

FREEFELLOW

FORMULA SHEET

CMA PART 1

IMA · Financial Planning & Analytics

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FORMULAS

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TOPICS

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EXTERNAL FINANCIAL REPORTING DECISIONS		11 items
Accounting equation Assets = Liabilities + Equity Expanded: Assets = Liab + Contributed Capital + Retained Earnings + Revenue – Expenses – Dividends	Cost of goods sold COGS = Beginning Inventory + Purchases – Ending Inventory Manufacturer: COGS = Beg FG + COGM – End FG where COGM = Beg WIP + DM used + DL + OH applied – End WIP	
Inventory lower of cost or net realizable value (FIFO / WA) Carry inventory at the lower of cost OR NRV. NRV = Estimated Selling Price – Costs to Complete – Costs to Sell Write-down recognized as expense in current period; reversals allowed under IFRS, not under US GAAP.	Straight–line depreciation $\text{Annual Depr} = \frac{\text{Cost} - \text{Salvage}}{\text{Useful Life (years)}}$ Equal expense each year. Book value declines linearly to salvage value.	
Double–declining balance depreciation $\text{DDB Rate} = 2 \times \frac{1}{\text{Useful Life}}$$\text{Depr Expense}_t = \text{Book Value}_{t-1} \times \text{DDB Rate}$ Ignores salvage in computation; stop depreciating once book value reaches salvage.	Units of production depreciation $\text{Depr per Unit} = \frac{\text{Cost} - \text{Salvage}}{\text{Total Estimated Units}}$ Period Depr = Depr per Unit × Units Produced	
Sum–of–years–digits depreciation $\text{SYD Denominator} = \frac{n(n + 1)}{2}$ where n = useful life in years $\text{Depr}_t = (\text{Cost} - \text{Salvage}) \times \frac{n - t + 1}{n(n + 1)/2}$ Accelerated method: larger expense in early years.	ASC 606 five–step revenue recognition 1. Identify contract with customer. 2. Identify performance obligations. 3. Determine transaction price. 4. Allocate transaction price to obligations (standalone selling prices). 5. Recognize revenue when (or as) each obligation is satisfied.	
Capitalized interest on self–constructed assets Avoidable Interest = Weighted-avg Accumulated Expenditures × Interest Rate Capitalized amount = lesser of avoidable interest OR actual interest incurred during construction period. Cease when asset is substantially complete and ready for intended use.	Basic and diluted EPS $\text{Basic EPS} = \frac{\text{Net Income} - \text{Preferred Dividends}}{\text{Weighted-Avg Common Shares Outstanding}}$ Diluted EPS adds potentially dilutive securities (options via treasury-stock method, convertibles via if-converted). Antidilutive securities are excluded.	
Bond issuance proceeds Proceeds = PV of Face + PV of Coupons = Face × PVF_{n,i} + Coupon × PVOA_{n,i} Discount: issued below face when market rate > coupon rate. Premium: issued above face when market rate < coupon rate.		

