UNIVERSITY OF LOUISVILLE
CENTER FOR RESEARCH IN MATHEMATICS & SCIENCE TEACHER DEVELOPMENT
(CRIMSTED)

Physical Science DTAMS Assessment – Version 6

Diagnostic Teacher Assessments in Mathematics and Science—Middle School

Date _____ **Start time**_____ **Finish time** _____

Please provide the following information about yourself:

Years teaching experience (0 if preservice) _____	Last 4 digits of Social Security number (*or any 4-digit number you'll remember*) _____ (used as identifier on score report)
Check grade level(s) **currently teaching** (or will be teaching if preservice). Mark one or more that best describes your situation. (*please describe below if "other"*) Pre-K_____ K-3_____ 4-5_____ 6-8_____ 9-12_____ other_____	Check current (or future if preservice) **teaching certificate grade level(s)**. Mark one or more that best describes your situation. (*please describe below if "other"*) Pre-K_____ K-3_____ 4-5_____ 6-8_____ 9-12_____ other_____
Number of college & graduate **earth science courses** _____	Number of college & graduate **life science courses** _____
Number of college & graduate **physical science courses** _____	Sex (M/F) _____

Content area of teaching certificate

Mark one or more that best describes your situation. If your certificate is a <u>general education certificate</u> that covers all subjects (e.g. as many elementary certificates do) but doesn't specifically include a separate science certification, please <u>mark "not science"</u>. If your certificate includes content areas in addition to science, please choose from the list on the right based on the science content portion only and <u>do not mark</u> the "not science" category.	not science_____ general science_____ biology/life science_____ chemistry_____ physics_____ physical science_____ earth science_____ astronomy_____ geology_____ other science_____ (*please describe "other science"*)

Multiple Choice

Identify and write in the space the letter of the choice that best completes the statement or answers the question.

____ 1. A teacher has two identical beakers of boiling water each at 100 degrees Celsius. She wraps one beaker of hot water in fur and the other beaker of hot water in aluminum foil and leaves them setting on a lab bench. Which of the following would she expect to observe a half-hour later?
   a. The fur-wrapped beaker would show a higher temperature than the room and the aluminum foil-wrapped one would show a lower temperature than the room because fur acts as an insulator whereas the aluminum foil conducts heat away from the second beaker.
   b. The fur-wrapped beaker would show a lower temperature than the aluminum foil-wrapped one because the fur more effectively removes the excess heat of the hot water.
   c. The fur-wrapped beaker would show a higher temperature than the aluminum foil-wrapped one because fur acts as a much better insulator than aluminum foil.
   d. They both would be the same temperature as each other since the ambient temperature of the room isn't affected by the type of wrap.

____ 2. Modern homes use artificial insulation materials such as fiberglass to retain heat inside during winter. However, native people in the far north of the North American continent once built winter homes, what we call "igloos," out of snow and ice that were effective at providing living quarters to survive the harsh winters. How did igloos accomplish this?
   a. Snow and ice do not conduct heat well, and so the interior of an igloo that was heated by bodies efficiently retained that heat.
   b. The ice generates heat as it undergoes a phase change from solid to liquid, and continuous replacement of the igloo's melting ice provides a continuous source of heat.
   c. The highly reflective surfaces of snow and ice cause heat waves to reflect back toward the interior of the igloo rather than propagating them to the outside.
   d. The curved igloo surface made out of glassy ice focused the sun's rays much like a magnifying glass, which generated enough heat to survive the cold winters.

____ 3. In green light, a white T-shirt appears
   a. black because no light is reflected.
   b. green because that is the only light available for it to reflect.
   c. white because green is in the visible spectrum and thus reflects the true color.
   d. yellow because the white dilutes the green color toward the middle of the visible spectrum.

____ 4. You flick a quarter so that it flies off the lab bench. Just as it is leaving the edge of the bench, it disturbs another quarter that is balanced there so that this second quarter drops straight down to the floor. Which quarter will hit the floor first and why?
   a. Both quarters will hit approximately simultaneously because their vertical velocities do not depend on the horizontal motion.
   b. The dropped quarter will hit first because it travels less distance than the moving one.
   c. The moving quarter will hit first because it is moving faster than the dropped quarter.
   d. It depends on the height of the lab bench in order to know if the dropped quarter has enough time to catch up to the moving one before it hits the ground.

____ 5. You are interested in determining the most effective antacid tablet brand to neutralize stomach acids. You select two brands, A and B, and to test the tablets you decide to react each tablet with an acid and measure the pH. Which of the following would be the best experimental setup for this purpose?

a. Alternate putting equal amounts of brand A and brand B tablets into one container of acid until you get a neutral pH.
b. Put equal amounts of brand A and B tablets into one container of acid and measure the resulting pH.
c. Put equal amounts of brand A and B tablets into separate containers, add identical amounts of one acid to A and a different acid to B, and measure the resulting pH of each container.
d. Put equal amounts of brand A and B tablets into separate containers, add identical amounts of the same acid to each, and measure the resulting pH of each container.

