ECC3640 Economics of Climate Change

MONASH UNIVERSITY · LEVEL 3 · SEMESTER 2, 2026 · CLOSED-BOOK MEMORY SHEET

Full guide + ask Sia about ECC3640

SIDE 1/2 EXAM MAP · DEFINITIONS · FORMULAS · DECISION RULES · COMPARISONS

CARRY IT IN YOUR HEAD

40% final eExam · no hurdle requirement

0 · Exam map

COURSE + WEEK 13

18	10	6	2	24	40% final

Weekly Discussion Forum 18% · Workshop Contributions 10% · Practice Quizzes 6% · Policy Brief Plan 2% · Policy Brief 24% · Final E-exam 40%.

★ "The final exam is a closed-book, fully invigilated eExam." — ECC3640 Week 13 Exam page, Moodle 2026 (MD_Week_13_Exam.md)

Format: four extended-matching parts × five questions; each fully correct answer = 2 marks; 40 marks total. Predict the concept from the launch pad, test *every* option against its exact wording, count required selections, then remove unsupported extras.

PRIORITY	FINAL BOUNDARY
Rehearse hard	Every topic with a practice quiz except Science (week 2) and Stabilisation (week 7).
Use as context	Science and Stabilisation are foundations but excluded under the current notice.
Policy brief	Enterprise-driven decarbonisation has no weekly quiz and supports the brief.

RECALL TEST → *Before looking down, say: mechanism → evidence → decision rule → limitation. Recognition is not recall.*

1 · Damage chain

CH 2 · EXAMINABLE

hazard ▶ impact ▶ adapt ▶ value ▶ damage

gross − avoided = residual

Do not price a hazard directly: identify exposure, adaptation, valuation boundary and residual loss.

Exposure = people/assets/ecosystems where hazard can affect them. ***Vulnerability*** = susceptibility, shaped by sensitivity and capacity to cope. ***Damage function*** maps a climate variable to economic loss under stated assumptions.

Audit: baseline and horizon? gross or post-adaptation? market plus non-market? population and price basis? thresholds? regional distribution? A dollar loss, percentage of output and mortality-risk change are not interchangeable.

Equal hazards need not mean equal welfare damage. Income, infrastructure, sector mix, population and adaptive capacity differ. Aggregate GDP can hide concentrated loss and values without market prices.

LAYER	WHAT A GOOD OPTION SAYS
Physical impact	health, ecosystem, infrastructure or production change before pricing
Market value	observable output/income effect, with boundary stated
Non-market value	health, biodiversity, amenity or culture valued by another method
Residual damage	harm left after adaptation; do not count avoided loss again

2 · Climate CBA

CH 3 · CORE MODEL

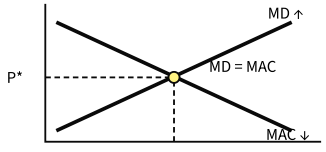
Policy variable: atmospheric concentration G. Total cost = climate damage + abatement cost. Tighter policy moves G toward reference G_0: damage falls, abatement cost rises.

QUADRATIC QUIGGIN FRAMEWORK

$$\text{Damage} = kD(G - G_0)^2$$
$$\text{Abatement cost} = kA(GBAU - G)^2$$
$$MD = 2kD(G - G_0)$$
$$MAC = 2kA(GBAU - G)$$

INTERIOR OPTIMUM

$$MD = MAC$$
$$G^* = (kA \times GBAU + kD \times G_0) \div (kA + kD)$$
$$P^* = MD(G^*) = MAC(G^*)$$



Interior minimum: tighten if MD > MAC; loosen if MAC > MD. A boundary solution is possible if curves do not cross feasibly.

CHANGE	DIRECTION	REASON
kD ↑	G^* ↓ toward G_0	extra concentration is costlier
kA ↑	G^* ↑ toward GBAU	tight control is costlier
discount rate ↑	damage side tends ↓	distant loss gets less present weight
omitted non-market loss added	damage side ↑	boundary widens

Check both margins and that $G_0 \le G^* \le GBAU$. The model gives a calibrated shadow value, not an observed tax or permit price and not a physical threshold.

ASSUMPTIONS CARRIED BY THE RESULT

Reference concentration fixes the damage anchor; **business-as-usual concentration** fixes the abatement anchor; **kD** and **kA** set curvature. Discounting, risk, non-market value and baseline growth affect the damage side. Technology and transition assumptions affect the abatement side.

Weighted-average intuition: G^* sits between the two anchors. A larger coefficient gives its associated anchor more weight: larger kD weights G_0; larger kA weights GBAU. This is the fastest direction check.

