

## Answers:

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|-----------------|-----------------|
| 1. Answer = A.  | 16. Answer = A. |
| 2. Answer = D.  | 17. Answer = B. |
| 3. Answer = C.  | 18. Answer = B. |
| 4. Answer = D.  | 19. Answer = A. |
| 5. Answer = E.  | 20. Answer = B. |
| 6. Answer = B.  | 21. Answer = D. |
| 7. Answer = D.  | 22. Answer = E. |
| 8. Answer = E.  | 23. Answer = B. |
| 9. Answer = C.  | 24. Answer = B. |
| 10. Answer = C. | 25. Answer = A. |
| 11. Answer = A. | 26. Answer = A. |
| 12. Answer = E. | 27. Answer = D. |
| 13. Answer = D. | 28. Answer = B. |
| 14. Answer = B. | 29. Answer = B. |
| 15. Answer = E. | 30. Answer = B. |

## Essays:

1. Aristotle is correct when he says that larger objects have larger forces on them because the force due to gravity (weight) =  $\text{mass} \cdot g$ . Larger masses have greater weights. But this does not mean that the acceleration is greater. The amount of acceleration depends on the force applied and on the mass according to Newton's 2<sup>nd</sup> Law:  $\text{Acceleration} = \text{force}/\text{mass}$ . So the actual acceleration of a falling object is  $a = (m \cdot g)/m = g$ . All objects fall with an acceleration of  $g$  (in the absence of air friction). Said another way: Larger masses **require** larger forces in order to accelerate at the same rate.

2. A "weightless" object still has weight. Weight is the force due to gravity. Objects become weightless when they accelerate at the acceleration rate of "g". In free fall  $a = g$ ; so any object in free fall is weightless.

When a person is on a scale which is accelerating downward they experience two forces: one due to gravity (i.e., weight) and one due to the scale. By Newton's 2nd Law:  $\text{Weight} - F_{\text{scale}} = \text{mass} \cdot \text{acceleration}$ , or  $m \cdot g - F_{\text{scale}} = m \cdot a$ . When  $a = g$ ,  $F_{\text{scale}} = 0$ . And that is what we mean by weightlessness.

3. Temperature (in absolute units) is proportional to the average internal energy per particle. Internal energy is the sum of the kinetic and potential energies of the individual particles. A material which is higher in temperature has, on the average, more internal energy per particle. When two solids, at different temperatures, are placed in contact the solid with the higher temperature has more kinetic energy per particle. Those particles on the surface of each solid experience collisions with each other. Energy will be transferred from the higher energy particles to the particles with the lower temperature during the collisions. Thus energy flows from one system to another because of the temperature difference. This energy is called heat.
4. Isotopes are atoms with the same number of protons but different neutron numbers. Not all isotopes of an element are stable. Example: carbon. It has two stable isotopes carbon-12 and carbon-13. All other isotopes of carbon are metastable or non-existent. Carbon-14 is unstable but it has a very long lifetime of approximately 5700 years. Carbon-15 is also unstable but it has a very short life time of about a few minutes or seconds. Hence carbon-14 is more stable than carbon-15. So the lifetime (or half-life) is an indicator of the degree of stability.
5. Metals contain free electrons which easily respond to electric fields. As an ionized piece of ash approaches the screen its electric field polarizes the metal. If the ion is positive it will produce an electric field which will attract the free electrons. Therefore the ion will be attracted to the metal. Hence it will not go through the mesh of the screen but will move to the metal part of the screen.
6. The basic operating principle here is Bernoulli's Principle. As we increase the air flow on the top of the tube we will effectively reduce the air pressure there. The normal atmospheric pressure over the rest of the perfume will cause the perfume level in the tube to rise up out of the tube. The perfume then gets sprayed out of the atomizer.