PLANNING, BUDGETING, AND FORECASTING		15 items
Production budget Units to Produce = Budgeted Sales + Desired Ending FG – Beginning FG Production = sales adjusted for inventory build-up or drawdown.	Direct materials purchases budget DM to Purchase = DM Needed for Production + Desired Ending DM – Beginning DM DM Needed = Units to Produce × DM per Unit	
Cash budget structure Beginning Cash +Cash Receipts (collections from sales) –Cash Disbursements (payments for purchases, operating, capex, debt service) = Cash Available before Financing ±Financing (borrowings or repayments) = Ending Cash Balance	Flexible budget Flex Budget Cost = Fixed Cost + (VC per Unit × Actual Activity) Used to compare actual results against what costs SHOULD have been at the actual activity level (vs static master budget).	
High-low method (variable cost per unit) $\text{VC per Unit} = \frac{\text{Cost at High} - \text{Cost at Low}}{\text{Activity at High} - \text{Activity at Low}}$ Fixed Cost = Total Cost at High – (VC per Unit × High Activity) Uses only two data points; less accurate than regression.	Simple linear regression $y = a + bx$ $b = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$ $a = \bar{y} - b\bar{x}$ b is slope (variable cost per unit); a is intercept (fixed cost component).	
Coefficient of determination R-squared $R^2 = 1 - \frac{SS_{res}}{SS_{tot}}$ where $SS_{res} = \sum (y_i - \hat{y}_i)^2$ and $SS_{tot} = \sum (y_i - \bar{y})^2$ Proportion of variance in y explained by x. Range 0 to 1. Higher is better fit.	Coefficient of variation $\text{CV} = \frac{\sigma}{\mu}$ Standard deviation per unit of mean. Used to compare relative risk across projects with different scales. Lower CV = lower relative risk.	
Expected value of a discrete random variable $E[X] = \sum_i p_i x_i$ Weighted average of outcomes by probabilities. Probabilities must sum to 1. Variance: $\sigma^2 = \sum p_i (x_i - E[X])^2$	Expected value of perfect information (EVPI) EVPI = EV with Perfect Info – EV of Best Decision under Uncertainty Maximum the decision maker should pay for perfect information. Upper bound on the value of any forecasting or market research.	
Learning curve (cumulative average-time model) $Y = aX^b$ where $b = \log(\text{learning rate}) / \log 2$ Y = cumulative average time per unit after X units, a = time for first unit. 80% curve: each doubling of cumulative output cuts cumulative average time to 80% of prior level. $b = \log(0.80) / \log 2 = -0.322$.	Simple moving average forecast $F_{t+1} = \frac{D_t + D_{t-1} + \cdots + D_{t-n+1}}{n}$ Average of the most recent n actual periods becomes forecast for next period. Equal weights. Smooths noise; lags behind real trends.	
Weighted moving average and exponential smoothing Weighted MA: $F_{t+1} = \sum w_i D_{t-i+1}$ with $\sum w_i = 1$. Heavier weights on recent periods. Exponential smoothing: $F_{t+1} = \alpha D_t + (1 - \alpha)F_t$ where $0 < \alpha < 1$. Higher α gives more responsiveness; lower α gives more stability.	Time-series decomposition components Multiplicative: $Y_t = T_t \times S_t \times C_t \times I_t$ Additive: $Y_t = T_t + S_t + C_t + I_t$ T = trend (long-run direction), S = seasonal (within-year cycles), C = cyclical (multi-year business cycle), I = irregular (random).	
Linear programming setup Maximize (or minimize): $Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$ Subject to: $a_{i1}x_1 + a_{i2}x_2 + \cdots \leq b_i$ for each constraint i $x_j \geq 0$ for all j Optimal solution lies at a corner (extreme point) of the feasible region.		

Contribution margin

CM = Revenue – Variable Costs
CM per Unit = Price – VC per Unit
Contribution toward covering fixed costs and producing profit. Variable costing income statement separates VC and FC.

Contribution margin ratio

$$\text{CM Ratio} = \frac{\text{CM}}{\text{Revenue}} = \frac{P - V}{P}$$

Fraction of each sales dollar available to cover fixed costs and profit.
Stable across volume changes when prices and VC structure are constant.

Breakeven point in units and dollars

$$\text{BE Units} = \frac{\text{Fixed Costs}}{\text{CM per Unit}}$$
$$\text{BE Dollars} = \frac{\text{Fixed Costs}}{\text{CM Ratio}}$$

Volume where total revenue equals total cost (zero profit).

Target profit (before-tax and after-tax)

Before-tax target:
$$\text{Units} = \frac{\text{FC} + \text{Target Profit}}{\text{CM per Unit}}$$

After-tax target:
$$\text{Units} = \frac{\text{FC} + \text{After-tax Profit}/(1 - t)}{\text{CM per Unit}}$$
 where t = tax rate.

