SKILL LIST WHOLE YEAR

Unit 1: Intro to Physics and Constant Velocity	Unit 2: Accelerated Motion	Unit 3: Dynamics	Unit 4: Energy	Unit 5: Electricity and Magnetism	Unit 6: Modern Physics and Waves
Translating between standard, scientific and metric notation [Skill 1]	Defining uniform acceleration. Kinematics Graphs [Skill 12]	Newton's Laws [Skill 20] 1st – Inertia 2nd - Fnet=ma (J=Δp) 3rd – force pairs	Kinetic Energy; Potential Energy (gravitational); Potential Energy (Elastic) [Skill 28]	Charge distribution -Electron transfer [Skill 33]	Particles and the Fundamental Forces [Skill 47] (Quarks, Leptons, Bosons) Strong, EM, Weak, Gravity
Estimating Metric Values [Skill 2]	Quantitative Problems [Skill 13] $v_f=v_i+at \quad v_f^2=v_i^2+2ad$ $d=v_it+\frac{1}{2}at^2$	Rules for force vectors (Resultant and Equilibrant) [Skill 21]	Energy Work-Theorem $\Delta E=W=Fd=1/2mv^2=mgh=\frac{F_s x}{2}$ [Skill 29]	Quantifying Charge $1e=1.6 \times 10^{-19}C$ [Skill 34]	Describing Waves [Skill 48] λ, f, T,v
Factor Label Method (Dimensional Analysis) [Skill 3]	Dropped Objects [Skill 14] $v_{iy}=0 \quad h=1/2gt^2 \quad t=\sqrt{2gh}$	Horizontal, Vertical and Inclined Planes [Skill 22]	Mechanical Power $P=\frac{W}{t}=\frac{Fd}{t}=F\bar{v}$ [Skill 30]	Coulomb's Law [Skill 35] $F_e=k\frac{q_1q_2}{r^2}$	Wave Phases [Skill 49]
Scalar vs. Vector [Skill 4]	Objects Launched upward v at top equals zero, a=g [Skill 15]	Coefficient of friction [Skill 23] $\mu=\frac{F_f}{F_N}$	Conservation of Energy E_T=KE+PE (+Q) [Skill 31]	Field Lines and Fe between plates –arrow away from + [Skill 36]	Mechanical Waves [Skill 50] -Need medium, Energy related to Amplitude
Combining vectors in 1 dimension (ie parallel vectors) [Skill 5]	Horizontal Projectiles x-axis a=0 (constant v in x) y-axis $a=9.8m/s^2$ (constant a in y) [Skill 16]	Spring Force (Hooke's Law) $F_s=kx$ [Skill 24]	Work done by friction (Internal Energy) $Q=E_T$-(KE +Q) [Skill 32]	Electrical Energy [Skill 37] W=Vq Potential Difference V=W/q V=IR	EM Waves –photons [Skill 51] -can move through vacuum, $v=c=3x10^8m/s$, transverse -created by oscillating charge
Position vs. time graphs [Skill 6]	Objects launched at an angle [Skill 17] $v_{ix}=v_i\cos\Theta \quad v_{iy}=v_i\sin\Theta$	Centripetal motion vectors Centripetal motion equations $a_c=\frac{v^2}{r} \quad F_c=ma_c \quad F_c=\frac{mv^2}{r}$ [Skill 25]		Current I =q/t Amperes = C/s [Skill 38]	Wave Phenomena: [Skill 52] Reflection, Refraction, Diffraction, Polarization
Graphical addition of vectors (Head to tail, Tail to Tail) [Skill 7]	Relationship between angle and path [Skill 18] Max range (d_x) 45 degrees Max time (d_y) highest angle	Universal Gravitation $F_g=G\frac{m_1m_2}{r^2}$ [Skill 26]		Resistance [Skill 39] $R=\frac{\rho L}{A}=\frac{\rho L}{\pi r^2}$ R=V/I	Wave Phenomena: Interference, Standing Waves, Resonance, Double Slit Experiment [Skill 53]
Vector equations [Skill 8] $A_x=A\cos\theta \quad : \quad A_y=A\sin\theta$ $A=\sqrt{A_x^2+A_y^2} : \theta=\tan^{-1}\frac{A_y}{A_x}$	Graphical Relationships -NO RELATIONSHIP, DIRECT, DIRECT SQUARE. SQUARE ROOT [Skill 19]	Conservation of Momentum $P_{before}=P_{after}$ [Skill 27]		Ohm's Law [Skill 40] V=IR	Doppler Effect Red shift, blue shift [Skill 54]
Velocity/speed equation [Skill 9] v=d/t d=vt (DIRECT RELATIONSHIPS)				Power Law and energy in a circuit [Skill 41] Circuit elements and symbols [Skill 42]	Law of Reflection [Skill 55]
Concurrent velocity vectors [Skill 10]				Series Circuits [Skill 43] Constant current Ammeters and Voltmeters	Snell's Law $n_1\sin\Theta_1=n_2\sin\Theta_2$ [Skill 56]
Representing constant velocity on a graph Displacement from a velocity vs time graph or from velocity vectors. [Skill 11]				Parallel Circuits [Skill 44] Constant voltage Ammeters and Voltmeters	Energy or a photon [Skill 57] $E_{photon}=hf=\frac{hc}{\lambda}$
				Junction Rule [Skill 45] Current In=Current out	Energy-Mass Equivalence $E=mc^2$ [Skill 58]
				Magnetic Fields [Skill 46] Away from north Moving charges	

