Inventory of Basic Conceptions in Physics
Form IBC-P04

Dear Student:

The Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET) at Arizona State University (ASU) is conducting a research study to determine how student performance in particular courses compares across instructional settings, schools, colleges and universities. We are requesting that you participate by taking the attached test following the instructions given below.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty (it will not affect your grade). The results of the research study may be published, but your identity will never be disclosed to any party.

If you have any questions concerning the research study, please contact CRESMET at:

(480) 965-7820.

Return of the questionnaire will be considered your consent to participate.

Please:

*Do **not write** anything on this questionnaire.*

*Mark your answers on the NCS Pearson **answer sheet**, and follow marking instructions given on the back side of this sheet.*

*Follow instructions given by your teacher to fill in your **Name and/or other personal information** on the left side of the front page of the answer sheet.*

*Mark **only one** answer per test item, starting with Item 1 on the answer sheet.*

*Answer **all questions** to the best of your knowledge. Do not skip any question.*

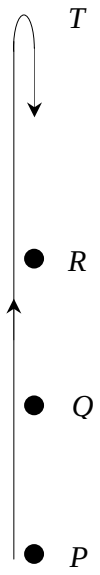
*Avoid guessing. Your answers should reflect what **you** actually and honestly think.*

*For efficient performance, read first the stem of an item and answer the question the way you know it **before** reading the provided alternatives marked (A) through (E). Once you have answered the question your way, read the provided alternatives and choose the one that best matches your own answer.*

Plan to finish the test in 45 minutes.

Thank You.

The accompanying figure shows a pebble thrown vertically upward from point *P*. The pebble goes through two points *Q* and *R* before reaching *T*, the highest point of its trajectory. Point *Q* is halfway between points *P* and *R* (*PQ* = *QR*). Air resistance is negligible.

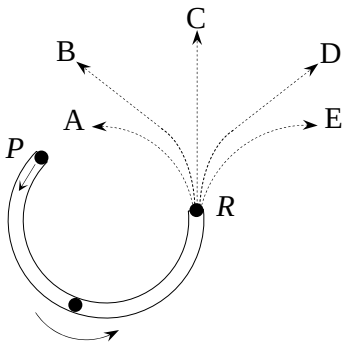


1. On its way up, how is the speed of the pebble at point *R* by comparison to its speed at point *Q*?
   (A) Half its speed at point *Q*.
   (B) Smaller than its speed at point *Q*, but not necessarily half as small.
   (C) Equal to its speed at point *Q*.
   (D) Twice its speed at point *Q*.
   (E) Greater than its speed at point *Q*, but not necessarily twice as big.

2. What happens to the speed and acceleration of the pebble as it reaches point *T* ?
   (A) Both its speed and its acceleration remain zero for a short time interval.
   (B) Its speed stays zero for a short time interval, and its acceleration becomes zero for only one instant.
   (C) Both its speed and its acceleration become zero for one instant.
   (D) Its speed becomes zero for one instant, and its acceleration remains constant.
   (E) Its speed stays zero for a short time interval, and its acceleration remains constant.

* * *

The accompanying figure shows an open circular channel anchored to a frictionless horizontal tabletop. You are looking down at the table. A marble is shot at high speed into the channel at P and exits at R without rolling on the tabletop.



3. Which of paths (A) through (E) would the marble most closely follow across the frictionless tabletop after it exits the channel at R?

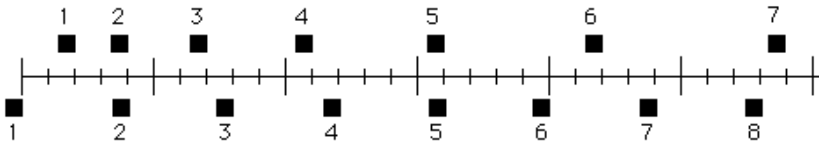
4. Ignoring air resistance, the speed of the marble along the chosen path outside the channel:
   (A) continuously increases.
   (B) increases for a while and remains constant thereafter.
   (C) continuously decreases.
   (D) remains constant all along.
   (E) remains constant for a while and decreases thereafter.

