# Review Questions

## Work and Energy

1. A box is pushed at constant speed along a horizontal surface. How does the work done by friction compare to the work done by the applied force?
2. As an object falls with negligible air resistance, what sum is always constant?
3. Can the speed of an object change if the net work done on it is zero?
4. Can the velocity of an object change if the net work done on it is zero?
5. Define power.
6. How are the units for work and energy related to one another?
7. In calculating the dot product of two vectors, what angle is represented by the variable $\theta$?
8. In calculating the dot product of two vectors, what trig function is used?
9. In order to produce a system that could do the same amount of work (as an existing system) in a shorter period of time, what would have to be increased?
10. In the experiment that uses a razor blade to convert a pendulum into a projectile, what two quantities cancel out of the equations?
11. In words, not an equation, what is the definition of work?
12. State the Work/Energy theorem.
13. The tension in the string of a pendulum is always acting on the weight. Why is gravity the only force that does work?
14. Two identical cars under identical conditions (friction, etc.) skid to a stop. One is moving twice as fast as the other. How does the faster car's stopping distance compare to that of the slower car?
15. Two objects have the same mass. One has twice the speed of the other. How is the kinetic energy of the faster object related to the kinetic energy of the other?
16. Two objects have the same speed. One of the objects has twice the mass of the other. How is the kinetic energy of the more massive object related to the kinetic energy of the other?
17. Under what circumstances, if any, can a ball bounce to a height greater than that from which it was dropped? This is an ordinary ball and an ordinary bounce.
18. What are the two conservative forces that we have used so far?
19. What effect does negative work generally have on the kinetic energy of an object?
20. What effect does positive work generally have on the kinetic energy of an object?
21. What is definition of efficiency in a mechanical system?
22. What is mechanical potential energy?
23. What is power?
24. What is the difference between the dot product and the cross product of two vectors?
25. What is the formula for calculating the kinetic energy of an object that is moving linearly?
26. What is the formula for calculating the work done by or against a spring?
27. What is the formula for calculating the work done by or against gravity?
28. What is the general formula for calculating the work done by a constant force?
29. What is the only non-conservative force that we have used in our problems?
30. What is the standard metric unit for energy? Express this unit in fundamental units (some combination of kilograms, meters, seconds, etc.)
31. What is the standard metric unit for work? Express this unit in fundamental units (some combination of kilograms, meters, seconds, etc.)
32. What is the work/energy theorem?
33. When a ball is thrown straight up, at what position is its gravitational potential energy at its maximum?

34. When a ball is thrown straight up, at what position is its gravitational potential energy at its minimum?
35. When a ball is thrown straight up, at what position is its kinetic energy at its maximum?
36. When a ball is thrown straight up, at what position is its kinetic energy at its minimum?
37. When a conservative force does negative work, what happens to the energy?
38. When a non-conservative force does negative work, what happens to the energy?
39. When an object moves along a plane, why does the normal force do no work?
40. When friction does work, what is usually the angle between the force and the displacement?
41. When negative work is done by a conservative force, what is increased?
42. When negative work is done by a non-conservative force, what is increased?
43. When negative work is done on an object, what normally decreases?
44. When positive work is done on an object, what normally increases?
45. Why does kinetic friction always do negative work on at least one of the objects?
46. Explain this equation: $\Sigma W = \Delta K$ .
47. Give the formula for calculating the potential energy stored in a spring.
48. When a non-conservative force does negative work, what is increased?
49. What is the formula for calculating an object's momentum?
50. What is the formula for calculating an object's kinetic energy?
51. What is the formula for calculating the work done by or against gravity?
52. When a conservative force does negative work, what increases?
53. In the formula $W = Fd\cos\theta$, what is θ?
54. What is Hooke's Law? – Give the formula.

