■ Solutions to Problems

***Note to instructor*:** In most problems involving the IRR calculation, a financial calculator has been used.

P9-1. LG 1: Payback period

Basic

a. $42,000 ÷ $7,000 = 6 years

b. The company should accept the project, since 6 < 8.

P9-2. LG 1: Payback comparisons

Intermediate

a. Machine 1: $14,000 ÷ $3,000 = 4 years, 8 months

Machine 2: $21,000 ÷ $4,000 = 5 years, 3 months

b. Only Machine 1 has a payback faster than 5 years and is acceptable.

c. The firm will accept the first machine because the payback period of 4 years, 8 months is less than the 5-year maximum payback required by Nova Products.

d. Machine 2 has returns that last 20 years while Machine 1 has only seven years of returns. Payback cannot consider this difference; it ignores all cash inflows beyond the payback period. In this case, the total cash flow from Machine 1 is $59,000 ($80,000 – $21,000) less than Machine 2.

P9-3. LG 1: Personal finance: Long-term investment decisions, payback period

a. and b.

	Project A		**Project B**	
Year	**Annual Cash Flow**	**Cumulative Cash Flow**	**Annual Cash Flow**	**Cumulative Cash Flow**
0	$(9,000)	$(9,000)	$(9,000)	$(9,000)
1	2,00	(6,800)	1,500	(9,000)
2	2,500	(4,300)	1,500	(6,000)
3	2,500	(1,800)	1,500	(4,500)
4	2,000		3,500	(1,000)
5	1,800		4,000	
Total Cash Flow	11,000		12,000	
Payback Period	3 + 1,800/2,000 = 3.9 years		4 + 1,000/4,000 = 4.25 years	

c. The payback method would select Project A since its payback of 3.9 years is lower than Project B's payback of 4.25 years.

d. One weakness of the payback method is that it disregards expected future cash flows as in the case of Project B.

P9-4. LG 2: NPV

Basic

PV_n = PMT × ($PVIFA_{14\%,20 \text{ yrs}}$)   NPV = PV_n – Initial investment

a. PV_n = $2,000 × 6.623   NPV = $13,246 – $10,000
PV_n = $13,246   NPV = $3,246
Calculator solution: $3,246.26
Accept

b. PV_n = $3,000 × 6.623   NPV = $19,869 – $25,000
PV_n = $19,869   NPV = –$5,131
Calculator solution: – $5,130.61
Reject

c. PV_n = $5,000 × 6.623   NPV = $33,115 – $30,000
PV_n = $33,115   NPV = $3,115
Calculator solution: $3,115.65
Accept

P9-5. LG 2: NPV for varying cost of capital

Basic

PV_n = PMT × ($PVIFA_{k\%,8 \text{ yrs.}}$)

a. **10%**
PV_n = $5,000 × (5.335)
PV_n = $26,675

NPV = PV_n – Initial investment
NPV = $26,675 – $24,000
NPV = $2,675
Calculator solution: $2,674.63
Accept; positive NPV

b. **12%**
PV_n = $5,000 × (4.968)
PV_n = $24,840
NPV = PV_n – Initial investment
NPV = $24,840 – $24,000
NPV = $840
Calculator solution: $838.20
Accept; positive NPV

c. **14%**

PV_n = $5,000 × (4.639)

PV_n = $23,195

NPV = PV_n – Initial investment

NPV = $23,195 – $24,000

NPV = –$805

Calculator solution: – $805.68

Reject; negative NPV

P9-6. LG 2: NPV–independent projects

Intermediate

Project A

PV_n = PMT × ($PVIFA_{14\%,10 \text{ yrs.}}$)

PV_n = $4,000 × (5.216)

PV_n = $20,864

NPV = $20,864 – $26,000

NPV = –$5,136

Calculator solution: –$5,135.54

Reject

Project B—PV of Cash Inflows

Year	CF	$PVIF_{14\%,n}$	PV
1	$100,000	0.877	$ 87,700
2	120,000	0.769	92,280
3	140,000	0.675	94,500
4	160,000	0.592	94,720
5	180,000	0.519	93,420
6	200,000	0.456	91,200
			$553,820

NPV = PV of cash inflows – initial investment = $553,820 – $500,000

NPV = $53,820

Calculator solution: $53,887.93

Accept

Project C—PV of Cash Inflows

Year	CF	$PVIF_{14\%,n}$	PV
1	$20,000	0.877	$17,540
2	19,000	0.769	14,611
3	18,000	0.675	12,150
4	17,000	0.592	10,064
5	16,000	0.519	8,304
6	15,000	0.456	6,840
7	14,000	0.400	5,600
8	13,000	0.351	4,563
9	12,000	0.308	3,696
10	11,000	0.270	2,970
			$86,338

NPV = PV of cash inflows – initial investment = $86,338 – $170,000

NPV = –$83,662

Calculator solution: –$83,668.24

Reject

Project D

PV_n = PMT × ($PVIFA_{14\%,8\text{ yrs.}}$)

