14.4: Solutions to CH 4 Exercises

Question 1

The three step approach for security valuation is:

Step 1: Forecast all expected cash flows associated with that security over its lifetime
Step 2: Choose an appropriate discount rate
Step 3: Solve for the PV

When applying this to bond valuation, we start with step 1. The cash flows associated with a bond are (A) the coupon payments and (B) the par value. The coupon payments are an annuity, paid twice each year. The annual coupon payments are calculated by taking the coupon rate times the par value (which we assume is always $1000). Therefore, a 5% coupon bond will pay $50 coupon payments annually as 5% of $1000 is $50. Since coupon payments are made semi-annually, this will generate a $25 coupon payment every six months. The par value is a single cash flow ($1000) paid at maturity.

Next, we must choose an appropriate discount rate. In class, this will be a given. However, it is an important step in practice. The riskier the bond, the higher the discount rate that you must use. Also, as expected inflation increases you will want to increase the discount rate. A common practice is to estimate the discount rate by starting with the interest rate (yield) on Treasury bonds of similar maturity and then adding in a risk premium to reflect how much riskier the bond you are valuing is relative to the Treasury bond.

Finally, we solve for PV. This step is easy with bonds. Convert your calculator to 2 Periods per Year. N represents the number of periods (years*2) the bond has remaining until maturity. I/Y represents the discount rate we estimated in step 2. PMT is the coupon payment we calculated in step 1. FV is the par value ($1000). Once we enter these four values into our financial calculator, we then solve for PV.

Question 2

Market rates of interest and bond prices have an inverse relationship. When market rates of interest increase, bond prices decline. When market rates of interest decrease, bond prices go up. The reason for this is that the cash flow stream associated with the bond does not change and the market rate of interest represents the discount rate. So, if we discount the same cash flow stream at a higher rate of interest it will be worth less while if we discount it at a lower rate of interest it will be worth more.

Question 3

The longer the time to maturity, the more sensitive the bond price will be to changes in the market rate of interest. Long-term bond prices will increase by a greater amount when interest rates go down and will fall by a greater amount when interest rates go up.

Question 4

I would be willing to pay a premium for a bond if the cash flow stream that it generates is higher than I can get elsewhere. For instance, if the current market rate of interest is 7%, that implies that newly issued bonds will be paying 7% coupon payments. If I can find a bond with a 9% coupon rate, I will receive an extra $20 per year in coupon payments. If that coupon stream will last for 10 years, then the premium that I am willing to pay is the present value of $20 per year for 10 years.

Question 5

A call provision is a feature in the bond indenture that allows the issuing party to repurchase the bond for a preset price prior to maturity. For instance, a firm may issue a 20-year 8% coupon bond that is callable in 5 years for $1040. Then, if interest rates have declined significantly after five years the firm will find it cheaper to call back the bond rather than to continue paying interest payments for the next 15 years. If they still need additional financing, the will be able to issue new bonds with a lower interest rate. On the other hand, if interest rates go up, the firm will decide not to call back the bond as it would cost them more to refinance it. If they no longer needed the financing, they could buy the bonds back in the open market for less than the call price (since bond prices decline when rates go up.)

Note that, everything else equal, call provisions are good for the issuer but bad for the investor. That is because if interest rates go down, the company is likely to call the bond and the investor won't get the full benefit of declining interest rates. On the other

hand, if interest rates go up the company is not likely to call which leaves the investor feeling the full downside of increasing interest rates. Because of this, the only way to get investors to buy callable bonds is to pay them slightly more. Therefore, callable bonds will typically offer investors a slightly higher yield in order to offset the call risk.

Question 6

Part 6a

The Yield-to-Maturity (YTM) is more relevant to an investor than the coupon rate. The coupon rate determines the coupon payments, so it tells us what the cash flow stream looks like, but doesn't take into account what we pay for it. For instance, which would you rather buy…a 3-year 5% coupon bond or a 3-year 10% coupon bond? At first glance, the 10% coupon bond seems better because we will get $100 per year in coupon payments instead of $50. However, how much are we paying for these bonds? What if the 5% bond is selling for $700 and the 10% bond is selling for $1300? We will get a much higher rate of return on the 5% bond making it a better purchase (assuming similar risk levels). Thus, the YTM provides a better measure of what we will earn on a bond because it takes into account more information. Not only does it consider coupon payment, but how much we are paying today and how long we will receive the coupon payment. Another simple way to look at this question is if the coupon rate was a more relevant measure, no one would ever buy a zero coupon bond.