Margin of safety

Margin of Safety = Actual or Budgeted Sales – Breakeven Sales
$$\text{MoS Ratio} = \frac{\text{Margin of Safety}}{\text{Actual Sales}}$$

Cushion against revenue decline before reaching breakeven.

Degree of operating leverage

$$\text{DOL} = \frac{\text{Contribution Margin}}{\text{Operating Income}} = \frac{\% \Delta \text{ Op Income}}{\% \Delta \text{ Sales}}$$

High DOL = more fixed costs in cost structure = profits move more dramatically with sales changes. DOL is highest near breakeven.

Multi-product weighted-average CM breakeven

$$\text{Weighted-Avg CM per Unit} = \sum (\text{CM}_i \times \text{Mix}_i)$$
$$\text{BE Composite Units} = \frac{\text{Fixed Costs}}{\text{Weighted-Avg CM per Unit}}$$

Decompose composite units by sales mix percentages to get per-product BE units. Assumes constant sales mix.

Direct materials price variance

$$\text{DM Price Var} = (\text{AP} - \text{SP}) \times \text{AQ}_{\text{purchased}}$$

AP = actual price, SP = standard price, AQ = actual quantity. Unfavorable when actual price exceeds standard. Usually responsibility of purchasing.

Direct materials quantity (usage) variance

$$\text{DM Quantity Var} = (\text{AQ}_{\text{used}} - \text{SQ}) \times \text{SP}$$

SQ = standard quantity allowed for actual output. Unfavorable when more materials used than standard. Usually responsibility of production.

Direct labor rate and efficiency variances

Rate:
$$(\text{AR} - \text{SR}) \times \text{AH}$$
 where AR/SR are actual/standard rates, AH = actual hours.
Efficiency:
$$(\text{AH} - \text{SH}) \times \text{SR}$$
 where SH = standard hours for actual output.
Rate is HR/payroll responsibility; efficiency is supervisor responsibility.

Variable overhead variances

Spending:
$$(\text{AR} - \text{SR}) \times \text{AH}$$
 where AH = actual hours of cost driver.
Efficiency:
$$(\text{AH} - \text{SH}) \times \text{SR}$$
 where SH = standard hours for actual output.
Spending captures rate differences; efficiency captures usage differences.

Fixed overhead budget and volume variances

Budget variance: Actual FOH – Budgeted FOH (flexible budget = static budget for FOH).
Volume variance: Budgeted FOH – FOH applied to production at standard rate.
Volume variance arises only because the rate uses denominator activity. Not a cash variance; reflects under- or over-absorption.

ROI, residual income, and EVA

$$\text{ROI} = \frac{\text{Operating Income}}{\text{Invested Capital}}$$

Residual Income = Op Income – (Invested Capital × Required Return)
EVA = NOPAT – (Invested Capital × WACC)
RI and EVA favor goal congruence over ROI.

Sales price and sales volume variances

Sales price:
$$(\text{Actual Price} - \text{Budgeted Price}) \times \text{Actual Units}$$

Sales volume:
$$(\text{Actual Units} - \text{Budgeted Units}) \times \text{Budgeted CM per Unit}$$

Sales volume decomposes into sales mix and sales quantity variances for multi-product companies.

Transfer pricing methods

Three methods:
1. Market-based: external market price for the same product.
2. Cost-based: variable cost, full cost, or cost-plus.
3. Negotiated: divisions agree on a price (often when no clear market exists).
General rule: minimum transfer price = variable cost + opportunity cost of forgone external sales.

Balanced scorecard four perspectives

- 1. Financial: revenue growth, profitability, ROI, EVA.
- 2. Customer: satisfaction, retention, market share, brand value.
- 3. Internal business processes: cycle time, defect rates, productivity.
- 4. Learning and growth: employee skills, information systems, organizational alignment.

Responsibility center accountability

Cost center: controls costs only (e.g., production line).
Revenue center: controls revenues only (e.g., sales region).
Profit center: controls both (e.g., product division).
Investment center: controls revenues, costs, AND invested capital (e.g., subsidiary). Measured by ROI, RI, EVA.

