

Motor Design Challenge

Name:

Block:

Objective

To design and build a motor that can reel in 5 m of string in the shortest possible time

Construction Rules

- The motor may not be pre-manufactured.
- The motor must be a self-supporting unit, operating without human assistance after activation.
- The entire motor (including batteries, spool, etc.) must fit within a 30 cm x 30 cm x 30 cm space.
- Aside from the specific exceptions listed below, there are no restrictions on materials, except that no additional energy sources (e.g., springs, compressed air, etc.) may be used. Only the electrical energy stored in the batteries is permitted.

Power Supply

- The motor must be powered by any combination of the following battery types: **AAA, AA, C, D, and 9-volt** batteries.
- The total voltage must not exceed **9 volts**.
- No other power sources are permitted.

Magnets

- There are no restrictions on the type, number, or size of magnets used.
- All magnets must be safe to handle and must not pose any hazard to participants or equipment.

Wire

- There are no restrictions on the type or amount of wire; however, insulated wire will be required for the motor coil to ensure that the current flows through the entire coil properly.
- Magnet (enameled) wire is recommended which is a type of copper wire with a very thin layer of insulation.

Switch

- The motor must be started with an electrical switch.
- A gentle tap is permitted to initiate motion.
- The motor must be able start within 10 seconds of switch activation.

Spool

- To qualify for a timed trial, the motor must have an attached spool capable of reeling in string.
- The spool may be made of any material but must be rotated by the motor itself.

String

- The string for all testing will be provided.
- The string is 20 lb braided Dacron fishing line, approximately 0.5 mm in diameter.
- A 5-metre length will be used for the timed trial.

Safety

- All students must exercise caution when working with tools of any kind.
- Personal protective equipment must be worn when using tools and must only be used under the direct supervision of a teacher or parent/guardian.
- Safety procedures and instructions for each tool or piece of equipment must be reviewed and followed at all times.
- Do not allow the battery to be shorted for an extended period (e.g., when the motor is connected but not spinning), as this can cause overheating or battery damage.
- Neodymium or other strong magnets should be kept away from electronics and must be handled with caution.

Motor Testing

1. The motor must be registered on the competition date. All motors will be inspected to ensure that all contestants have met the construction rules.
2. The motor will first be tested without string. The spool attachment is optional during this stage.
3. The motor will be started using a single switch. A gentle tap to start the motor is permitted.
4. To qualify for a timed run, the motor must start within 10 seconds and rotate consistently.

If the motor qualifies for a timed run:

5. A 5-meter-long string will be attached to the spool.
6. The string will be arranged by the contestants on the table and/or floor. The string may not be placed higher than the attachment point on the spool.
7. A timer will be started when the switch is activated.
8. The timer will be stopped when the first of the following occurs:
 - the 5 m of string is reeled in
 - the motor stops spinning
 - the string falls off the spool
 - 100 seconds has elapsed

Scoring

Motors will receive a grade based on either the time taken to reel in 5 m of string.

Time (rounded up)	Grade
20 s	100
24 s	99
28 s	98
32 s	97
36 s	96
40 s	95
44 s	94
48 s	93
52 s	92
56 s	91
60 s	90
64 s	89
68 s	88
72 s	87
76 s	86
80 s	85
84 s	84
88 s	83
92 s	82
96 s	81
100 s	80
Motor rotates consistently ¹	75
Motor rotates inconsistently ²	65
Motor moves ³	50
Disallowed Motors ⁴	<50

¹ Motors that start within 10 seconds and have sustained operation without interruption earn a 75.

² Motors that take over 10 seconds to start and/or have interrupted operation (minimum 10 seconds) earn a 65.

³ Motors that show some movement (under 10 seconds of rotation) earn a 50.

⁴ Motors that do not meet design requirements are scaled between 0 and 50. This includes, but is not limited to, motors which do not incorporate a switch and motors which are not self-supporting.

One bonus point will be awarded for every 2 seconds faster than 20 seconds. Bonus points are awarded only to motors which meet all design requirements.