____ 6. What is the difference between nuclear fusion and nuclear fission?

a. In fusion the nuclei of atoms combine to form a larger nucleus whereas in fission the nucleus of an atom splits to form two or more separate nuclei.
b. In fusion the lowest energy level electrons absorb radioactive energy whereas in fission the highest energy level electrons give off radioactive energy.
c. In fusion the valence electrons of atoms are lost to surrounding atoms whereas in fission an atom gains valence electrons from surrounding atoms.
d. In fusion the atoms consume energy in order to combine together whereas in fission the atoms split apart to release energy.

____ 7. Knowledge of a trip's average speed allows you to know (or compute)

a. how fast you are going at that moment.
b. how long a particular trip of known distance will take.
c. how far you're car can travel before needing to be refueled.
d. the maximum speed attained during the trip.

____ 8. When dissolving a solid in a liquid, the resulting mixture is called a

a. solvent.
b. substance.
c. solution.
d. solute.

____ 9. In the periodic table of the elements (ignoring the transition metals), the number of elements that appear in the first few horizontal rows is the same as the number of

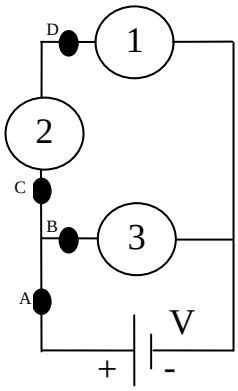
a. energy levels electrons inhabit.
b. electron capacity in the outmost shell.
c. isotopes an element can form.
d. protons and neutrons in the nucleus.

____ 10. A student says, “It is easier to go fast in tenth gear (using the smallest gear on the rear wheel) on a ten-speed bike because the small gear allows more energy to transfer to the back wheel than the energy you put in at the pedal." Why is this a misconception?

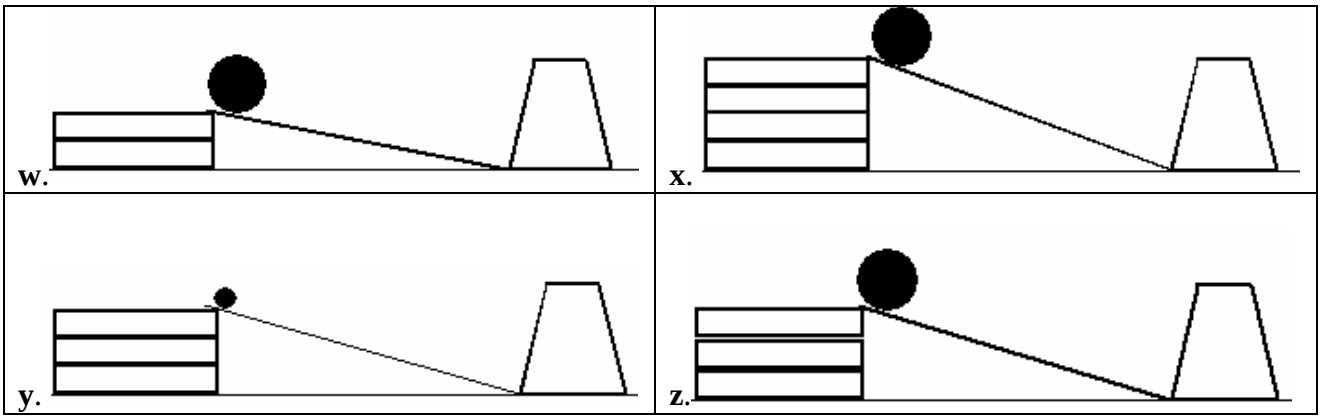
a. The misconception is that the energy transfer is the key concept when in fact it is the power that is the critical concept for this situation. The small (high speed) gear amplifies the power applied to the back wheel which is why it is useful in this scenario.
b. The misconception is that the energy transfer is the key concept to moving at high speed in this scenario. Instead, the advantage of the small (high speed) gear is that it permits a better angle of pedal torque so that no energy is lost in wasted pedaling.
c. There is more energy transferred to the back wheel; the misconception is that this is a function of the size of the gear. Any gear will transfer more energy to the back wheel, but the advantage of the smallest (high speed) gear is that it gives you more torque for this energy transfer.
d. The misconception is that energy is amplified when actually the energy output is essentially equal to the energy input. The advantage gained is that more speed is available with the small (high speed) gear, but at the expense of greater force input needed.

