Background picture: Aurora Borealis. What is Aurora? How does it happen? What are we seeing?

From the universe, nebulaes, stars, solar system, planets, our earth, magnetic field, charged particles, light years, acceleration, forces, nature, ionization, aurora, earthquake, tsunami, Ketsana, H1N1, to human & people interactions, humankind will never stop enduring and exploring in finding the truth…
Sternberg suggests Curriculum must develop the other 3 R’s.

• **Reasoning**
  - which include analytical, critical thinking, and problem solving skills

• **Resilience**
  - which encompasses life skills such as flexibility, adaptability, and self-reliance

• **Responsibility**
  - wisdom, which he defines as “the application of intelligence, creativity, and knowledge for a common good.”

Wagner et. al suggests Curriculum must develop the other 3 R’s.

• **Rigor**
  - What students are able to do as a result of their learning.

• **Relevance**
  - helping students understand how their learning connects to their further studies and future work settings.

• **Responsibility**
  - Promoting respectful relationships between and among teachers and students that foster academic and social competence.
Marc Tucker and Judy Codding urges adoption of **thinking curriculum**

that provides a **deep understanding of the subject** and the **ability to apply** that understanding to the **complex, real-world problems** that the student will **face as an adult**


Can **explain**: provide thorough, supported, and justifiable accounts of phenomena, facts, and data.

Can **interpret**: tell meaningful stories; offer apt translations; provide a revealing historical or personal dimension to ideas and events; make it personal or accessible through images, anecdotes, analogies, and models.

Can **apply**: effectively use and adapt what we know in diverse contexts.

Have **perspective**: see and hear points of view through critical eyes and ears; see the big picture.

Source: Grant Wiggins and Jay McTighe, *Understanding by Design*; Chap 4.
Can empathize: find value in what others might find odd, alien, or implausible; perceive sensitively on the basis of prior direct experience.

Have self-knowledge: perceive the personal style, prejudices, projections, and habits of mind that both shape and impede our own understanding; we are aware of what we do not understand and why understanding is so hard.

Grant Wiggins and Jay McTighe. Understanding by Design; Chap 4.

Producing Change: The 3 Domains of Educational Goals

Cognitive Knowing, the Head
The KNOWLEDGE

Psychomotor Doing, The Hand, Body
The SKILLS

Affective Feeling, The Heart
The CARE

Copyright DrJJ, ASERG, FSG UiTM, Oct 2009
"The principle goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done -- men who are creative, inventive and discoverers."

Jean Piaget

"Teachers are powerful people and keepers of the future. Help your students dream big!"

Leslie Owen Wilson

"The only person who is educated is the one who has learned how to learn and change."

Carl Rogers
If you were to fall in a hole through the center of the earth, how long before you land in a bowl of authentic dim sum in Beijing?
Outcome Based Education

Who is DrJJ?

- Born & Raised in the state of Hang Jebat...
- Early education at St. David's, Science Malacca & SDAR (Seremban)
- Teaching Certificate (1986) – MPTI
- Served ITM – Jan 1987
- Physics & Education expert
  - Practiced OBE & Active Learning especially since 1997.
  - Vice-Chair Asian Physics Education Network (ASPEN), UNESCO
  - Chair for ASPEN, Malaysia
  - Nominated for Innovative Teaching & Learning National & International
  - Keynote, Plenary and Invited Speaker in Conferences Nationally & Internationally

Learning Outcomes

At the end of this lecture, you will be able to:

1. Provide 3 examples of a learning outcomes.
2. Discuss MOHE’s “Human Capital With 1st Class Mentality”.
3. Summarize Spady’s OBE in less than 100 words.
4. Elaborate and discuss your role as future physics teachers based on the Core Competencies for Physics Teachers.
“The MOHE will thus introduce a holistic programme that will cut across all disciplines and focus on communication and entrepreneurial skills. The programme, which is intended to build a balanced perspective in all students, will expose them to subjects beyond their area of specialisation. For example, students reading for degrees in the sciences such as medicine, engineering and chemistry will be exposed to courses covering literature and philosophy. Likewise, students in the humanities will be exposed to the rudiments of science and technology, and certainly, ICT.”

