

The Antlion's Budget: Dig, Wait, or Move? An Energy Decision

Learning target: I can use an energy budget to compare three strategies for an animal that must store enough energy to grow and change form, model where the matter and energy in its food go, and justify a decision under uncertainty.

Transfer and design

About 55 min

Pairs

MS-LS1-7 · assesses

MS-LS2-3 · supports

engineering design

data analysis

writing

Name _____

Date _____

Period _____

Directions

Read the brief and the facts about antlions. Study the budget rules carefully; every number you need is in the rules table, and the energy unit is a teaching unit, not a real measurement. Work through the parts in order: do the arithmetic in Part A before you argue in Part D. Show every calculation so a partner can check it. Your final decision must be justified with numbers, with the model of how the antlion uses its food, and with an honest statement of what could go wrong.

You will need: This worksheet, Pencil, Calculator, Scrap paper for day-by-day tallies

The brief — You are advising an antlion larva (as a thought experiment). It lives at the bottom of a cone-shaped pit it dug in loose sand, waiting for ants to slide in. It has 30 days to store enough energy, as body fat, to change into its winged adult form; if it falls short, it cannot complete the change. Its patch of open sand is windy, and wind wrecks the pit about once a week. A sheltered patch under a bush is 2 days' crawl away. Decide: should the antlion keep rebuilding where it is, stop rebuilding and hunt from a damaged pit, or move?

Real antlion facts: antlion larvae dig funnel-shaped pits in dry, loose sand and wait buried at the bottom. When an ant slips in, the larva flicks sand to make it slide down, seizes it with its jaws and digests it. Larvae can survive long gaps between meals, and they eventually form a cocoon in the sand and emerge as winged adults. Digging and sand-flicking are hard work for an animal this small, and that work is powered by cellular respiration using the energy in the ants it ate earlier. The numbers below, however, are invented for this exercise.

Budget rules (teaching numbers; 1 EU = one energy unit, invented for this sheet)

Item	Rule
Staying alive (upkeep)	Costs 2 EU every day, all 30 days, no matter what. This is the energy its cells release just to keep working.
Pit maintenance	Costs 1 EU on every day the antlion hunts from a working pit (flicking out sand that blows in).
Full pit build or rebuild	Costs 9 EU and takes the whole day: no hunting and no maintenance cost that day.
Hunting, open patch, working pit	Gains 6 EU per day from ants caught (about one ant a day).
Hunting, open patch, damaged pit	Gains 2 EU per day; no maintenance is done on a damaged pit.
Hunting, sheltered patch, working pit	Gains 5 EU per day. This is an estimate from one week of counting ants walking past the bush.
Storms	Open patch: wind wrecks the pit on the evenings of days 6, 12, 18 and 24. Sheltered patch: no storm expected in 30 days.
Moving to the sheltered patch	Takes days 1 and 2, costs an extra 3 EU per travel day (6 EU total), no pit and no hunting on those days. Day 3 must be a build day.
Goal	Net stored energy of at least 30 EU (as fat) by the end of day 30. More stored energy makes a larger, healthier adult.

Three strategies**1 Strategy A: Stay and rebuild**

Hunt from the open-patch pit. After each storm, spend the next day rebuilding (9 EU, no hunting), then hunt again from a working pit. Pay maintenance on every hunting day.

2 Strategy B: Stay and wait it out

Hunt from the open-patch pit until the first storm on day 6. Never rebuild. From day 7 on, hunt from the damaged pit (2 EU per day) and pay no maintenance.

3 Strategy C: Move to the bush

Spend days 1 and 2 crawling to the sheltered patch (no hunting, 3 EU extra per day). Build a pit on day 3 (9 EU). Hunt from a working pit on days 4 to 30 with no storms, paying maintenance every hunting day.

Part A: Do the math before you decide

1. Complete the 30-day budget for each strategy. Net stored = energy from ants – (upkeep + maintenance + building or moving). Show the calculation for at least one strategy in full below the table.

Hunting days	Energy from ants (EU)	Upkeep (EU)	Maintenance (EU)	Building or moving (EU)	Net stored by day 30 (EU)
Strategy A					
Strategy B					
Strategy C					

2. Write out the full calculation for Strategy A: count the hunting days, multiply to get the energy from ants, add up all the costs, and subtract.

3. Which strategies meet the goal of at least 30 EU stored? By how much does each one pass or fail?

Part B: Connect the budget to the science

4. Every cost in the budget (upkeep, maintenance, digging, crawling) is paid by the same process inside the antlion's cells. Name the process, its reactants and its products, and explain why the antlion's upkeep cost continues even on a day when it does nothing.
5. An ant is matter as well as energy. Describe two different things that happen to the atoms of an ant the antlion digests: one that releases the ant's energy and one that adds to the antlion's body. Where does the 'net stored' energy in the budget physically end up?

Part C: Test the plan against what could go wrong

6. Two things are uncertain. (i) The sheltered patch's 5 EU per day came from one week of counting; recompute Strategy C's net if the real gain is only 4 EU per day. (ii) The storm schedule is an average; recompute Strategy A's net if a fifth storm wrecks the pit on the evening of day 27 and the antlion rebuilds on day 28. Show both calculations and state whether each strategy still meets the goal.

Part D: Decide, justify, and model

7. Choose a strategy and justify it. Your justification must (a) use the net values from Part A, (b) use the results of Part C to say which risk you are accepting and why, (c) explain the trade-off between a one-time cost now and repeated costs later, and (d) say what new information in the first week would make you change your plan.

8. Draw a model of the antlion as a system for your chosen strategy. Show matter and energy entering (ants, oxygen), the process inside its cells that releases energy, matter leaving (carbon dioxide, water), energy leaving as heat and as work (digging, flicking sand, crawling), and the two places the ant's matter and energy can stay in the antlion (stored fat; new body for growth). Label every arrow and give the model a title.



One strategy, one line at a time

For each strategy, fill the columns in this order and write the day numbers as you go. (1) Hunting days: start with 30 and subtract every day the antlion cannot hunt (rebuild days, travel days, build day). (2) Energy from ants: hunting days $\times$ EU per day; for Strategy B split the days into before and after the first storm. (3) Upkeep is always $30 \times 2 = 60$ EU. (4) Maintenance: 1 EU $\times$ hunting days from a working pit only. (5) Building or moving: 9 EU per build, plus 6 EU of travel for Strategy C. (6) Subtract the costs from the energy from ants.

A fourth strategy and a real-world check

Invent Strategy D: stay on the open patch but rebuild only after every second storm. Compute its 30-day net and compare it with A and B; explain why a cheaper plan can still be worse. Then write a paragraph on what a real antlion actually 'knows': it cannot count days or calculate, so describe what simple rules of behavior (for example, 'rebuild if no ant arrives for two days') would produce something like the strategy you recommended, and how a scientist could test whether antlions follow such a rule.