Answers to Warm-Up Exercises

E12-1. Sensitivity analysis

Answer: Using the 12% cost of capital to discount all of the cash flows for each scenario to yield the following NPVs, resulting in a NPV range of $19,109.78:

Pessimistic	**Most Likely**	**Optimistic**
–$3,283.48	$6,516.99	$15,826.30

E12-2. Using IRR selection criteria

Answer: The minimum amount of annual cash inflow needed to earn 8% is $11,270.54

N = 5, I = 8%, PV = $45,000

Solve for PMT = $11,270.54

The IRR of the project is 12.05%.

N = 5, PV = $45,000, PMT = $12,500

Solve for I = $12.05%

The project is acceptable since its IRR exceeds the firm's 8% cost of capital. Since the required cash flow is much less than the anticipated cash flow, one would expect the IRR to exceed the required rate of return.

E12-3. Risk-adjusted discount rates

Answer: **Project Sourdough** RADR = 7.0%

N = 7, I = 7%, PMT = $5,500

Solve for PV = $29,641.09

NPV = PV_n – Initial investment

NPV = $29,641.09 – $12,500

NPV = $17,141.09

Project Greek Salad RADR = 8.0%

N = 7, I =8%, PMT = $4,000

Solve for PV = $20,825.48

NPV = PV_n – Initial investment

NPV = $20,825.48 – $7,500

NPV = $13,325.48

Yeastime should select Project Sourdough.

E12-4. ANPV

Answer: You may use a financial calculator to determine the IRR of each project. Choose the project with the higher IRR.

Project M

Step 1: Find the NPV of the project

NPV_M Key strokes

CF_0 = -\$35,000, CF_1 = \$12,000, CF_2 = \$25,000, CF_3 = \$30,000

Set I = 8%

Solve for NPV = \$21,359.55

Step 2: Find the ANPV

N = 3, I = 8, PV = \$21,359.55

Solve for PMT = \$8,288.22

Project N

Step 1: Find the NPV of the project

NPV_M Key strokes

CF_0 = -\$55,000, CF_1 = \$18,000, CF_2 = \$15,000, CF_3 = \$25,000

CF_4 = \$10,000, CF_5 = \$8,000, CF_6 = \$5,000, CF_7 = \$5,000

Set I = 8%

Solve for NPV = \$13,235.82

Step 2: Find the ANPV

N = 7, I = 8, PV = \$13,235.82

Solve for PMT = \$2,542.24

Based on ANPV, you should advise Outcast, Inc. to choose Project M.

E12-5. NPV profiles

Answer: The investment opportunity schedule (IOS) in this problem does not allow us to determine the maximum NPV allowed by the budget constraint. In order to determine whether the IOS maximizes the NPV for Longchamps Electric, we will need to know the NPV for each of the six projects. However, it does appear likely that Longchamps Electric will maximize firm value by selecting Project 4 (IRR =11%), Project 2 (IRR = 10%), and Project 5 (IRR = 9%). The total investment in these three projects will be \$135,000, leaving \$15,000 excess cash for future investment opportunities.

Solutions to Problems

P12-1. Recognizing risk

LG 1; Basic

a. and b.

Project	Risk	Reason
A	Low	The cash flows from the project can be easily determined since this expenditure consists strictly of outflows. The amount is also relatively small.
B	Medium	The competitive nature of the industry makes it so that Caradine will need to make this expenditure to remain competitive. The risk is only moderate since the firm already has clients in place to use the new technology.
C	Medium	Since the firm is only preparing a proposal, their commitment at this time is low. However, the $450,000 is a large sum of money for the company and it will immediately become a sunk cost.
D	High	Although this purchase is in the industry in which Caradine normally operates, they are encountering a large amount of risk. The large expenditure, the competitiveness of the industry, and the political and exchange risk of operating in a foreign country add to the uncertainty.

Note: Other answers are possible depending on the assumptions a student may make. There is too little information given about the firm and industry to establish a definitive risk analysis.

P12-2. Breakeven cash flows

LG 2; Intermediate

a. N = 12, I =14%, PV = $35,000

Solve for PMT = $6,183.43

b. N = 12, I = 10%, PV = $35,000

Solve for PMT = $5,136.72

The required cash flow per year would decrease by $1,047.27.

P12-3. Breakeven cash inflows and risk

LG 2; Intermediate

a.

