(2 x pi x Fr))squared] / L

If we take Fr as 1.8 MHz for the 160-meter band then:

C = [(1/(2 x 3.14 x 1.8E6))squared] / 100E-6

We get C = 7.8E-11 Farads = 78 picofarads.

A7D07:
The pass band of a Butterworth filter is free of ripple.

A7D08:
A Chebyshev filter will typically have steeper skirts than a Butterworth filter with a similar number of components.

A7D09:
The sharp cutoff is achieved at a cost of some ripple in the passband.

A7D10:
An elliptical filter design can be regarded as an extreme version of the Chebyshev filter. This is where the passband ripples are infinitely deep and the cut-off is even sharper.

A7D11:
An elliptical filter design can be regarded as an extreme version of the Chebyshev filter where the passband ripples are infinitely deep and the cut-off is even sharper.

A7E01:
The control element is often a high power transistor. The line voltage is compared to a reference voltage (often this is a Zener diode) to derive a difference signal that is fed to the control element.

A7E02:
The switching is done at a fairly high frequency and the resultant pulses can be smoothed to DC fairly easily without the need for large filter components. Since the control device is being rapidly switched a relatively small amount of heat is generated.

A7E03:
A Zener diode has a junction that, when reverse biased across a certain current range, has a fairly constant voltage across it. Zener diodes come in a variety of voltage and current ratings.

A7E04:
The control element is in series with the load.

A7E05:
The voltage across the load is varied by varying the amount of current bypassed into the control element. The element is in parallel with the load.

A7E06:
We need an operating voltage that is high enough to provide a good reference voltage. However, it must not be too high for reasons of temperature stability.

A7E07:
Remote sensing allows voltage drops in the wiring to a high current load to be sensed. It can then be compensated for by adjusting the voltage of the power supply.

A7E08:
This device contains all the components needed for a complete regulator circuit. One terminal is usually (but not always) grounded. One is the unregulated input and the other is the regulated output. Three terminal regulators come in many voltage and current ratings.

A7E09:
If you were choosing a three terminal voltage regulator, you would have to consider the amount of regulation given by the device and whether any overload protection was present.

A7E10:
A Zener diode can be used as a two terminal, shunt type voltage regulator.

A7E11:
This device contains all the components needed for a complete regulator circuit. One terminal is usually (but not always) grounded. One is the unregulated input and the other is the regulated output. Three terminal regulators come in many voltage and current ratings.

A7F01:
Oscillators all rely on positive feedback. The three oscillators in this question use different methods to apply this feedback.

A7F02:
For maximum purity of output the positive feedback should be just sufficient to overcome losses, but no more.

A7F03:
The tap is at the lowest position to maintain oscillation. Less than 25% is usually sufficient, depending on the gain of the active device.

A7F04:
The capacitors in the divider must be selected to give the least possible amount of feedback consistent with reliable oscillation. The extra capacitance in the divider appears across the oscillator tuned circuit, which means that a smaller inductance is used in the parallel tuned version of the Colpitts oscillator.

A7F05:
The feedback capacitor is actually the capacitance of a series connected crystal

A7F06:
In the Pierce oscillator the feedback path is by way of a crystal that has capacitance. The reactance of this capacitance is low enough for feedback to occur.

A7F07:
Using a quartz crystal to determine the frequency results in a more frequency stable oscillator. For a given crystal the frequency of the oscillator can only be varied slightly. For wider frequency coverage there must be several switched crystals.

A7F08:
Colpitts and Hartley oscillators are both controlled by L-C tuned circuits. The frequency can be varied over a range by varying either the L or the C. It is usually the C that is varied. Since L and C are determined by mechanical dimensions the L-C part of a VFO must be constructed for maximum mechanical stability.

A7F09:
The construction of a stable VFO oscillator is something of an art. In the case of a Colpitts oscillator it is important to carefully select the capacitors for temperature stability. Polystyrene capacitors are good in this respect.

A7F10:
Frequency control by use of a varactor diode is a quite coarse method when used by itself. It is often used as part of a phase locked loop circuit.

A7F11:
This is because the output signal is phase locked to the reference oscillator signal.

A7G01:
In amateur radio communication the information is speech or data.

A7G02:
FM is generated by varying a reactance in the oscillator tuned circuit. The reactance is always capacitive for practical reasons. If the final amplifier is reactance modulated then phase modulation will result.