____ 11. Students are assigned the task of designing electrical circuits with prescribed properties in a laboratory activity. In the following wiring diagram with three identical bulbs and a power source, where would you install switches so that you could independently turn bulbs 2 and 3 on or off without affecting any other bulb?

a. None of these choices.
b. Locations A and C.
c. Locations B and C.
d. Locations B and D.



____ 12. The diagrams below show different experimental setups of a board propped up on a stack of books. All books are the same thickness. A plastic cup is placed at the bottom of the ramp. Balls of two different weights (shown as small and large balls) are used in the experiments shown.



A student wants to use a controlled experiment to find out if the cup will move further when struck by a larger force. Which pair of experimental setups is used to test the height of the ramp as the variable?

a. x and z
b. y and z
c. w and y
d. x and y

____ 13. As a water puddle outside is undergoing the process of freezing on a cold winter day,

a. its temperature falls.
b. vibrations between molecules are slower and slower.
c. vibrations between molecules are faster and faster.
d. its molecules change shape.

____ 14. In a laboratory experiment, you would like to compare the electrical conductivity of aluminum, steel, and tin wires. You plan on using the wires in a circuit along with a voltage source (e.g. a 9-volt battery) and an identical ammeter to measure current for each test wire. Which experimental setup is best for this?

a. Connect the voltage source and just use one ammeter for the whole circuit of test wires in parallel to control for differences in ammeters.
b. Connect the test wires in parallel with the voltage source and put an ammeter in parallel with each test wire.
c. Connect the test wires in parallel with the voltage source and put an ammeter in series with each test wire.
d. Connect separate voltage sources and an ammeter to each test wire to avoid interaction influences.

____ 15. You would like to compare the thermal conductivity of copper, tin and aluminum. You plan on putting equal amounts of water in copper, tin and aluminum containers of equal volume, shape, and thickness. You will then simultaneously subject them to identical heat sources and measure the temperature of the water in each container after 5 minutes.
Which quantity represents an independent variable for this experiment?
a. temperature of the water after 5 minutes
b. thermal conductivity
c. type of metal used to make each container
d. amount of water in each container

____ 16. In some developing countries with hot, desert-like climates, people are able to cool their rooms without electricity. One technique involves spraying or splashing water on the concrete or adobe walls inside the house. Why does this process cool the rooms?
a. The extra humidity in the air from the splashed water causes more dense, cooler air to sink down to the rooms whereas hotter, less dense air rises up and out of the rooms, leaving the rooms cooler than before.
b. The water splashed on the inside walls is transported through the air to people's skin, increasing their bodies' abilities to cool off and making the room seem cooler even though it really isn't any cooler than before.
c. The hot, dry air inside the rooms evaporates the water splashed on the walls; this evaporation removes heat from the air and results in the air being cooler than before the evaporation.
d. The water on the inside walls helps seal the walls airtight against the hot outside air, which prevents the hot outside air from coming into the rooms.

____ 17. During a lab activity, students were investigating the refraction of laser light through a container of water. One student hypothesized that this refraction was possible because water is a fluid that can flow and carry the laser light off at an angle different from the incidence angle. To investigate this hypothesis, the teacher could lead students to develop an investigation with the following characteristics:
a. Experiment with laser light passing through water containing different materials dissolved in it such as salt and sugar to see if refraction still occurs.
b. Experiment with laser light passing through translucent solids such as glass to see if refraction still occurs.
c. Experiment with refraction of laser light through translucent liquids of different viscosities such as glycerin or rubbing alcohol.
d. Experiment with laser light of different colors passing through the water to see if refraction still occurs.

____ 18. Information needed in order to classify energy as either kinetic energy or potential energy is whether the energy is
a. highly concentrated or whether it is dispersed widely.
b. manifested in motion or whether it is stored energy.
c. being transferred to a new system or whether it remains inside the system.
d. visible to observation or whether it is hidden energy.

____ 19. Friction is a force that
   a. cannot exist in an airless setting.
   b. is intrinsic to a particular object.
   c. cannot be varied.
   d. often opposes the net of the other acting forces.

____ 20. In many science fiction stories that include large, permanently occupied space stations, there is a need to create an artificial gravitational field for the space station. This is usually done by having the large, doughnut-shaped space station rotating at a sufficiently high speed about its center to get the desired effect around the perimeter of the doughnut. Why would this approach create an artificial gravitational field?
   a. Rotation of such a huge structure like a permanent space station requires a lot of energy, and the expenditure of this large amount of energy creates radiating fields of force that feel similar to a gravitational force field; this would be experienced as a force radiating out and pushing toward the outside wall of the station, making the outside wall feel like it is "down."
   b. A centrifugal force is created by the rotation which pushes all objects away from the center of rotation and toward the outside walls of the space station, making the outside wall feel like it is "down" because of this push on the body.
   c. A person's body has inertia which resists a change in direction, but the rotation of the space station means that the outside wall of the station must constantly push against your body to keep changing the body's direction, making the outside wall feel like "down."
   d. The rotation of the space station generates an artificial gravitational field because it mimics the 24 hour rotation of the earth, except that the space station has to be at a higher speed to get the same effect because the space station is significantly smaller than the earth; this makes the outside wall feel like "down."