PV_n = $230,000 × 4.639

PV_n = $1,066,970

NPV = PV_n – Initial investment

NPV = $1,066,970 – $950,000

NPV = $116,970

Calculator solution: $116,938.70

Accept

Project E—PV of Cash Inflows

Year	CF	$PVIF_{14\%,n}$	PV
4	$20,000	0.592	$11,840
5	30,000	0.519	15,570
6	0		0
7	50,000	0.400	20,000
8	60,000	0.351	21,060
9	70,000	0.308	21,560
			$90,030

NPV = PV of cash inflows – initial investment

NPV = $90,030 – $80,000

NPV = $10,030

Calculator solution: $9,963.63

Accept

P9-7. LG 2: NPV and maximum return

Challenge

$PV_n = PMT \times (PVIFA_{k\%,n})$

a. $PV_n = \$4,000 \times (PVIFA_{10\%,4})$

$PV_n = \$4,000 \times (3.170)$

$PV_n = \$12,680$

$NPV = PV_n - \text{Initial investment}$

NPV = $12,680 – $13,000

NPV = –$320

Calculator solution: –$320.54

Reject this project due to its negative NPV.

b. $\$13,000 = \$4,000 \times (PVIFA_{k\%,n})$

$\$13,000 \div \$4,000 = (PVIFA_{k\%,n})$

$3.25 = PVIFA_{9\%,4}$

Calculator solution: 8.86%

8.86% is the maximum required return that the firm could have for the project to be acceptable. Since the firm's required return is 10% the cost of capital is greater than the expected return and the project is rejected.

P9-8. LG 2: NPV–mutually exclusive projects

Intermediate

$PV_n = PMT \times (PVIFA_{k\%,n})$

a. and b.

Press A **PV of cash inflows; NPV**

$PV_n = PMT \times (PVIFA_{15\%,8\ yrs})$

$PV_n = \$18,000 \times 4.487$

$PV_n = \$80,766$

$NPV = PV_n - \text{initial investment}$

NPV = $80,766 – $85,000

NPV = –$4,234

Calculator solution: –$4,228.21

Reject

Press B

Year	CF	$PVIF_{15\%,n}$	PV
1	$12,000	0.870	$10,440
2	14,000	0.756	10,584
3	16,000	0.658	10,528
4	18,000	0.572	10,296
5	20,000	0.497	9,940
6	25,000	0.432	10,800
			$62,588

NPV = \$62,588 – \$60,000
NPV = \$2,588
Calculator solution: \$2,584.34
Accept

Press C

Year	**CF**	**PVIF$_{15\%,n}$**	**PV**
1	\$50,000	0.870	\$ 43,500
2	30,000	0.756	22,680
3	20,000	0.658	13,160
4	20,000	0.572	11,440
5	20,000	0.497	9,940
6	30,000	0.432	12,960
7	40,000	0.376	15,040
8	50,000	0.327	16,350
			\$145,070

NPV = \$145,070 – \$130,000
NPV = \$15,070
Calculator solution: \$15,043.89
Accept

c. Ranking–using NPV as criterion

Rank	**Press**	**NPV**
1	C	\$15,070
2	B	2,588
3	A	–4,234

P9-9. LG 2. Personal finance: Long-term investment decisions, NPV method

Cost of MBA program	\$100,000
Annual incremental benefit	\$ 20,000
Time frame (years)	40
Opportunity cost	6.0%
PVIFA	15.0463
PVA	\$300,926
NPV	\$200,926

The financial benefits outweigh the cost of the MBA program.

P9-10. LG 2: Payback and NPV

Intermediate

a.

Project	**Payback Period**
A	\$40,000 ÷ \$13,000 = 3.08 years
B	3 + (\$10,000 ÷ \$16,000) = 3.63 years
C	2 + (\$5,000 ÷ \$13,000) = 2.38 years

Project C, with the shortest payback period, is preferred.

b. **Project A** PV_n = \$13,000 × 3.274

PV_n = \$42,562

PV = \$42,562 – \$40,000

NPV = \$2,562

Calculator solution: \$2,565.82

Project B

Year	**CF**	**$PVIF_{16\%,n}$**	**PV**
1	\$7,000	0.862	\$ 6,034
2	10,000	0.743	7,430
3	13,000	0.641	8,333
4	16,000	0.552	8,832
5	19,000	0.476	9,044
			\$39,673

NPV = \$39,673 – \$40,000

NPV = –\$327

Calculator solution: –\$322.53

Project C

Year	**CF**	**$PVIF_{16\%,n}$**	**PV**
1	\$19,000	0.862	\$16,378
2	16,000	0.743	11,888
3	13,000	0.641	8,333
4	10,000	0.552	5,520
5	7,000	0.476	3,332
			\$45,451

NPV = \$45,451 – \$40,000

NPV = \$5,451

Calculator solution: \$5,454.17

Project C is preferred using the NPV as a decision criterion.

c. At a cost of 16%, Project C has the highest NPV. Because of Project C's cash flow characteristics, high early-year cash inflows, it has the lowest payback period and the highest NPV.

P9-11. LG 2: IRR

Intermediate

IRR is found by solving:

$$\$0 = \sum_{t=1}^{n}\left[\frac{CF_t}{(1+\text{IRR})^t}\right] - \text{initial investment}$$

It can be computed to the nearest whole percent by the estimation method as shown for Project A below or by using a financial calculator. (Subsequent IRR problems have been solved with a financial calculator and rounded to the nearest whole percent.)