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# One Dimensional Motion

55. What is the symbol used to express the acceleration due to gravity?
56. What must be negligible for an object to be in "free fall?"
57. What is the acceleration of an object if its position as a function of time is $x = 22 - 6t + 4t^2$? All units are SI (standard metric.)
58. What is the initial velocity of an object if its position as a function of time is $x = 22 - 6t + 4t^2$? All units are SI (standard metric.)
59. What is the acceleration of an object if its velocity as a function of time is $v = -45 - 2.2t$? All units are SI (standard metric.)
60. What is the acceleration of an object in "free fall?"
61. What must be the effect of air resistance for an object to be in "free fall?"
62. State one circumstance in which a motion problem must be divided into at least two parts. That is: two complete sets of values for position, velocity, acceleration and time.
63. Explain why the fall of a bowling ball from a height of 2 m can be considered "free fall" while the motion of a Styrofoam peanut from the same height is not.
64. State the three equations that have been given in class that can be used to solve our kinematics problems.

    x =

    v =

    v2 =

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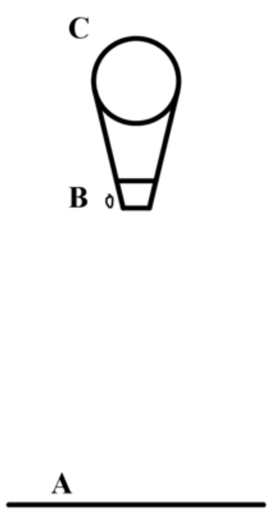
The following table of values describes the motion of a sandbag after it is dropped from a hot air balloon that is moving vertically at a constant rate. The location of the origin and the positive direction have already been decided. The numbers in the table refer to the motion of the sandbag from the time it is released until it reaches the ground. The ground is considered stationary (not the balloon.) Point A is at the ground. Point B is the point where the sandbag is released. Point C is the location of the top of the balloon when the sandbag is released.

| | |
|---|---|
| $\mathbf{x}_0$ | 0 |
| **x** | h |
| $\mathbf{v}_0$ | -2.5 m/s |
| **v** | v |
| **a** | g |
| *t* | 22.0 s |




65. Where is the origin for this problem (point A, B or C)?
66. What direction is positive (up or down)?

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67. In straight line motion, what is the relationship between velocity and acceleration when speed is decreasing?
68. In straight line motion, what is the relationship between velocity and acceleration when speed is increasing?
69. In straight line motion, the choice of a line, its origin and the positive direction constitutes the definition of what?
70. What is the physical significance of a negative value in regard to motion?
71. An object has an initial position of 3.5 m along the x axis, it is initially moving in the negative direction at 4.5 m/s and has a constant acceleration of 1.8 m/s$^2$ in the positive direction. Write the equation for position as a function of time.

72. An object has an initial position of 3.5 m along the x axis, it is initially moving in the negative direction at 4.5 m/s and has a constant acceleration of 1.8 $m/s^2$ in the positive direction. Write the equation for velocity as a function of time.

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73. What is numerically equal to the area under the velocity graph?
74. What is the name given to the slope of the displacement graph?
75. How is the instantaneous velocity of an object determined from the graph of its position?
76. How is the change in position of an object determined from the graph of its velocity?
77. Suppose the equation: $x = 2.5t^3$ describes the motion of an object over time. Why is it clear that this equation DOES NOT represent the motion of an object undergoing "uniform acceleration"?

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A coin is tossed vertically upward.

78. The effect of the air is negligible, what happens to its velocity while it is in the air?
79. The effect of the air is negligible, does its acceleration increase, decrease, or remain constant while it is in the air?

