Module 9 · Asset pricing theories P14 · 9.1 · 9.2

SM pp. 383–406 (exercise 407–418). **4–11 marks every paper** (expected 7.9): **Q5(a) a CAPM / beta sum** in five of six papers (D24, J25, D25, J26; APT J24) plus **MCQs (vii) CAPM / SML and (viii) levered / unlevered beta** (D25, J26, both practice papers). The June Q6(a) "cut beta with risk-free securities" also lives here.

Paper	Q5(a)	MCQ
Jun'23	Q6(a): portfolio beta, risk-free securities to cut beta to 1.125	SML intercept = risk-free
Dec'23	(Jensen + Treynor → beta, Rf: Module 10)	SML slope = risk premium · beta from SDs and correlation
Jun'24	Q5(b) two-factor APT	characteristic line v SML
Dec'24	expected returns by probability, beta, CAPM, under / over-priced	–
Jun'25	levered beta, CAPM (T-bill yield from price)	APT v CAPM
Dec'25	CAPM return and alpha of two portfolios	equity beta after a debt-funded buy-back
Jun'26	**beta from covariance, CAPM with T-bill yield from its price, over / under-valued**	many macro factors = APT · asset beta from D/E

HOW IT IS ASKED

- **Q5(a)**: beta (covariance ÷ market variance, or ρ $\sigma_s \div \sigma_m$) → risk-free rate (often a T-bill: coupon ÷ price) → CAPM required return → compare with the expected return → under / over-valued.
- **MCQ (viii)**: levered ↔ unlevered beta with the tax factor; equity beta after a buy-back financed by debt.
- **MCQ (vii)**: SML v CML v characteristic line; APT = many factors.

A Formula sheet — when to use

Formula	When to use · notes	SM
$E(R) = R_F + \beta (R_M - R_F)$	CAPM required / equilibrium return of a security or portfolio.	[SM 384]
$\beta = Cov_{SM} \div \sigma_M^2$; $\beta = \rho_{SM}\, \sigma_S \div \sigma_M$	Beta from covariance, or from correlation and SDs.	[SM 344, SM 505]
Portfolio beta = $\Sigma\, W_i\, \beta_i$	Weights by market value.	[SM 404]
CAPM return < estimated return → **undervalued (buy)**; > → overvalued (sell)	Above the SML = under-priced; below = over-priced.	[SM 384, SM 387]
CML: $E(R_p) = R_f + \lambda\, \sigma_p$; $\lambda = (R_m - R_f) \div \sigma_M$	Efficient portfolios only; total risk (SD) on the x-axis.	[SM 385–386]
APT: $E(R) = R_F + R_1\beta_1 + R_2\beta_2 + \ldots + R_n\beta_n$	Multi-factor: one beta and one risk premium per factor.	[SM 388]
Risk-free route: buy risk-free = V × (present β − desired β); sell risk-free = V × (desired β − present β)	Change portfolio beta without futures (June Q6(a)).	[SM 388]
$\beta_L = \beta_U \times [1 + (1 - t) \times D/E]$; $\beta_U = \beta_L \div [1 + (1 - t)\, D/E]$	Levered (equity) ↔ unlevered (asset) beta; proxy beta for a project.	[SM 390–391]
Asset (project) beta = $W_E\, \beta_E + W_D\, \beta_D$ (debt weight × (1 − t) with taxes)	Beta balance sheet; $\beta_D = 0$ if debt is risk-free.	[SM 389]
Risk-return ratio = $(R_s - R_f) \div \beta$ (or ÷ σ)	Excess return per unit of risk.	[SM 387]

B CAPM, SML, CML, APT · Q5(a) and MCQ (vii) 9.1

- **CAPM features**: links expected return, systematic risk and value; diversification removes unsystematic risk; beta depends on market risk, asset risk and their correlation. [SM 383]
- **Assumptions**: rational, utility-maximising investors with homogeneous expectations; free information; unlimited borrowing and lending at the risk-free rate; no taxes or costs; assets divisible and marketable. [SM 383–384]
- **SML** = expected return v beta; every security and portfolio lies on it. **CML** = return v SD; only efficient portfolios; individual securities do not lie on it. [SM 384–386]
- **Characteristic line**: time series of security returns v index returns; its slope is beta. SML is cross-sectional. [SM 386–387]
- APT is a multi-factor model; CAPM a single-factor model. [SM 388]

1 · Beta
Cov ÷ σ_M^2 (or $\rho\sigma_S/\sigma_M$, or weighted)