Boundary case: equality identifies only an interior optimum. If MD and MAC do not cross inside the feasible interval, compare total cost at the relevant boundary rather than forcing the formula to describe an infeasible target.

3 · Time, risk, equity

CH 4 · CORE

DISCRETE PRESENT VALUE

$$PV = \text{Future amount} \div (1 + r)^t$$

Higher r or longer t → lower PV

RAMSEY RULE

$$r = \delta + \eta g$$

δ = pure time preference
η = elasticity of marginal utility
g = consumption growth

Interpret: δ gives later utility less weight simply because it is later; ηg reflects diminishing marginal utility if future people are richer. Arithmetic is technical; parameter choice is empirical and ethical.

same $10,000 loss in year 30

2% → PV $5,522 r ↑

5% → PV $2,314 PV ↓

The physical loss is unchanged; only its present weighting changes.

RISK IS NOT DEEP UNCERTAINTY

RISK	DEEP UNCERTAINTY
known / estimable probabilities → EV	model or distribution disputed → robustness

ambiguity increases →

Expected value needs defensible probabilities; robustness, learning and precaution matter when structure itself is uncertain.

EXPECTED VALUE

$$EV = \sum \text{probability(state)} \times \text{consequence(state)}$$

Fat tail: enough probability on extremes that rare catastrophic loss can materially affect expected welfare, especially with irreversibility or limited adaptation. Do not infer "uncertainty = no action" or "uncertainty = maximal action"; match the rule to the uncertainty.

ROBUSTNESS ANSWER IN FOUR MOVES

1. Identify states, probabilities or competing model structures.
2. Show welfare under each, including an extreme-loss state where relevant.
3. Ask whether the preferred action survives plausible alternatives.
4. Use learning, staging or an adaptive trigger when revision has value.

Precaution is not a free conclusion. Explain asymmetry, irreversibility or fat-tail loss. **Waiting is not free either:** current damage, lock-in and lost options can accumulate while information improves.

4 · Cooperation game

CH 5 · EXAMINABLE

Global public good: mitigation benefits are broadly non-rival and difficult to exclude. Efficient provision adds marginal benefits vertically across countries, while a government considering only domestic benefit tends to underprovide.

Free-riding: enjoy others' mitigation while avoiding own cost. A prisoners' dilemma can make mutual withholding individually stable even though mutual contribution is jointly better.

Country B

Country A	Contribute	Withhold
Contribute	6, 6	1, 8
Withhold	8, 1	3, 3

joint best = C,C · Nash equilibrium = W,W

Circle each best response first; only then name the Nash equilibrium and compare joint welfare.

SOLVE ANY PAYOFF TABLE

1 Against each action by the other, choose own higher payoff.
2 Intersection of best responses = Nash equilibrium.
3 Sum payoffs to find joint-welfare maximum.
4 Explain the gap; propose an institution that changes it.

DESIGN FEATURE	CHANNEL CHANGED
Monitoring / transparency	information about performance
Repeated interaction / reciprocity	future payoff and expectations
Finance / transfers	current contribution cost + distribution
Club benefit / penalty	reward from withholding
Review cycle	learning and later ambition

pledge ▶ monitor ▶ review ▶ ratchet

Participation alone does not prove success: assess ambition, implementation, credibility and behaviour.

Equity principles: capacity, historical responsibility and vulnerability must become an operational contribution or finance rule.

ARCHITECTURE EVALUATION

DESIGN	TRADE-OFF
Broad participation	coverage improves; weak voluntary commitments may leave a collective-action gap
Stringent obligations	stronger commitments; harder to negotiate or enforce

5 · Instrument chooser

CH 7 · CORE

Hold the environmental target constant. A policy may look cheap only because it covers fewer emissions or delivers less reduction. Under certainty, price and quantity can be calibrated to the same outcome.

Rule	Q certain	P certain	revenue
Tax	low	high	yes
ETS	high	low	auction

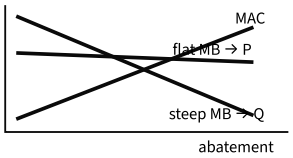
tax: price · ETS: quantity

Free allocation changes wealth and public revenue; the permit's opportunity cost can preserve the marginal signal.

INSTRUMENT	STRENGTH	WATCH
Standard	direct performance/technology rule	may not equalise MAC; information burden
Tax	price certainty + revenue	emissions quantity adjusts
Subsidy	targets selected reductions	finance, additionality, expansion
ETS	quantity certainty + trade	price volatility, allocation, market power

COST EFFECTIVENESS

For a fixed aggregate target, rank marginal abatement units lowest to highest. Flexible sources abate until $MAC_1 = MAC_2 = \ldots$, subject to monitoring and constraints.