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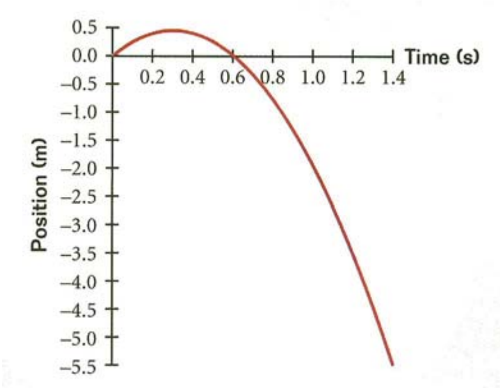
80. A ball is thrown vertically upward. What are its velocity and acceleration when it reaches its maximum altitude? What is its acceleration just before it hits the ground?
81. Two children are bouncing small rubber balls. One child simply drops a ball. At the same time, the second child throws a ball downward so that it has an initial speed of 10 m/s. What is the acceleration of each ball while in motion?
82. A gymnast practices two dismounts from the high bar on the uneven parallel bars. During one dismount, she swings up off the bar with an initial upward velocity of + 4.0 m/s. In the second, she releases from the same height but with an initial velocity of -3.0 m/s. How do the final velocities of the gymnast as she reaches the ground differ? What is her acceleration in each case?
83. The figure is a position-time graph of the straight-line motion of a basketball. Use the graph to sketch a velocity-time graph of the basketball's motion. a.) Is the velocity of the basketball constant? b.) Is the acceleration of the basketball constant? c.) What is the initial velocity of the basketball?

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# Two Dimensional Motion and Projectiles

84. What is the vertical component of a projectile's velocity when it is at the very top of its trajectory?
85. In solving projectile problems, occasionally there are two values for time resulting from the use of the quadratic formula. Why?
86. Why does the quadratic formula occasionally result in a negative value for time?
87. When solving for time with the quadratic formula, there are always two values for time. When they are both positive, how is the correct value chosen?

# Review Questions

88. A ball is thrown with an initial speed of 12.5 m/s at an angle of 35.5° from the horizontal. What is the formula used to calculate the horizontal component of the initial velocity?
89. A ball is thrown with an initial speed of 12.5 m/s at an angle of 35.5° from the horizontal. What is the formula used to calculate the vertical component of the initial velocity?
90. What is the acceleration of any projectile?
91. What must be negligible in order for an object to be considered a projectile?
92. What is the horizontal component of a projectile's acceleration in a standard x – y coordinate system?
93. What is the vertical component of a projectile's acceleration in a standard x – y coordinate system?
94. When an object is dropped, what is its initial velocity?
95. When a ball is thrown, at what point (in time) does it become a projectile?
96. When a cannon ball is fired, at what point (in time) does it become a projectile?
97. Why is a rocket NOT considered a projectile?
98. What is the difference between **d** in $\mathbf{d} = \mathbf{d}_0 + \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$ and $d$ in ($d$, $\theta_d$)?
99. What is the relationship among these three equations: $\mathbf{d} = \mathbf{d}_0 + \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$ , $x = x_0 + v_{0x}t + a_x t^2$ and $y = y_0 + v_{0y}t + a_y t^2$ ?
100. How is $v_x$ related to $v$?
101. Why do bullets seem not to fall while they travel?
102. In projectile motion when an object lands at the same elevation as it started ($y = y_0$), there are two angles that result in the same range (horizontal distance). How are these angles related?
103. In projectile motion when an object lands at the same elevation as it started ($y = y_0$), how are the initial and final speeds related?
104. What angle for the initial velocity will give a projectile the greatest range (horizontal distance)?

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# RELATIVE VELOCITY

105. When a person is driving a car at 28.5 m/s north relative to Philadelphia, what is the velocity of Philadelphia relative to the person?
106. In the vector equation $\mathbf{V}_{\mathbf{AB}} = -\mathbf{V}_{\mathbf{BA}}$, what do A and B represent?
107. Write the relative velocity equation that relates the velocities of three objects.
108. A swimmer wishes to cross a stream that has a relatively swift current. If the swimmer wishes to cross in the shortest amount of time, in what direction should (s)he swim relative to the river bank?
109. When we describe the motion of most objects, what is our usual frame of reference? In other words: what is the object that the motions of all other objects are described relative to?
110. What is meant by the equation: $\mathbf{V}_{\mathbf{AB}} = -\mathbf{V}_{\mathbf{BA}}$ ?
111. In relative velocity problems involving a boat moving across a river, what, in general, are the three objects whose relative velocities are considered?
112. In relative velocity problems involving the navigation of airplanes, what, in general, are the three objects whose velocities are considered?
113. When swimming or rowing across flowing water. What direction should one head if (s)he desires to make the crossing in the shortest time?
114. When a person wishes to move directly across flowing water, (s)he heads somewhat up-stream. When does it become impossible to move directly across?