Source: NATIONAL HIGHER EDUCATION ACTION PLAN 2007-2010
MOHE’s Attributes of Human Capital with First-Class Mentality

Knowledge Attributes:
- Mastery of core subjects and ability to apply that knowledge
- Mastery of Bahasa Malaysia and English, and at least one other global language.
- A continuing passion for knowledge through lifelong learning.
- Excellent general knowledge and interest in current events.
- Appreciation of the arts, culture and sports.
- Sound analytical and problem-solving skills.
- Awareness of business and management principles, and technology.

Personal Attributes:
- Goal-oriented: proactive, self-starting, self-disciplined, confident, resilient, motivated, and fiercely competitive.
- Intellectually engaging: creative, innovative, and possessing critical thinking skills.
- Quick learner, adaptable, and flexible.
- Entrepreneurial.
- Ethically and morally upright.
- Spiritually grounded.
- Compassionate and caring (through volunteerism and social services).

Interpersonal Attributes:
- Able communicator and effective presenter.
- Able to relate and be comfortable with people at all levels.
- Able to develop and leverage on personal and professional networks to achieve goals.
- Natural leader.
- Team player.

MOHE LOs

Prior to Dec 2008
1. Knowledge (K)
2. Practical Skills (P)
3. Social skills and responsibility (A)
4. Values, attitudes and professionalism (A)
5. Communication, leadership and team skills (P/A)
6. Problem solving and scientific skills (K/P)
7. Information management and lifelong learning skills (P/A)
8. Managerial and entrepreneurial skills (K/P/A)

IS
1. Knowledge (K)
2. Practical Skills (P)
3. Thinking and scientific skills
4. Communication skills
5. Social skills, teamwork and responsibility
6. Values, ethics, moral and professionalism (A)
7. Information management and lifelong learning skills (P/A)
8. Managerial and entrepreneurial skills (K/P/A)
9. Leadership skills
1. Critical thinking and problem solving skills (P)-LO3
2. Communication skills (P)-LO4
3. Group working skills (A)-LO5
4. Ethics and professionalism (A)-LO6
5. Lifelong learning and information management (A)-LO7
6. Entrepreneurship skills (P)-LO8
7. Leadership skills (A)-LO9

Three to five years upon completing the program, graduates will be educators who are ethical and competent in teaching and learning and who are multi skilled, including entrepreneurship and are able to work in various sectors.

Source: CRITERIA AND STANDARDS FOR PROGRAMMES IN THE FIELD OF EDUCATION
BAHAGIAN JAMINAN KUALITI, JABATAN PENDIDIKAN TINGGI, JANUARI 2003
1. Plan, execute, assess and manage teaching and learning.
2. Facilitate the optimum development of a balanced individual.
3. Safeguard the ethics and profession of teaching.
5. Enhance the quality of education through research.
6. Assume leadership in striving for a virtuous and knowledgeable society.

What is an Outcome?
What is Outcome Based Education?
How is Competency Related to Outcomes?
The result or consequence of a performance (in terms of success and failure).
- the way a thing turns out; a consequence

- The outcome of my discussion with PM Madya Dr Nurul is, an invited talk given by me today.
- Upon the completion of your study at UPSI you will be able to apply your knowledge and skills to ....
- Upon completion of the symposium today, you will be able....

What is a Program/Course/Lesson Outcome??

A statement of what students will be able to do when they have completed the program/course/lesson and it involves graduate’s skills and knowledge that arise from the educational activities of the program/course/lesson which lead to the achievement of the Program Objectives

An outcome has three major components:

- A description of what you will be able to do
- The conditions under which you will perform the task.
- The criteria for evaluating your performance.
An outcome at the course level

At the end of this talk, you will be able to write a 200-words summary about OBE and competency.