A7G03:

FM is generated by varying a reactance in the oscillator tuned circuit. The reactance could be inductive, but is always capacitive for practical reasons. If the final amplifier is reactance modulated then phase modulation will result.

A7G04:
FM is generated by varying a reactance in the oscillator tuned circuit. The reactance could be inductive, but is always capacitive for practical reasons. If the final amplifier is reactance modulated then phase modulation will result.

A7G05:
Phase modulation sounds and behaves much like frequency modulation.

A7G06:
If the final amplifier is reactance modulated then phase modulation will result. The reactance could be inductive, but is always capacitive for practical reasons.

A7G07:
The balancing refers to cancellation of the carrier. Balanced modulators can provide 30-50 dB of carrier suppression.

A7G08:
One of the sidebands is filtered out. The suppressed carrier is further reduced by the filter skirt attenuation that may be 20 - 30 dB. Total carrier suppression of 80 dB is not uncommon.

A7G09:
This is the classical method of producing a double sideband with carrier AM signal.

A7G10:
A pre-emphasis network in the transmitter attenuates lower frequencies and emphasizes the higher ones. The resulting audio band has an even spread of energy. A de-emphasis network in the receiver restores the original signal. A result of this processing is a better overall signal to noise ratio.

A7G11:
A pre-emphasis network in the transmitter attenuates lower frequencies and emphasizes the higher ones. The resulting audio band has an even spread of energy. A de-emphasis network in the receiver restores the original signal. A result of this processing is a better overall signal to noise ratio.

A7H01:
This is the opposite of modulation. An alternate term for detection is de-modulation.

A7H02:
A diode is the simplest type of detector. A tuned circuit diode is the simplest type of radio receiver. It is called a "crystal set".

A7H03:
The locally generated carrier replaces the carrier that was removed in the transmitter. It must be very close to the original carrier position for proper reproduction of the original modulating signal.

A7H04:
A discriminator is another name for an FM detector.

A7H05:
A discriminator is another name for an FM demodulator.

A7H06:
Signal to noise ratio is not relevant since an active filter is used at a point in the receiver where the signal level is high.

A7H07:
If the interfering signal is a plain carrier it will have a very narrow bandwidth and can be "notched out" with little effect on the SSB transmission.

A7H08:
Typical SSB filters are built from a number of elements to produce the required passband and skirt shape. The resulting phase response in the filter passband is not important for speech work.

A7H09:
The adaptive filter will analyze the signal and remove parts of it that contain signals that do not change with time.

A7H10:
Notch and elliptical filters are not necessarily digital signal processing filters. An adaptive filter is used to reduce extraneous signals.

A7H11:
A cavity filter will have a very high Q value. This will give the filter a narrow bandwidth. It will have little loss at the center of the passband.

A7I01:
For new frequencies to be produced there must be a non linear element in the mixer circuit.

A7I02:
For new frequencies to be produced there must be a non linear element in the mixer circuit.

A7I03:
A wide range of input frequencies is converted to a standard frequency. Tuned circuits and filters can be more easily optimized when designed for a fixed frequency.

A7I04:
The spurious products will be heard as extra signals.

A7I05:
A frequency synthesizer has the best of both worlds. It has the high stability of a fixed reference source and the ability to output a wide range of frequencies.

A7I06:
A direct digital synthesizer uses digital computer techniques to synthesize a sine-wave. The amplitude values at regular intervals of a sine wave are stored in a lookup table. These amplitude values are read out in succession to produce a signal. The anti-alias filter removes the "steps" produced between each amplitude value.

A7I07:
A frequency synthesizer has the best of both worlds. It has the high stability of a fixed reference source and the ability to output a wide range of frequencies.

A7I08:
A direct digital synthesizer uses digital computer techniques to synthesize a sine-wave. The amplitude values at regular intervals of a sine wave are stored in a lookup table. These amplitude values are read out in succession to produce a signal. The anti-alias filter removes the "steps" produced between each amplitude value.

A7I09:
A direct digital synthesizer uses digital computer techniques to synthesize a sine-wave. The amplitude values at regular intervals of a sine wave are stored in a lookup table. These amplitude values are read out in succession to produce a signal. The anti-alias filter removes the "steps" produced between each amplitude value.

