

NPV, IRR and payback

These formulas judge an investment in today's money. Each has a worked example with its own numbers; the two model sheets follow. They serve IPMA, PMI and APM exams alike. APM's PMQ exam names no formula, so for it, know what each measure tells you and why a business case discounts.

FORMULAS

Discount factor (DF) and present value (PV)

$$DF = 1 \div (1 + r)^t \cdot PV = \text{cash flow in year } t \times DF$$

What a euro in year t is worth today at rate r . Finance sets r : the cost of capital or a hurdle rate.

Example: At 5%: $1 \div 1.05 = 0.952$, $1 \div 1.05^2 = 0.907$, $1 \div 1.05^3 = 0.864$; €80k in year 2 is worth $80 \times 0.907 \approx \text{€}73\text{k}$

Net present value (NPV) and benefit-cost ratio (BCR)

$$NPV = \sum \text{cash flow}(t) \times DF(t), \text{ investment as a minus} \cdot BCR = PV \text{ of benefits} \div PV \text{ of costs}$$

Above zero (BCR above 1), accept; for options doing one job, take the highest NPV. Benefits may fall by $NPV \div PV \text{ of benefits}$ before $NPV = 0$.

Example: €200k now, €80k a year for 3 years, 5%: $76 + 73 + 69 = 218$; $NPV = 218 - 200 = +\text{€}18\text{k}$; $BCR \approx 1.09$; break-even fall $18 \div 218 \approx 8\%$

Equal yearly amounts: a shortcut

$$PV = \text{yearly amount} \times (DF_1 + DF_2 + \dots + DF_n)$$

Why it works: $a \times DF_1 + a \times DF_2 + \dots = a \times (DF_1 + DF_2 + \dots)$. Only when the amount is the same every year.

Example: €30k a year for 4 years at 5%: $0.952 + 0.907 + 0.864 + 0.823 = 3.546$; $PV = 30 \times 3.546 \approx \text{€}106\text{k}$

Internal rate of return (IRR)

$$IRR = \text{the rate at which } NPV = 0 \text{ (by trial, or with a spreadsheet)}$$

Accept if it beats the hurdle rate. It ignores size, and two sign changes can give two IRRs: choose between options by NPV.

Example: -200, then +80 a year for 3 years (€k): $NPV +18$ at 5%, -1 at 10%, so $IRR \approx 9.7\%$. Two sign changes, -100, +230, -132: $NPV = 0$ at 10% and at 20%

Simple and discounted payback

$$\text{payback} = \text{full years before break-even} + \text{shortfall} \div \text{that year's cash flow}$$

Cash arrives evenly within a year. Discounted payback uses present values, so it comes later. Both ignore cash after payback.

Example: -200, +80, +80, +80 (€k): -200, -120, -40, +40, so $2 + 40 \div 80 = 2.5$ years; discounted at 5%: -200, -124, -51, +18, so $2 + 51 \div 69 \approx 2.7$ years

IN THIS HANDOUT

Net present value and IRR

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Payback period

p. 3

Sources: IPMA ICB4 (2015); PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026); Kerzner, Project Management: A Systems Approach (11th ed.); Park, Contemporary Engineering Economics (4th ed.); Buttrick, The Programme and Portfolio Workout (2020); IPMA International Certification Regulations (ICR) v4.4 (2025)

Key: IPMA = International Project Management Association; ICB4 = IPMA's Individual Competence Baseline; PMI = Project Management Institute; PMBOK® Guide = PMI's body-of-knowledge guide; PMP® = PMI's Project Management Professional; APM = Association for Project Management; PMQ = APM's Project Management Qualification; ICR = IPMA's International Certification Regulations; NPV = net present value; IRR = internal rate of return. Unofficial study material for IPMA®, PMI® and APM exams. Not affiliated with, endorsed by or approved by IPMA, PMI or APM, and not an accredited or endorsed training provider. IPMA® and IPMA ICB® are registered trademarks of IPMA in Switzerland and other countries. PMI, PMP, CAPM and PMBOK are registered marks of Project Management Institute, Inc. APM is a trade mark of the Association for Project Management. Other marks belong to their owners. PMP® exam facts are from PMI's public PMP® Examination Content Outline (2026); check the current version on pmi.org. APM's qualifications are its own; this series is not an APM Accredited Provider or APM Endorsed. Examples use a fictional city and its projects.

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Net present value and IRR

Judge an investment in today's money: discount each year's cash flow, add them up, and find the rate that gives zero.

YEAR	NET CASH FLOW	FACTOR AT 5%	PRESENT VALUE
0: invest	-200	1.000	-200
1	+80	0.952	+76
2	+80	0.907	+73
3	+80	0.864	+69
Total	+40 undiscounted		NPV +18

Illustrative, € thousand. NPV (net present value) = $218 - 200 = +18$. At 10%, NPV ≈ -1 , so the IRR (internal rate of return) $\approx 9.7\%$. Benefit-cost ratio $218 \div 200 \approx 1.09$.