5. Which of the following forces act(s) on the marble when it moves along the chosen path outside the channel?
   F_1: A horizontal force in the direction of motion
   F_2: A vertically downward attraction exerted by Earth
   F_3: A vertically upward force exerted by the table

   (A) F_1.
   (B) F_2.
   (C) F_1 and F_2.
   (D) F_2 and F_3.
   (E) F_1, F_2 and F_3.

* * *

The positions of two blocks at successive 0.20-second time intervals are represented by the numbered squares in the figure below. The blocks are moving toward the right.

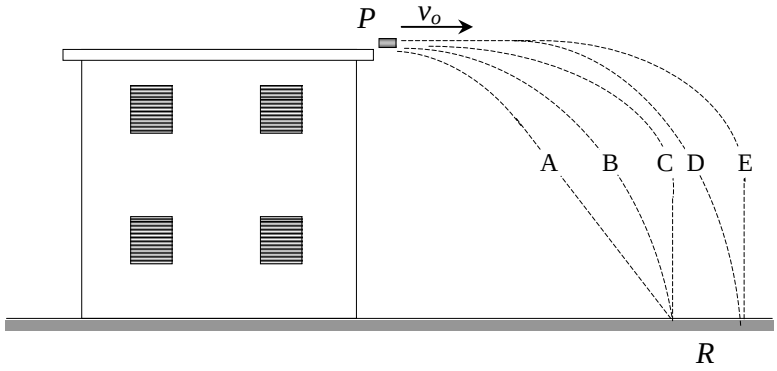


6. Do the blocks ever have the same speed?
   (A) No.
   (B) Yes, at instant 2.
   (C) Yes, at instant 5.
   (D) Yes, at instants 2 and 5.
   (E) Yes, at some time between instants 3 and 4.

* * *

A hockey puck (thick metallic disc) is kicked with high speed v_o, horizontally off edge *P* of the roof of a two-story building.

7. Which of paths (A) through (E) shown in the figure below would the puck most closely follow as it flies from point *P* to point *R* where it hits the ground?



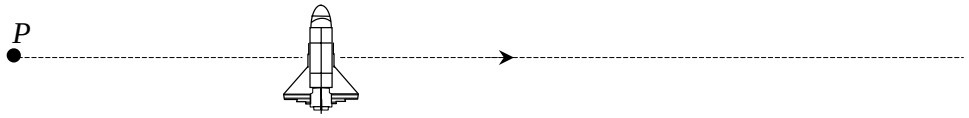
8. Which of the following forces act on the puck during its flight from *P* to *R*?
   F_1: A downward push exerted by air
   F_2: An upward push exerted by air
   F_3: A vertically downward attraction exerted by Earth
   F_4: A force in the variable direction of motion

   (A) F_1 and F_3.
   (B) F_2 and F_3.
   (C) F_1 and F_4.
   (D) F_1, F_3 and F_4.
   (E) F_2, F_3 and F_4.

9. During its flight from *P* to *R*, the speed of the puck:
   (A) remains constant all the way down.
   (B) remains constant for a while and increases thereafter.
   (C) continuously increases all the way down.
   (D) increases for a while and remains constant thereafter.
   (E) decreases for a while and increases thereafter.

* * *

A spaceship is flying in outer space with its engine turned off. At a certain point *P* in space, the spaceship starts drifting sideways with a constant speed and in a straight line.



10. Which of the forces below may have caused the spaceship to move the way it did beyond *P*?
    F_1: A force in the direction of motion exerted by some planets or other celestial objects
    F_2: A force in the direction of motion due to the original thrust of the spaceship
    F_3: An internal impulse developed gradually by the spaceship as it moves beyond *P*
    (A) F_1.
    (B) F_2.
    (C) F_3.
    (D) either one or a combination of the above three forces.
    (E) None. The spaceship can move the way it did beyond *P* without being driven by any internal or external force.

* * *

The figure below shows two hockey pucks *P* and *Q* sitting on a frictionless horizontal table. You are looking down at the table. The two pucks are the same size, but puck *P* is twice as heavy as puck *Q*.

The two pucks are now being pushed on the table in the same direction and with equal forces, **F**, until they reach the finish line.

