A spring with two energy routes

Mechanical energy | constructed spring data

Name _____ Date _____

A spring has k=200 N/m and is stretched 0.10 m within its elastic range. Its force increases linearly from zero to 20 N.

1. Calculate elastic potential energy using k and extension.

2. Verify with the area under the force-extension graph.

3. Explain why multiplying final force by the full extension overestimates the work.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.

A circuit with a carried result

Electrical energy | constructed series circuit

Name _____ Date _____

An ideal 12 V supply connects 2-ohm and 4-ohm resistors in series. A student incorrectly calculates total resistance as 3 ohms, then uses that result consistently to find current and power.

1. Find the correct resistance, current and total power.

2. Identify the student's originating error and their resulting values.

3. Explain how an official rubric might distinguish the originating error from later consistent work.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.

A ray measured from which line?

Wave behavior | constructed refraction model

Name _____ Date _____

Light travels from air (n=1.00) into glass (n=1.50). The incident ray makes 30 degrees with the normal. Use Snell's law.

1. Find the refracted angle to the nearest degree.

2. State whether the ray bends toward or away from the normal.

3. Explain how the result would change if 30 degrees had been measured from the surface instead.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.

The vector survives the calculation

Motion and forces | constructed momentum

Name _____ Date _____

A 2 kg cart moves east at 3 m/s and then west at 1 m/s. Take east as positive. The change occurs over 0.5 s.

1. Calculate the change in momentum.

2. Find the average net force with direction.

3. Explain why subtracting speed magnitudes alone gives a different result.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.

A photon between two levels

Modern physics | constructed energy-level model

Name _____ Date _____

An atom drops from -2.0 eV to -5.0 eV. Use h=6.63e-34 J s and 1 eV=1.60e-19 J. The change emits one photon.

1. Find the photon energy in eV and joules.

2. Calculate its frequency.

3. Explain why the emitted photon energy is positive despite negative level labels.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.

The charge-distance comparison

Fields and interactions | constructed electrostatic model

Name _____ Date _____

Two point charges are separated by distance r. A second configuration keeps the charges fixed but doubles their separation. Use the inverse-square force model.

1. Compare force magnitudes.

2. Explain the direction relationship for opposite charges.

3. State a model condition relevant to using the point-charge law.

Use evidence and show the relationships in your reasoning. Additional paper is permitted.