WHAT IT IS

A euro later is worth less than one now. The **discount factor** for year t is $1 \div (1 + r)^t$; Finance sets r , the cost of capital or a hurdle rate. **NPV** sums the discounted flows less the investment; positive means the project beats r . **IRR** is the rate where NPV = 0; it ignores size, and two sign changes can give two IRRs (Park, 2007).

HOW IT WORKS

- 01 Place each cash flow in its year; name who owns it.
- 02 Take the rate from Finance; work out the discount factors.
- 03 Multiply, add, less the investment: accept a positive NPV.
- 04 For like-for-like options, prefer NPV over IRR.
- 05 Test a higher rate and lower benefits; list unpriced value.

MID-LEVEL • WORKED EXAMPLE

Apply it well

The situation: A city team moves resident parking permits online in eight months for €640k; net savings are €140k in year 1, then €250k a year for three years.

At 5% (factors 0.952, 0.907, 0.864, 0.823): $133 + 227 + 216 + 206 = €782k$, so NPV = $782 - 640 = +€142k$; IRR $\approx 13.4\%$. Savings could fall 18% ($142 \div 782$) before NPV = 0.

In the exam: Show cash flows, factors, present values and the sum. State the rate's source, the rule and one sensitivity.

SENIOR • WORKED EXAMPLE

Design and lead it

The situation: A city is joining 14 online services under one login over 30 months, for about €13.5m, with funds released phase by phase.

The project manager agrees one rate with the Chief Financial Officer. Each owner signs up to its own savings, so none is counted twice (Buttrick, 2020); each release of funds re-appraises the case.

In the exam: Explain the design: one rate, owned benefits, appraisal at each gate, and non-cash value beside NPV.

WHERE IT SITS

IPMA • ICB4	PMI • PMBOK® GUIDE 8 • PMP® EXAM	APM • BOK 8 • PMQ EXAM
4.3.1.3 (p. 42): the business or organisational justification; 4.5.7 (p. 124): return on investment and rates of return	Guide §2.4.1 (p. 59): value metrics incl. IRR; Table 2-8 (p. 67): NPV and IRR checks. Exam outline: Process task 3	BoK (APM's Body of Knowledge) §2.3.1: NPV, NPSV (net present social value) and IRR against a hurdle rate. PMQ (APM's Project Management Qualification) objective 4

Sources: IPMA ICB4 (2015); PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026); Kerzner, Project Management: A Systems Approach (11th ed.); Park, Contemporary Engineering Economics (4th ed.); Buttrick, The Programme and Portfolio Workout (2020)

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Payback period

Show how long the money is at risk: the time until the cash coming back equals the cash put in.



Illustrative: €200k now, then €80k a year for 3 years, arriving evenly. Discounted at 5%, payback is $2 + 51 \div 69 \approx 2.7$ years.

WHAT IT IS

Payback is when the running total of net cash flows reaches zero, assuming even in-year flow. **Discounted payback** uses present values, so it comes later. It ignores cash after that point, and the simple form ignores the time value of money (Park, 2007). Use it beside NPV (net present value), never alone.

HOW IT WORKS

- 01 Add the net cash flows year by year, the investment first.
- 02 Find the year in which the running total turns positive.
- 03 $\text{Payback} = \text{years before it} + \text{shortfall} \div \text{that year's cash}$.
- 04 Discounted payback: the same, with present values.

MID-LEVEL · WORKED EXAMPLE

Apply it well

The situation: A city team moves resident parking permits online in eight months for €640k; net savings are €140k in year 1, then €250k a year for three years.

Running total -640, -500, -250, 0: payback 3.0 years.
Discounted at 5%: -640, -507, -280, -64, +142, so $3 + 64 \div 206 \approx 3.3$ years. The project manager adds the NPV for the value.

In the exam: Show the running total, the step within the year and both paybacks; then say what payback ignores.

SENIOR · WORKED EXAMPLE

Design and lead it

The situation: A city is joining 14 online services under one login over 30 months, in phases; each group of services starts saving at a different time.

The project manager shows payback per phase and in total, agrees with the Chief Financial Officer which savings are real cash, and asks the board whether a payback limit suits services the city must provide.

In the exam: Treat payback as one lens. Explain why a strict payback limit can reject the option with the most value.

WHERE IT SITS

IPMA · ICB4	PMI · PMBOK® GUIDE 8 · PMP® EXAM	APM · BOK 8 · PMQ EXAM
4.5.7 (p. 124): cash flow and rates of return among the finance knowledge; 4.3.1.3 (p. 42): the justification	Guide §2.4.1 (p. 59): payback period among the financial value metrics. Exam outline: Process task 3	BoK (APM's Body of Knowledge) §2.3.1: payback not named; simple measures (value ratio, net benefit, ROI) and discounted ones. PMQ (APM's Project Management Qualification) objective 4

Sources: Park, Contemporary Engineering Economics (4th ed.); Kerzner, Project Management: A Systems Approach (11th ed.); PMI, PMBOK® Guide, 8th ed.; PMI, PMP® Examination Content Outline (2026); APM Body of Knowledge, 8th ed.; APM, PMQ handbook (v6, 2026); IPMA ICB4 (2015)

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