Project X	**Project Y**
N = 5, I = 15%, PMT = $10,000	N = 5, I = 15%, PMT = $15,000
Solve for PV = 33,521.55	Solve for PV = $50,282.33
NPV = PV – initial investment	NPV = PV – initial investment
NPV = $33,521.55 – $30,000	NPV = $50,282.33 – $40,000
NPV = $3,521.55	NPV = $10,282.33

b.

Project X	**Project Y**
N = 5, I = 15%, PV = $30,000	N = 5, I = 15%, PV = $40,000
Solve for PMT = $8,949.47	Solve for PMT = $11,932.62

c.

Project X	**Project Y**
Probability = 60%	Probability = 25%

d. Project Y is more risky and has a higher potential NPV. Project X has less risk and less return while Project Y has more risk and more return, thus the risk-return tradeoff.

e. Choose Project X to minimize losses; to achieve higher NPV, choose Project Y.

P12-4. Basic scenario analysis

LG 2; Intermediate

a. Range A = $1,800 – $200 = $1,600 Range B = $1,100 – $900 = $200

b.

	NPVs	
Outcome	**Project A**	**Project B**
Pessimistic	–$ 6,297.29	–$ 337.79
Most likely	513.56	513.56
Optimistic	7,324.41	1,364.92
Range	$13,621.70	$1,702.71

c. Although the “most likely” outcome is identical for Project A and B, the NPV range varies considerably.

d. Project selection would depend upon the risk disposition of the management. (A is more risky than B but also has the possibility of a greater return.)

P12-5. Scenario analysis

LG 2; Intermediate

a. Range P = \$1,000 – \$500 = \$500

Range Q = \$1,200 – \$400 = \$800

b.

NPVs		
Outcome	**Project P**	**Project Q**
Pessimistic	\$72.28	–\$542.17
Most likely	1,608.43	1,608.43
Optimistic	3,144.57	4,373.48

c. Range P = \$3,144.57 – \$72.28 = \$3,072.29

Range Q = \$4,373.48 – (–\$542.17) = \$4,915.65

Each computer has the same most likely result. Computer Q has both a greater potential loss and a greater potential return. Therefore, the decision will depend on the risk disposition of management.

P12-6. Personal Finance: Impact of inflation on investments

LG 2; Easy

a. – c.

Year	Investment Cash Flows	Current NPV (a)	Higher Inflation NPV (b)	Lower Inflation NPV (c)
0	(7,500)	(7,500)	(7,500)	(7,500)
1	2,000	1,878	1,860	1,896
2	2,000	1,763	1,731	1,797
3	2,000	1,656	1,610	1,703
4	1,500	1,166	1,123	1,211
5	1,500	1,095	1,045	1,148
Total NPV		\$ 58	\$ (131)	\$ 254

d. As the inflation rate rises the NPV of a given set of cash flows declines.

P12-7. Simulation

LG 2; Intermediate

a. Ogden Corporation could use a computer simulation to generate the respective profitability distributions through the generation of random numbers. By tying various cash flow assumptions together into a mathematical model and repeating the process numerous times, a probability distribution of project returns can be developed. The process of generating random numbers and using the probability distributions for cash inflows and outflows allows values for each of the variables to be determined. The use of the computer also allows for more sophisticated simulation using components of cash inflows and outflows. Substitution of these values into the mathematical model yields the NPV. The key lies in formulating a mathematical model that truly reflects existing relationships.

b. The advantages to computer simulations include the decision maker's ability to view a continuum of risk-return tradeoffs instead of a single-point estimate. The computer simulation, however, is not feasible for risk analysis.

P12-8. Risk-adjusted discount rates—Basic

LG 4; Intermediate

a. **Project E**

N = 4, I = 15%, PMT = \$6,000

Solve for PV = \$17,129.87

NPV = \$17,129.87 − \$15,000

NPV = \$2,129.87

Project F

CF_0 = -\$11,000, CF_1 = \$6,000, CF_2 = \$4,000, CF_3 = \$5,000, CF_4 = \$2,000

Set I = 15%

Solve for NPV = \$1,673.05

Project G

CF_0 = -\$19,000, CF_1 = \$4,000, CF_2 = \$6,000, CF_3 = \$8,000, $C4_4$ = \$12,000

Set I = 15%

Solve for NPV = \$1,136.29

Project E, with the highest NPV, is preferred.

