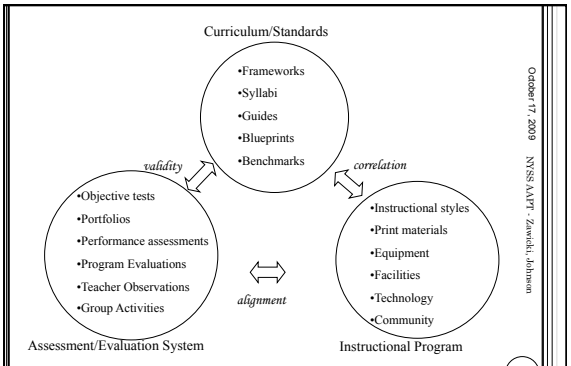
Lessons from the June 2009 NYS Regents Physics Examination – Notes for the Classroom

NYSS AAPT Fall Conference
Syracuse, New York – October 17, 2009

J. Zawicki, SUNY Buffalo State College
T. Johnson, Western New York Regional Information Center

Objectives

1. To increase student success on science assessments
   a) Knowledge
   b) Skills
2. Methods
   a) Analysis of Student Performance (Aggregate)
   b) Program Review/Brainstorming Teaching Strategies
   c) Implementation of Changes
   d) Evaluation of Efficacy



ASSESSMENT FORMATS

- Classroom Measures
  - **Formative**
    - Embedded assessments
    - Prediction activities (predict/observe/explain)
    - Whiteboard activities
    - Informal assessments
    - Documentation and record keeping
  - **Summative**
    - Final assessments
      - hands-on
      - pencil-and-paper
- Statewide Assessments
  - Multiple Choice
  - Short Constructed Response
  - Open-Ended

October 17, 2009 NYSS AAPT - Zawicki, Johnson

4

ITEM ANALYSIS

- Select Target Areas for Improvement
  - Overview
    - Areas of success
    - Areas for improvement
  - Suggest Program Revision
    - Brainstorm Instructional Strategies
    - Implement Strategies/Interventions
    - Evaluate Intervention Efficacy

October 17, 2009 NYSS AAPT - Zawicki, Johnson

5

5.4 ENERGY RELATIONSHIPS

Item	Difficulty	1 (0)	2 (1)	3 (2)	4
31-MC	0.58	370	532	1366	***3133***
32-MC	0.66	1134	259	448	***3561***
71-CR	0.80	681	636	4026	---
44-MC	0.59	573	1174	445	***3208***
33-MC	0.68	451	***3678***	173	1101
35-MC	0.58	***3154***	400	1473	380

October 17, 2009 NYSS AAPT - Zawicki, Johnson

6

5.4 Energy Relationships

31 An alpha particle consists of two protons and two neutrons. What is the charge of an alpha particle?

(1) 1.25×10^{19} C
(2) 2.00 C
(3) 6.40×10^{-19} C
(4) 3.20×10^{-19} C

Item	Difficulty	1	2	3	4
31-MC	0.58	370	532	1366	***3133***

October 17, 2009 NYSS AAPT - Zawicki, Johnson

7

5.4 Energy Relationships

32 An electron in the *c* level of a mercury atom returns to the ground state. Which photon energy could *not* be emitted by the atom during this process?

(1) 0.22 eV
(2) 4.64 eV
(3) 4.86 eV
(4) 5.43 eV

Item	Difficulty	1	2	3	4
32-MC	0.66	1134	259	448	***3561***

October 17, 2009 NYSS AAPT - Zawicki, Johnson

8

5.4 Energy Relationships

Base your answers to questions 70 through 72 on the information below.

A photon with a frequency of 5.48×10^{14} hertz is emitted when an electron in a mercury atom falls to a lower energy level.