Open Response Directions

Write responses to parts **(a)** *and* **(b)** *in the space provided. If more space is needed, please use the back of the paper and indicate that your response continues on the back.*

Directions for part (a):

In each question, students expressed a misconception. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. Explain the science in as much depth as possible, even if that level of depth would be inappropriate to expect middle school students to know. Your explanation should demonstrate a thorough knowledge of the underlying science – simply stating the opposite of the students' misconception without further explanation is not sufficient.

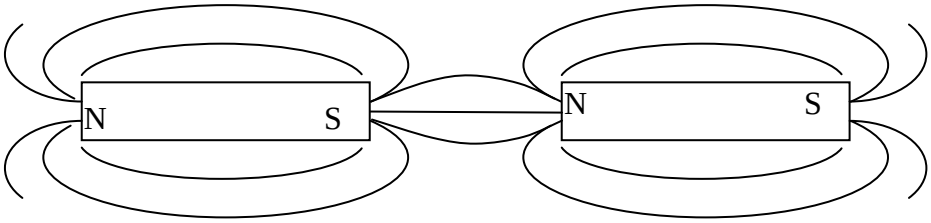
Directions for part (b):

Explain how you would address this misconception using best instructional practices. Please describe the classroom instruction, including what the students and teacher are doing, in enough detail so that the reader can envision what is happening. For example, if you refer to a specific lesson, textbook, activity, piece of equipment, or media, assume the reader is not familiar with it and explain how it is used to support student learning. Assume you have access to any equipment that would be available in a reasonably well-funded K-12 school setting so that your proposed instruction is feasible to implement.

21. When studying inertia, your students point out that Newton's First Law of Motion (an object in motion continues in motion unless acted on by an outside force) cannot be true because otherwise nearly everything around us would still be moving since it had likely been moving at least once in the past.
    a. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. See directions at beginning of the open response section for more detailed directions.

    b. Explain how you would address this misconception using best instructional practices. See directions at beginning of the open response section for more detailed directions.

22. While studying a unit on magnetism, students were in the lab and did an exercise to make the magnetic field lines of two bar magnets visible. They did this by using small iron filings sprinkled on a sheet of paper which is covering the magnets. They got a result similar to the diagram below.



While describing this result, some students pointed out that the field lines show that the opposite poles in the middle attract each other, but that there are no field lines emanating from the middle of each bar magnet. They concluded that if both bar magnets were broken in half and put back in this configuration, the middle poles would still attract each other but that there would be no magnetism on either end of the broken bars.

a. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. See directions at beginning of the open response section for more detailed directions.

b. Explain how you would address this misconception using best instructional practices. See directions at beginning of the open response section for more detailed directions.

23. Doing an activity to recover salt that had been dissolved in water, students poured the salt water in a shallow pan and left it on the lab bench for several days. They scraped together all of the salt crystals in the dry pan and when they massed them, they found that the mass of the salt was less than the mass of the initial salt water. From this, the students concluded that the principle of conservation of mass had been violated.
    a. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. See directions at beginning of the open response section for more detailed directions.

    b. Explain how you would address this misconception using best instructional practices. See directions at beginning of the open response section for more detailed directions.

24. To investigate conservation of energy, students are setting up a model roller coaster where a marble is released and rolls to the end of the track. Assume the friction in this situation is small and can be safely ignored. When designing their roller coaster, the students state, "Since conservation of energy means that all of the initial potential energy is converted to kinetic energy by the end, the roller coaster must end at the lowest point since that will be where the marble has the greatest speed."

    a. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. See directions at beginning of the open response section for more detailed directions.

    b. Explain how you would address this misconception using best instructional practices. See directions at beginning of the open response section for more detailed directions.

25. In a music video students brought to class to demonstrate science principles, people dressed in spacesuits and ostensibly working on the surface of the moon were listening to a radio playing the musician's song when that musician appeared in a spacesuit and they all started a choreographed dance routine. Students were not able to identify any problems with this scene in terms of accurate science.
    a. Please describe the currently accepted scientific explanation of the phenomenon that the students are not understanding. See directions at beginning of the open response section for more detailed directions.

    b. Explain how you would address this misconception using best instructional practices. See directions at beginning of the open response section for more detailed directions.