↓

2 · Risk-free rate
given, or T-bill coupon ÷ price

↓

3 · CAPM return
$R_F + \beta (R_M - R_F)$

↓

4 · Compare
expected > CAPM → undervalued, buy; < → overvalued, sell

PROBLEMS BOX · CAPM (Q5(a) — RECOMPUTED BY SCRIPT m09_patterns.py)

WORKED PATTERN · SM SOLVED CASE 1 (FIVE-STOCK FUND)

Stock	Weight	Beta	CAPM 9 + 6β	Expected	Verdict
A	0.20	1.10	15.60%	15%	overvalued
B	0.10	0.75	13.50%	14%	undervalued
C	0.15	0.90	14.40%	15%	undervalued
D	0.25	1.20	16.20%	16%	overvalued
E	0.30	1.40	17.40%	17%	overvalued
Fund	**1.00**	**1.15**	**15.90%**		

R_f 9%, R_m 15%. [SM 403–404]

JUN'26 Q5(a) ROHAN (OUR WORKING)

- β_A = 0.020 ÷ 0.016 = **1.25**; β_B = 0.028 ÷ 0.016 = **1.75**.
- R_f = T-bill coupon 6.75 ÷ price 108 = **6.25%**.
- CAPM A = 6.25 + 1.25 × 8.75 = **17.19%** < 19% → **undervalued**; B = 6.25 + 1.75 × 8.75 = **21.56%** > 20% → **overvalued**.

APT · SM ADDITIONAL ILLUS. 14 (ITC, FIVE FACTORS)

4.5 + 0.65 − 0.224 + 2.88 − 0.30 + 2.853 = **10.36%**. [SM 403]

PRACTISE THESE (MOST LIKELY FIRST)

J26, D24 Q5(a) · MQP Q5(a), PTP Q5(a), postal Q7(a) · J24 Q5(b) (APT) · J23, J24, J25 Q6(a) (risk-free route) · MCQs J23 Q1(viii), D23 Q1(ix), (xiv), J24 Q1(xii), J25 Q1(vii), J26 Q1(vii) · SM exercise MCQs (SM 407–410, 414–415), Additional illus. (SM 393–403) · **ICMAI Practice Workbook Ch6 illus. 1, 4, 5, 10; Ch7 illus. 4, 5, 7, 8, 9** · MCQ bank Q98, Q100–Q103, Q191.

C Levered and unlevered beta · MCQ (viii) and J25 / D25 Q5(a) 9.2

- **Levered (equity, geared) beta** carries both business and financial risk; used in CAPM for the cost of equity. [SM 390]
- **Unlevered (asset) beta**: market risk with no debt — compares firms with different capital structures. [SM 390–391]
- **Proxy beta**: the beta of a levered firm arrived at from an unlevered firm's beta (project in a new line of business). [SM 389]
- Illus. 8: β_U 0.90, tax 0.30, 60% debt / 40% equity → 0.90 × (1 + 0.70 × 1.5) = 0.90 × 2.05 = **1.85**. [SM 391]
- Solved case 2: all-equity β 0.6; half the equity bought back with risk-free debt → 0.6 = 0.5 × β_E + 0.5 × 0 → **β_E = 1.20** (= D25 MCQ (viii) type). [SM 404–405]

⚠ SM SLIP

SM 305 prints β = COV_{SM} ÷ σ_m; it is ÷ σ_m^2 (the market **variance**), as SM 344 and every worked answer use.

Practise: J25, D25 Q5(a) · MCQs D25, J26 Q1(viii), MQP / PTP Q1(viii) · SM Illus. 8, solved cases 1–2 · **WB Ch6 illus. 2, 3; Ch7 illus. 1, 2, 3, 6** · MCQ bank Q96, Q97, Q99, Q195, Q198, Q200, Q214–Q217.

Item	Rule	SM
CAPM	$R_F + \beta(R_M - R_F)$	[SM 384]
Beta	Cov ÷ σ_M^2	[SM 344]
Levered β	$\beta_U[1 + (1 - t)D/E]$	[SM 390]
APT	$R_F + \Sigma R_i\beta_i$	[SM 388]
Risk-free route	V × (β − β*)	[SM 388]

⚠ TRAPS

- T-bill yield = coupon ÷ **market price**, not the face value.
- Undervalued means the expected return is **above** the CAPM return (the stock plots above the SML).
- Levered beta uses D/E (not D/total); multiply D/E by (1 − t).
- Market risk premium = $R_M - R_F$; if the question gives the premium, do not subtract R_F again.
- **Hook: "Above the line, buy the stock."** SML = beta, CML = sigma.