Conservation of Momentum CWA

The Conservation of Momentum CWA is a lesson specific assessment. The overarching question is: When two objects collide, is their total momentum conserved? The following handouts are included:

- Prompt
- Sample student response
- Actual student response

Students should be provided the prompt, which includes the question as well as data necessary to answer the question. A sample student response is included as well as actual student work. Either the CWA Common Scoring Rubric or the Old Science CWA Rubric can be used to score the responses.

Conservation of Momentum

Claim-Evidence-Reasoning (CER) Writing Assignment

Scientific Question: When two objects collide, is their total momentum conserved?

Conservation of Momentum: Sample Student Response

Claim:

Yes, total momentum is conserved when two objects collide, provided no external net force acts on the objects.

Evidence 1:

In the experiment, the total momentum of car 1 and car 2 after the collision is the exact same amount as the total momentum before the collision in five of the six collisions. Moreover, for these five collisions, the momentum of car 1 decreased by the same amount that the momentum of car 2 increased.

Reasoning 1:

This conservation of momentum occurs because the forces acting on the two cars are equal in magnitude and opposite in direction (Newton's Third Law: $F_1 = - F_2$) and the cars are in contact with each other for the same amount of time ($t_1 = t_2$). Therefore, the impulse, which is force times the time, is also equal in magnitude and opposite in direction (Impulse-momentum Change Theorem: $F_1 * t_1 = - F_2 * t_2$). Since each object experiences equal and opposite impulses, it follows logically that they must also experience equal and opposite momentum changes (Law of Conservation of Momentum: $m_1 * \Delta v_1 = - m_2 * \Delta v_2$). This law holds true as long as no external net force acts on the objects in the system.

Evidence 2:

In the other collision, #4, the before/after total momentum numbers were different by .1 kg m/s (15.5 kg m/s – 15.4 kg m/s), or .6% (.1/15.5).

Reasoning 2:

The discrepancy in the total momentum numbers before and after in collision #4 could potentially be due to an external net force, such as friction acting on the cars, or, it could potentially be due to an error in measurement, such as the motion sensor speed reading.

Conservation of Momentum – Sample Student Response

Name _____ Date 10/22/13

Claim-Evidence-Reasoning (CER) Writing Assignment
ACTIVE PHYSICS
Sports Chapter 2
10/22/13
****This assignment must be completed during this class period.****

Directions: Read the following Prompt. Then construct a scientific argument, using the Claim-Evidence-Reasoning (CER) framework, that answers the Scientific Question below. Use what you learned in class about momentum and collisions, particularly in Activity 8. Use your notebook notes and homework sheets (or the textbook) for background on the relevant physics concepts. To help in preparing your response, refer to the background handout that contains the "CER Rubric," "CER Framework," and "Tips for Completing the CER Writing Assignment."

Prompt: In an experiment, two toy cars on a low-friction track underwent a series of six collisions. For each different collision, the masses and speeds of the cars were changed before the collision. After each collision, the cars remained separate (i.e., they did not stick together).

The velocities immediately before and after collision for each car were measured using motion sensors. The momentum of each car was calculated (using the formula, p = mv), and then the two momenta were added together to determine total momentum of the two cars, before and after collision. The results are shown in the table below.

	BEFORE COLLISION			AFTER COLLISION		
Collision	MOMENTUM OF CAR 1 (kg•m/s)	MOMENTUM OF CAR 2 (kg•m/s)	TOTAL MOMENTUM OF CAR 1 & 2 (kg•m/s)	MOMENTUM OF CAR 1 (kg•m/s)	MOMENTUM OF CAR 2 (kg•m/s)	TOTAL MOMENTUM OF CAR 1 & 2 (kg•m/s)
1	5.0	6.2	11.2	4.1	7.1	11.2
2	8.3	0	8.3	6.3	2.0	8.3
3	10.0	2.5	12.5	6.6	5.9	12.5
4	8.0	7.5	15.5	7.2	8.2	15.4
5	7.3	3.4	10.7	4.5	6.2	10.7
6	9.4	0	9.4	5.7	3.7	9.4

Scientific Question: When two objects collide, is their total momentum conserved?

SCORE: Claim: 3 Evidence: 3 Reasoning: 3 Writing: 3 TOTAL: 12

COMMENTS: Nice work. See comments.

Be sure to write your response on the form on the back of this sheet.

Claim: *Write a statement (based on your evidence and reasoning) that directly answers the scientific question.*

The total momentum is conserved after a collision when two objects collide.

Evidence: *Provide specific scientific observations/data that support your claim.*

For collision 1-6 5 out of 6 collisions have equal total momentums before and after the collision and the one time the total momentums where not the same it was only off by .1 (kg·m/s). For collision 4 the total momentum was 5.5 kg·m/s and after it was 5.4 kg·m/s.

Reasoning: *Explain, using relevant science concepts you learned, why your evidence backs up your claim.*

The law of conservation of momentum states "the total momentum before a collision is equal to the total momentum after the collision if no exteral forces act on the system". For 5 of the collisions the data shown was equal before and after as the law says it should be. For collision four the data shown was off by .1. The measurements could have been slightly off, ~~creating~~ or there could have been an error in the caculations. When finding the momentum of car 1 and car 2 before the collision, and then again after, a same error could have been made placing the data off by one.