Name _____

Regents Review Skills

127. One car travels 40. meters due east in 5.0 seconds, and a second car travels 64 meters due west in 8.0 seconds. During their periods of travel, the cars definitely had the same (Skill 9, 16)

A) average velocity
B) total displacement
C) total distance
D) average speed

128. As a cart travels around a horizontal circular track, the cart *must* undergo a change in (Skill 12, 25)

A) velocity B) inertia
C) speed D) weight

129. Two stones, *A* and *B*, are thrown horizontally from the top of a cliff. Stone *A* has an initial speed of 15 meters per second and stone *B* has an initial speed of 30. meters per second. Compared to the time it takes stone *A* to reach the ground, the time it takes stone *B* to reach the ground is (Skill 16)

A) the same
B) twice as great
C) half as great
D) four times as great

130. An object is dropped from rest and falls freely 20. meters to Earth. When is the speed of the object 9.8 meters per second? (Skill 14)

A) during the entire first second of its fall
B) at the end of its first second of fall
C) during its entire time of fall
D) after it has fallen 9.8 meters

131. Cart *A* has a mass of 2 kilograms and a speed of 3 meters per second. Cart *B* has a mass of 3 kilograms and a speed of 2 meters per second. Compared to the inertia and magnitude of momentum of cart *A*, cart *B* has (Skill 20, 27)

A) the same inertia and a smaller magnitude of momentum
B) the same inertia and the same magnitude of momentum
C) greater inertia and a smaller magnitude of momentum
D) greater inertia and the same magnitude of momentum

132. If the speed of a moving object is doubled, which quantity associated with the object must also double? (Skill 19, 29, 28)

A) its momentum
B) its kinetic energy
C) its acceleration
D) its gravitational potential energy

133. Which quantity has both a magnitude and a direction? (Skill 4, 28, 30, 20)

A) energy B) impulse
C) power D) work

134. A 1.0-kilogram laboratory cart moving with a velocity of 0.50 meter per second due east collides with and sticks to a similar cart initially at rest. After the collision, the two carts move off together with a velocity of 0.25 meter per second due east. The total momentum of this frictionless system is (Skill 27)

A) zero before the collision
B) zero after the collision
C) the same before and after the collision
D) greater before the collision than after the collision

135. A rock is thrown straight up into the air. At the highest point of the rock's path, the magnitude of the net force acting on the rock is (Skill 15)