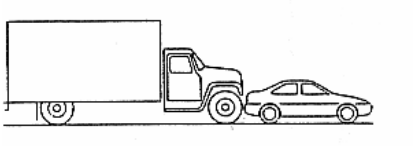
11. The time interval it takes the heavier puck *P* to reach the finish line is:
    (A) twice the time interval it takes the lighter puck *Q* to get there.
    (B) greater than the time interval it takes the lighter puck *Q* to get there, but not necessarily twice as long.
    (C) equal to the time interval it takes the lighter puck *Q* to get there.
    (D) half the time interval it takes the lighter puck *Q* to get there.
    (E) smaller than the time interval it takes the lighter puck *Q* to get there, but not necessarily half as long.

12. At the finish line, the speed of the heavier puck *P* is:
    (A) twice the speed of the lighter puck *Q* at this line.
    (B) greater than the speed of the lighter puck *Q* at this line, but not necessarily twice as big.
    (C) equal to the speed of the lighter puck *Q* at this line.
    (D) half the speed of the lighter puck *Q* at this line.
    (E) smaller than the speed of the lighter puck *Q* at this line, but not necessarily half as small.

13. Throughout their motion, the acceleration of the heavier puck *P* is:
    (A) twice the acceleration of the lighter puck *Q*.
    (B) greater than the acceleration of the lighter puck *Q*, but not necessarily twice as big.
    (C) equal to the acceleration of the lighter puck *Q*.
    (D) half the acceleration of the lighter puck *Q*.
    (E) smaller than the acceleration of the lighter puck *Q*, but not necessarily half as small.

* * *

A compact car breaks down out on a horizontal road. A large truck gives it a push back into town as shown in the figure at right.

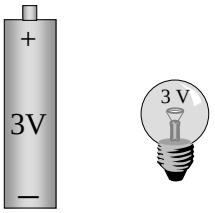


14. As the truck touches the car and begins to push it:
    (A) the two vehicles do not exert any force on one another.
    (B) the truck exerts a force on the car, but the car does not exert any force on the truck.
    (C) the truck first exerts a force on the car, then a short while afterwards the car starts exerting a force on the truck.
    (D) the car first exerts a force on the truck, then a short while afterwards the truck starts exerting a force on the car.
    (E) the two vehicles exert forces on one another at the same time.

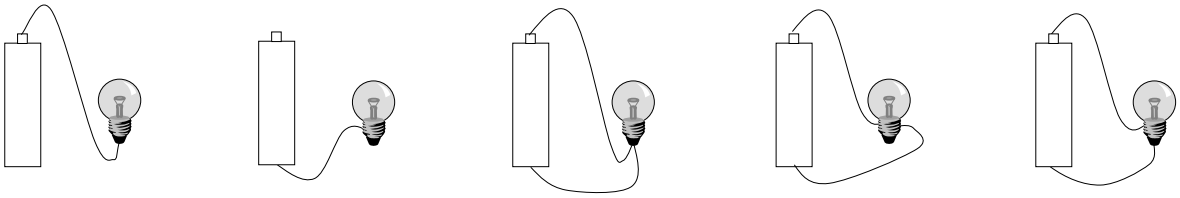
15. As the truck begins to move the car on the horizontal road:
    (A) the two vehicles do not exert any force on one another.
    (B) the truck exerts a force on the car, but the car does not exert any force on the truck.
    (C) the two vehicles exert forces of the same magnitude on one another.
    (D) each vehicle exerts a force on the other, but the truck exerts the bigger force.
    (E) each vehicle exerts a force on the other, but the car exerts the bigger force.

* * *

The figure at right shows a 3-V incandescent bulb and a 3-V dry cell battery.



16. Which of the figures below shows the most appropriate wiring for the bulb to light up?



(A) (B) (C) (D) (E)

17. Which of the following filament features affect(s) the brightness of the bulb in question 16:
    (A) The material that the filament is made of.
    (B) The length of the filament.
    (C) The thickness of the filament.
    (D) (A) and (B).
    (E) (A), (B) and (C).

