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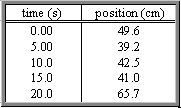
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| 1. | Which one of the following is an SI base unit? | |
| A) | gram |
| B) | slug |
| C) | newton |
| D) | centimeter |
| E) | kilogram |

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| 2. | Which one of the following is the longest length? | |
| A) | 100 meters |
| B) | 102 centimeters |
| C) | 104 millimeters |
| D) | 105 micrometers |
| E) | 107 nanometers |

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| 3. | Which one of the following choices is equivalent to 8.0 m2? | |
| A) | 8.0  10–4 cm2 |
| B) | 8.0  102 cm2 |
| C) | 8.0  10–2 cm2 |
| D) | 8.0  104 cm2 |
| E) | 8.0  103 cm2 |

Use the following to answer questions 4-5:

Peter noticed a bug crawling along a meter stick and decided to record the bug's position in five-second intervals. After the bug crawled off the meter stick, Peter created the table shown.



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| 4. | What is the displacement of the bug between *t* = 0.00 s and *t* = 20.0 s? | |
| A) | +39.9 cm |
| B) | –39.9 cm |
| C) | +65.7 cm |
| D) | –16.1 cm |
| E) | +16.1 cm |

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| 5. | What is the total distance that the bug traveled between *t* = 0.00 s and *t* = 20.0 s? Assume the bug only changed directions at the end of a five-second interval. | |
| A) | 39.9 cm |
| B) | 65.7 cm |
| C) | 16.1 cm |
| D) | 47.1 cm |
| E) | 26.5 cm |

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| 6. | A Canadian goose flew 845 km from Southern California to Oregon with an average speed of 28.0 m/s. How long, in hours, did it take the goose to make this journey? | |
| A) | 27.7 h |
| B) | 8.33 h |
| C) | 66.1 h |
| D) | 7.70 h |
| E) | 8.38 h |

Use the following to answer questions 7-10:

A racecar, traveling at constant speed, makes one lap around a circular track of radius *r* in a time *t*. Note: The circumference of a circle is given by *C* = 2*r.*

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| 7. | When the car has traveled halfway around the track, what is the magnitude of its *displacement* from the starting point? | |
| A) | *r* |
| B) | 2*r* |
| C) | *r* |
| D) | 2*r* |
| E) | zero meters |

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| 8. | What is the *average speed* of the car for one complete lap? | |
| A) |  |
| B) |  |
| C) |  |
| D) |  |
| E) | zero meters/second |

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| 9. | Determine the *magnitude* of the *average velocity* of the car for one complete lap. | |
| A) |  |
| B) |  |
| C) |  |
| D) |  |
| E) | zero meters/second |

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| 10. | Which one of the following statements concerning this car is true? | |
| A) | The displacement of the car does not change with time. |
| B) | The instantaneous velocity of the car is constant. |
| C) | The average speed of the car is the same over any time interval. |
| D) | The average velocity of the car is the same over any time interval. |
| E) | The average speed of the car over any time interval is equal to the magnitude of the average velocity over the same time interval. |

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| 11. | In which one of the following situations does the car have a westward acceleration? | |
| A) | The car travels westward at constant speed. |
| B) | The car travels eastward and speeds up. |
| C) | The car travels westward and slows down. |
| D) | The car travels eastward and slows down. |
| E) | The car starts from rest and moves toward the east. |

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| 12. | Starting from rest, a particle confined to move along a straight line is accelerated at a rate of 5.0 m/s2. Which one of the following statements accurately describes the motion of this particle? | |
| A) | The particle travels 5.0 m during each second. |
| B) | The particle travels 5.0 m *only* during the first second. |
| C) | The speed of the particle increases by 5.0 m/s during each second. |
| D) | The acceleration of the particle increases by 5.0 m/s2 during each second. |
| E) | The final speed of the particle will be proportional to the distance that the particle covers. |

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| 13. | Which one of the following situations is *not* possible? | |
| A) | A body has zero velocity and non-zero acceleration. |
| B) | A body travels with a northward velocity and a northward acceleration. |
| C) | A body travels with a northward velocity and a southward acceleration. |
| D) | A body travels with a constant velocity and a time-varying acceleration. |
| E) | A body travels with a constant acceleration and a time-varying velocity. |

Use the following to answer questions 14-16:

An object starts from rest and accelerates uniformly in a straight line in the positive *x* direction.

After 11 seconds, its speed is 70.0 m/s.

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| 14. | Determine the acceleration of the object. | |
| A) | +3.5 m/s2 |
| B) | +6.4 m/s2 |
| C) | –3.5 m/s2 |
| D) | –6.4 m/s2 |
| E) | +7.7 m/s2 |

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| 15. | How far does the object travel during the first 11 seconds? | |
| A) | 35 m |
| B) | 77 m |
| C) | 390 m |
| D) | 590 m |
| E) | 770 m |

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| 16. | What is the *average velocity* of the object during the first 11 seconds? | |
| A) | +3.6 m/s |
| B) | +6.4 m/s |
| C) | +35 m/s |
| D) | +72 m/s |
| E) | –140 m/s |

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| 17. | Ball A is dropped from rest from a window. At the same instant, ball B is thrown downward; and ball C is thrown upward from the same window. Which statement concerning the balls after their release is necessarily true if air resistance is neglected? | |
| A) | At some instant after it is thrown, the acceleration of ball C is zero. |
| B) | All three balls strike the ground at the same time. |
| C) | All three balls have the same velocity at any instant. |
| D) | All three balls have the same acceleration at any instant. |
| E) | All three balls reach the ground with the same velocity. |

Use the following to answer questions 18-20:

A ball is shot straight up from the surface of the earth with an initial speed of 19.6 m/s.