A) less than the magnitude of the rock's weight, but greater than zero
B) greater than the magnitude of the rock's weight
C) the same as the magnitude of the rock's weight
D) zero

136. Which situation represents a person in equilibrium? (Skill 20

A) a child gaining speed while sliding down a slide
B) a woman accelerating upward in an elevator
C) a man standing still on a bathroom scale
D) a teenager driving around a corner in his car

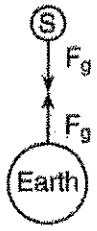
137. A carpenter hits a nail with a hammer. Compared to the magnitude of the force the hammer exerts on the nail, the magnitude of the force the nail exerts on the hammer during contact is (Skill 20)

A) less
B) greater
C) the same

138. Which diagram best represents the gravitational forces, F_g, between a satellite, S, and Earth? (Skill 26)

A)


B)


C)


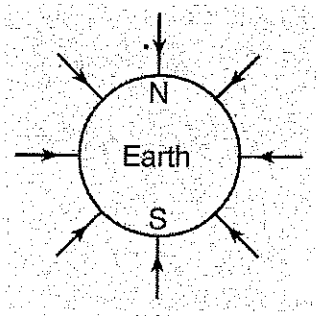
D)


139. Gravitational forces differ from electrostatic forces in that gravitational forces are (Skill 26, 35)

A) attractive, only
B) repulsive, only
C) neither attractive nor repulsive
D) both attractive and repulsive

140. In which diagram do the field lines best represent the gravitational field around Earth? (Skill 26)

A)



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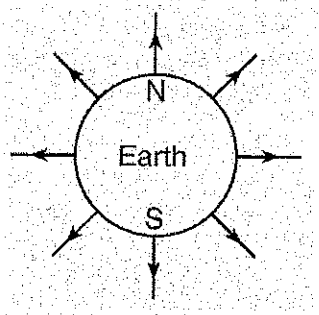
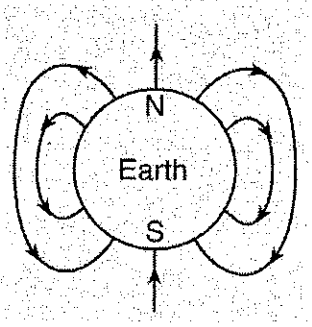


C)



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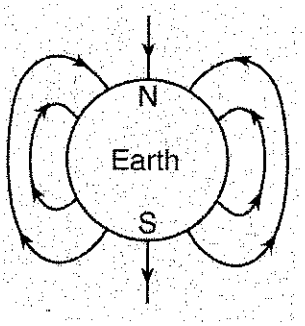


141. A person weighing 785 newtons on the surface of Earth would weigh 298 newtons on the surface of Mars. What is the magnitude of the gravitational field strength on the surface of Mars? (Skill 20,22)

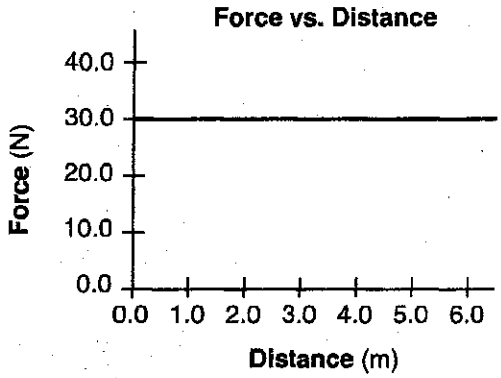
A) 2.63 N/kg
B) 3.72 N/kg
C) 6.09 N/kg
D) 9.81 N/kg

142. As an astronaut travels from the surface of Earth to a position that is four times as far away from the center of Earth, the astronaut's (Skill 20,22)

A) mass decreases
B) mass remains the same
C) weight increases
D) weight remains the same

143. Base your answer to the following question on the information below.

A boy pushes his wagon at constant speed along a level sidewalk. The graph below represents the relationship between the horizontal force exerted by the boy and the distance the wagon moves. (Skill 28, 32)



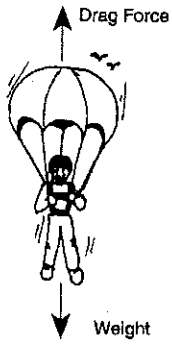
As the boy pushes the wagon, what happens to the wagon's energy?

