

Work done, energy conservation and power

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab

Name: _____ Date: _____ Class: _____

How efficiently can a small motor turn electrical energy into gravitational potential energy? In this lab you lift loads through a fixed height, time each lift, read the meters and compare the useful energy with the energy supplied.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB A.3

Aim

To measure the efficiency of a small electric motor as it lifts loads of different mass through the same height, using work done, electrical input and time.

Equipment

- Small DC motor (3 V) with a spool, fixed at the top of a retort stand
- Slotted masses (0.050 kg to 0.250 kg) and a hanger
- Variable DC power supply set to 3.0 V
- Ammeter, voltmeter and connecting leads
- Metre rule and stopwatch
- Thread (about 1.2 m)

Safety

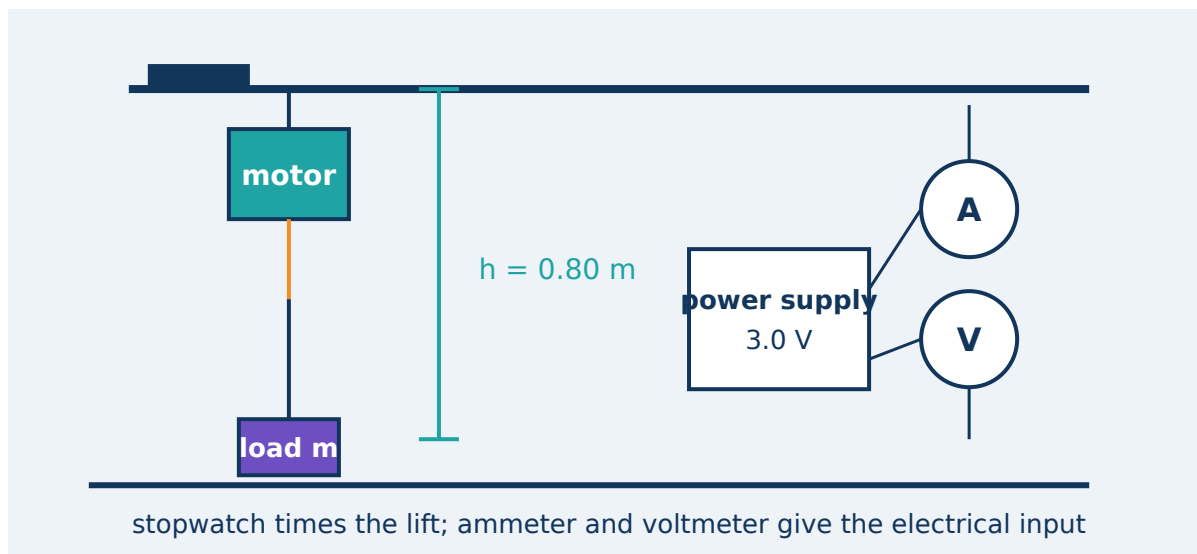
Safety

Keep feet and hands away from the falling load and clamp the stand to the bench. Switch off at once if the motor or wires feel hot. Do not exceed 3.0 V.

Method

1. Fix the motor at the top of the stand. Tie the thread to the spool and to the hanger, then mark a lift height of 0.80 m with the rule.
2. Set the supply to 3.0 V. Connect the ammeter in series and the voltmeter across the motor.
3. Add 0.050 kg to the hanger. Start the stopwatch as you switch on and stop it when the load reaches the 0.80 m mark.
4. Read the current while the load is moving.
5. Repeat for 0.100, 0.150, 0.200 and 0.250 kg. Use fresh batteries or let the motor cool

between runs.



Set-up: a motor winds in a string and lifts the load 0.80 m while you time it and read the meters.

Results

Sample results from Kofi's school lab in Accra. The mass of the hanger is included in m .

m (kg)	I (A)	t (s)	useful energy $m g h$ (J)	input energy $V I t$ (J)	efficiency (%)
0.050	0.32	4.1	0.39	3.94	10.0
0.100	0.34	5.0	0.78	5.10	15.4
0.150	0.36	6.0	1.18	6.48	18.2
0.200	0.38	7.3	1.57	8.32	18.9
0.250	0.40	8.6	1.96	10.32	19.0

Analysis questions

Question 1 Useful energy

Show how the useful energy 0.39 J in the first row was calculated. State why the hanger mass is included.

Question 2 Input energy

Calculate the electrical energy supplied for the 0.150 kg load and explain why $V I t$ gives energy.

Question 3 Efficiency values

Check the efficiency for the 0.250 kg load and state the trend in the table.

Question 4 Graph

Describe a graph of useful energy against input energy and say what its gradient represents.

Question 5 Where the energy goes

Name two places where the 'wasted' electrical energy goes.

Question 6 Uncertainty in time

The stopwatch reaction time is about 0.2 s. Calculate the percentage uncertainty in the 4.1 s measurement and its effect on the input energy.

Question 7 Improvement

Suggest two improvements that would make the efficiency values more reliable.

Question 8 Conclusion

State a conclusion and say whether efficiency of 100 % could ever be reached.