Relative-slope rule under uncertain abatement cost: flat marginal benefit favours price; steep marginal benefit near a threshold strengthens quantity control.

Implementation gate: coverage · liable entity · measurement · baseline · enforcement · transaction cost · market power · revenue use · distribution. Hybrid designs can limit extreme price or quantity outcomes.

ONE-SENTENCE INSTRUMENT DEFENCES

6 · Policy mechanism audit

CH 8 · EXAMINABLE

Start with the chain, not the programme name: **objective → regulated/supported entity → emissions boundary → baseline → target → compliance unit → enforcement → behavioural response → measured outcome.**

technology ▶ inputs ▶ demand ▶ location

Which decisions does the policy actually reach?

Broad coverage helps only if emissions are measurable and the responsible decision-maker can respond.

TEST	MEMORY SENTENCE
Additionality	Would the claimed reduction occur without the incentive?
Baseline	Is the counterfactual inflated, unstable or manipulable?
Leakage	Did production/emissions move outside the boundary?
Distribution	Households, regions, competitiveness, revenue recycling.
Durability	Can investors plan long-lived low-emissions assets?

Leakage risk ↑ when production is trade-exposed, emissions cost is material, relocation feasible and foreign production at least as emissions-intensive.

Crediting integrity needs measurement, reporting and verification; participation alone never proves additionality.

7 · Adaptation decision

CH 10 · EXAMINABLE

AUTONOMOUS	POLICY-DRIVEN
private adjustment insurance · crops timing · design	public coordination infrastructure · info zoning · finance

short-run protection ↔ long-run transformation

Public action bites where spillovers, information, infrastructure, finance, land use or equity block efficient private adjustment.

Mitigation changes future hazard; **adaptation** changes exposure, vulnerability or consequences. They are complements. Appraise: consistent horizon and prices → expected avoided damage → cost → residual risk → spillovers → non-market effects → distribution → robustness.

ADAPTATION VALUE

Avoided damage = expected harm without measure − expected residual harm
NPV = PV(avoided damage) − present intervention cost

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SIDE 2/2 FIVE WORKED DRILLS · IF X → DO Y · CLASSIC TRAPS · EXAM-MORNING PLAN

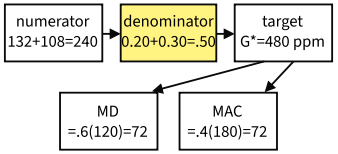
ANSWER BEFORE CHECKING

Extended matching · formula + interpretation + limitation

8 · Drill 1: solve G*

CH 3 WORKED EXAMPLE

Given: kA=0.20, kD=0.30, G_0=360 ppm, GBAU=660 ppm. Compute target, verify both margins, interpret.



Every number follows from the printed formula; equality is the error check.

1. G*=(.20×660+.30×360)/(.20+.30).
2. Numerator =132+108=240; denominator =.50.
3. G*=480 ppm, inside [360,660].
4. MD=2×.30×(480-360)=72.
5. MAC=2×.20×(660-480)=72.

Interpret: at this calibration, total modelled damage plus abatement cost is minimised. It is not scientific certainty and P*=72 is a modelled marginal value, not necessarily a market price.

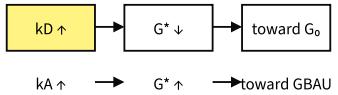
SELF-CHECK	PASS?
Correct anchors and minus signs	MD uses G-G_0; MAC uses GBAU-G
Direction	higher kD should pull G* down
FOC	MD must equal MAC

TRAP → *Swapping kA and kD in the weighted average reverses the sensitivity story.*

8b · Rapid oral prompts

CH 3 FAQ

MD>MAC? Tighten. MAC>MD? Loosen. No feasible intersection? Check a boundary. Point estimate fragile? Run sensitivity. Carbon value vs tax? Shadow value ≠ observed price.



kA ↑ → G* ↑ → toward GBAU

Say the curve/weight movement before stating the policy direction.

Option-set filters: reject "optimal concentration = safe concentration"; reject "P* is today's market price"; reject a sensitivity answer that changes two inputs at once; reject a claim that a point estimate is robust merely because the algebra is exact.

Full-credit verbal check: "Holding other inputs fixed, the higher damage coefficient increases the weight on the lower reference concentration, so the preferred concentration falls. The numerical size still depends on calibration."

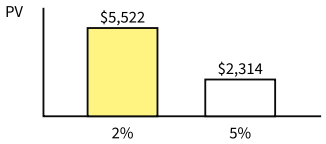
9 · Drill 2: discount

CH 4 WORKED EXAMPLE

Given: one avoided loss of **$10,000 in 30 years**; 1.02^{30}=1.811, 1.05^{30}=4.322.