Outcome Based Education
In Spady’s words: “Outcome-Based Education means clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences.

This means starting with a clear picture of what is important for students to be able to do, then organizing the curriculum, instruction, and assessment to make sure this learning ultimately happens”

(Spady, 1994:1)


OBE is an approach to planning, delivering and evaluating instruction that requires administrators, teachers and students to focus their attention and efforts on the desired results of education—results that are expressed in terms of individual student learning

Traditional/Transitional OBE emphasises student mastery of traditional subject-related academic outcomes (usually with a strong focus on subject-specific content) and some cross-discipline outcomes (such as the ability to solve problems or to work cooperatively).

Transformational OBE emphasises long-term, cross-curricular outcomes that are related directly to students’ future life roles (such as being a productive worker or a responsible citizen or a parent). Spady (1994)

Spady
• favours the transformational approach to OBE where outcomes are "high-quality, culminating demonstrations of significant learning in context"
• learning is not significant unless the outcomes reflect the complexities of real life and give prominence to the life-roles that learners will face after they have finished their formal education.

Key Competencies in Australia (Mayer, 1993)

Education must be oriented to the future needs of students, and of society in general

(Northern Territory Board of Studies, 1998:2)

“The learning outcomes comprise the knowledge, understanding, skills and attitudes that students should acquire to enable them to reach their full potential and lead successful and fulfilling lives as individuals, as of the community and at work”

- **Competence** is a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. It indicates sufficiency (state of being 'good enough') of knowledge and skills.
- **Competency** (plural competencies) refers to a cluster of abilities relating to excellence in a specific activity.

Source: BusinessDictionary.com; [http://www.businessdictionary.com/definition/competence.html](http://www.businessdictionary.com/definition/competence.html)

- The ability to do something well. Source: Cambridge Advanced Learner's Dictionary
- The quality of being adequately or well qualified physically and intellectually. Source: The Sage Dictionary

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**Assess the specified outcomes**

(Explicit, observable workplace performances)
Knowledge (cognition)
Skills & Abilities (Psychomotor)
Caring (Affective)

Specify the outcomes in all 3 domain of learning relevant to workplace

Specify the outcomes in all 3 domain of learning relevant to workplace

Judge workplace Competency

Source: Competency-Based Education– Neither a Panacea nor a Pariah Professor John A. Bowden Director, Educational Programme Improvement Group Royal Melbourne Institute of Technology, Australia
Core Competencies of Physics Teachers

1. **Content**: The physics teacher knows, understands, and applies scientific concepts and principles, including major unifying themes, that are needed to advance student learning as defined by state and national standards developed by the science education community.

   **The physics teacher has a deep understanding of the following big ideas of physics**

   1. Application of mathematical concepts and skills to the analysis of physical systems
   2. Mechanics
   3. Electricity & magnetism
   4. Waves & optics

---

Core Competencies of Physics Teachers

1. **Content**: The physics teacher knows, understands, and applies scientific concepts and principles, including major unifying themes, that are needed to advance student learning as defined by state and national standards developed by the science education community.

   **The physics teacher has a basic understanding of**

   6. Modern physics
   7. Students’ initial beliefs (FCI, CSEM-data, FMCE, ECCE…)
   8. Science and its inquiry techniques
   9. Nature and Context of Science - The physics teacher knows the values, beliefs, and assumptions inherent to the creation of scientific knowledge within the scientific community, and contrasts science to other ways of knowing (VASS)
Core Competencies of Physics Teachers

2. Instructional Methodology
   1. Skills of Teaching: Physics teachers know the equipment, materials, and preparation required in the laboratory.
      - Physics teachers, incorporate instructional materials, create a community of diverse student learners who can construct meaning from science and possess a disposition for further inquiry and learning.
   2. Curriculum: Physics teachers know the earth science curriculum.
      - The physics teacher develops and applies a coherent, focused physics curriculum that is consistent with state and national standards for physics education and appropriate for addressing the need, abilities, and interests of students.