* * *

The light bulb of question 16 is replaced by another 3-V bulb of greater internal resistance. The new bulb is appropriately connected to the same 3-V dry cell battery so that it may light up if possible.

18. By comparison to the original light bulb of question 16, the electric current that flows through the new bulb is:
    (A) bigger.
    (B) the same.
    (C) zero.
    (D) smaller.
    (E) (C) or (D), depending on the internal resistance of the new bulb.

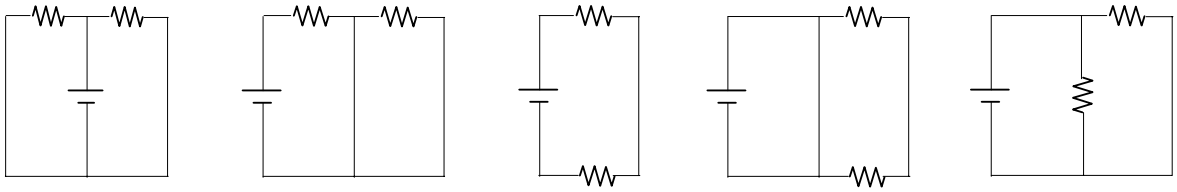
* * *

The bulb of question 16 is connected to a 1.5-V dry cell battery instead of the original 3-V battery.

19. By comparison to the situation in question 16, the electric current that flows through the new bulb is:
    (A) bigger.
    (B) the same.
    (C) zero.
    (D) smaller.
    (E) (C) or (D), depending on the internal resistance of the bulb.

* * *

Each of the five diagrams below shows two resistors connected in a special way to a dry cell battery. ⩙ represents a resistor; ⫟ represents a battery.



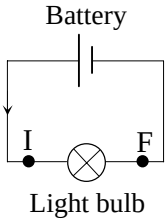
(1) (2) (3) (4) (5)

20. Which of the above diagrams represent(s) two resistors in series with the battery?
    (A) 1 and 2.
    (B) 3
    (C) 3 and 4.
    (D) 3 and 5.
    (E) 3, 4 and 5.

21. Which of the above diagrams represent(s) two resistors in parallel with the battery?
    (A) 1 and 2.
    (B) 5.
    (C) 1 and 5.
    (D) 2 and 5.
    (E) 1, 2 and 5.

* * *

The figure at right shows a light bulb connected to a dry cell battery. I and F are two points on the connection wires located on opposite sides of the bulb. The arrow indicates the direction in which electric current flows.

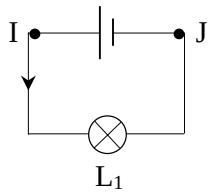


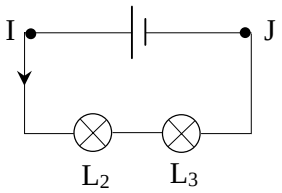
22. Which of the statements below describes best the electric current and electric potential at points I and F?
    (A) Both electric current and electric potential are smaller at F than at I.
    (B) The electric current is about the same at I and F; the electric potential is smaller at F than at I.
    (C) The electric current is about the same at I and F; the electric potential is greater at F than at I.
    (D) The electric current is smaller at F than at I; the electric potential is about the same at these two points.
    (E) Both electric current and electric potential are about the same at F and I.

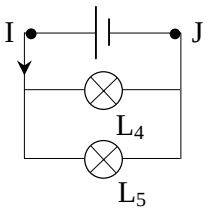
* * *

The three diagrams below show circuits containing dry cell batteries and light bulbs. The five light bulbs are identical. The batteries maintain the same electric potential at the three points I, as well at the three points J. Arrows indicate the direction in which electric current flows out of the batteries.

Bulbs L_2 and L_3 in the middle diagram are connected in series. Bulbs L_4 and L_5 in the right-hand diagram are connected in parallel.







23. How are the electric currents through bulbs L_2 and L_3 relative to each other and to the current through bulb L_1?
    (A) About the same current flows through L_2 and L_3; this current is about the same as the one that flows through L_1.
    (B) About the same current flows through L_2 and L_3; less current flows through L_1 than through either L_2 or L_3.
    (C) About the same current flows through L_2 and L_3; more current flows through L_1 than through either L_2 or L_3.
    (D) Less current flows through L_2 than through L_3; the current that flows through L_1 is not necessarily the same as the one that flows through either L_2 or L_3.
    (E) More current flows through L_2 than through L_3; the current that flows through L_1 is not necessarily the same as the one that flows through either L_2 or L_3.