FORMULA BEFORE NUMBERS

PV = Future amount ÷ $(1+r)^t$



Same future loss, different present weights: higher r reduces PV.

1. At 2%: 10,000÷1.811 ≈ $5,522.
2. At 5%: 10,000÷4.322 ≈ $2,314.
3. Difference comes from intertemporal weighting, *not* changed future physical damage.
4. Debate δ and ηg; do not choose r to force a preferred answer.

IF PROMPT SAYS...	DO...
probabilities supplied	compute EV, then discuss tails/irreversibility
probabilities disputed	robustness, precaution, learning, adaptive policy
future people richer	explain ηg, not pure time preference
aggregate benefit positive	still analyse incidence and compensation

9b · Classic category traps

CH 4 PRACTICE

- **Discounting** changes weight across time.
- **Risk** attaches known/estimable probabilities.
- **Deep uncertainty** disputes distribution or model.
- **Equity** asks who bears costs and receives benefits.

Do not use the four terms as synonyms. An option that slides between them without an argument is overbroad.

EQUITY AND TAILS: FAST JUDGEMENTS

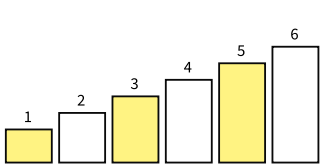
If a low-probability state has enormous irreversible loss, show its expected-welfare contribution and explain why the central estimate may be insufficient. If probabilities themselves are disputed, do not fabricate an EV: compare robust performance across plausible structures.

CLAIM	AUDIT
"Higher r means less physical damage"	false: it means lower present weight
"Future people richer"	connect to ηg; distribution may still be unequal
"Positive aggregate NPV"	ask who loses, whether compensation is feasible
"Small probability"	combine with consequence; inspect fat tail

10 · Drill 3: allocate abatement

CH 7 WORKED EXAMPLE

Given successive MACs: A = 2,4,6,8,10,12; B = 1,3,5,7,9,11. Achieve six units at minimum total cost.



Select marginal units globally, not each firm's average cost.

1. Order all units: B1=1, A1=2, B2=3, A2=4, B3=5, A3=6, ….
2. Choose first six ⇒ each firm abates three.
3. Efficient cost = 1+2+3+4+5+6 = 21.
4. Rigid A5/B1 cost = 2+4+6+8+10+1 = 31.
5. Saving = 31−21 = 10, same aggregate abatement.

Source audit: the chapter's step list gives rigid cost 31; its answer line says 41 and saving 20. The printed marginal costs verify **31 and 10**. Trust the recomputation.

ECONOMIC EXPLANATION

A common tax or permit price directs more abatement to lower-MAC opportunities until marginal costs are equalised.

PROMPT	RESPONSE
tax vs cap under certainty	can calibrate either to same outcome
flat MB, steep/uncertain MAC	price stronger
steep MB near threshold	quantity stronger
free permits	rents change; marginal opportunity cost can remain
subsidy	check finance, additionality, output expansion

TRAP → *"Cheaper" is meaningless unless the environmental targets match.*

IMPLEMENTATION STRESS TEST

After the textbook allocation, reopen reality: Can emissions be measured? Is coverage upstream, facility-based or narrow? Can firms adjust the priced margin? Are permits enforceable? Could market power distort trade? Do transaction and administrative costs overturn the ranking?

DESIGN CHOICE	DISTRIBUTION / INTEGRITY EFFECT
auction permits	public revenue; marginal cap signal retained
free permits	scarcity rents transferred; opportunity cost may remain
recycle tax revenue	changes household/industry incidence

11 · Drill 4: mitigation game

CH 5 WORKED EXAMPLE

Payoffs: mutual contribution (6,6); free-rider gets 8, sole contributor 1; mutual withholding (3,3).

A \ B	C	W
C	6,6	1,8
W	8,1	3,3

joint best — Nash: W,W

Mutual contribution maximises joint welfare; withholding is each country's dominant best response.

1. If other contributes: 8>6 ⇒ withhold.
2. If other withholds: 3>1 ⇒ withhold.
3. Mutual withholding (3,3) = Nash equilibrium.
4. Mutual contribution (6,6) is jointly preferred.
5. An agreement must change payoff, information or expectation—not merely restate the desired outcome.

IF THE PROBLEM IS...	MECHANISM
hidden defection	monitoring + transparency
one-shot temptation	repetition + reciprocity
high contribution cost	finance or technology transfer
reward to outsiders	club benefit / border measure
low ambition	review and ratchet expectations

11b · Extended-matching discipline

COURSE FAQ

Launch pad → prediction → option audit. A familiar topic word is not sufficient. Ask whether the option describes the right player, margin, baseline, causal channel and strength of conclusion.