Absorption vs variable costing income reconciliation

Income differs by the change in fixed OH in inventory.

Absorption Income – Variable Income = Δ Units in Inventory $\times$ Fixed OH per Unit

Production > Sales: absorption income higher (FOH deferred in inventory).

Production < Sales: variable income higher.

Predetermined overhead rate

$$POHR = \frac{\text{Estimated Total OH for Period}}{\text{Estimated Total Activity Base (denominator)}}$$

Applied OH = POHR $\times$ actual activity. Over- or under-applied OH closed to COGS (or prorated to WIP/FG/COGS for material amounts).

Process costing equivalent units (weighted average)

$EU_{WA} = \text{Units Completed} + (\text{Ending WIP Units} \times \% \text{ complete})$

Cost per EU: (Beg WIP Cost + Current Period Cost) / EU.

WA blends prior- and current-period costs.

Process costing equivalent units (FIFO)

$EU_{FIFO} = \text{Units Started \& Completed} + (\text{Beg WIP} \times \% \text{ to complete}) + (\text{End WIP} \times \% \text{ complete})$

Cost per EU uses only current-period cost. FIFO separates beginning WIP from current production.

Joint cost allocation methods

- Physical units: allocate by relative output quantities.
- Sales value at split-off: allocate by relative sales value at split-off point.
- NRV: $NRV_i = \text{Final Sales Value}_i - \text{Separable Costs}_i$; allocate joint cost by relative NRV.
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Activity-based costing rate

$$ABC \text{ Rate per Activity} = \frac{\text{Cost of Activity Pool}}{\text{Total Cost Driver Activity}}$$

Product cost = direct materials + direct labor + sum over activities of (rate $\times$ driver consumption). Reduces cost distortion vs single-rate volume-based costing.

Economic order quantity

$$EOQ = \sqrt{\frac{2DS}{H}}$$

D = annual demand, S = order (setup) cost per order, H = holding cost per unit per year.

At EOQ, total ordering cost equals total holding cost.

Number of Orders = D/EOQ ; Cycle Time = EOQ/D .

Reorder point and safety stock

$ROP = (\text{Avg Daily Demand} \times \text{Lead Time in Days}) + \text{Safety Stock}$

Safety stock = $z \times \sigma_{LTD}$ where z is z-score for desired service level (e.g., 1.65 for 95%) and σ_{LTD} is std dev of lead-time demand.

JIT and lean inventory concepts

JIT: zero inventory targets; pull system; small lot sizes; close supplier partnerships; high quality emphasis (defects halt the line).

Lean: eliminate seven wastes (transportation, inventory, motion, waiting, overprocessing, overproduction, defects). Value-stream mapping.

Continuous improvement (kaizen).

Theory of constraints throughput accounting

Throughput Contribution = Revenue – Totally Variable Costs (TVC)

TVC = direct materials only (labor and OH treated as period costs).

Five focusing steps: identify constraint, exploit, subordinate, elevate, repeat. Manage to the bottleneck.

Service department cost allocation

Direct method: allocate service dept costs directly to operating depts; ignore service-to-service.

Step-down (sequential): allocate one service dept fully first, then next, etc. No reciprocal recognition.

Reciprocal: solve simultaneous equations; full recognition of service-to-service. Most accurate.

Cost of quality four categories

- Prevention: training, design for quality, supplier certification.
- Appraisal: inspection, testing, quality audits.
- Internal failure: rework, scrap, downtime (detected before shipment).
- External failure: warranty, returns, lost sales (detected by customer).

COSO Internal Control framework (2013) five components

- 1. Control Environment (tone at the top, ethics, governance).
- 2. Risk Assessment (identify and analyze risks to objectives).
- 3. Control Activities (policies and procedures to mitigate risks).
- 4. Information and Communication (relevant info captured and shared).
- 5. Monitoring (ongoing and separate evaluations).