A7I10:
The spurs correspond to the steps that are produced during digital synthesis of the signal.

A7I11:
Some of this noise comes from random phase variations in the reference source. Another source is the junction in the varactor diode that controls the output signal as well as noise on the varactor control signal.

A7J01:
This upper limit is what determines the bandwidth of the transmitted signal.

A7J02:
This answer is fairly self-explanatory. RMS values for each harmonic are obtained and then the values are summed.

A7J03:
Gains of more than 100 dB are common with this configuration.

A7J04:
The output from a microphone will be a few millivolts, much too low for a modulator.

A7J05:
Because it is fixed-tuned the frequency response can be tailored exactly to communications requirements.

A7J06:
Good selectivity is easier to achieve at low IF frequencies but better RF image rejection can be obtained at high IF frequencies.

A7J07:
This stage may include crystal or other types of filters.

A7J08:
This concept provides the ultimate in image rejection performance.

A7J09:
Mixers are inherently quite noisy devices and so the input signal must be raised to a higher level if weak signals are not to be swamped by mixer noise. If too much RF signal is present then the mixer will generate spurious products.

A7J10:
Mixers are inherently quite noisy devices and so the input signal must be raised to a higher level if weak signals are not to be swamped by mixer noise. If too much RF signal is present then the mixer will generate spurious products.

A7J11:
Mixers are inherently quite noisy devices and so the input signal must be raised to a higher level by an RF amplifier if weak signals are not to be swamped by mixer noise. The receiver noise figure will be mainly determined by the noise performance of the RF amplifier.

A8A01:
Facsimile (FAX) is the transmission of printed pictures. As a dot of light scans across the document the scattered light varies. These light variations are converted to a voltage variation and sent to the FAX receiver. AM facsimile is designated by A3C while FM FAX is designated by F3C (see ITU Emission Designators).

A8A02:
Facsimile (FAX) is the transmission of printed pictures. As a dot of light scans across the document the scattered light varies. These light variations are converted to a voltage variation and sent to the FAX receiver. AM facsimile is designated by A3C while FM FAX is designated by F3C (see ITU Emission Designators).

A8A03:
Facsimile (FAX) is the transmission of printed pictures. As a dot of light scans across the document the scattered light varies. These light variations are converted to a voltage variation and sent to the FAX receiver. AM facsimile is designated by A3C while FM FAX is designated by F3C (see ITU Emission Designators).

A8A04:
Facsimile (FAX) is the transmission of printed pictures. As a dot of light scans across the document the scattered light varies. These light variations are converted to a voltage variation and sent to the FAX receiver. AM facsimile is designated by A3C while FM FAX is designated by F3C (see ITU Emission Designators).

A8A05:
Facsimile (FAX) is the transmission of printed pictures. As a dot of light scans across the document the scattered light varies. These light variations are converted to a voltage variation and sent to the FAX receiver. AM facsimile is designated by A3C while FM FAX is designated by F3C (see ITU Emission Designators).

A8A06:
Television is designated by A3F in the case of amplitude modulated television signals and F3F for FM modulated television (see ITU Emission Designators).

A8A07:
Television is designated by A3F in the case of amplitude modulated television signals and F3F for FM modulated television (see ITU Emission Designators).

A8A08:
Television is designated by A3F in the case of amplitude modulated television signals and F3F for FM modulated television (see ITU Emission Designators).

A8A09:
Television is designated by A3F in the case of amplitude modulated television signals and F3F for FM modulated television (see ITU Emission Designators).

A8A10:
J3F is the ITU emission designator for slow scan television signals (see ITU Emission Designators).

A8A11:
The key word here is "telegraphy."

A8B01:
(See ITU Emission Designators.)

A8B02:
(See ITU Emission Designators.)

A8B03:
(See ITU Emission Designators.)

A8B04:
(See ITU Emission Designators.)

A8B05:
(See ITU Emission Designators.)

A8B06:
(See ITU Emission Designators.)

A8B07:
(See ITU Emission Designators.)

A8B08:
(See ITU Emission Designators.)

A8B09:
(See ITU Emission Designators.)

A8B10:
(See ITU Emission Designators.)

A8B11:
(See ITU Emission Designators.)

A8C01:
FM is generated by varying a reactance in the oscillator tuned circuit. The reactance could be inductive but is always capacitive for practical reasons. If the final amplifier is reactance modulated then phase modulation will result.