A) Gravitational potential energy increases.
B) Gravitational potential energy decreases.
C) Internal energy increases.
D) Internal energy decreases.

144. A box is pushed toward the right across a classroom floor. The force of friction on the box is directed toward the (Skill 22,23)

A) left
B) right
C) ceiling
D) floor

145. In the diagram below, the upward drag force acting on a parachute is equal in magnitude but opposite in direction to the weight of the parachutist and equipment.



As a result of the forces shown, the parachutist may be moving (Skill 20,21,22)

A) downward with decreasing speed
B) downward at constant speed
C) upward with decreasing speed
D) upward with constant acceleration

146. A car's performance is tested on various horizontal road surfaces. The brakes are applied, causing the rubber tires of the car to slide along the road without rolling. The tires encounter the greatest force of friction to stop the car on (Skill 23)

A) dry concrete B) dry asphalt
C) wet concrete D) wet asphalt

147. Compared to the force needed to start sliding a crate across a rough level floor, the force needed to keep it sliding once it is moving is (Skill 23)

A) less B) greater
C) the same

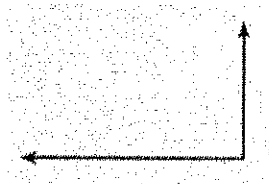
148. As more force is applied to a steel box sliding on a steel surface, the coefficent of kinetic friction will (Skill 23)

A) decrease B) increase
C) remain the same

149. Two 20.-newton forces act concurrently on an object. What angle between these forces will produce a resultant force with the greatest magnitude? (Skill 21)

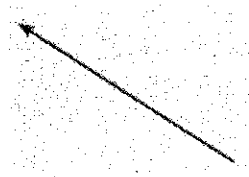
A) 0° B) 45°
C) 90.° D) 180.°

150. The diagram below represents two concurrent forces. (Skill 21)



Which vector represents the force that will produce equilibrium with these two forces?

A)



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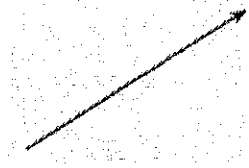
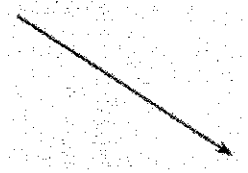


C)

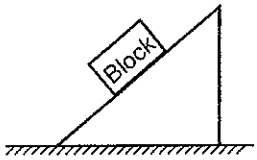


D)

151. As the angle between two concurrent forces decreases, the magnitude of the force required to produce equilibrium (Skill 21)

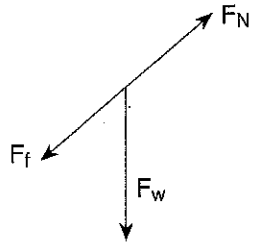
A) decreases
B) increases
C) remains the same

152. The diagram below represents a block at rest on an incline.

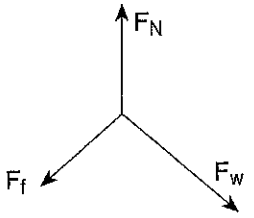


Which diagram best represents the forces acting on the block? (F_f = frictional force, F_N = normal force, and F_w = weight.) (Skill 22)

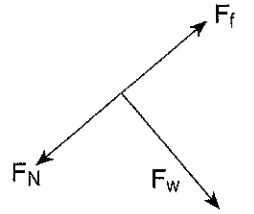
A)



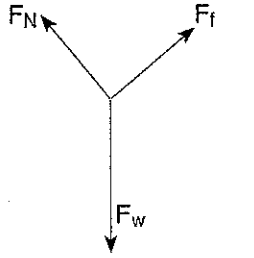
B)