3. Social Context: Physics teachers know the relation between science and the community and know the human and institutional resources in the community.
   1. Physics teachers can relate science to the community and use human and institutional resources in the community to advance the education of their students in physics.
   2. Assessment: The physics teacher knows a variety of contemporary assessment strategies to evaluate the intellectual, social, and personal development of the learner in all aspects of physics. Assessment refers to knowing the measurement and evaluation of student learning in a variety of dimensions including state assessments.
Core Competencies of Physics Teachers

2. Instructional Methodology
   4. Assessment
      - The physics teacher uses a variety of contemporary assessment strategies to evaluate the intellectual, social, and personal development of the learner in all aspects of science

5. Environment for Learning – Physics teachers know safe and supportive learning environments reflecting high expectations for the success of all students
   - Physics teachers design and manage the instructional environment.

3. Professional Practice:
   1. Physics teachers have a knowledge base that prepares them for professional practice. It refers to:
      - Knowledge of science and educational professional organizations.
      - Knowledge of standards of ethical behavior consistent with the best interests of students and the community
   2. Physics teachers participate in the professional community, improving practice through their personal actions, education, and development.
1.0 Core Competency CONTENT
The physics teacher has a deep understanding of the following big ideas of physics:
1. Application of mathematical concepts and skills to the analysis of physical systems
2. Mechanics
3. Electricity & Magnetism
4. Waves & Optics
5. Fluid Statics and Dynamics
6. Particle nature of matter and its supporting evidence
7. Conservation Laws
8. Heat and Temperature
9. Ideal Gas Law
10. Thermodynamics

The physics teacher has a basic understanding of:

1. Technological applications of electricity and electronics
2. Atomic Structure and Spectroscopy
3. Nuclear physics, radioactivity, fission and fusion
4. Fundamental particles, fundamental forces
5. Wave/particle duality
6. Heisenberg’s Uncertainty Principle and Bohr’s Correspondence Principle
7. Frames of reference and Galilean relativity
8. Special relativistic kinematics
9. Interrelationship of matter and energy
10. Applications of physics concepts and principles to contexts in biology, chemistry, and earth and space science
1.0 Core Competency - CONTENT

The Physics teacher is able to determine students' ideas on:

1. Motion
2. Nature of forces
3. Forces and Motion
4. Energy
5. Light
6. Heat and Temperature
7. Electric Circuits
8. Basic electricity and magnetism

Familiar with and have utilized inventories such as FCI, MBT, FCME, CSEM, ECCE, BEMA, WCI, HTCE

Inquiry – The physics teacher is able to

1. Operationalize definitions of physical quantities
2. Generate and evaluate questions that can be answered through scientific investigations.
3. Plan and conduct systematic and complex scientific investigations.
4. Synthesize a revised scientific explanation using evidence, data, and inferential logic.
5. Analyze how physical, conceptual, and mathematical models represent and are used to investigate objects, events, systems, and processes.
6. Report and evaluate complex scientific investigations and explanations of objects, events, systems, and processes.
7. Analyze why curiosity, honesty, cooperation, openness, and skepticism are important to scientific explanations and investigations.
1.0 Core Competency - CONTENT

Inquiry – The physics teacher is able to

8. Analyze scientific theories for logic, consistency, historical and current evidence, limitations, and capacity to be investigated and modified.
9. Evaluate inconsistent or unexpected results from scientific investigations using scientific explanations.
10. Analyze scientific investigations for validity of method and reliability of results.
11. Discuss how scientific knowledge evolves.