Part 6b

Sometimes the Yield-to-Maturity (YTM) is more relevant than the Yield-to-Call (YTC) and sometimes the YTC is more relevant than the YTM. It depends on the situation. To understand this, we first must remember what the numbers represent. We defined the YTM as the expected rate of return we would earn on the bond if we bought it today and held it until maturity and the YTC as the expected rate of return if we bought it today and it got called at the first call date. Those definitions come from the viewpoint of the bondholder. However, someone has to pay the bondholder those rates of return and it is the issuer. Therefore, the bondholders expected rate of return is the issuers expected cost. Now, remember who makes the call decision – the issuer. Since the issuer would prefer to face a lower cost, it will likely call the bonds back if the YTC is less than the YTM. Alternatively, if the YTM is less than the YTC, the issuer will not want to call the bond back early. Thus, the investor is likely to receive whichever is lower between the YTM and YTC and that means whichever one is lower is the more relevant number.

Question 7

Bond ratings are important because they provide a measure of the default risk associated with investing in bonds. The worse the bond rating, the greater the default risk. Everything else being equal, investors will demand higher returns (YTMs) for bonds with bad bond ratings. From a firm's perspective, that means a bad bond rating is going to translate into paying more to raise additional debt financing. One important point to remember about bond ratings though is that they only measure DEFAULT risk, and not total risk. There are several other risk factors associated with bonds (such as interest rate risk and liquidity risk) that also must be considered when evaluating the total risk of a particular bond.

Question 8

Part 8a

A 20-year bond with a BB rating should have a higher YTM than a 20-year bond with a AA rating. The reason for this is that the lower bond rating indicates more default risk. Since the bonds have the same time to maturity, the primary risk differential is default risk. The greater the risk, the higher the YTM should be.

Part 8b

There is not enough information to answer this question. The problem is we are changing two important factors – time to maturity and bond rating. The YTM will depend on inflationary expectations (over the 5-year and 30-year periods respectively), maturity risk, and default risk.

Question 9

FALSE. While it is true that junk bonds have a higher probability of default than investment grade bonds, that does not mean that they are a poor investment or that we should expect low rates of return. The higher probability of default means that they are

riskier. Riskier investments should offer higher expected returns to compensate investors for the additional risk (if they were riskier and offered lower expected returns, no one would purchase them). This higher expected returns may make them good investments for some people. Whether or not junk bonds are a good investment depends on the individual. For people with low risk tolerances, junk bonds are likely to be a poor investment (although there could even be some situations where they make sense as part of the overall portfolio for someone with a low risk tolerance as long as they are a very small portion). For people with greater risk tolerance the risk-return tradeoff may be attractive. However, they should always offer higher expected returns than investment grade bonds. Note that higher expected returns do not mean that an investor will earn a higher return. Instead, it means that ON AVERAGE junk bonds will offer higher returns, but that there will be periods where most junk bonds earn low (or negative) returns and in virtually all periods there will be some junk bonds that see large negative returns.

Question 10

The zero-coupon bond will be more sensitive to changes in interest rates than the 10% coupon bond (in terms of % differences). The reason for this is that the coupon payments start returning some of our investment quicker, so the bond's value is not impacted as much by changes in interest rates. For instance, part of the value of the 10% bond is the $100 in coupon payments during the first year ($50 every ½ year). Since, it is only one year away, its present value will not be changed much by changing the discount rate. However, the zero coupon bond has no coupon payments (the entire cash flow will not be received until maturity which is several years out), so its value will be impacted significantly by changes in the interest rate. Consider the following two bonds.

Bond A – 10% coupon bond with 10-years remaining and a 10% market rate of interest
Bond B – Zero-coupon bond with 10-years remaining and a 10% market rate of interest

Calculate the percentage increase in the bond prices if the market rate of interest drops to 8%.

Bond A starting value (at 10%): $1000.00
Bond A new value (at 8%): $1135.90
Percent Increase: 13.59%

Bond B starting value (at 10%): $376.89
Bond B new value (at 8%): $456.39
Percent Increase: 21.09%

Calculation for Bond Values

Starting Value 10% coupon bond at 10% ⇒ No calculation needed, when coupon rate and market rate of interest are the same, the bond price will always be par value ($1000).