C)



D)

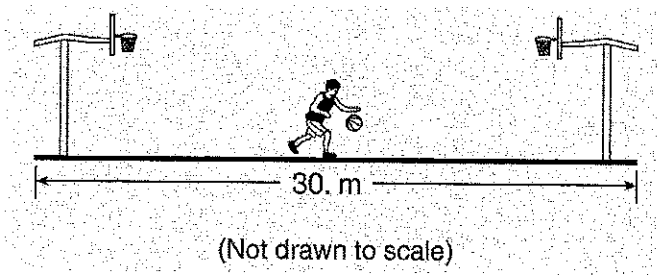


153. Which term identifies a scalar quantity? (Skill 4+)

A) displacement B) momentum
C) velocity D) time

154. Base your answer to the following question on the information below.

In a drill during basketball practice, a player runs the length of the 30.-meter court and back. The player does this three times in 60. seconds.



The magnitude of the player's total displacement after running the drill is (Skill 4, 5)

A) 0.0 m B) 30. m C) 60. m D) 180 m

155. If the speed of a moving object is doubled, the kinetic energy of the object is (Skill 28)

A) halved B) doubled
C) unchanged D) quadrupled

156. When a teacher shines light on a photocell attached to a fan, the blades of the fan turn. The brighter the light shone on the photocell, the faster the blades turn. Which energy conversion is illustrated by this demonstration? (Skill 57, 28)

A) light → thermal → mechanical
B) light → nuclear → thermal
C) light → electrical → mechanical
D) light → mechanical → chemical

157. As a bullet shot vertically upward rises, the kinetic energy of the bullet (Skill 28)

A) decreases
B) increases
C) remains the same

158. Which statement describes the kinetic energy and total mechanical energy of a block as it is pulled at constant speed up an incline? (Skill 28, 31)

A) Kinetic energy decreases and total mechanical energy increases.
B) Kinetic energy decreases and total mechanical energy remains the same.
C) Kinetic energy remains the same and total mechanical energy increases.
D) Kinetic energy remains the same and total mechanical energy remains the same.

159. The gravitational potential energy, with respect to Earth, that is possessed by an object is dependent on the object's (Skill 28)

A) acceleration B) momentum
C) position D) speed

160. As friction slows a cart moving along a horizontal surface, the gravitational potential energy of the cart (Skill 28)

A) decreases
B) increases
C) remains the same

161. The potential energy stored in a compressed spring is to the change in the spring's length as the kinetic energy of a moving body is to the body's (Skill 28)

A) speed B) mass
C) radius D) acceleration

162. Which action would require no work to be done on an object? (Skill 28,29)

A) lifting the object from the floor to the ceiling
B) pushing the object along a horizontal floor against a frictional force
C) decreasing the speed of the object until it comes to rest
D) holding the object stationary above the ground

163. When a force moves an object over a rough, horizontal surface at a constant velocity, the work done against friction produces an increase in the object's (Skill 32)

A) weight B) momentum
C) potential energy D) internal energy

164. The watt•second is a unit of (Skill 28,39,41)

A) power
B) energy
C) potential difference
D) electric field strength

165. Which quantity is a measure of the rate at which work is done? (Skill 30, 41)

A) energy B) power
C) momentum D) velocity

166. Student *A* lifts a 50.-newton box from the floor to a height of 0.40 meter in 2.0 seconds. Student *B* lifts a 40.-newton box from the floor to a height of 0.50 meter in 1.0 second. Compared to student *A*, student *B* does (Skill 29, 30)

A) the same work but develops more power
B) the same work but develops less power
C) more work but develops less power
D) less work but develops more power

167. Two elevators, *A* and *B*, move at constant speed. Elevator *B* moves with twice the speed of elevator *A*. Elevator *B* weighs twice as much as elevator *A*. Compared to the power needed to lift elevator *A*, the power needed to lift elevator *B* is (Skill 30)