1.1 Application of mathematical concepts and skills to the analysis of physical systems including:
   i. Interpretation of graphs which are: Linear, Quadratic, Exponential & Trigonometric
   ii. Algebra which includes Proportional reasoning, Interpretation of multivariable equations & Manipulation of multivariable equations
   iii. Vectors • addition and subtraction • multiplication by a scalar • dot product and cross product • vector components
   iv. Matrix addition and multiplication
   v. Concepts of calculus relevant to physics including Limits, Derivatives and integrals of functions, Slope of and area under graph followed by Line, surface, and volume integrals of vector and scalar fields.
Outcome Based Education

Outcomes  LOs
OBE    OBE-more
COs-PHY407

MQF – Bachelors degree (Hons.)

A Bachelors degree prepares students for general employment, entry into postgraduate programme and research as well as highly skilled careers. It enables the individuals to pair responsibilities, which require great autonomy in professional decision-making. The bachelors degree is conferred on individuals who are able to:

(i) demonstrate knowledge and comprehension on fundamental principles of a field of study, acquired from advanced textbooks;
(ii) use the knowledge and comprehension through methods that indicate professionalism in employment;
(iii) argue and solve problems in their field of study;
(iv) show techniques and capabilities to search and use data to make decisions having considered social, scientific and relevant ethical issues;
(v) communicate effectively and convey information, ideas, problems and solutions to experts and non-experts;
(vi) apply team and interpersonal skills which are suitable to employment; and
(vii) posses independent study skills to continue further study with a high degree of autonomy.

Back  MQF
Knowledge & Comprehension
• systematic and coherent body of complex knowledge, some of it at the boundaries of an academic discipline
• major studies in which significant literature is available. Course content is taken to a significant depth and progressively developed to a high level which provides a basis for postgraduate study and professional careers.

Intellectual Skills
• analytical techniques and problem solving skills that can be applied in many types of employment, including in a professional

Psychomotor Skills
• Practical/technical skills relevant to the discipline

Generic Skills
• communicate effectively.
• interpersonal and team skills appropriate for employment
• prepared to undertake research, comprehend and evaluate new information and concepts from a range of sources, weigh evidence, arguments and assumptions, to reach sound judgments,
• have developed a foundation for self-directed and lifelong learning
• exercise of substantial personal responsibility and decision-making in complex and unpredictable circumstances.
• Observation of professional ethics
Course Outcomes: Upon completion of this course, students will be able to:

1. **State, write and explain** the concepts, laws and theories in electrostatics, electricity, magnetism, introductory atomic physics and modern physics. (LO1 (C1))

2. **Verbally, visually (pictures & graphs) and algebraically relate and discuss** the concepts, laws and theories in electrostatics, electricity, magnetism, introductory atomic physics and modern physics. (C-Comprehension) (LO1- C2)

3. **Verify, assess & employ** the concepts, laws and theories in electrostatics, electricity, magnetism, light, introductory atomic physics and modern physics to solve qualitative & quantitative problems visually, algebraically and occasionally, numerically. (C-Application) (LO1)

4. **Analyze, summarize and discuss** solution to real world problems associated with electrostatics, electricity, magnetism, introductory atomic physics and modern physics. (for 3rd year course only) (LO1 (C4))

5. **Observe, formulate, plan, conduct, and report** scientific investigations in areas of electrostatics and electricity. (LO2 (P4))

6. **Verbally justify and convince peers** and the facilitator, their rationale for the choice of methods, their ability to use and manipulate equipments, the need to transform raw scores into tabular and graphical forms and their ability to explain and interpret results of their investigation in areas of electrostatics and electricity. (LO3(CTPS), LO4(CS))

7. **Collaborate, motivate and truthful** with team members and with facilitators in both the labs and in the classroom. (LO5 (TS), LO6 (EM))
At the end of this activity students will be able to:

1. Draw the electric force exerted by one point charge onto another and describe the motion of charges in the presence of other point charges.
2. Describe the cause of motion between point charges.
3. Describe and produce a model of the force in terms of the strength and direction that are acting on and by a point charge and on and by many point charges.