115. When describing the flight of an aircraft, one of the velocities is frequently described as “air speed” and “heading.” These two quantities are the magnitude and direction of which vector?
116. Keeping to the convention that East is 0º, what is the degrees measure of the direction of a wind out of the northwest?
117. Keeping to the convention that East is 0º, what is the degrees measure of the direction of a wind out of the south?
118. A boat traveling at 4.0 m/s relative to the water in a river is encountering a current whose velocity is 1.5 m/s. What is the lowest speed the boat could have relative to the land?
119. A boat traveling at 4.0 m/s relative to the water in a river is encountering a current whose velocity is 1.5 m/s. What is the highest speed the boat could have relative to the land?

# Newton’s Laws of Motion

120. State Newton’s Third Law of Motion.
121. In SI, what are the units for the coefficient of static friction ($\mu_s$)?
122. What is the formula for calculating the maximum possible static friction using coefficient of friction and the normal force?
123. What is the direction of kinetic friction?
124. What is the formula for calculating kinetic friction?
125. What is the direction of static friction?
126. Define normal force.
127. Give an example of a situation where the normal force is not equal to an object’s weight and explain the example.
128. When choosing a coordinate system, what physical quantity should be made to lie on an axis?
129. An object of mass *m* rests on a plane whose angle of inclination is θ, what expression is used to calculate the component of the object’s weight that is perpendicular to the plane?
130. An object of mass *m* rests on a plane whose angle of inclination is θ, what expression is used to calculate the component of the object’s weight that is parallel to the plane?
131. An object is supported by a rope and is moving upward with a constant speed. How does the tension in the rope compare to its weight? (greater than, equal to, less than, not enough information given)
132. An object is supported by a rope and is moving downward with a constant speed. How does the tension in the rope compare to its weight? (greater than, equal to, less than, not enough information given)
133. An object is supported by a rope and is accelerating downward. How does the tension in the rope compare to its weight? (greater than, equal to, less than, not enough information given)
134. An object is supported by a rope and is accelerating upward. How does the tension in the rope compare to its weight? (greater than, equal to, less than, not enough information given)
135. An object having a mass m is resting on a table. What is the Newton’s Third Law reaction force that corresponds to its weight?
136. An object having a mass m is resting on a table. What is the Newton’s Third Law reaction force that corresponds to the normal force that the table exerts on it?
137. An object having a mass m is resting on plane whose angle of inclination is θ. What is the Newton’s Third Law reaction force that corresponds to the normal force that the plane exerts on it?
138. An object having a mass m is resting on plane whose angle of inclination is θ. What is the Newton’s Third Law reaction force that corresponds to the weight of the object?
139. Draw a free body diagram for an object on a horizontal surface that is accelerating to the right as a result of a force applied to it horizontally. Include friction.
140. Draw a free body diagram for an object resting on an inclined plane. Include friction.
141. State the equation for Newton’s Second Law of Motion.