Project A

Average annuity = ($20,000 + $25,000 + 30,000 + $35,000 + $40,000) ÷ 5

Average annuity = $150,000 ÷ 5

Average annuity = $30,000

$\text{PVIFA}_{k\%,\text{5yrs.}}$ = $90,000 ÷ $30,000 = 3.000

$\text{PVIFA}_{19\%,\text{5 yrs.}}$ = 3.0576

$\text{PVlFA}_{20\%,\text{5 yrs.}}$ = 2.991

However, try 17% and 18% since cash flows are greater in later years.

Year$_t$	**CF_t (1)**	**$\text{PVIF}_{17\%,t}$ (2)**	**PV@17% [(1) × (2)] (3)**	**$\text{PVIF}_{18\%,t}$ (4)**	**PV@18% [(1) × (4)] (5)**
1	$20,000	0.855	$17,100	0.847	$16,940
2	25,000	0.731	18,275	0.718	17,950
3	30,000	0.624	18,720	0.609	18,270
4	35,000	0.534	18,690	0.516	18,060
5	40,000	0.456	18,240	0.437	17,480
			$91,025		$88,700
Initial investment			–90,000		–90,000
NPV			$ 1,025		–$ 1,300

NPV at 17% is closer to $0, so IRR is 17%. If the firm's cost of capital is below 17%, the project would be acceptable.

Calculator solution: 17.43%

Project B

PV_n = PMT × ($\text{PVIFA}_{k\%,\text{4 yrs.}}$)

$490,000 = $150,000 × ($\text{PVIFA}_{k\%,\text{4 yrs.}}$)

$490,000 ÷ $150,000 = ($\text{PVIFA}_{k\%,\text{4 yrs.}}$)

3.27 = $\text{PVIFA}_{k\%,\text{4 yrs.}}$

8% < IRR < 9%

Calculator solution: IRR = 8.62%

The firm's maximum cost of capital for project acceptability would be 8% (8.62%).

Project C

$PV_n = PMT \times (PVIFA_{k\%,5\text{ yrs.}})$

$\$20,000 = \$7,500 \times (PVIFA_{k\%,5\text{ yrs.}})$

$\$20,000 \div \$7,500 = (PVIFA_{k\%,5\text{ yrs.}})$

$2.67 = PVIFA_{k\%,5\text{ yrs.}}$

25% < IRR < 26%

Calculator solution: IRR = 25.41%

The firm's maximum cost of capital for project acceptability would be 25% (25.41%).

Project D

$$\$0 = \frac{\$120,000}{(1+\text{IRR})^1} + \frac{\$100,000}{(1+\text{IRR})^2} + \frac{\$80,000}{(1+\text{IRR})^3} + \frac{\$60,000}{(1+\text{IRR})^4} - \$240,000$$

IRR = 21%; Calculator solution: IRR = 21.16%

The firm's maximum cost of capital for project acceptability would be 21% (21.16%).

P9-12. LG 2: IRR–Mutually exclusive projects

Intermediate

a. and b.

Project X

$$\$0 = \frac{\$100,000}{(1+\text{IRR})^1} + \frac{\$120,000}{(1+\text{IRR})^2} + \frac{\$150,000}{(1+\text{IRR})^3} + \frac{\$190,000}{(1+\text{IRR})^4} + \frac{\$250,000}{(1+\text{IRR})^5} - \$500,000$$

IRR = 16%; since IRR > cost of capital, accept.

Calculator solution: 15.67%

Project Y

$$\$0 = \frac{\$140,000}{(1+\text{IRR})^1} + \frac{\$120,000}{(1+\text{IRR})^2} + \frac{\$95,000}{(1+\text{IRR})^3} + \frac{\$70,000}{(1+\text{IRR})^4} + \frac{\$50,000}{(1+\text{IRR})^5} - \$325,000$$

IRR = 17%; since IRR > cost of capital, accept.

Calculator solution: 17.29%

c. Project Y, with the higher IRR, is preferred, although both are acceptable.

P9-13. LG: 2: Long-term investment decisions, IRR method

Intermediate

IRR is the rate of return at which NPV equals zero

Computer inputs and output:

5*N*, 6,000 PMT (25,000) PV Compute IRR = 6.40%

Required rate of return: 7.5%

Decision: Reject investment opportunity

P9-14. LG 2: IRR, investment life, and cash inflows

Challenge

a. $PV_n = PMT \times (PVIFA_{k\%,n})$

$\$61,450 = \$10,000 \times (PVIFA_{k\%,10\text{ yrs.}})$

$\$61,450 \div \$10,000 = PVIFA_{k\%,10\text{ yrs.}}$

$6.145 = PVIFA_{k\%,10\text{ yrs.}}$

k = IRR = 10% (calculator solution: 10.0%)

The IRR < cost of capital; reject the project.

b. $PV_n = PMT \times (PVIFA_{\%,n})$

$\$61,450 = \$10,000 \times (PVIFA_{15\%,n})$

$\$61,450 \div \$10,000 = PVIFA_{15\%,n}$

$6.145 = PVIFA_{15\%,n}$

18 yrs. < n < 19 yrs.