A8C02:
One of the sidebands is filtered out. The suppressed carrier is further reduced by the filter skirt attenuation that may be 20 - 30 dB. Total carrier suppression of 80 dB is not uncommon.

A8C03:
The formula for modulation index is:
(Maximum carrier frequency deviation Hz) / (Modulation frequency Hz).

A8C04:
The formula for modulation index is:
(Maximum carrier frequency deviation Hz) / (Modulation frequency Hz).

A8C05:
The formula for modulation index is:
(Maximum carrier frequency deviation Hz) / (Modulation frequency Hz).

There is no term for carrier frequency in this formula.

A8C06:
The formula for modulation index is:
(Maximum carrier frequency deviation Hz) / (Modulation frequency Hz).

We have:
Modulation index = 3000 / 1000 = 3

A8C07:
The formula for modulation index is:
(Maximum carrier frequency deviation Hz) / (Modulation frequency Hz).

We have:
Modulation index = 63000 / 2000 = 3

A8C08:
Deviation ratio is given by the formula:
Deviation ratio = (Maximum carrier deviation Hz) / (Highest modulation frequency Hz).

A8C09:
Deviation ratio is given by the formula:
Deviation ratio = (Maximum carrier deviation Hz) / (Highest modulation frequency Hz).

A8C10:
Deviation ratio is given by the formula:
Deviation ratio = (Maximum carrier deviation Hz) / (Highest modulation frequency Hz).

In the question we have:
Deviation ratio = 5000 / 3000 = 1.66

A8C11:
Deviation ratio is given by the formula:
Deviation ratio = (Maximum carrier deviation Hz) / (Highest modulation frequency Hz).

In the question we have:
Deviation ratio = 7,500 / 3,500 = 2.14

A8D01:
When we refer to polarization, it is always the electric field that is referenced.

A8D02:
At this velocity it takes about 8 minutes for light from the sun to reach us. It can take millions of years for light from some stars to reach us! If you have full break in keying and are using a long distance band under good conditions you may be able to hear your own "dits" after they have traveled around the earth.

A8D03:
This principle is the basis of RF shielding.

A8D04:
Electromagnetic waves do not require a transmission medium. They can propagate across a perfect vacuum.

A8D05:
When we describe polarization it is always the electric field that is referenced.

A8D06:
Circularly polarized radio waves can be generated by helical antennas. The waves can have a left hand or right hand twist…honestly!

A8D07:
The electromagnetic field is always at right angles to the electric field. Normally, it is the electric field that we refer to when describing polarization.

A8D08:
The electromagnetic field is always at right angles to the electric field. Normally, it is the electric field that we refer to when describing polarization.

A8D09:
The electromagnetic field is always at right angles to the electric field. Normally, it is the electric field that we refer to when describing polarization.

A8D10:
The electromagnetic field is always at right angles to the electric field. Normally, it is the electric field that we refer to when describing polarization.

A8D11:
At HF atmospheric noise is always greater than receiver generated front-end noise.

A8D12:
At VHF atmospheric noise is at low levels and receiver front-end noise places a lower limit on weak signal reception.

A8E01:
A clue to the correct answer is the reference to trigonometry, which relates to circles or circular movement. If you feed two sine waves to the horizontal and vertical plates of an oscilloscope and they are of equal frequency (and 90 degrees out of phase) then a circle will be seen.

A8E02:
Once at the 180 degree halfway point then as it finishes at the 360 degree point.

A8E03:
Just like on a protractor.

A8E04:
A sine wave cycle has a positive half and a negative half.

A8E05:
The wave gets its name from the shape when seen on an oscilloscope.

A8E06:
The wave gets its name from the square shape when seen on an oscilloscope.

A8E07:
All wave shapes can be analyzed in terms of combinations of sine waves. This technique is called Fourier analysis.

A8E08:
All wave shapes can be analyzed in terms of combinations of sine waves. This technique is called Fourier analysis.

A8E09:
The wave gets its name from the shape when seen on an oscilloscope. It looks like a close-up of the cutting edge of a saw blade.

A8E10:
The wave gets its name from the shape when seen on an oscilloscope. It looks like a close-up of the cutting edge of a saw blade.

A8E11:
All wave shapes can be analyzed in terms of combinations of sine waves. This technique is called Fourier analysis.