# Review Questions

142. Newton's First Law of Motion is a special case of what other law?
143. Why does the coefficient of friction (μ) have no units?
144. In terms of forces, what does "equilibrium" mean?
145. What is the weight of an object of mass *m* when it is in free fall?
146. Give an expression for the gravitational force exerted by the earth on an object of mass *m* when it is being held up by a rope attached to the ceiling.
147. List the currently identified "four fundamental forces in nature."
148. When a bullet which has a relatively small mass and a high speed, hits a target having a large mass and a zero velocity, which object experiences the larger force?
149. What force causes the acceleration of a car regardless of whether the car's speed is increasing or decreasing or the direction of its motion is changing?
150. What is the name given to a diagram that is used to isolate an object and analyze the forces acting on it?
151. An elevator contains a person who is standing on a bathroom scale. If the elevator is rising and accelerating upward, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
152. An elevator contains a person who is standing on a bathroom scale. If the elevator is rising and slowing down, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
153. An elevator contains a person who is standing on a bathroom scale. If the elevator is rising at a constant speed, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
154. An elevator contains a person who is standing on a bathroom scale. If the elevator is descending and accelerating downward, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
155. An elevator contains a person who is standing on a bathroom scale. If the elevator is descending and slowing down, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
156. An elevator contains a person who is standing on a bathroom scale. If the elevator is descending at a constant speed, how does the reading on the scale compare to the person's weight? (greater than, equal to, less than, not enough information given)
157. What is the name given to the force that one surface exerts on another and that is '*perpendicular'* (sic) to both surfaces?
158. What is the name given to the force that one surface exerts on another and that is "*parallel"* to the two surfaces?
159. A person is standing on a bathroom scale inside an elevator that is accelerating upward. What actual force exerted by what object is called the person's "apparent weight"?
160. A person is standing on the floor of an elevator that is accelerating downward. What actual force exerted by what object is called the person's "apparent weight"?
161. A light fixture is hanging from a chain on the ceiling of an elevator that is accelerating upward. What actual force exerted by what object is called the fixture's "apparent weight"?
162. An astronaut is in a seat in the crew cabin at the top of a rocket that is accelerating upward very rapidly. What actual force exerted by what object is called the astronaut's "apparent weight"?

163. Which of Newton's Laws can be expressed in this way: "If a net force acts on a body, it will cause and acceleration of that body. That acceleration is in the direction of the net force, and its magnitude is proportional to the net force and inversely proportional to the mass of the body."?
164. When an object slides down an inclined plane, what force exerted on the object prevents it from falling vertically downward?

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# Momentum

165. What is the formula for calculating an object's momentum?
166. Kinetic energy and momentum are both calculated from an object's mass and velocity. What is the major difference between the two quantities?
167. Define the term: "perfectly elastic collision".
168. Define the term "perfectly inelastic collision"
169. In terms of momentum problems, what is the <u>*reverse*</u> of a perfectly inelastic collision?
170. What type of energy is conserved only in perfectly elastic collisions?
171. Which one of Newton's Three Laws of Motion is most directly connected to the Law of Conservation of Momentum?
172. There are some collisions in nature that can be considered <u>**perfectly**</u> elastic. What are they?
173. What is the **physical** (not mathematical) meaning of the term *impulse*?
174. Give the formula that relates force, time and momentum.
175. In perfectly elastic collisions, two physical quantities are conserved. What are they?
176. In inelastic collisions, one physical quantity is conserved and at least one is not. What quantity <u>***that is***</u> conserved in perfectly elastic collisions <u>***is not***</u> conserved in inelastic collisions?
177. What happens in a collision that makes it more than inelastic but "perfectly" inelastic?
178. What is the meaning of the term "system?"
179. The location of an object's center of mass is determined by calculating what kind of an average?
180. When a spring or explosion causes two objects with different masses to move apart, which object acquires more kinetic energy? (the more massive object, the less massive object, both objects acquire the same amount of kinetic energy)
181. When a spring or explosion causes two objects with different masses to move apart, which object acquires more momentum? (the more massive object, the less massive object, both objects acquire the same amount of momentum)
182. What relatively large object accounts for changes in momentum that appear to be unbalanced like cars starting and stopping or a rock gaining momentum as it falls?