Calculator solution: 18.23 years

The project would have to run a little over 8 more years to make the project acceptable with the 15% cost of capital.

c. $PV_n = PMT \times (PVIFA_{15\%,10})$

$\$61,450 = PMT \times (5.019)$

$\$61,450 \div 5.019 = PMT$

$\$12,243.48 = PMT$

Calculator solution: $12,244.04

P9-15. LG 2: NPV and IRR

Intermediate

a. $PV_n = PMT \times (PVIFA_{10\%,7\text{ yrs.}})$

$PV_n = \$4,000 \times (4.868)$

$PV_n = \$19,472$

$NPV = PV_n - \text{Initial investment}$

NPV = $19,472 – $18,250

NPV = $1,222

Calculator solution: $1,223.68

b. $PV_n = PMT \times (PVIFA_{k\%,n})$

$\$18,250 = \$4,000 \times (PVIFA_{k\%,7\text{yrs.}})$

$\$18,250 \div \$4,000 = (PVIFA_{k\%,7\text{ yrs.}})$

$4.563 = PVIFA_{k\%,7\text{ yrs.}}$

IRR = 12%

Calculator solution: 12.01%

c. The project should be accepted since the NPV > 0 and the IRR > the cost of capital.

P9-16. LG 1, 2: Payback, NPV, and IRR

Intermediate

a. Payback period

3 + ($20,000 ÷ $35,000) = 3.57 years

b. PV of cash inflows

Year	**CF**	**PVIF$_{16\%,n}$**	**PV**
1	$20,000	0.893	$ 17,860
2	25,000	0.797	19,925
3	30,000	0.712	21,360
4	35,000	0.636	22,260
5	40,000	0.567	22,680
			$104,085

NPV = PV of cash inflows – initial investment

NPV = $104,085 – $95,000

NPV = $9,085

Calculator solution: $9,080.60

c. $$\$0 = \frac{\$20,000}{(1+\text{IRR})^1} + \frac{\$25,000}{(1+\text{IRR})^2} + \frac{\$30,000}{(1+\text{IRR})^3} + \frac{\$35,000}{(1+\text{IRR})^4} + \frac{\$40,000}{(1+\text{IRR})^5} - \$95,000$$

IRR = 15%

Calculator solution: 15.36%

d. NPV = $9,085; since NPV > 0; accept

IRR = 15%; since IRR > 12% cost of capital; accept

The project should be implemented since it meets the decision criteria for both NPV and IRR.

P9-17. LG 2, 3: NPV, IRR, and NPV profiles

Challenge

a. and b.

Project A

PV of cash inflows:

Year	**CF**	**PVIF$_{12\%,n}$**	**PV**
1	$25,000	0.893	$ 22,325
2	35,000	0.797	27,895
3	45,000	0.712	32,040
4	50,000	0.636	31,800
5	55,000	0.567	31,185
			$145,245

NPV = PV of cash inflows – initial investment

NPV = $145,245 – $130,000

NPV = $15,245

Calculator solution: $15,237.71

Based on the NPV the project is acceptable since the NPV is greater than zero.

$$\$0 = \frac{\$25,000}{(1+\text{IRR})^1} + \frac{\$35,000}{(1+\text{IRR})^2} + \frac{\$45,000}{(1+\text{IRR})^3} + \frac{\$50,000}{(1+\text{IRR})^4} + \frac{\$55,000}{(1+\text{IRR})^5} - \$130,000$$

IRR = 16%

Calculator solution: 16.06%

Based on the IRR the project is acceptable since the IRR of 16% is greater than the 12% cost of capital.

Project B

PV of cash inflows:

Year	CF	$\text{PVIF}_{12\%,n}$	PV
1	$40,000	0.893	$35,720
2	35,000	0.797	27,895
3	30,000	0.712	21,360
4	10,000	0.636	6,360
5	5,000	0.567	2,835
			$94,170

NPV = $94,170 − $85,000

NPV = $9,170

Calculator solution: $9,161.79

Based on the NPV the project is acceptable since the NPV is greater than zero.

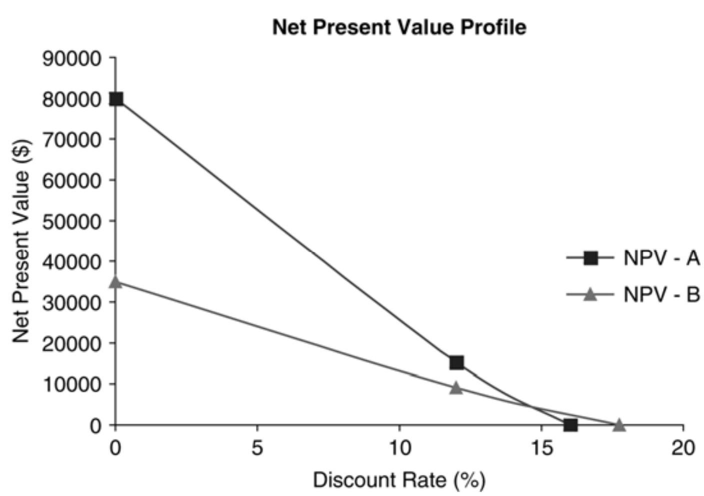
$$\$0 = \frac{\$40,000}{(1+\text{IRR})^1} + \frac{\$35,000}{(1+\text{IRR})^2} + \frac{\$30,000}{(1+\text{IRR})^3} + \frac{\$10,000}{(1+\text{IRR})^4} + \frac{\$5,000}{(1+\text{IRR})^5} - \$85,000$$

IRR = 18%

Calculator solution: 17.75%

Based on the IRR the project is acceptable since the IRR of 16% is greater than the 12% cost of capital.

c.