A8F01:
Peak voltage = RMS voltage x 1.414

For this question:
Peak voltage = 117 x 1.414 = 170 volts (approximately).

A8F02:
Peak-to-peak voltage is how you would measure an ac waveform on an oscilloscope. It is measured from the bottom to the top of the displayed waveform. It is twice the peak voltage. In this question peak-to-peak voltage from a household electrical outlet is:
RMS voltage x 1.414 x 2 = 117 x 1.414 = 340 volts (approximately).

A8F03:
The RMS voltage is the equivalent DC voltage that would produce the same heating effect if connected to a resistor. RMS voltage = peak voltage / 1.414

A8F04:
In this question we halve the peak-to-peak voltage to get the peak voltage. We must then divide by 1.414 to get the RMS voltage.
RMS voltage = (Peak-to-peak voltage / 2) / 1.414 = 120 volts

A8F05:
The RMS voltage is the equivalent DC voltage that would produce the same heating effect as the AC voltage if it were connected to a resistor.   RMS voltage = peak voltage / 1.414

A8F06:
The RMS value would be the voltage of a DC waveform that produced the same heating effect.

A8F07:
The 1.414 value used in RMS to peak voltage calculations only applies to sine waves. A speech waveform is nothing like a sine wave and often results in a ratio of about 2.5 for many voices.

A8F08:
The 1.414 value used in RMS to peak voltage calculations only applies to sine waves. A speech waveform is nothing like a sine wave and often results in a ratio of about 2.5 for many voices.

A8F09:
In a Class B amplifier efficiency is about 60%.
RF output = DC input x efficiency
So DC input = RF output / efficiency = 1500 / 0.6 = 2,500 watts.

A8F10:
In a Class C amplifier efficiency is about 80%.
RF output = DC input x efficiency
So DC input = RF output / efficiency = 1000 / 0.8 = 1,250 watts.

A8F11:
In a Class AB amplifier efficiency is about 50%.
RF output = DC input x efficiency
So DC input = RF output / efficiency = 500 / 0.5 = 1000 watts.

A9A01:
An antenna with a 50 ohm radiation resistance would be a good match to a 50 ohm feedline.

A9A03:
An antenna with a 50 ohm radiation resistance would be a good match to a 50 ohm feedline.

A9A04:
An antenna with a 50 ohm radiation resistance would be a good match to a 50 ohm feedline. Factors such as the presence of nearby objects causes the radiation resistance to vary and result in reflected power due to the mismatch.

A9A05:
Antenna efficiency = Radiation resistance / (radiation resistance + ohmic resistance) x 100

A9A06:
Antenna efficiency = Radiation resistance / (radiation resistance + ohmic resistance) x 100

A9A07:
On VHF a folded dipole is made of parallel rigid conductors, and may be fabricated from a single, folded rod. On HF a folded dipole could be made from a length of twin lead transmission line. The conductors would have to be joined at the ends.

A9A08:
A folded dipole can be fed with 300 ohm twin feeder. A matching network will be needed at the transmitter end. Folded dipoles have greater bandwidth than simple dipoles, since the effective element thickness is greater.

A9A09:
The "other antenna" is sometimes a dipole or it may be a theoretical isotropic (point source) antenna.

A9A10:
Higher gain antennas tend to have smaller bandwidths. Also, lower frequency antennas tend to have narrower bandwidths.

A9A11:
This can be done using your receiver S-meter, a signal of constant amplitude and your antenna rotator.

A9A12:
Antenna efficiency = Radiation resistance / (radiation resistance + ohmic resistance) x 100

A9A13:
The radials can be on, or just below, ground level.   Good connections at the central point are important.

A9B01:
The electromagnetic field is always at right angles to the electric field. Normally, it is the electric field that we refer to when describing polarization.

A9B02:
Azimuth is an angle measured clockwise from the North. The angles around an azimuth chart are directions.

A9B03:
The main lobe is the one that extends to the edge of the chart. It is in the upward position on this chart. At approximately 25 degrees each side of the upward position the lobe is about 3 dB from the edge, giving a total beamwidth of 50 degrees.

A9B04:
The lobe at 180 degrees from the main lobe is 18 dB away from the edge of the chart.

A9B05:
The radiation resistance determines how much power is transferred from the feedline. The field patterns indicate directions of maximum/minimum radiation. The loss resistance affects how much power is absorbed by the antenna structure.