70 Identify the color of light associated with this photon. [1]

71 Calculate the energy of this photon in joules. [Show all work, including the equation and substitution with units.] [2]

72 Determine the energy of this photon in electronvolts. [1]

Item	Difficulty	(0)	(1)	(2)
70-CR*	0.94	282	5062	---
71-CR	0.80	681	636	4026
72-CR*	0.63	1910	3434	---

October 17, 2009 NYSS AAPT - Zawicki, Johnson

9

5.4 Energy Relationships

44 The momentum of a photon, p, is given by the equation $p = \frac{h}{\lambda}$ where h is Planck's constant and λ is the photon's wavelength. Which equation correctly represents the energy of a photon in terms of its momentum?

(1) $E_{photon} = phc$ (3) $E_{photon} = \frac{p}{c}$

(2) $E_{photon} = \frac{hp}{c}$ (4) $E_{photon} = pc$

Item	Difficulty	1	2	3	4
44-MC	0.59	573	1174	445	***3208***

October 17, 2009 NYSS AAPT - Zawicki, Johnson

10

5.4 Energy Relationships

33 Which phenomenon provides evidence that light has a wave nature?

(1) emission of light from an energy-level transition in a hydrogen atom
(2) diffraction of light passing through a narrow opening
(3) absorption of light by a black sheet of paper
(4) reflection of light from a mirror

Item	Difficulty	1	2	3	4
33-MC	0.68	451	***3678***	173	1101

October 17, 2009 NYSS AAPT - Zawicki, Johnson

11

5.4 Energy Relationships

35 The particles in a nucleus are held together primarily by the

(1) strong force (3) electrostatic force
(2) gravitational force (4) magnetic force

Item	Difficulty	1	2	3	4
35-MC	0.58	***3154***	400	1473	380

October 17, 2009 NYSS AAPT - Zawicki, Johnson

12

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

Item	Difficulty	1 (0)	2 (1)	3 (2)	4
68-CR	0.80	776	496	4073	---
69-CR	0.76	1233	4112	---	---
67-CR	0.87	415	403	4527	---
66-CR	0.75	1308	4037	---	---
25-MC	0.64	117	***3463***	709	1118
26-MC	0.64	598	***3488***	596	715
58-CR	0.55	2352	2994	---	---
23-MC	0.35	534	***1906***	1980	982

October 17, 2009 NYSS AAPT - Zawicki, Johnson

13

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

Base your answers to questions 68 and 69 on the information below.

A ray of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) passes from air into Lucite at an angle of incidence of 30.°.

68 Calculate the angle of refraction in the Lucite. [Show all work, including the equation and substitution with units.] [2]

69 Using a protractor and straightedge, on the diagram *in your answer booklet*, draw the refracted ray in the Lucite. [1]

Item	Difficulty	(0)	(1)	(2)
68-CR	0.80	776	496	4073
69-CR	0.76	1233	4112	---

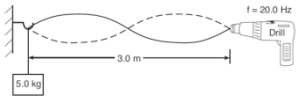
October 17, 2009 NYSS AAPT - Zawicki, Johnson

14

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

Base your answers to questions 66 and 67 on the information below.

One end of a rope is attached to a variable speed drill and the other end is attached to a 5.0-kilogram mass. The rope is draped over a hook on a wall opposite the drill. When the drill rotates at a frequency of 20.0 Hz, standing waves of the same frequency are set up in the rope. The diagram below shows such a wave pattern.



66 Determine the wavelength of the waves producing the standing wave pattern. [1]

67 Calculate the speed of the wave in the rope. [Show all work, including the equation and substitution with units.] [2]

Item	Difficulty	(0)	(1)	(2)
67-CR	0.87	415	403	4527
66-CR	0.75	1308	4037	---

October 17, 2009 NYSS AAPT - Zawicki, Johnson

15

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

25 A periodic wave is produced by a vibrating tuning fork. The amplitude of the wave would be greater if the tuning fork were

(1) struck more softly
(2) struck harder
(3) replaced by a lower frequency tuning fork
(4) replaced by a higher frequency tuning fork

Item	Difficulty	1	2	3	4
25-MC	0.64	117	***3463***	709	1118

October 17, 2009 NYSS AAPT - Zawicki, Johnson

16

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

26 The sound wave produced by a trumpet has a frequency of 440 hertz. What is the distance between successive compressions in this sound wave as it travels through air at STP?