Data for NPV Profiles

	NPV	
Discount Rate	**A**	**B**
0%	$80,000	$35,000
12%	$15,245	—
15%	—	$ 9,170
16%	0	—
18%	—	0

d. The net present value profile indicates that there are conflicting rankings at a discount rate less than the intersection point of the two profiles (approximately 15%). The conflict in rankings is caused by the relative cash flow pattern of the two projects. At discount rates above approximately 15%, Project B is preferable; below approximately 15%, Project A is better. Based on Candor Enterprise's 12% cost of capital, Project A should be chosen.

e. Project A has an increasing cash flow from Year 1 through Year 5, whereas Project B has a decreasing cash flow from Year 1 through Year 5. Cash flows moving in opposite directions often cause conflicting rankings. The IRR method reinvests Project B's larger early cash flows at the higher IRR rate, not the 12% cost of capital.

P9-18. LG 1, 2: All techniques–decision among mutually exclusive investments

Challenge

	Project		
	A	**B**	**C**
Cash inflows (years 1–5)	$20,000	$ 31,500	$ 32,500
Payback*	3 years	3.2 years	3.4 years
NPV*	$10,340	$ 10,786	$ 4,303
IRR*	20%	17%	15%

*Supporting calculations shown below:

a. **Payback Period:** Project A: $60,000 ÷ $20,000 = 3 years
Project B: $100,000 ÷ $31,500 = 3.2 years
Project C: $110,000 ÷ $32,500 = 3.4 years

b. **NPV**

Project A

$PV_n = PMT \times (PVIFA_{13\%,5\text{ yrs.}})$

$PV_n = \$20,000 \times 3.517$

$PV_n = 70,340$

NPV = $70,340 – $60,000

NPV = $10,340

Calculator solution: $10,344.63

Project B

PV_n = \$31,500.00 × 3.517
PV_n = \$110,785.50

NPV = \$110,785.50 – \$100,000
NPV = \$10,785.50
Calculator solution: \$10,792.78

Project C

PV_n = \$32,500.00 × 3.517
PV_n = \$114,302.50

NPV = \$114,302.50 – \$110,000
NPV = \$4,302.50
Calculator solution: \$4,310.02

c. **IRR**

Project, A

NPV at 19% = \$1,152.70
NPV at 20% = –\$187.76
Since NPV is closer to zero at 20%, IRR = 20%

Calculator solution: 19.86%

Project B

NPV at 17% = \$779.40
NPV at 18% = –\$1,494.11

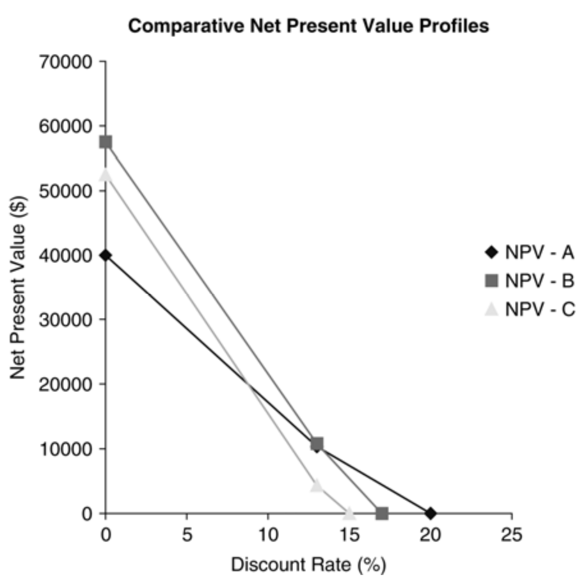
Since NPV is closer to zero at 17%, IRR = 17%
Calculator solution: 17.34%

Project C

NPV at 14% = \$1,575.13
NPV at 15% = –\$1,054.96

Since NPV is closer to zero at 15%, IRR = 15%
Calculator solution: 14.59%

d.



Data for NPV Profiles

Discount Rate	NPV A	NPV B	NPV C
0%	$40,000	$57,500	$52,500
13%	$10,340	10,786	4,303
15%	—	—	0
17%	—	0	—
20%	0	—	—

The difference in the magnitude of the cash flow for each project causes the NPV to compare favorably or unfavorably, depending on the discount rate.

e. Even though A ranks higher in Payback and IRR, financial theorists would argue that B is superior since it has the highest NPV. Adopting B adds $445.50 more to the value of the firm than does A.