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# MEASUREMENT and UNITS

183. What is the definition of a "unit"?
184. What is the meaning of the term "standard" when used to define a unit?
185. What general class of numbers do not have units?
186. How many fundamental physical quantities (or base units) exist?
187. What can be said about the units for physical quantities that are not fundamental?
188. Why have the base units and their definitions been changed over the years?
189. What two basic arithmetic operations cannot be carried out with quantities that have different units?
190. What two basic arithmetic operations can be carried out with quantities that have different units?
191. What is the SI unit for pure ratios?
192. Define accuracy.
193. Define precision.
194. In terms of accuracy and precision, which can usually be improved by adjusting the instrument or the technique?

# Review Questions

195. In terms of accuracy and precision, which usually requires additional expense to improve?
196. When writing measured and calculated values, what will we most frequently use to indicate the precision of the number?
197. What determines the number of significant figures in a number calculated by multiplication or division?
198. What determines the number of significant figures in a number calculated by addition or subtraction?
199. When doing a unit conversion, it is essential to multiply by a ratio that is equal to what?
200. Force expressed in newtons (kg•m/$s^2$) is divided by speed expressed in m/s. In what units must the result be expressed?
201. What three base units will be used to derive all others in the study of mechanics?
202.

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203. Explain the relationship between precision and significant figures.
204. As an alternative to significant figures, how is the precision of a number indicated?
205. Suppose the equation: $x = 2.5t^3$ describes the motion of an object over time. If x is in meters and t is in seconds, what are the units of the coefficient 2.5?
206. Which is a better indication of precision – significant figures or tolerance? Why?
207. What is the metric prefix used to represent the multiplier $10^{-9}$? Give both the symbol (one letter – Greek or English) and the name (phonetic spelling).
208. Which is meaningless without the other when making measurements: accuracy or precision?
209. What unit is the same in all three common measurement systems (English, SI, cgs) and what physical quantity is it used to measure?

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# Gravity and Kepler's Laws

210. Parabolas, hyperbolas, ellipses and circles are all in what mathematical category?
211. What formula is used to calculate the force of gravitational attraction between any two objects?
212. How does the mass of a satellite effect its orbit?
213. What ratio relating orbital radius and orbital period is a constant for every object orbiting the sun?
214. What supplies the centripetal force for all orbiting objects?
215. What is most common shape of the orbits of planets, moons and satellites?
216. What expression is multiplied by an object's mass in order to determine the Kepler's law constant for the object?
217. What units must be used for r and T respectively when doing Kepler's law calculations? Why?
218. What great circle is every satellite in a geosynchronous orbit directly above?
219. What point does every earth satellite, including the moon, orbit around?
220. How is the speed of a satellite in a high orbit related to the speed of a satellite in a lower orbit around the same planet? (greater than, less than, the same as, not enough information given)
221. What would be the acceleration due to gravity inside of a hollow planet?
222. If the earth's radius is R and a particular object weighs 80 N on the surface of the earth, what would the object weigh if it is moved to a height R above the surface of the earth? (This question does not require a calculator.)
223. What would be the force of gravity (from the earth) acting on a 1.00 kg object if it could be placed at the center of mass of the earth? (This question does not require a calculator.)

224. What ratio is this expression equal to: $\frac{G}{4\pi^2} m_p$ ?
225. What is meant by the term “center of mass”?

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226. How is the gravitational potential energy of an object at the surface of the earth related to its escape velocity?
227. At what distance from the earth is the gravitational potential energy considered to be zero?
228. How is the gravitational potential energy of an object at the surface of the earth related to its escape velocity?
229. What formula is used to calculate the gravitational potential energy of an object relative to the center of mass of another object?
230. What is Kepler’s first law of planetary motion?
231. What is Kepler’s second law of planetary motion?
232. What is Kepler’s third law of planetary motion?
233. How is the Kepler’s law constant calculated for a planet or star?
234. What great circle lies on the ground directly below the orbit of every satellite in a geosynchronous (aka: geostationary) orbit?