(1) 1.5×10^{-6} m
(2) 0.75 m
(3) 1.3 m
(4) 6.8×10^{5} m

Item	Difficulty	1	2	3	4
26-MC	0.64	598	***3488***	596	715

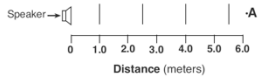
October 17, 2009 NYSS AAPT - Zawicki, Johnson

17

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

Base your answers to questions 58 and 59 on the information and diagram below.

The vertical lines in the diagram represent compressions in a sound wave of constant frequency propagating to the right from a speaker toward an observer at point *A*.



58 Determine the wavelength of this sound wave. [1]

59 The speaker is then moved at constant speed toward the observer at *A*. Compare the wavelength of the sound wave received by the observer while the speaker is moving to the wavelength observed when the speaker was at rest. [1]

Item	Difficulty	(0)	(1)
58-CR	0.55	2352	2994
59-CR*	0.65	1851	3495

October 17, 2009 NYSS AAPT - Zawicki, Johnson

18

4.3 STUDENTS CAN EXPLAIN VARIATIONS IN WAVELENGTH AND FREQUENCY IN TERMS OF THE SOURCE OF THE. . .

23 Which color of light has a wavelength of 5.0×10^{-7} meter in air?

(1) blue
(2) green
(3) orange
(4) violet

Item	Difficulty	1	2	3	4
23-MC	0.35	534	***1906***	1980	982

October 17, 2

t.t. Johnson

19

5.1G A PROJECTILE'S TIME OF FLIGHT IS DEPENDENT UPON THE VERTICAL COMPONENT OF ITS MOTION.

5 A 25-newton weight falls freely from rest from the roof of a building. What is the total distance the weight falls in the first 1.0 second?

(1) 19.6 m
(2) 9.8 m
(3) 4.9 m
(4) 2.5 m

Item	Difficulty	1	2	3	4
05-MC	0.69	57	1261	***3731***	355

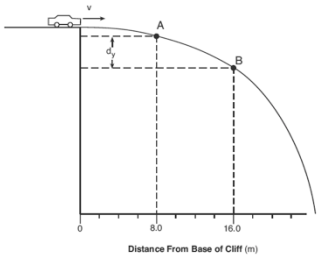
October 17, 2009 NYSS AAPT - Zawicki, Johnson

20

5.1G A PROJECTILE'S TIME OF FLIGHT IS DEPENDENT UPON THE VERTICAL COMPONENT OF ITS MOTION.

Base your answers to questions 60 through 62 on the information below.

The path of a stunt car driven horizontally off a cliff is represented in the diagram below. After leaving the cliff, the car falls freely to point *A* in 0.50 second and to point *B* in 1.00 second.



October 17, 2009 NYSS AAPT - Zawicki, Johnson

21

5.1G A PROJECTILE'S TIME OF FLIGHT IS DEPENDENT UPON THE VERTICAL COMPONENT OF ITS MOTION.

60 Determine the magnitude of the horizontal component of the velocity of the car at point *B*. [Neglect friction.] [1]

61 Determine the magnitude of the vertical velocity of the car at point *A*. [1]

62 Calculate the magnitude of the vertical displacement, d_y, of the car from point *A* to point *B*. [Neglect friction.] [Show all work, including the equation and substitution with units.] [2]

Item	Difficulty	(0)	(1)	(2)
60-CR*	0.74	1320	4025	---
61-CR	0.4	3190	2155	---
62-CR	0.4	2430	1497	1418

QUESTIONS, COMMENTS, CONCERNS?

J. Zawicki, SUNY Buffalo State College
zawickjl@buffalostate.edu
(716) 878-3800