New Value 10% coupon bond at 8%
Step 1: 2 P/Y
Step 2: 20 N
Step 3: 8 I/Y
Step 4: 1000 FV
Step 5: 50 PMT
Step 6: PV⇒ $1,135.90

Starting Value zero coupon bond at 10%
Step 1: 2 P/Y
Step 2: 20 N
Step 3: 10 I/Y
Step 4: 1000 FV
Step 5: 0 PMT
Step 6: PV⇒ $376.89

New Value zero coupon bond at 8%
Step 1: 2 P/Y
Step 2: 20 N
Step 3: 8 I/Y
Step 4: 1000 FV

Step 5: 0 PMT
Step 6: PV⇒ $456.39

Question 11

No. A non-convertible zero-coupon bond will only pay par value at maturity. There will be no other payments. Therefore, a $1000 par value zero-coupon, non-convertible bond will pay exactly $1000 at maturity. Let's say the bond matures in 4 years. There is never a good reason to pay more than $1000 today to receive $1000 four years later. Even if the market rate of interest was zero, it would make more sense to just hold onto our money rather than pay more than $1000 today to receive $1000 at a later date.

Reminder: For all bond exercises, your calculator should be set to 2 P/Y to reflect semi-annual coupon payments. Also, the payment is equal to the annual coupon divided by 2.

Problem 1

Part 1a

Step 1: 60 N
Step 2: 9 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $845.21

Part 1b

Step 1: 60 N
Step 2: 7.5 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,000.00

Part 1c

Step 1: 60 N
Step 2: 6 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,207.57

Part 1d

Step 1: 20 N
Step 2: 9 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $902.44

Part 1e

Step 1: 20 N
Step 2: 7.5 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,000.00

Part 1f

Step 1: 20 N
Step 2: 6 I/Y

Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,111.58

Part 1g

Step 1: 4 N
Step 2: 9 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $973.09

Part 1h

Step 1: 4 N
Step 2: 7.5 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,000.00

Part 1i

Step 1: 4 N
Step 2: 6 I/Y
Step 3: 1000 FV
Step 4: 37.50 PMT
Step 5: PV⇒ $1,027.88

Problem 2

Step 1: 20 N
Step 2: -918.23 PV
Step 3: 1000 FV
Step 4: 21.25 PMT
Step 5: I/Y⇒ 5.31%

Problem 3

Yield to Maturity

Step 1: 40 N
Step 2: -1318 PV
Step 3: 1000 FV
Step 4: 48.75 PMT
Step 5: I/Y⇒ 6.81%

Yield to Call

Step 1: 14 N
Step 2: -1318 PV
Step 3: 1050 FV
Step 4: 48.75 PMT
Step 5: I/Y⇒ 4.93%

Since the YTC is less than the YTM, this bond is likely to be called based on information available today. Note that the interest rate environment may change before the call date arrives in 7 years which may cause the YTC and YTM to change. Therefore, we are not saying the bond WILL be called, only that it is LIKELY to be called. An investor should buy this bond only if he or she is happy with the 4.89% rate of return that would be earned if the bond was called in 7 years.

Problem 4

NOTE – Even though zero coupons don't pay a semi-annual coupon payment (they actually pay no coupon payment) we are using the semi-annual convention – 2 P/Y – to keep consistent with regular coupon bond valuation.

Price with a 12% required return

Step 1: 40 N
Step 2: 12 I/Y
Step 3: 1000 FV
Step 4: 0 PMT
Step 5: PV ⇒ $97.22

Price with a 10% required return

Step 1: 40 N
Step 2: 10 I/Y
Step 3: 1000 FV
Step 4: 0 PMT
Step 5: PV ⇒ $142.05

Problem 5

Part 5a

It is important to recognize that the value of the bond is the present value of remaining cash flows. At the time of purchase, the bond had 30 years until maturity and this is when we purchased it. This means the value at the time it was purchased should be based on the 30 years until maturity (60 semi-annual periods).

Step 1: 60 N
Step 2: 6.5 I/Y
Step 3: 1000 FV
Step 4: 45 PMT
Step 5: PV ⇒ $1,328.17

Part 5b

Since you purchased the bond 10 years ago when it had 30 years to maturity, there are now 20 years (40 semi-annual periods) remaining until maturity.

Step 1: 40 N
Step 2: 10.5 I/Y
Step 3: 1000 FV
Step 4: 45 PMT
Step 5: PV ⇒ $875.59

Part 5c

Now, it is no longer a bond pricing problem, but a time value of money problem. You paid $1328.17 ten years (20 periods) ago, you received $45 twice per year in coupon payments, and today you sold the bond for $875.59 ⇒ Solve for your return.

Step 1: 20 N
Step 2: -1328.17 PV
Step 3: 875.59 FV
Step 4: 45 PMT
Step 5: I/Y ⇒ 3.97%