4. Describe and draw the electric field patterns created by point charges surrounding a point charge.
5. Describe and draw the electric field patterns surrounding two like point charges and two unlike point charges.
6. Measure the strength of an electric field produced by a point charge at various localities and produce a mathematical model of the strength.
At the end of this activity students will be able to:

Draw the electric force exerted by one point charge onto another and describe the motion of charges in the presence of other point charges.

At the end of this activity students will be able to:

Describe and draw the electric field patterns created by point charges surrounding a point charge.
Activity

Using the Electric Field Hockey PHET simulation and choose the hockey putt be the negatively charged particle feeling the force, move a negative charge near it to “see” the force exerted on the putt. Then draw the force diagram based on your observation. Using a ruler, measure the length of each force line. Now compare the force diagram for each of the electrons to your predicted diagram. How different are they? Explain the similarity and differences you observed in terms of the direction and length of the force line.

Paradigm Shift-The Evolution

Traditional

Electrostatic forces
like charges repel
+ +

opposite charges attract
+

Magnetic forces
like poles repel
S N

opposite poles attract
N S
A negatively charged object is brought near to a neutral, conducting sphere. Electrons in the sphere are forced from the left side of the sphere to the right side.

Two neutral conducting spheres are touching one another, thus allowing for the free movement of electrons between them.
Reflection

“The goal of intellectual education is not how to repeat or retain ready-made truths... It is in learning to master the truth by oneself at the risk of losing a lot of time and going thru all the roundabout ways that are inherent in real activity.” (Jean Piaget, Swiss cognitive psychologist, 1896-1980)

“The great aim of education is not knowledge, but action”.
Herbert Spencer

Reflection

Ready for CHANGE??

“Education, we see, is not merely gaining knowledge or skills helpful toward productive work, though certainly that is a part of it. Rather it is a replenishment and an expansion of the natural thirst of the mind and soul. Learning is a gradual process of growth, each step building upon the other. It is a process whereby the learner organizes and integrates not only facts but attitudes and values. The Lord has told us that we must open our minds and our hearts to learn. There is a Chinese proverb: Wisdom is as the moon rises, perceptible not in progress but in result. As our knowledge is converted to wisdom, the door to opportunity is unlocked”. Barbara W. Winder

“The one real goal of education is to leave a person asking questions”. Max Beerbohm
Outcome Based Education

OBE is a method of curriculum design and teaching that focuses on what students can actually do after they are taught. OBE addresses the key questions as:

- Why do you want them to learn it? – Vision, Mission, PEOs, POs
- What do you want the students to learn? – course structure, syllabus
- How can you best help students learn it? – Learning Activities
- How will you know what they have learnt? - Assessment
Towers (1996) listed four points to the OBE system that are necessary to make it work:

a) What the student **is to learn must be clearly identified**.

b) The student’s progress is based on demonstrated achievement.

c) **Multiple instructional and assessment strategies** need to be available to meet the needs of each student.

d) **Adequate time and assistance need to be provided** so that each student can reach the maximum potential.

---

1. **Clarity of focus about outcomes**
   - Always have the significant, culminating exit outcomes as the focus.
   - Let the students know what they are aiming for.

2. **Designing backwards**
   - Design curriculum backward by using the major outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.
3. Consistent, high expectations of success

- Set the expectation that OBE is for ALL learners.
- Expect students to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set (Spady, 1994b).

4. Expanded opportunity

- Develop curriculum to give scope to every learner to learn in his/her own pace.
- Cater for individual needs and differences, for example, expansion of available time and resources so that all students succeed in reaching the exit outcomes.

