The Mechanism Workshop · Teacher sheet

GCSE D&T · AQA 3.1.5 mechanical devices · application lesson · 50 minutes · works solo

The idea

Each student is an engineer at a toy and tool company. Briefs describe what a product must do; students choose the mechanism, name the input and output movement, do the calculation where asked and justify the choice.

How the briefs work

Students do at least two Bronze briefs first, then any order.

Print (per student)

- Mechanism Guide (pages 2–3). Can be shared or laminated.
- Brief Board (pages 4–5), double-sided.
- Engineering Report (pages 6–7), double-sided.

Running it

1. **5 min:** PowerPoint to the worked example (a hand drill using bevel gears; not on the Brief Board).
2. **30 min:** students work alone: two Bronze first, then any order.
3. **10 min:** students mark their OWN report in green pen using the answer slides.
4. **5 min:** totals and ranks. **The Audit:** anyone claiming Senior Engineer or Chief Engineer brings their report to you.

Fees

Bronze £100 · Silver £200 · Gold £300 · Platinum £500. **Full fee** = right mechanism + movement in → out + calculation right (where asked) + reason with **so…** · **Half fee** = right mechanism, weak reason or one calculation slip · **£0** = wrong mechanism · **+£50** = a sensible rejected mechanism with a reason.

Ranks

£0–399 Apprentice · £400–899 Engineer · £900–1,599 Senior Engineer · £1,600+ **Chief Engineer**

Calculators allowed. Students may add a quick sketch of their mechanism.

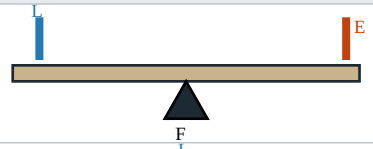
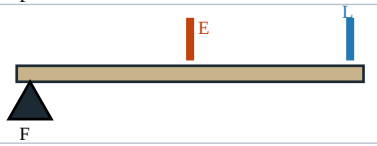
Mechanism Guide · 1. Movement and levers

F = fulcrum (pivot) · L = load · E = effort

Four types of movement

Movement	What it does	Example
Linear	Moves in a straight line	Sliding door, rack
Rotary	Turns round and round	Wheel, motor shaft
Reciprocating	Moves back and forth in a straight line	Piston, sewing machine needle
Oscillating	Swings back and forth in an arc	Pendulum, seesaw, swing

Levers

Lever	Diagram	Fulcrum, load, effort	Examples
1st class		Fulcrum in the middle	Seesaw, crowbar, scissors
2nd class		Load in the middle	Wheelbarrow, nutcracker, bottle opener
3rd class		Effort in the middle	Tweezers, tongs, fishing rod, your arm

Formulas

What	Formula
Mechanical advantage (MA)	load ÷ effort
Gear ratio	teeth on driven gear ÷ teeth on driver gear
Pulley ratio	driven pulley diameter ÷ driver pulley diameter
Output speed	input speed ÷ ratio
Compound gear ratio	ratio of stage 1 × ratio of stage 2

Mechanism Guide · 2. Linkages and rotary systems

Linkages

Linkage	What it does	Example
Reverse motion	Output moves the opposite way to the input	Folding mechanisms, pop-up cards
Parallel motion	Output moves the same way, parallel to the input	Toolbox trays, lazy tongs
Bell crank	Changes the direction of motion through 90°	Bike brakes, doorbells
Push/pull	Transfers motion along a line	Car handbrake, cable controls
Crank and slider	Rotary ↔ reciprocating	Engine piston, automata

Cams and followers (rotary → reciprocating)

Cam	Follower movement
Circular / eccentric	Smooth rise and fall
Pear	Rest, then rise and fall, then rest
Snail (drop)	Slow rise, then sudden drop; turns one way only
Heart	Steady rise and fall
Followers	Knife edge (precise), flat (hard-wearing), roller (low friction)

Gears, pulleys and others

System	Movement and notes
Simple gear train	Rotary → rotary. Driven gear turns the opposite way. Idler gear keeps direction.
Compound gear train	Two gears on one shaft: big speed reductions in a small space.
Rack and pinion	Rotary → linear (gate openers, steering).
Worm and wormwheel	Huge reduction; turns motion through 90°; cannot be driven backwards.
Bevel gears	Turn motion through 90° (hand drills).
Pulleys and belt	Rotary → rotary, same direction; belt can slip safely if overloaded. Crossed belt reverses.
Chain and sprocket	Like pulleys but cannot slip (bicycles).

Brief Board

Do at least two Bronze briefs first. Write the company's name on your report.

Bronze

AutoToys — BRONZE £100

“A wooden automaton: turning the handle must make a bird bob up and down.”

GardenGo — BRONZE £100

“A wheelbarrow for heavy soil. Which class of lever is it, and why does it make lifting easy?”

ChefTools — BRONZE £100

“Kitchen tongs for picking up food delicately. Which class of lever?”

PlayPark — BRONZE £100

“A seesaw. Which class of lever, and what type of movement do the riders make?”

Silver

FastFan — SILVER £200

“A motor turns at 3000 rpm. Driver gear 10 teeth, driven gear 30 teeth. Find the gear ratio and output speed.”

LiftRight — SILVER £200

“A crowbar: an effort of 100 N lifts a load of 400 N. Find the mechanical advantage.”

MarbleRun Toys — SILVER £200

“A toy where a marble is lifted slowly, then dropped suddenly, once every turn of the handle.”

BikeLab — SILVER £200

“The brake cable must pull round a 90° corner to reach the brake.”

Brief Board (continued)

Gold

HoistIt — GOLD £300

“A 50 mm motor pulley drives a 200 mm pulley. Motor speed 1200 rpm. Find the output speed. Why use a belt here?”

GateMaster — GOLD £300

“A motor must slide a heavy gate open and shut along a track.”

TuneUp Guitars — GOLD £300

“A guitar tuning peg: big reduction, and the string must not unwind it. Wormwheel has 40 teeth.”

Mixers Ltd — GOLD £300

“Compound gears: 10 → 40 teeth, then on the same shaft 10 → 40 teeth. Input 1600 rpm. Find the output speed.”

Platinum

ToyFactory — PLATINUM £500

“A toy car: motor 6000 rpm, wheels must turn at 300 rpm in the SAME direction as the motor. Design the gear train.”

Automaton Deluxe — PLATINUM £500

“Turning one handle must make a figure's head bob up and down AND its arm swing side to side.”

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Engineering Report

Name: _____ Mark in GREEN pen

Example: *Mechanism: rack and pinion · movement: rotary → linear · so… the motor's turning slides the door open in a straight line.*

Company	Mechanism	Movement in → out	Calculation	So…	I rejected … because …	Fee £

Engineering Report (page 2)

Name: _____ Mark in GREEN pen

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Company	Mechanism	Movement in → out	Calculation	So…	I rejected … because …	Fee £

TOTAL EARNED: £_____ Rank: Apprentice · Engineer · Senior Engineer · Chief Engineer (circle)