24. How are the electric currents through bulbs L_4 and L_5 relative to each other and to the current through bulb L_1?
    (A) About the same current flows through L_4 and L_5; this current is about the same as the one that flows through L_1.
    (B) About the same current flows through L_4 and L_5; less current flows through L_1 than through either L_4 or L_5.
    (C) About the same current flows through L_4 and L_5; more current flows through L_1 than through either L_4 or L_5.
    (D) Less current flows through L_4 than through L_5; the current that flows through L_1 is not necessarily the same as the one that flows through either L_4 or L_5.
    (E) More current flows through L_4 than through L_5; the current that flows through L_1 is not necessarily the same as the one that flows through either L_4 or L_5.

25. How are the electric potential differences (voltage) across bulbs L_2 and L_3 relative to each other and to the electric potential difference across bulb L_1?
    (A) About the same potential difference exists across L_2 and L_3; this potential difference is about the same as the one across L_1.
    (B) About the same potential difference exists across L_2 and L_3; a lower potential difference exists across L_1 than across either L_2 or L_3.
    (C) About the same potential difference exists across L_2 and L_3; a higher potential difference exists across L_1 than across either L_2 or L_3.
    (D) A lower potential difference exists across L_2 than across L_3; the potential difference across L_1 is not necessarily the same as the one across either L_2 or L_3.
    (E) A higher potential difference exists across L_2 than across L_3; the potential difference across L_1 is not necessarily the same as the one across either L_2 or L_3.

26. How are the electric potential differences (voltage) across bulbs L_4 and L_5 relative to each other and to the electric potential difference across bulb L_1?
    (A) About the same potential difference exists across L_4 and L_5; this potential difference is about the same as the one across L_1.
    (B) About the same potential difference exists across L_4 and L_5; a lower potential difference exists across L_1 than across either L_4 or L_5.
    (C) About the same potential difference exists across L_4 and L_5; a higher potential difference exists across L_1 than across either L_4 or L_5.
    (D) A lower potential difference exists across L_4 than across L_5; the potential difference across L_1 is not necessarily the same as the one across either L_4 or L_5.
    (E) A higher potential difference exists across L_4 than across L_5; the potential difference across L_1 is not necessarily the same as the one across either L_4 or L_5.

27. Which of the following statements best describes the situation in the middle diagram that contains L_2 and L_3:
    (A) The electric current at I equals the sum of electric currents through L_2 and L_3.
    (B) The electric potential difference (voltage) between I and J equals the sum of electric potential differences across L_2 and L_3.
    (C) (A) and (B).
    (D) The likelihood of either (A) or (B) depends on the internal resistance of each bulb.
    (E) Neither (A) nor (B).

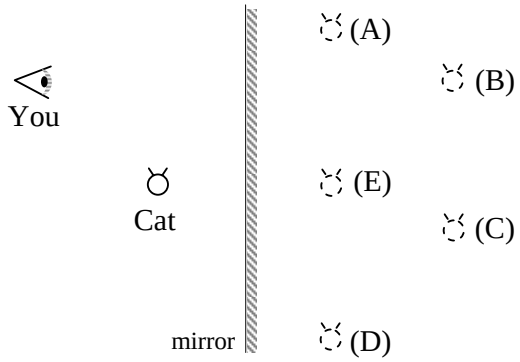
28. Which of the following statements best describes the situation in the right-hand diagram that contains L_4 and L_5:
    (A) The electric current at I equals the sum of electric currents through L_4 and L_5.
    (B) The electric potential difference (voltage) between I and J equals the sum of electric potential differences across L_4 and L_5.
    (C) (A) and (B).
    (D) The likelihood of either (A) or (B) depends on the internal resistance of each bulb.
    (E) Neither (A) nor (B).