P9-19. LG 1, 2, 3: All techniques with NPV profile–mutually exclusive projects

Challenge

a. **Project A**

Payback period

Year 1 + Year 2 + Year 3	=	$60,000
Year 4	=	$20,000
Initial investment	=	$80,000

Payback = 3 years + ($20,000 ÷ 30,000)

Payback = 3.67 years

Project B

Payback period

$50,000 ÷ $15,000 = 3.33 years

b. **Project A**

PV of cash inflows

Year	CF	$PVIF_{13\%,n}$	PV
1	$15,000	0.885	$13,275
2	20,000	0.783	15,660
3	25,000	0.693	17,325
4	30,000	0.613	18,390
5	35,000	0.543	19,005
			$83,655

NPV = PV of cash inflows – initial investment

NPV = $83,655 – $80,000

NPV = $3,655

Calculator solution: $3,659.68

Project B

NPV = PV of cash inflows − initial investment

$PV_n = PMT \times (PVIFA_{13\%,n})$

$PV_n = \$15{,}000 \times 3.517$

$PV_n = \$52{,}755$

NPV = $52,755 – $50,000

NPV = $2,755

Calculator solution: $2,758.47

c. **Project A**

$$\$0 = \frac{\$15{,}000}{(1+\text{IRR})^1} + \frac{\$20{,}000}{(1+\text{IRR})^2} + \frac{\$25{,}000}{(1+\text{IRR})^3} + \frac{\$30{,}000}{(1+\text{IRR})^4} + \frac{\$35{,}000}{(1+\text{IRR})^5} - \$80{,}000$$

IRR = 15%

Calculator solution: 14.61%

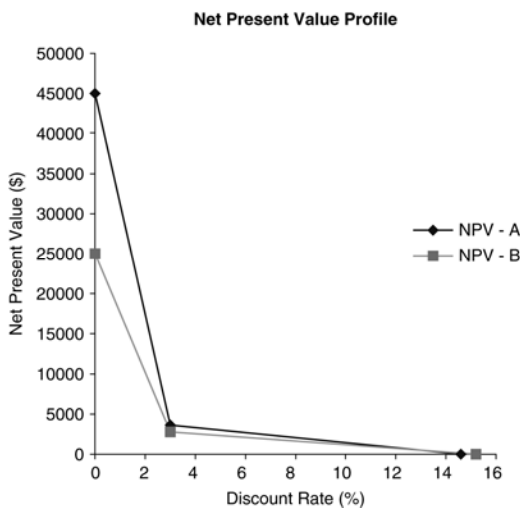
Project B

$\$0 = \$15{,}000 \times (PVIFA_{k\%,5}) - \$50{,}000$

IRR = 15%

Calculator solution: 15.24%

d.



Data for NPV Profiles		
	NPV	
Discount Rate	A	B
0%	$45,000	$25,000
13%	$3,655	2,755
14.6%	0	—
15.2%	—	0

Intersection—approximately 14%

If cost of capital is above 14%, conflicting rankings occur.

The calculator solution is 13.87%.

e. Both projects are acceptable. Both have similar payback periods, positive NPVs, and equivalent IRR's that are greater than the cost of capital. Although Project B has a slightly higher IRR, the rates are very close. Since Project A has a higher NPV accept Project A.

P9-20. LG 1, 2: Integrative–complete investment decision

Challenge

a. Initial investment:

Installed cost of new press =		
Cost of new press		$2,200,000
– After-tax proceeds from sale of old asset		
Proceeds from sale of existing press	(1,200,000)	
+ Taxes on sale of existing press*	480,000	
Total after-tax proceeds from sale		(720,000)
Initial investment		$1,480,000

* Book value = $0

$1,200,000 – $0 = $1,200,000 income from sale of existing press

$1,200,000 income from sale × (0.40) = $480,000

b.

Calculation of Operating Cash Flows

Year	Revenues	Expenses	Depreciation	Net Profits before Taxes	Taxes	Net Profits after Taxes	Cash Flow
1	$1,600,000	$800,000	$440,000	$360,000	$144,000	$216,000	$656,000
2	1,600,000	800,000	704,000	96,000	38,400	57,600	761,600
3	1,600,000	800,000	418,000	382,000	152,800	229,200	647,200
4	1,600,000	800,000	264,000	536,000	214,400	321,600	585,600
5	1,600,000	800,000	264,000	536,000	214,400	321,600	585,600
6	0	0	110,000	–110,000	–44,000	–66,000	44,000

c. Payback period = 2 years + ($62,400 ÷ $647,200) = 2.1 years

d. PV of cash inflows:

Year	CF	$PVIF_{11\%,n}$	PV
1	$656,000	0.901	$ 591,056
2	761,000	0.812	618,419
3	647,200	0.731	473,103
4	585,600	0.659	385,910
5	585,600	0.593	347,261
6	44,000	0.535	23,540
			$2,439,289

NPV = PV of cash inflows – initial investment

NPV = $2,439,289 – $1,480,000

NPV = $959,289

Calculator solution: $959,152

$$\$0 = \frac{\$656,000}{(1+\text{IRR})^1} + \frac{\$761,600}{(1+\text{IRR})^2} + \frac{\$647,200}{(1+\text{IRR})^3} + \frac{\$585,600}{(1+\text{IRR})^4} + \frac{\$585,600}{(1+\text{IRR})^5} + \frac{\$44,000}{(1+\text{IRR})^6} - \$1,480,000$$

IRR = 35%

Calculator solution: 35.04%

e. The NPV is a positive $959,289 and the IRR of 35% is well above the cost of capital of 11%. Based on both decision criteria, the project should be accepted.