A9B06:
Dielectric constant is a term used to describe insulators. It does not vary with frequency and is not relevant to antenna design. The other options are all antenna characteristics that will vary with frequency.

A9B07:
Antenna design is a compromise between many different requirements.

A9B08:
As well as a gain increase, there is an increase in antenna bandwidth as the element spacing increases.

A9B09:
A "moment" is a single value that is derived from a set of values. In antenna modeling programs the antenna elements are modeled as a set of segments, each having a specific current. The total effect of an element at any given point in space is a "moment" of the effects of all the segments in that element.

A9B10:
A "moment" is a single value that is derived from a set of values. In antenna modeling programs the elements are modeled as a set of segments, each having a specific current.

A9B11:
The side lobes, at 90 degrees from the main lobe in this example, are 14 dB away from the edge of the chart.

A9C01:
The angles around the edge of an elevation pattern represent upward tilt. An elevation of 90 degrees is vertical while 0 degrees elevation is horizontal.

A9C02:
The electric field lines are in a direction parallel to the elements and so it is horizontally polarized.

A9C03:
Perfectly conducting soil would result in a pattern like a vertical dipole in free space. The elevation pattern would show a maximum in the horizontal direction.

A9C04:
The conductivity of the soil is not relevant to the RF characteristics of an antenna that uses an adequate system of ground radials. The optimum length of the radials is the same length as the height of the antenna. In the antenna example here 60 ground radials is already ample!

A9C05:
A perfectly conducting ground would result in a pattern like a vertical dipole in free space. The elevation pattern would show a maximum in the horizontal direction. Sea water is a better conductor than rocky soil and so the antenna would behave more like a vertical dipole in free space.

A9C06:
At antenna heights of one wavelength and above effects due to ground proximity become insignificant.

A9C07:
In many elevated radial designs, the radials slope downwards. They double as guy wires for the supporting mast. A further advantage of this design is that the downward slope of the radials results in a feed impedance of about 50 ohms.

A9C08:
The size of the mesh should be approximately equal to the height of the antenna.

A9C09:
The main (largest) lobe touches the edge of the chart at 7.5 degrees.

A9C10:
The small lobe pointing away from the main lobe is 28 dB away from the edge of the chart.

A9C11:
There are four lobes in the same direction as the main lobe.

A9D01:
A folded dipole has a feed impedance four times greater than a simple dipole.

A9D02:
The position of the loading coil is a compromise. If the coil is placed near the top then the high current portion of the antenna will be longer, resulting in greater radiation efficiency. However the coil will require more inductance for resonance. More inductance requires more turns. This adds to the total antenna resistance and reduces the efficiency. A base-loaded vertical requires the least coil inductance. However, it is the least efficient due to the current carrying portion of the antenna being limited to the coil.

A9D03:
The loading coil should be air cored and be wound with thick wire to reduce ohmic losses. You might be able to fabricate a self supporting coil from copper microbore heating tube!

A9D04:
An antenna that is shorter than a quarter wavelength will be capacitive.

A9D05:
For example, a dual band antenna for 14 and 28 MHz will efficiently radiate second harmonic emissions from a transmitter working on 14 MHz.

A9D06:
The traps act as isolators that shorten the elements when the antenna is used on the higher frequency bands. The traps are parallel resonant tuned circuits.

A9D07:
So the coil inductance has to be increased and the matching coil of L-network has to be adjusted. In practice, a mobile antenna will be preset for a preferred working frequency.

A9D08:
Both the transmission-line impedance and the antenna feedpoint impedance are needed to determine what impedance transformation is needed.

A9D09:
The impedance matching section is not a quarter wave in length and this will introduce reactance at the feedline connection. Shortening the driven element slightly will introduce enough reactance to cancel the reactance of the matching section.

A9D10:
It is equivalent to a series inductor, which is why the driven element needs to be slightly capacitive.

A9D11:
The bandwidth tends to become dominated by the Q of the loading coil.

A9D12:
It is the current section of the antenna that does most of the radiating. A top loaded antenna will have a longer current section.

A9E01:
The velocity factor is influenced mainly by the dielectric of a transmission line.

A9E02:
The velocity factor is influenced mainly by the dielectric of a transmission line.