29. If bulb L_2 burns up (the filament inside breaks apart), bulb L_3:
    (A) does not light up at all.
    (B) remains lit, almost as bright as before.
    (C) remains lit, but brighter than before.
    (D) remains lit, but dimmer than before.
    (E) starts dimming down until it goes off.

30. If bulb L_4 burns up (the filament inside breaks apart), bulb L_5:
    (A) does not light up at all.
    (B) remains lit, almost as bright as before.
    (C) remains lit, but brighter than before.
    (D) remains lit, but dimmer than before.
    (E) starts getting brighter and brighter, and may eventually burn up.

* * *

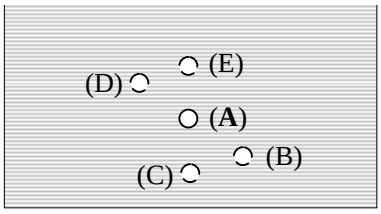
31. You and a cat are facing a flat mirror.



Which of positions (A) through (E) indicates most closely the location at which you perceive the image of the cat given by the mirror?

* * *

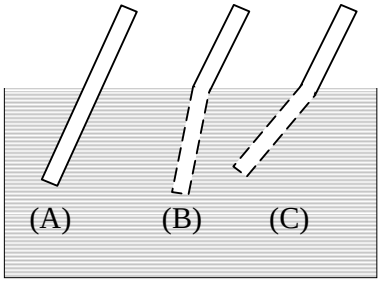
32. You are looking at a fish located at position (A) inside an aquarium filled with water.



Which of positions (A) through (E) indicates most closely the location at which you actually perceive the fish?

* * *

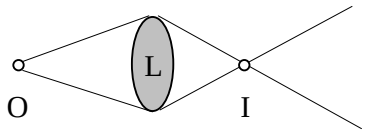
33. A wooden ruler is partly immersed in water. When you look at it from outside the water tank, the ruler appears:



(A) straight as shown in situation (A).
(B) bent as shown in situation (B).
(C) bent as shown in situation (C).
(D) (A) or (B), depending on the position of your eyes.
(E) (A) or (C), depending on the position of your eyes.

* * *

The picture on the right shows the positions of an object O and of its image I given by a converging lens L.



34. Where can your eyes be located so that you may see image I?
(A) Somewhere in the cone extending to the right side of I.
(B) Somewhere in the cone extending to the left side of I and based on the lens.
(C) Somewhere in the cone extending to the right side of O and based on the lens.
(D) Somewhere on the left side of O.
(E) None of the above.

35. Which of the following factors affect(s) the position of image I?
(A) The composition of the material of which the lens is made.
(B) The shape of the lens.
(C) The composition of the medium where the image I is formed.
(D) (A) and (C).
(E) (A), (B) and (C).

* * *

36. How are the wavelength and frequency of a red light beam affected as the beam travels from vacuum to glass?
(A) The wavelength decreases while the frequency stays the same.
(B) The wavelength increases while the frequency stays the same.
(C) The frequency decreases while the wavelength stays the same.
(D) The frequency increases while the wavelength stays the same.
(E) Both wavelength and frequency vary.

* * *

You are observing fireworks that shoot colored lights in the sky as they detonate with an explosive sound. You are located far away from the firing site.

37. Consider the following factors:
    (1) The distance that separates you from the firing site.
    (2) The loudness of the explosion.
    (3) The weather.

    Which of the above factors determine(s) how soon you hear the explosion?
    (A) 1.
    (B) 1 and 2.
    (C) 1 and 3.
    (D) 1, 2 and 3.
    (E) None. You hear the explosion at the same instant fireworks detonate at the firing site.

38. You are most likely to see the colored lights:
    (A) before you hear the explosion.
    (B) at the same time you hear the explosion.
    (C) after you hear the explosion.
    (D) and hear the explosion at the same or different times depending on the weather.
    (E) and hear the explosion at the same or different times depending on how loud the explosion is.

* * *

Consider the following media:

(1) Vacuum
(2) Air
(3) Water

39. In which of the above media can light travel?
    (A) 2
    (B) 1 and 2.
    (C) 1 and 3.
    (D) 2 and 3.
    (E) 1, 2 and 3.