P9-21. LG 2, 3: Integrative–investment decision

Challenge

a. Initial investment:

Installed cost of new asset =		
Cost of the new machine	$1,200,000	
+ Installation costs	150,000	
Total cost of new machine		$1,350,000
– After-tax proceeds from sale of old asset =		
Proceeds from sale of existing machine	(185,000)	
– Tax on sale of existing machine*	(79,600)	
Total after-tax proceeds from sale		
		(264,600)
+ Increase in net working capital		25,000
Initial investment		$1,110,400

*Book value = $384,000

$185,000 – $384,000 = $199,000 loss from sale of existing press

$199,000 loss from sale × (0.40) = $79,600

Calculation of Operating Cash Flows New Machine

Year	Reduction in Operating Costs	Depreciation	Net Profits before Taxes	Taxes	Net Profits after Taxes	Cash Flow
1	$350,000	$270,000	$80,000	$32,000	$48,000	$318,000
2	350,000	432,000	–82,000	–32,800	–49,200	382,800
3	350,000	256,500	93,500	37,400	56,100	312,600
4	350,000	162,000	188,000	75,200	112,800	274,800
5	350,000	162,000	188,000	75,200	112,800	274,800
6	0	67,500	–67,500	–27,000	–40,500	27,000

Existing Machine

Year	Depreciation	Net Profits before Taxes	Taxes	Net Profits after Taxes	Cash Flow
1	$152,000	–$152,000	–$60,800	$91,200	$60,800
2	96,000	–96,000	–38,400	–57,600	38,400
3	96,000	–96,000	–38,400	–57,600	38,400
4	40,000	–40,000	–16,000	–24,000	16,000
5	0	0	0	0	0
6	0	0	0	0	0

Incremental Operating Cash Flows

Year	New Machine	Existing Machine	Incremental Cash Flow
1	$318,000	$60,800	$257,200
2	382,800	38,400	344,400
3	312,600	38,400	274,200
4	274,800	16,000	258,800
5	274,800	0	274,800
6	27,000	0	27,000

Terminal cash flow:

After-tax proceeds from sale of new asset =		
Proceeds from sale of new asset	$200,000	
– Tax on sale of new asset*	(53,000)	
Total proceeds-sale of new asset		$147,000
– After-tax proceeds from sale of old asset		0
+ Change in net working capital		25,000
Terminal cash flow		$172,000

*Book value of new machine at the end of year 5 is $67,500
200,000 – $67,500 = $132,500 income from sale of old machine
132,500 × 0.40 = $53,000 tax liability

b.

Year	CF	$PVIF_{9\%,n}$	PV
1	$257,200	0.917	$ 235,852
2	344,400	0.842	289,985
3	274,200	0.772	211,682
4	258,800	0.708	183,230
5	274,800	0.650	178,620
Terminal value	172,000	0.650	111,800
			$1,211,169

NPV = PV of cash inflows – initial investment

NPV = $1,211,169 – $1,110,400

NPV = $100,769

Calculator solution: $100,900.39

c. $$\$0 = \frac{\$257{,}200}{(1+\text{IRR})^1} + \frac{\$344{,}400}{(1+\text{IRR})^2} + \frac{\$274{,}200}{(1+\text{IRR})^3} + \frac{\$258{,}800}{(1+\text{IRR})^4} + \frac{\$446{,}800}{(1+\text{IRR})^5} - \$1{,}110{,}400$$

IRR = 12.2%

Calculator solution: 12.24%

d. Since the NPV > 0 and the IRR > cost of capital, the new machine should be purchased.

e. 12.24%. The criterion is that the IRR must equal or exceed the cost of capital; therefore, 12.24% is the lowest acceptable IRR.

P9-22. LG 4: Real options and the strategic NPV

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.

P9-23. LG 4: Capital Rationing-IRR and NPV Approaches

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 a net present value 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).

P9-24. LG 4: Capital Rationing-NPV Approach

Intermediate

a.

Project	**PV**
A	$384,000
B	210,000
C	125,000
D	990,000
E	570,000
F	150,000
G	960,000

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.

P9-25. L 6: Ethics problem

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.

■ Case

Making Norwich Tool's Lathe Investment Decision

The student is faced with a typical capital budgeting situation in Chapter 9's case. Norwich Tool must select one of two lathes that have different initial investments and cash inflow patterns. After calculating both unsophisticated and sophisticated capital budgeting techniques, the student must reevaluate the decision by taking into account the higher risk of one lathe.

1. Payback period

Lathe A:

Years 1–4 = $644,000

Payback = 4 years + ($16,000 ÷ $450,000) = 4.04 years

Lathe B:

Years 1–3 = $304,000

Payback = 3 years + ($56,000 ÷ $86,000) = 3.65 years

Lathe A will be rejected since the payback is longer than the 4-year maximum accepted, and Lathe B is accepted because the project payback period is less than the 4-year payback cutoff.