b. $RADR_E = 0.10 + (1.80 \times (0.15 - 0.10)) = 0.19$

$RADR_F = 0.10 + (1.00 \times (0.15 - 0.10)) = 0.15$

$RADR_G = -0.10 + (0.60 \times (0.15 - 0.10)) = 0.13$

c. **Project E**

N = 4, I = 19%, PMT = \$6,000

Solve for PV = \$15,831.51

NPV = \$15,831.51 − \$15,000

NPV = \$831.51

Project F

Same as in part a, \$1,673.05

Project G

CF_0 = -\$19,000, CF_1 = \$4,000, CF_2 = \$6,000, CF_3 = \$8,000, CF_4 = \$12,000

Set I = 13%

Solve for NPV = \$2,142.93

Rank	**Project**
1	G
2	F
3	E

d. After adjusting the discount rate, even though all projects are still acceptable, the ranking changes. Project G has the highest NPV and should be chosen.

P12-9. Risk-adjusted discount rates—Tabular

LG 4; Intermediate

a. **Project A**

N = 5, I = 8%, PMT = $7,000

Solve for PV = $27,948.97

NPV = $27,948.97 – $20,000

NPV = $7,948.97

Project B

N = 5, I = 14%, PMT = $10,000

Solve for PV = $34,330.81

NPV = $34,330.81 – $30,000

NPV = $4,330.81

Project A, with the higher NPV, should be chosen.

b. Project A is preferable to Project B, since the NPV of A is greater than the NPV of B.

P12-10. Personal Finance: Mutually exclusive investment and risk

LG 4; Intermediate

a. N = 6, I = 8.5%, PMT = $3,000

Solve for PV = 13,660.76

NPV = $13,660.76 – $10,000

NPV = $3,660.76

b. N = 6, I = 10.5%, PMT = $3,800

Solve for PV = $16,310.28

NPV = $16,31.28 – $12,000

NPV = $4,310.28

c. Using NPV as her guide, Lara should select the second investment. It has a higher NPV.

d. The second investment is riskier. The higher required return implies a higher risk factor.

P12-11. Risk-adjusted rates of return using CAPM

LG 4; Challenge

a. $r_X = 7\% + 1.2(12\% - 7\%) = 7\% + 6\% = 13\%$

$r_Y = 7\% + 1.4(12\% - 7\%) = 7\% + 7\% = 14\%$

NPV calculation for X:

N = 4, I = 13%, PMT = $30,000

Solve for PV = 89,234.14

NPV = $89,234.14 – $70,000

NPV = $19,234.14

NPV calculation for Y:

CF_0 = -$78,000, CF_1 = $22,000, CF_2 = $32,000, CF_3 = $38,000, CF_4 = $46,000

Set I = 14%

Solve for NPV = $18,805.82

b. The RADR approach prefers Project Y over Project X. The RADR approach combines the risk adjustment and the time adjustment in a single value. The RADR approach is most often used in business.

P12-12. Risk classes and RADR

LG 4; Basic

a. **Project X**

CF_0 = -\$180,000, CF_1 = \$80,000, CF_2 = \$70,000, CF_3 = \$60,000,

CF_4 = \$60,000, CF_5 = \$60,000

Set I = 22%

Solve for NPV = \$14.930.45

Project Y

CF_0 = -\$235,000, CF_1 = \$50,000, CF_2 = \$60,000,

CF_3 = \$70,000, CF_4 = \$80,000, CF_5 = \$90,000

Set I = 13%

Solve for NPV = \$2,663.99

Project Z

CF_0 = -\$310,000, CF_1 = \$90,000, CF_2 = \$90,000, CF_3 = \$90,000,

CF_4 = \$90,000, CF_5 = \$90,000

[or, CF_0 = -\$310,000, CF_1 = \$90,000, F_1 = 5]

Set I = 15%

Solve for NPV = -\$8,306.04

b. Projects X and Y are acceptable with positive NPVs, while Project Z with a negative NPV is not. Project X, with the highest NPV, should be undertaken.