COSO ERM framework (2017) five components

- 1. Governance and Culture.
 - 2. Strategy and Objective-Setting.
 - 3. Performance (risk identification, assessment, prioritization, response).
 - 4. Review and Revision.
 - 5. Information, Communication, and Reporting.
- 20 underlying principles.

Three lines of defense model

Line 1: Operational management (owns and manages risk).

Line 2: Risk management, compliance, controllership functions (oversight, frameworks).

Line 3: Internal audit (independent assurance to the board).

External auditors and regulators sit outside the model. Each line reports to governing body.

Sarbanes-Oxley §302 and §404

§302: CEO and CFO must certify accuracy of financial reports and adequacy of disclosure controls. Quarterly certification.

§404: Management must assess and report on internal control over financial reporting (ICFR). Auditor must attest (for accelerated filers). Annual assessment.

Risk: inherent, residual, control

Inherent risk: risk before any controls (gross risk).

Control risk: risk that controls fail to prevent or detect misstatement.

Residual risk: risk that remains after controls (net risk).

Materiality thresholds (quantitative)

Common quantitative benchmarks (rule-of-thumb only; judgment required):

- 5% of pre-tax income (most common)
- 0.5% of total revenue
- 1% of total assets
- 5% of equity

Qualitative factors (small amounts that turn losses to gains, hide trends, affect compliance) can make even small misstatements material.

Segregation of duties (SoD)

Four incompatible functions must be separated:

- 1. Authorization (approve transactions).
- 2. Recording (post to records).
- 3. Custody (hold assets).
- 4. Reconciliation (independently verify).

No one person should perform two functions for the same transaction.

Compensating controls when SoD impractical (e.g.

NIST Cybersecurity Framework five functions

- 1. Identify (asset management, business environment, governance, risk assessment).
- 2. Protect (access control, awareness training, data security).
- 3. Detect (anomaly detection, continuous monitoring).
- 4. Respond (response planning, communications, mitigation).
- 5.

Data analytics four types

- 1. Descriptive: what happened? (dashboards, KPIs, historical summaries).
- 2. Diagnostic: why did it happen? (drill-down, root cause, variance analysis).
- 3. Predictive: what will happen? (regression, classification, forecasting).
- 4. Prescriptive: what should we do? (optimization, simulation, decision models).

Pearson correlation coefficient

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

Range −1 to +1. Measures linear association only. $r = 0$ means no LINEAR relationship (could still have nonlinear pattern). r^2 is coefficient of determination.

Sensitivity, scenario, and simulation analysis

Sensitivity: change ONE variable at a time; observe effect on outcome (NPV, profit). What-if.

Scenario: change a CONSISTENT SET of variables (e.g., recession scenario shifts revenue down AND costs up).

Data governance dimensions

Accuracy: data reflects reality.

Completeness: required fields present.

Consistency: same data agrees across systems.

Timeliness: available when needed.

Validity: conforms to defined rules and formats.

Uniqueness: no unwarranted duplicates.

Integrity: relationships maintained across tables and time.

Big data five Vs

Volume: scale of data (terabytes to petabytes).

Velocity: speed of generation and processing (real-time vs batch).

Variety: structured, semi-structured, unstructured (text, images, logs).

Veracity: data quality and trustworthiness.

Value: usefulness of insights extracted.

Decision tree expected value

At each decision node, compute expected value of each branch as $\sum p_i \times \text{outcome}_i$. Roll back from end nodes.

Path that maximizes expected payoff (or minimizes expected cost) is the optimal decision.

Sensitivity analysis: vary probabilities or payoffs and observe whether optimal choice changes.

Altman Z-score (manufacturing public firms)

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

$$X_1 = \text{WC/TA}, X_2 = \text{RE/TA}, X_3 = \text{EBIT/TA}, X_4 = \text{MV Equity/BV Liab}, X_5 = \text{Sales/TA}.$$

Z > 2.99: safe. 1.81 < Z < 2.99: grey zone. Z < 1.81: distress.