A9E03:
So the length of a quarter wave section using this type of feeder is 0.66 x (quarter wave length in free space)

A9E04:
Less lossy dielectrics tend to have velocity factors closer to one (1).

A9E05:
The velocity of electromagnetic waves is given as 299,792,458 meters per second in free space. When the electromagnetic energy encounters matter the velocity is always reduced. The velocity is usually approximated to 300,000,000 meters per second in radio calculations.

A9E06:
At 14.1 MHz a quarter wavelength in free space is:
(3e8 / 14.1E6) / 4 = 5.3 meters
So the physical length of a quarter wave transmission line at this frequency (velocity factor = 0.66) is:
5.3 x 0.66 = 3.51 meters.

A9E07:
At 14.1 MHz a quarter wavelength in free space is:
(3e8 / 7.2E6) / 4 = 10.4 meters
So the physical length of a quarter wave transmission line at this frequency (velocity factor = 0.66) is:
10.4 x 0.66 = 6.88 meters.

A9E08:
At 14.1 MHz a quarter wavelength in free space is:
(3e8 / 14.1E6) / 2 = 10.6 meters
So the physical length of a quarter wave transmission line at this frequency (velocity factor = 0.66) is:
10.6 x 0.95 = 10.1 meters.

A9E09:
No calculation is required for this question. The frequency is not relevant. A velocity factor of 0.8 means that the physical length is (electrical length) x 0.8

A9E10:
The reflection coefficient is defined as:
(voltage in the reflected wave) / (Voltage in forward wave).

A9E11:
In practice SWRs of up to 2:1 may be considered tolerable.

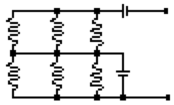
A9E12:
At 50 MHz RG-58 cable has a loss of 3.5 dB per 100 feet while 450-ohm ladder line has a loss of less than 0.3 dB per 100 feet.

ITU emission designators

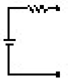
First Symbol	Type of main modulation.
N	Unmodulated
A	Amplitude modulation
J	SSB suppressed carrier
F	Frequency modulation
G	Phase modulation
P	Unmodulated pulses
Second Symbol	Modulating signal
0	No modulation
1	Unmodulated digital channel
2	Modulated digital channel
3	Single analog channel
7	Two or more channels, digital
8	Two or more channels, analog
9	Combined digital and analog
Third Symbol	
N	No information present
A	Telegraphy, human readable
B	Telegraphy, machine readable
C	Facsimile
D	Telemetry and telecommand
E	data
F	Voice telephony
W	Video
	A combination of above

Thevenin's Theorem

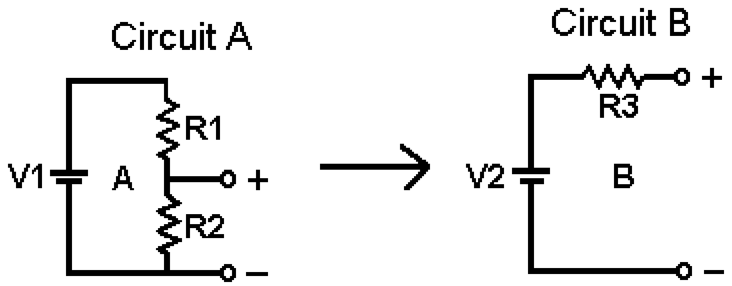
Any network of voltage sources and resistors can be replaced by an equivalent circuit containing a single voltage source and a single series resistor. For example



can be replaced by



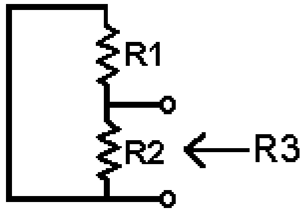
You are not required to work with complex circuits like the one above. All the questions are based on converting circuit A to the equivalent circuit B:



The questions ask you to find V2 and R3.   To determine the equivalent single voltage source V2 in circuit B we calculate the open circuit voltage of circuit A using Ohms Law:

In Circuit B we have **V2 = V1 x R2 / (R1 + R2).**

To determine the equivalent single series resistance R3 in circuit B we replace the voltage source in circuit A with a short circuit and calculate the resistance at the output as shown below:



In Circuit B **R3 = (R1 x R2) / (R1 + R2).**

The formulae for V2 and R3 allow you to answer all the Thevenin theory questions in the Advanced Class question pool.