Neglect any effects due to air resistance.

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| 18. | What is the magnitude of the ball's displacement from the starting point after 1.00 second has elapsed? | |
| A) | 9.80 m |
| B) | 14.7 m |
| C) | 19.6 m |
| D) | 24.5 m |
| E) | 58.8 m |

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| 19. | What maximum height will the ball reach? | |
| A) | 9.80 m |
| B) | 14.7 m |
| C) | 19.6 m |
| D) | 24.5 m |
| E) | 58.8 m |

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| 20. | How much time elapses between the throwing of the ball and its return to the original launch point? | |
| A) | 4.00 s |
| B) | 2.00 s |
| C) | 12.0 s |
| D) | 8.00 s |
| E) | 16.0 s |

Use the following to answer question 21:

A tennis ball is shot vertically upward in an *evacuated chamber* inside a tower with an initial speed of 20.0 m/s at time *t* = 0 s.

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| 21. | Determine the velocity of the ball at *t* = 3.00 seconds. | |
| A) | 9.40 m/s, downward |
| B) | 9.40 m/s, upward |
| C) | 29.4 m/s, downward |
| D) | 38.8 m/s, upward |
| E) | 38.8 m/s, downward |

Use the following to answer questions 22-24:

During a one-hour trip, a small boat travels 80.0 km north and then travels 60.0 km east.

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| 22. | What is the boat's displacement for the one-hour trip? | |
| A) | 20 km |
| B) | 100 km |
| C) | 140 km |
| D) | 280 km |
| E) | 10 000 km |

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| 23. | What is the boat's average speed during the one-hour trip? | |
| A) | 20 km/h |
| B) | 100 km/h |
| C) | 140 km/h |
| D) | 280 km/h |
| E) | 10 000 km/h |

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| 24. | What is the magnitude of the boat's average velocity for the one-hour trip? | |
| A) | 20 km/h |
| B) | 100 km/h |
| C) | 140 km/h |
| D) | 10 000 km/h |
| E) | 20 000 km/h |

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| 25. | A football is kicked at an angle ** with respect to the horizontal. Which one of the following statements best describes the *acceleration* of the football during this event if air resistance is neglected? | |
| A) | The acceleration is zero m/s2 at all times. |
| B) | The acceleration is 9.8 m/s2 at all times. |
| C) | The acceleration is zero m/s2 when the football has reached the highest point in its trajectory. |
| D) | The acceleration is positive as the football rises, and it is negative as the football falls. |
| E) | The acceleration starts at 9.8 m/s2 and drops to some constant lower value as the ball approaches the ground. |

Use the following to answer questions 26-31:

A projectile fired from a gun has initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s, respectively.

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| 26. | Determine the initial speed of the projectile. | |
| A) | 40 m/s |
| B) | 50 m/s |
| C) | 60 m/s |
| D) | 70 m/s |
| E) | 80 m/s |

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| 27. | At what angle is the projectile fired (measured with respect to the horizontal)? | |
| A) | 37° |
| B) | 40° |
| C) | 45° |
| D) | 53° |
| E) | 60° |

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| 28. | *Approximately* how long does it take the projectile to reach the highest point in its trajectory? | |
| A) | 1 s |
| B) | 2 s |
| C) | 4 s |
| D) | 8 s |
| E) | 16 s |

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| 29. | What is the speed of the projectile when it is at the highest point in its trajectory? | |
| A) | 0 m/s |
| B) | 20 m/s |
| C) | 30 m/s |
| D) | 40 m/s |
| E) | 50 m/s |

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| 30. | What is the acceleration of the projectile when it reaches its maximum height? | |
| A) | zero m/s2 |
| B) | 9.8 m/s2, downward |
| C) | 4.9 m/s2, downward |
| D) | less than 9.8 m/s2 and non-zero. |
| E) | Its magnitude is 9.8 m/s2;and its direction is changing. |

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| 31. | What is the magnitude of the projectile's velocity just before it strikes the ground? | |
| A) | zero m/s |
| B) | 9.8 m/s |
| C) | 30 m/s |
| D) | 40 m/s |
| E) | 50 m/s |

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| 32. | Which one of the following terms is used to indicate the natural tendency of an object to remain at rest or in motion at a constant speed along a straight line? | |
| A) | velocity |
| B) | inertia |
| C) | acceleration |
| D) | equilibrium |
| E) | force |