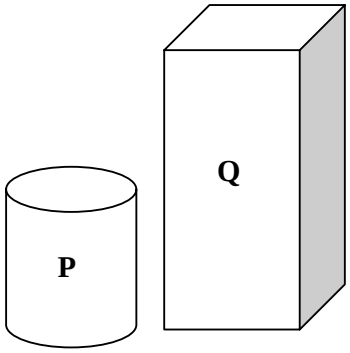
40. In which of the above media can sound travel?
    (A) 2
    (B) 1 and 2.
    (C) 1 and 3.
    (D) 2 and 3.
    (E) 1, 2 and 3.

* * *

41. The bigger the density of a homogeneous medium in which both sound and light can travel,
    (A) the slower both sound and light travel.
    (B) the faster both sound and light travel.
    (C) the slower sound travels and the faster light travels.
    (D) the faster sound travels and the slower light travels.
    (E) the speed of either sound or light would not be affected.

* * *

Two containers P and Q have the same mass. Container P has a circular base while container Q has a square base. Container P is shorter than container Q. The inner cross section (base area) of P is half (½) that of Q.



We fill P with water to the rim, then we pour the entire amount of water out of P into Q.

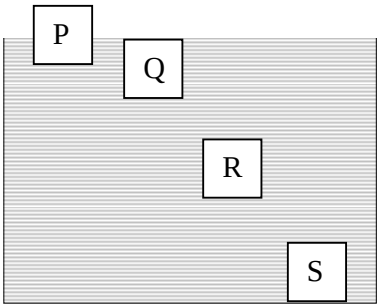
42. Water then reaches in Q a height that is:
    (A) equal to the height of P.
    (B) twice the height of P.
    (C) greater than the height of P but not necessarily twice of it.
    (D) half the height of P.
    (C) smaller than the height of P but not necessarily half of it.

43. Water fills in Q a volume that is:
    (A) equal to the volume it filled in P.
    (B) twice the volume it filled in P.
    (C) greater than the volume it filled in P but not necessarily twice of it.
    (D) half the volume it filled in P.
    (E) smaller than the volume it filled in P but not necessarily half of it.

44. Once poured in Q the mass of the water is:
    (A) the same as its mass in P.
    (B) twice its mass in P.
    (C) greater than its mass in P but not necessarily twice of it.
    (D) half its mass in P.
    (E) smaller than its mass in P but not necessarily half of it.

* * *

Four cubes P, Q, R and S are made up of different materials of respective densities ρ_P, ρ_Q, ρ_R and ρ_S. They are released inside a tank full of water (ρ_o = 1 g/cm^3). The four cubes occupy then positions shown in the figure at right.



45. Among the following relationships, which one represents best how the densities of the four cubes are by comparison to the density of water ρ_o?
    (A) $\rho_P < \rho_o$; $\rho_Q = \rho_o$; $\rho_R = \rho_o$; $\rho_S = \rho_o$.
    (B) $\rho_P < \rho_o$; $\rho_Q = \rho_o$; $\rho_R = \rho_o$; $\rho_S > \rho_o$.
    (C) $\rho_P < \rho_o$; $\rho_Q = \rho_o$; $\rho_R > \rho_o$; $\rho_S > \rho_o$.
    (D) $\rho_P = \rho_o$; $\rho_Q = \rho_o$; $\rho_R > \rho_o$; $\rho_S > \rho_o$.
    (E) $\rho_P = \rho_o$; $\rho_Q > \rho_o$; $\rho_R > \rho_o$; $\rho_S > \rho_o$.

46. Among the following relationships, which one represents best the relative densities of the four cubes?
    (A) $\rho_P < \rho_Q < \rho_R < \rho_S$.
    (B) $\rho_P < \rho_Q$; $\rho_Q = \rho_R = \rho_S$.
    (C) $\rho_P < \rho_Q$; $\rho_Q = \rho_R$; $\rho_R < \rho_S$.
    (D) $\rho_P = \rho_Q$; $\rho_Q < \rho_R$; $\rho_R = \rho_S$.
    (E) $\rho_P = \rho_Q$; $\rho_Q < \rho_R$; $\rho_R < \rho_S$.

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