Chapter 7: Net Present Value and Other Investment Criteria

1. NPV_A = – €600 + [€225 × annuity factor(11%, 4 periods)] =

$$-€600 + €225 \times \left[\frac{1}{0.11} - \frac{1}{0.11 \times (1.11)^4}\right] = €98.05$$

NPV_B = – €600 + [€400 × annuity factor(11%, 2 periods)] =

$$-€600 + €400 \times \left[\frac{1}{0.11} - \frac{1}{0.11 \times (1.11)^2}\right] = €85.01$$

Both projects are worth pursuing.

2. Choose Project A, the project with the higher NPV.

3. NPV_A = – €600 + [€225 × annuity factor(20%, 4 periods)] =

$$-€600 + €225 \times \left[\frac{1}{0.20} - \frac{1}{0.20 \times (1.20)^4}\right] = -€17.53$$

NPV_B = – €600 + [€400 × annuity factor(20%, 2 periods)] =

$$-€600 + €400 \times \left[\frac{1}{0.20} - \frac{1}{0.20 \times (1.20)^2}\right] = €11.11$$

Therefore, you should now choose project B.

4. IRR_A = Discount rate (r) which is the solution to the following equation:

$$€\,225 \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^4}\right] = €600 \Rightarrow r = IRR_A = 18.45\%$$

IRR_B = Discount rate (r) which is the solution to the following equation:

$$€\,400 \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^2}\right] = €600 \Rightarrow r = IRR_B = 21.53\%$$

5. No. Even though project B has the higher IRR, its NPV is lower than that of project A when the discount rate is lower (as in Problem 1) and higher when the discount rate is higher (as in Problem 3). This example shows that the project with the higher IRR is not necessarily better. The IRR of each project is fixed, but as the discount rate increases, project B becomes *relatively* more attractive compared to project A. This is because B's cash flows come earlier, so the present value of these cash flows decreases less rapidly when the discount rate increases.

6. The profitability indexes are as follows:

   Project A: €98.05/ €600 = 0.1634

   Project B: €85.01/ €600 = 0.1417

   In this case, *with equal initial investments*, both the profitability index and NPV give projects the same ranking. This is an unusual case, however, since it is rare for the initial investments to be equal.

7. Project A has a payback period of: €600/ €225 = 2.67 years

   Project B has a payback period of 1.50 years.

8. No. Despite its longer payback period, Project A may still be the preferred project, for example, when the discount rate is 11% (as in Problems 1 and 2). As in Problem 5, you should note that the payback period for each project is fixed, but the NPV changes as the discount rate changes. The project with the shorter payback period need not have the higher NPV.

15. IRR_A = Discount rate (r) which is the solution to the following equation:

$$\$21{,}000 \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^2}\right] = \$30{,}000 \Rightarrow r = IRR_A = 25.69\%$$

IRR_B = Discount rate (r) which is the solution to the following equation:

$$\$33{,}000 \times \left[\frac{1}{r} + \frac{1}{r \times (1+r)^2}\right] = \$50{,}000 \Rightarrow r = IRR_B = 20.69\%$$

The IRR of project A is 25.69%, and that of B is 20.69%. However, project B has the higher NPV and therefore is preferred.

16. $$NPV = \$5{,}000 + \frac{\$4{,}000}{1.12} - \frac{\$11{,}000}{(1.12)^2} = -\$197.70$$

Because the NPV is negative, you should reject the offer. You should reject the offer despite the fact that the IRR exceeds the discount rate. This is a 'borrowing type' project with positive cash flows followed by negative cash flows. A high IRR in these cases is not attractive: You don't want to borrow at a high interest rate.

17. a. $r = 0\% \Rightarrow NPV = -\$6{,}750 + \$4{,}500 + \$18{,}000 = \$15{,}750$

$$r = 50\% \Rightarrow NPV = -\$6{,}750 + \frac{\$4{,}500}{1.50} + \frac{\$18{,}000}{1.50^2} = \$4{,}250$$

$$r = 100\% \Rightarrow NPV = -\$6{,}750 + \frac{\$4{,}500}{2.00} + \frac{\$18{,}000}{2.00^2} = \$0$$

b. IRR = 100%, the discount rate at which NPV = 0.

18. $NPV_{9\%}$ = –$20,000 + [$4,000 × annuity factor(9%, 8 periods)] =

$$-\$20{,}000 + \$4{,}000 \times \left[\frac{1}{0.09} - \frac{1}{0.09 \times (1.09)^8}\right] = \$2{,}139.28$$

$NPV_{14\%}$ = –$20,000 + [$4,000 × annuity factor(14%, 8 periods)] =

$$-\$20{,}000 + \$4{,}000 \times \left[\frac{1}{0.14} - \frac{1}{0.14 \times (1.14)^8}\right] = -\$1{,}444.54$$

IRR = Discount rate (r) which is the solution to the following equation:

$$\$4{,}000 \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^8}\right] = \$20{,}000 \Rightarrow r = IRR = 11.81\%$$

[Using a financial calculatior, enter: PV = (–)20,000; PMT = 4000; FV = 0; n = 8, and compute i.]

The project will be rejected for any discount rate above this rate.

26. a. The less–risky projects should have lower discount rates.

b. First, find the profitability index of each project.

Project	PV of Cash flow	Investment	NPV	Profitability Index
A	$3.79	$3	$0.79	0.26
B	$4.97	$4	$0.97	0.24
C	$6.62	$5	$1.62	0.32
D	$3.87	$3	$0.87	0.29
E	$4.11	$3	$1.11	0.37

Then, select projects with the highest profitability index until the $8 million budget is exhausted. Therefore, choose Projects E and C.

c. All the projects have positive NPV so that all will be chosen if there is no capital rationing (and if the projects are all independent of each other).

31. The equivalent annual cost of the new machine is the 4-year annuity with present value equal to $20,000:

$$C \times \left[\frac{1}{0.15} - \frac{1}{0.15 \times (1.15)^4} \right] = \$20,000$$

$$C \times \text{annuity factor}(15\%, 4 \text{ years}) = \$20,000$$

$$C \times 2.85498 = \$20,000 \Rightarrow C = EAC = \$7,005.30$$

This can be interpreted as the extra yearly charge that should be attributed to the purchase of the new machine spread over its life. It does not yet pay to replace the equipment since the incremental cash flow provided by the new machine is:

$10,000 – $5,000 = $5,000

This is less than the equivalent annual cost of the new machine.

33.

Time until purchase	Cost	NPV at purchase date [a]	NPV today [b]
0	$400.00	–$31.33	–$31.33
1	320.00	48.67	44.25
2	256.00	112.67	93.12
3	204.80	163.87	123.12
4	163.84	204.83	139.90
5	131.07	237.60	147.53
6	104.86	263.81	148.91
7	83.89	284.78	146.14

Notes:

a. – Cost + [60 × annuity factor(10%, 10 years)]
b. (NPV at purchase date)/$(1.10)^n$

NPV is maximized when you wait six years to purchase the scanner.