P12-13. Unequal lives—ANPV approach

LG 5; Intermediate

a. **Machine A**

CF_0 = -\$92,000, CF_1 = \$12,000, CF_2 = \$12,000, CF_3 = \$12,000,

CF_4 = \$12,000, CF_5 = \$12,000, CF_6 = \$12,000

[or, CF_0 = -\$92,000, CF_1 = \$12,000, F_1 = 6]

Set I = 12%

Solve for NPV = -\$42,663.11

Machine B

CF_0 = -\$65,000, CF_1 = \$10,000, CF_2 = \$20,000, CF_3 = \$30,000, CF_4 = \$40,000

Set I = 12%

Solve for NPV = \$6,646.58

Machine C

CF_0 = -\$100,500, CF_1 = \$30,000, CF_2 = \$30,000,

CF_3 = \$30,000, CF_4 = \$30,000, CF_5 = \$30,000

[or, CF_0 = -\$105,000, CF_1 = \$30,000, F_1 = 5]

Set I = 12%

Solve for NPV = \$7,643.29

Rank	Machine
1	C
2	B
3	A

(Note that Machine A is not acceptable and could be rejected without any additional analysis.)

b. **Machine A**
N = 6, I = 12%, PV = –\$42,663.11
Solve for ANPV (PMT) = –\$10,376.77

Machine B
N = 4, I = 12%, PV = \$6,646.58
Solve for ANPV (PMT) = \$2,188.28

Machine C
N = 5, I = 12%, PV = \$7,643.29
Solve for ANPV (PMT) = \$2,120.32

Rank	Machine
1	B
2	C
3	A

c. Machine B should be acquired since it offers the highest ANPV. Not considering the difference in project lives resulted in a different ranking based in part on Machine C's NPV calculations.

P12-14. Unequal lives—ANPV approach

LG 5; Intermediate

a. **Project X**
CF_0 = -\$78,000, CF_1 = \$17,000, CF_2 = \$25,000, CF_3 = \$33,000, CF_4 = \$41,000
Set I = 14%

Solve for NPV = \$2,698.32

Project Y
CF_0 = -\$52,000, CF_1 = \$28,000, CF_2 = \$38,000
Set I = 14%

Solve for NPV = \$1,801.17

Project Z
CF_0 = -\$66,000, CF_1 = \$15,000, CF_2 = \$15,000, CF_3 = \$15,000, CF_4 = \$15,000, CF_5 = \$15,000, CF_6 = \$15,000, CF_7 = \$15,000, CF_8 = \$15,000
[or, CF_0 = -\$66,000, CF_1 = \$15,000, F_1 = 8]

Set I = 14%

Solve for NPV = \$3,582.96

Rank	Project
1	Z
2	X
3	Y

b. **Project X**
N = 4, I = 14%, PV = $2698.32
Solve for ANPV (PMT) = –$9,260.76

Project Y
N = 2, I = 14%, PV = $1801.17
Solve for ANPV (PMT) = $1,093.83

Project Z
N = 5, I = 14%, PV = $3582.96
Solve for ANPV (PMT) = $1,043.65

Rank	Project
1	X
2	Y
3	Z

c. Project Y should be acquired since it offers the highest ANPV. Not considering the difference in project lives resulted in a different ranking based primarily on the unequal lives of the projects.

P12-15. Unequal lives—ANPV approach

LG 5; Intermediate

a. **Sell**

CF_0 = -$200,000, CF_1 = $200,000, CF_2 = $250,000
Set I = 12%
Solve for NPV = $177,869.90

License
CF_0 = -$200,000, CF_1 = $250,000, CF_2 = $100,000
CF_3 = $80,000, CF_4 = $60,000, CF_5 = $40,000
Set I = 12%
Solve for NPV = $220,704.25

Manufacture
CF_0 = -$450,000, CF_1 = $200,000, CF_2 = $250,000, CF_3 = $200,000,
CF_4 = $200,000, CF_5 = $200,000, CF_6 = $200,000
[or, CF_0 = -$450,000, CF_1 = $200,000, F_1 = 1,
CF_2 = $250,000, F_2 = 1, CF_3 = $200,000, F_3 = 4]
Set I = 12%
Solve for NPV = $412,141.16

Rank	Alternative
1	Manufacture
2	License
3	Sell

b. **Sell**
N = 2, I = 12%, PV = $177,869.90
Solve for ANPV (PMT) = $105,245.28

License
N = 5, I = 12%, PV = $220,704.25
Solve for ANPV (PMT) = $61,225.51

Manufacture
N = 6, I = 12%, PV = $412,141.16
Solve for ANPV (PMT) = $100,243.33

Rank	Alternative
1	Sell
2	Manufacture
3	License

c. Comparing the NPVs of projects with unequal lives gives an advantage to those projects that generate cash flows over the longer period. ANPV adjusts for the differences in the length of the projects and allows selection of the optimal project. This technique implicitly assumes that all projects can be selected again at their conclusion an infinite number of times.