---

**A Working Definition of Teaching From Engineering Univ Lecturers**

**TEACHING IS**

- An art of delivering info & processing of shared info
- A process of transferring knowledge from teacher to students
- Conveying knowledge in systematic way
- Process of educating (an individual) another person motivate to learn
- Delivery of knowledge

- "teaching is undertaking certain ethical tasks or activities the intention of which is to induce learning"
A Working Definition of Teaching

TEACHER IS

• Mirror showing self n path of choices
• Person or equipment that conduct the teaching. Person or equipment having knowledge
• Person who is knowledgeable, good listener and a motivator to ensure knowledge is fully received by students n to develop positive attitudes to students
• Mentor, educator, expert, actor, performer, role-model, friends, evaluator
• Tool that delivers knowledge thru effective communication

Cognitive Science
The Brain-Gardners' 8 MI's

• Linguistic intelligence
• Logical-mathematical intelligence
• Musical intelligence
• Bodily-kinesthetic intelligence
• Spatial intelligence
• Interpersonal intelligence
• Intrapersonal intelligence
• Naturalists
• ..... Existential…..

“... the theory validates educators' everyday experience: students think and learn in many different ways.
Skills:
- Analyse
- Lines
- Language
- List
- Logic
- Numbers
- Words

Coding Devices:
- COLOR
- SHAPE
- MAPS
- IMAGINATION
- DAYDREAM
- RYTHEM

Look at the chart: say the **Color** not the word

<table>
<thead>
<tr>
<th>Black</th>
<th>Blue</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>Green</td>
<td>Aqua</td>
<td>Yellow</td>
</tr>
<tr>
<td>Yellow</td>
<td>Pink</td>
<td>Tan</td>
</tr>
<tr>
<td>Red</td>
<td>Yellow</td>
<td>White</td>
</tr>
</tbody>
</table>

Example produces a Left/Right brain conflict
- The right brain tries to say the color
- The left brain tries to read the color

http://OfficeSpam.ChattaBlogs.com

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Key Memory Systems & How they Interact

ACTIVITY: READ & REMEMBER THE NUMBER
21066119571963
Instrument: CSEM – Q7

7. The picture below shows a particle (labeled B) which has a net electric charge of +1 unit. Several centimeters to the left is another particle (labeled A) which has a net charge of -2 units. Choose the pair of force vectors (the arrows) that correctly compare the electric force on A (caused by B) with the electric force on B (caused by A).

-2 units

\[ \text{A} \]

\[ \text{B} \]

\[ \text{force on A} \quad \text{force on B} \]

(a) \[ \rightarrow \quad \rightarrow \quad \text{Bef:61%, Aft:37%} \]

(b) \[ \rightarrow \quad \rightarrow \quad \text{Bef:9%, Aft:10%} \]

(c) \[ \rightarrow \quad \rightarrow \quad \text{Bef:15%, Aft:23%} \]

(d) \[ \rightarrow \quad \rightarrow \quad \text{Bef:9%, Aft:13%} \]

(e) \[ \rightarrow \quad \rightarrow \quad \text{Bef:6%, Aft:17%} \]

CRI=2.3

Instrument: CSEM – Q8

8. In the figure below, positive charges \( q_2 \) and \( q_3 \) exert on charge \( q_1 \), a net electric force that points along the +x axis. If a positive charge \( Q \) is added at (b,0), what now will happen to the force on \( q_1 \)? (All charges are fixed at their locations.)

\[ \begin{array}{c}
\text{before} \quad \text{after} \\
\text{y} \quad \text{y} \\
+q_2 \quad +q_2 \\
q_1 \quad q_1 \\
+q_3 \quad +q_3 \\
x 
\end{array} \]

\( CRI=1.3 \)

(a) 9%, After:7%

(b) 18%, After:17%

(c) 21%, After:17%

(d) 41%, After:37%

(e) 12%, After:23%

(a) No change in the size of the net force since \( Q \) is on the x-axis.

(b) The size of the net force will change but not the direction.

(c) The net force will decrease and the direction may change because of the interaction between \( Q \) and the positive charges \( q_2 \) and \( q_3 \).

(d) The net force will increase and the direction may change because of the interaction between \( Q \) and the positive charges \( q_2 \) and \( q_3 \).

(e) Cannot determine without knowing the magnitude of \( q_1 \) and/or \( Q \).