Motor Lift Challenge

Compare two motor designs using work, speed, and efficiency.

PHS.9.3 "Enrichment: Use an engineering design process to construct a working electric motor to perform a task. Communicate the design process and comparisons of task performance efficiencies.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the task and the parts of the motor that make it turn. Circle what stays the same in both tests, then number the three calculations needed to compare efficiency.

Which Coil Lifts Better?

1. Build a small motor by winding insulated copper wire into a coil. Leave two straight wire ends to rest on metal supports connected to a 1.5 V battery. Place a magnet beneath the coil. Remove insulation from the same half of each wire end so current flows during part of each turn. Give the coil a gentle push.

2. Attach a spool to the axle so the motor can raise a 0.020 kg load by 0.50 m. Compare a wide coil with a narrower coil that has the same number of turns. Keep the battery, magnet, and load unchanged. Measure lifting time and average current; the voltage across the motor is 1.5 V during both tests.

RESULTS FROM ONE LIFT PER BUILD

Coil build	Lifting time (s)	Average current (A)
Wide	10	0.20
Narrower	8	0.10

3. Useful lifting work equals mass times gravitational field strength times height; use 9.8 N/kg. Electrical input equals voltage times average current times lifting time. Efficiency is useful work divided by electrical input, multiplied by 100%. Compare speed and efficiency before choosing a build. Repeat tests to check whether coil width caused the difference.

2 ANSWER WITH EVIDENCE

Use the passage

1. How much useful lifting work did each build do? Show your calculation.

2. Calculate the electrical input for each build.

3. Calculate each build's efficiency. Which build would you choose if you want a faster lift with higher efficiency?

4. How would you test whether coil width caused the performance difference? Explain what your plan would improve.

3 YOUR TURN

Your own words

Design a different task for a motor to perform. Describe one design change to test, what you would keep constant, what you would measure to compare task performance and efficiency, and how you would report your choice.

ANSWER KEY

Motor Lift Challenge

PART 1 · READ AND MARK

Underline the task and the parts of the motor that make it turn. Circle what stays the same in both tests, then number the three calculations needed to compare efficiency. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How much useful lifting work did each build do? Show your calculation.	**Each did (0.020 kg)(9.8 N/kg)(0.50 m) = 0.098 J.**
2	Calculate the electrical input for each build.	**Wide: (1.5 V)(0.20 A)(10 s) = 3.0 J. Narrower: (1.5 V)(0.10 A)(8 s) = 1.2 J.**
3	Calculate each build's efficiency. Which build would you choose if you want a faster lift with higher efficiency?	**Wide: (0.098 J ÷ 3.0 J) × 100% ≈ 3.3%. Narrower: (0.098 J ÷ 1.2 J) × 100% ≈ 8.2%. Choose the narrower coil; it lifts faster and is more efficient in these tests.**
4	How would you test whether coil width caused the performance difference? Explain what your plan would improve.	**Repeat several lifts with each coil while keeping the other parts and the load unchanged. Repeated results would make a difference due to coil width more convincing.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My motor will pull a toy cart 1 m across a level table. I will test two spool diameters while keeping the motor, battery, cart mass, and surface the same. For each test, I will measure average pulling force, distance, voltage across the motor, average current, and travel time. I will compare force times distance with voltage times current times time to calculate efficiency. I will report efficiency and travel time for both spools before choosing one, since the faster cart might use more electrical energy.

Accept rounded efficiencies and equivalent calculations with units. For the design task, accept any measurable motor-driven task with a fair comparison and a valid way to compare useful work with electrical input.