P12-16. NPV and ANPV decisions

LG 5; Challenge

a. – b.

Unequal-Life Decisions
Annualized Net Present Value (ANPV)

	Samsung	Sony
Cost	$(2,350)	$(2,700)
Annual Benefits	$900	$1,000
Life	3 years	4 years
Terminal value	$400	$350
Required rate of return	9.0%	9.0%

a. CF_0 = -\$2,350, CF_1 = \$900, CF_2 = \$900, CF_3 = \$900 + \$400 = \$1,300
Set I = 9%
Solve for NPV = $237.04

b. N = 3, I = 9%, PV = $237.04
Solve for ANPV (PMT) = $93.64

c. CF_0 = -\$2,700, CF_1 = \$1,000, CF_2 = \$1,000, CF_3 = \$1,000, CF_4 = \$1,000 + \$350 = \$1,350
Set I = 9%

Solve for NPV = \$787.67

d. N = 4, I = 9%, PV = \$787.67
Solve for ANPV (PMT) = \$243.13

e. Richard and Linda should select the Sony set because its ANPV of \$243.13 is greater than the \$93.64 ANPV of Samsung.

P12-17. Real options and the strategic NPV

LG 6; Intermediate

a. Value of real options = value of abandonment + value of expansion + value of delay
Value of real options = (0.25 × \$1,200) + (0.30 × \$3,000) + (0.10 × \$10,000)
Value of real options = \$300 + \$900 + \$1,000 = \$2,200
$NPV_{strategic} = NPV_{traditional}$ + Value of real options = −1,700 + 2,200 = \$500

b. Due to the added value from the options Rene should recommend acceptance of the capital expenditures for the equipment.

c. In general this problem illustrates that by recognizing the value of real options a project that would otherwise be unacceptable ($NPV_{traditional} < 0$) could be acceptable ($NPV_{strategic} > 0$). It is thus important that management identify and incorporate real options into the NPV process.

P12-18. Capital rationing—IRR and NPV approaches

LG 6; Intermediate

a. **Rank by IRR**

Project	IRR	Initial Investment	Total Investment
F	23%	\$2,500,000	\$2,500,000
E	22	800,000	3,300,000
G	20	1,200,000	4,500,000
C	19		
B	18		
A	17		
D	16		

Projects F, E, and G require a total investment of \$4,500,000 and provide a total present value of \$5,200,000, and therefore an NPV of \$700,000.

b. **Rank by NPV (NPV = *PV* – Initial investment)**

Project	NPV	Initial Investment
F	\$500,000	\$2,500,000
A	400,000	5,000,000
C	300,000	2,000,000
B	300,000	800,000
D	100,000	1,500,000
G	100,000	1,200,000
E	100,000	800,000

Project A can be eliminated because while it has an acceptable NPV, its initial investment exceeds the capital budget. Projects F and C require a total initial investment of \$4,500,000 and provide a total present value of \$5,300,000 and a net present value of \$800,000. However, the best option is to choose Projects B, F, and G, which also use the entire capital budget and provide an NPV of $900,000.

c. The internal rate of return approach uses the entire $4,500,000 capital budget but provides $200,000 less present value ($5,400,000 – $5,200,000) than the NPV approach. Since the NPV approach maximizes shareholder wealth, it is the superior method.

d. The firm should implement Projects B, F, and G, as explained in part c.

P12-19. Capital Rationing—NPV Approach

LG 6; Intermediate

a.

Project	**PV**	**Initial Investment**	**Total Investment**
A	$384,000		
B	210,000		
C	125,000	$100,000	$100,000
D	990,000		
E	570,000		
F	150,000	$100,000	$200,000
G	960,000	$800,000	$1,000,000

b. The optimal group of projects is Projects C, F, and G, resulting in a total net present value of $235,000. Project G would be accepted first because it has the highest NPV. Its selection leaves enough of the capital budget to also accept Project C and Project F.

P12-20. Ethics problem

LG 4; Challenge

Student answers will vary. Some students might argue that companies should be held accountable for any and all pollution that they cause. Other students may take the larger view that the appropriate goal should be the reduction of overall pollution levels, and that carbon credits are a way to achieve that goal. From an investor standpoint, carbon credits allow the polluting firm to meet legal obligations in the most cost-effective manner, thus improving the bottom line for the company and investor.