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| 33. | A 975-kg car accelerates from rest to 26.7 m/s in a distance of 120 m. What is the magnitude of the average net force acting on the car? | |
| A) | 740 N |
| B) | 2900 N |
| C) | 91 N |
| D) | 1300 N |
| E) | 7900 N |

Use the following to answer questions 34-35:

A physics student in a hot air balloon ascends vertically at constant speed. Consider the following four forces present in this situation:

1 = the weight of the hot air balloon 3 = the force of the student pulling on the earth

2 = the weight of the student 4 = the force of the hot air balloon pulling on the student

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| 34. | Which two forces form an "action-reaction" pair that obeys Newton's third law? | |
| A) | 1 and 2 |
| B) | 2 and 3 |
| C) | 1 and 3 |
| D) | 2 and 4 |
| E) | 3 and 4 |

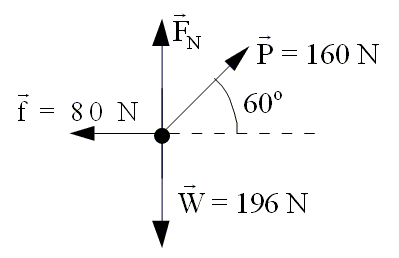
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| 35. | Which one of the following relationships concerning the forces or their magnitudes is true? | |
| A) | *F*4 > *F*2 |
| B) | *F*1 < *F*2 |
| C) | *F*4 > *F*1 |
| D) | 2 = –4 |
| E) | 3 = –4 |

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| 36. | Consider the following forces.  (*1*) frictional (*2*) gravitational (*3*) tension (*4*) strong nuclear (*5*) normal (*6*) electroweak  Which of the forces listed are considered fundamental forces? | |
| A) | *1*, *2*, and *4* |
| B) | *1*, *2*, *3*, and *5* |
| C) | *1*, *3*, and *5* |
| D) | *2*, *4*, and *6* |
| E) | *2*, *3*, *4*, and *6* |

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| 37. | Two point masses *m* and *M* are separated by a distance *d*. If the distance between the masses is increased to 3*d*, how does the gravitational force between them change? | |
| A) | The force will be one-third as great. |
| B) | The force will be one-ninth as great. |
| C) | The force will be three times as great. |
| D) | The force will be nine times as great. |
| E) | It is impossible to determine without knowing the numerical values of *m*, *M*, and *d*. |

Use the following to answer questions 38-39:

A force  pulls on a crate of mass *m* that is in contact with a rough surface. The figure shows the magnitudes and directions of the forces that act on the crate in this situation. represents the weight of the crate.  represents the normal force on the crate, and represents the frictional force.



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| 38. | Which statement best describes the motion of the crate? | |
| A) | The crate must be at rest. |
| B) | The crate must be moving with constant velocity. |
| C) | The crate must be moving with constant acceleration. |
| D) | The crate may be either at rest or moving with constant velocity. |
| E) | The crate may be either at rest or moving with constant acceleration. |

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| 39. | What is the magnitude of , the normal force on the crate? | |
| A) | 57 N |
| B) | 80 N |
| C) | 160 N |
| D) | 196 N |
| E) | 230 N |

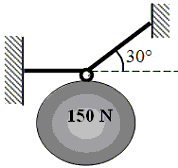
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| 40. | A rock is suspended from a string; and it moves downward at constant speed. Which one of the following statements is true concerning the tension in the string *if air resistance is not ignored?* | |
| A) | The tension is zero newtons. |
| B) | The tension points downward. |
| C) | The tension is equal to the weight of the rock. |
| D) | The tension is less than the weight of the rock. |
| E) | The tension is greater than the weight of the rock. |

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| 41. | A 4-kg block is connected by means of a *massless* rope to a 2-kg block as shown in the figure. Complete the following statement: If the 4-kg block is to begin sliding, the coefficient of static friction between the 4-kg block and the surface must be | |
| A) | less than zero. |
| B) | greater than 2. |
| C) | greater than 1, but less than 2. |
| D) | greater than 0.5, but less than 1. |
| E) | less than 0.5, but greater than zero. |

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| 42. | A block of mass *M* is hung by ropes as shown. The system is in equilibrium. The point O represents the knot, the junction of the three ropes. Which of the following statements is true concerning the magnitudes of the three forces in equilibrium? | |
| A) |  |
| B) |  |
| C) |  |
| D) |  |
| E) |  |

Use the following to answer questions 43-44:

A system of two cables supports a 150-N ball as shown.



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| 43. | What is the tension in the right-hand cable? | |
| A) | 87 N |
| B) | 150 N |
| C) | 170 N |
| D) | 260 N |
| E) | 300 N |

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| 44. | What is the tension in the horizontal cable? | |
| A) | 87 N |
| B) | 150 N |
| C) | 170 N |
| D) | 260 N |
| E) | 300 N |

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| 45. | A woman stands on a bathroom scale in an elevator that is not moving. The scale reads 500 N. The elevator then moves downward at a constant velocity of 5 m/s. What does the scale read while the elevator descends with constant velocity? | |
| A) | 100 N |
| B) | 250 N |
| C) | 500 N |
| D) | 600 N |
| E) | 750 N |