2. a. **NPV**

Year	**Lathe A Cash Flow**	**$PVIF_{13\%}$**	**PV**	**Lathe B Cash Flow**	**$PVIF_{13\%,t}$**	**PV**
1	$128,000	0.885	$113,280	$88,000	0.885	$ 77,880
2	182,000	0.783	142,506	120,000	0.783	93,960
3	166,000	0.693	115,038	96,000	0.693	66,528
4	168,000	0.613	102,984	86,000	0.613	52,718
5	450,000	0.543	244,350	207,000	0.543	112,401
		PV =	718,158		PV =	$403,487

NPV_A = $718,158 – $660,000
= $58,158
Calculator solution: $58,132.88

NPV_B = $403,487 – $360,000
= $43,487
Calculator solution: $43,483.24

b. **IRR**

Lathe A

$$\$0=\frac{\$128,000}{(1+\text{IRR})^1}+\frac{\$182,000}{(1+\text{IRR})^2}+\frac{\$166,000}{(1+\text{IRR})^3}+\frac{\$168,000}{(1+\text{IRR})^4}+\frac{\$450,000}{(1+\text{IRR})^5}-\$660,000$$

IRR = 16%

Calculator solution: 15.95%

Lathe B

$$\$0=\frac{\$88,000}{(1+\text{IRR})^1}+\frac{\$120,000}{(1+\text{IRR})^2}+\frac{\$96,000}{(1+\text{IRR})^3}+\frac{\$86,000}{(1+\text{IRR})^4}+\frac{\$207,000}{(1+\text{IRR})^5}-\$360,000$$

IRR = 17%

Calculator solution: 17.34%

Under the NPV rule both lathes are acceptable since the NPVs for A and B are greater than zero. Lathe A ranks ahead of B since it has a larger NPV. The same accept decision applies to both projects with the IRR, since both IRRs are greater than the 13% cost of capital. However, the ranking reverses with the 17% IRR for B being greater than the 16% IRR for Lathe A.

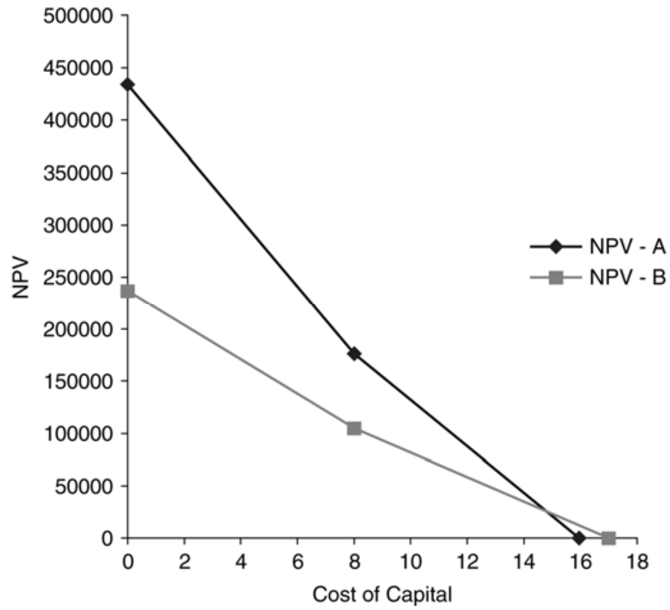
3. Summary

	Lathe A	**Lathe B**
Payback period	4.04 years	3.65 years
NPV	$58,158	$43,487
IRR	16%	17%

Both projects have positive NPVs and IRRs above the firm’s cost of capital. Lathe A, however, exceeds the maximum payback period requirement. Because it is so close to the 4-year maximum and this is an unsophisticated capital budgeting technique, Lathe A should not be eliminated from consideration on this basis alone, particularly since it has a much higher NPV.

If the firm has unlimited funds, it should choose the project with the highest NPV, Lathe A, in order to maximize shareholder value. If the firm is subject to capital rationing, Lathe B, with its shorter payback period and higher IRR, should be chosen. The IRR considers the relative size of the investment, which is important in a capital rationing situation.

4. To create an NPV profile it is best to have at least 3 NPV data points. To create the third point an 8% discount rate was arbitrarily chosen. With the 8% rate the NPV for Lathe A is $176,077 and the NPV for Lathe B is $104,663



Lathe B is preferred over Lathe A based on the IRR. However, as can be seen in the NPV profile, to the left of the cross-over point of the two lines Lathe A is preferred. The underlying cause of this conflict in rankings arises from the reinvestment assumption of NPV versus IRR. NPV assumes the intermediate cash flows are reinvested at the cost of capital, while the IRR has cash flows being reinvested at the IRR. The difference in these two rates and the timing of the cash flows will determine the cross-over point.

5. On a theoretical basis Lathe A should be preferred because of its higher NPV and thus its known impact on shareholder wealth. From a practical perspective Lathe B may be selected due to its higher IRR and its faster payback. This difference results from managers preference for evaluating decisions based on percent returns rather than dollar returns, and on the desire to get a return of cash flows as quickly as possible.

■ Spreadsheet Exercise

The answer to Chapter 9’s Drillago Company spreadsheet problem is located in the Instructor’s Resource Center *at www.prenhall.com/irc*.

■ A Note on Web Exercises

A series of chapter-relevant assignments requiring Internet access can be found at the book’s Companion Website at *http://www.prenhall.com/gitman*. In the course of completing the assignments students access information about a firm, its industry, and the macro economy, and conduct analyses consistent with those found in each respective chapter.