Count required selections. Remove a partly true option if its unsupported clause makes the whole option false.

AGREEMENT TRAPS

- **Public good ≠ common resource:** the examined mechanism is non-rival, difficult-to-exclude benefit and free-riding.
- **Nash ≠ socially best:** it is stable against unilateral deviation, not necessarily efficient.
- **More signatories ≠ success:** inspect ambition, implementation and behaviour.
- **Fairness word ≠ rule:** turn capacity, responsibility or vulnerability into a contribution/finance mechanism.

Institution sentence stem: "This feature changes [information/current payoff/future payoff/distribution], reducing the private attraction of withholding and making reciprocal contribution more credible."

12 · Drill 5: adaptation NPV

CH 10 WORKED EXAMPLE

Given: flood barrier costs **$18m now**; avoids expected losses of **$4m** at each year-end for six years; at 5%, annuity factor =5.076.

PV avoided loss

$4m × 5.076 = $20.304m

NPV = +$2.304m

cost = $18m

excl. social effects

Positive financial NPV supports the project only within the simplified boundary.

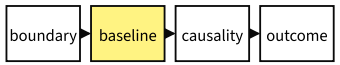
1. PV avoided loss = $4m×5.076=$20.304m.
2. NPV = $20.304m-$18m=$2.304m.
3. Then add maintenance, shifted flood/erosion risk, habitat/amenity, unequal protection and uncertainty.
4. State residual and transferred risks; protection ≠ elimination.

RECOMMENDATION SENTENCE

Positive simplified NPV supports the barrier under stated assumptions; recommendation still depends on spillovers, non-market value, distribution, performance across plausible futures and a monitoring trigger.

12b · Policy-claim audit

CH 8 + CH 9



finance / label ≠ impact

Outsourcing can lower reported direct emissions without lowering total relevant emissions; reconcile boundaries before celebrating a trend.

CLAIM	REQUIRED EVIDENCE
credited reduction	counterfactual + additionality + verification
climate finance	eligible assets + use tracking + independent review + outcomes
transition plan	inventory + interim target + capital decisions + accountability
positive project NPV	financial case; climate case still needs baseline and emissions factors

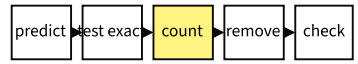
AUSTRALIAN-POLICY JUDGEMENT CARDS

Fixed rebate regardless of displaced emissions: objective/action mismatch and weak targeting. Scale support to independently estimated lifetime abatement; use declining rates or eligibility as costs fall; retain targeted finance where constraints are evidenced.

13 · If you see X → do Y

ALL EXAMINABLE CHAPTERS

SIGNAL IN STEM	IMMEDIATE MOVE
hazard or temperature only	insert exposure → adaptation → valuation
MD>MAC	tighten; if MAC>MD, loosen
future flow	PV = F/(1+r)^t; r↑ ⇒ PV↓
probabilities disputed	robustness, learning, staging
public-good game	best responses → Nash → joint welfare
six abatement units	rank marginal units; stop at six
flat MB, uncertain steep MAC	price; steep MB → quantity
policy name only	entity, base, baseline, incentive, enforcement
credit/rebate	counterfactual, additionality, verification
protection project	avoided loss − cost; residual/shifted risk



scope · mechanism · direction · qualifier

Extended matching rewards exact fit, not keyword recognition.

14 · Classic traps

FAQ + PRACTICE

- Modelled target presented as a physical threshold or certain fact.
- Carbon shadow value confused with observed instrument price.
- Uncertainty treated as zero effect or equal likelihood for all outcomes.
- Agreement judged only by signatories or announcements.
- Free permits treated as removing opportunity cost.
- Additionality inferred from participation or certification.
- Policy costs compared at different environmental outcomes.
- Residual or transferred risk made to disappear.

15 · Exam-morning plan

COURSE STUDY STRATEGY

1 · Closed notes. Rebuild from memory: G*, MD/MAC, PV, Ramsey, EV, MAC equalisation, price/quantity slope rule, adaptation NPV.

2 · Five oral chains. Damage; CBA; public-good game; policy mechanism; adaptation appraisal. For each: definition → rule → caveat.

3 · One clean drill each. Recompute 480 ppm, $5,522/$2,314, allocation cost 21 vs 31, Nash (3,3), adaptation NPV $2.304m.

4 · Option-set rehearsal. Predict before reading choices; reject overbroad clauses; count selections.