A) the same
B) twice as great
C) half as great
D) four times as great

168. The work done in accelerating an object along a frictionless horizontal surface is equal to the change in the object's (Skill 29)

A) momentum B) velocity
C) potential energy D) kinetic energy

169. A force is applied to a block, causing it to accelerate along a horizontal, frictionless surface. The energy gained by the block is equal to the (Skill 29)

A) work done on the block
B) power applied to the block
C) impulse applied to the block
D) momentum given to the block

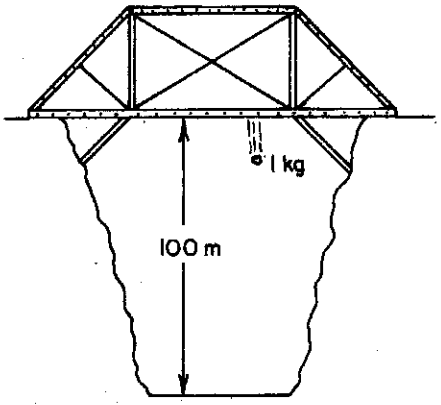
170. As a pendulum moves from the bottom of its swing to the top of its swing, the (Skill 28, 31)

A) kinetic energy of the pendulum increases
B) kinetic energy of the pendulum remains the same
C) potential energy of the pendulum decreases
D) potential energy of the pendulum increases

171. **This question has only three choices.** As a ball falls freely toward the ground, its total mechanical energy (Skill 31)

A) decreases
B) increases
C) remains the same

172. Base your answer to the following question on the diagram below which shows a 1-kilogram stone being dropped from rest from a bridge 100 meters above a gorge.



As the stone falls, the gravitational potential energy of the stone (Skill 31)

A) decreases
B) increases
C) remains the same

173. As an object falls freely, the kinetic energy of the object (Skill 28, 31)

A) decreases
B) increases
C) remains the same

174. A car uses its brakes to stop on a level road. During this process, there must be a conversion of kinetic energy into (Skill 28, 31)

A) light energy
B) nuclear energy
C) gravitational potential energy
D) internal energy

175. Which device transforms mechanical energy into electrical energy? (Skill 37 ?)

A) generator
B) motor
C) transformer
D) mass spectrometer

176. Energy is measured in the same units as (Skill 28-32)

A) force
B) momentum
C) work
D) power

177. When a neutral metal sphere is charged by contact with a positively charged glass rod, the sphere (Skill 33)

A) loses electrons
B) gains electrons
C) loses protons
D) gains protons

178. A device commonly used to detect the presence of a static electric charge is (Skill 33)

A) a galvanometer B) a voltmeter
C) a compass D) an electroscope

179. Which net charge could be found on an object? (Skill 34)

A) $+4.80\ 10^{-19}$ C B) $+2.40\ 10^{-19}$ C
C) $-2.40\ 10^{-19}$ C D) $-5.60\ 10^{-19}$ C

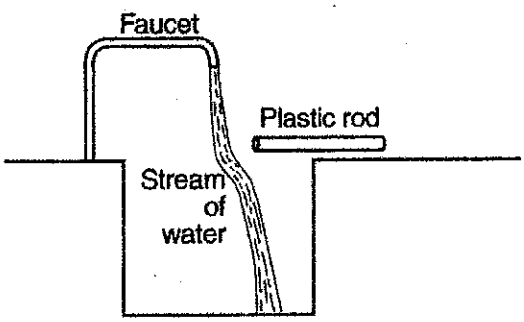
180. If an object has a net negative charge of 4.0 coulombs, the object possesses (Skill 34)

A) 6.3×10^{18} more electrons than protons
B) 2.5×10^{19} more electrons than protons
C) 6.3×10^{18} more protons than electrons
D) 2.5×10^{19} more protons than electrons

181. Which fundamental force is primarily responsible for the attraction between protons and electrons? (Skill 35)

A) strong B) weak
C) gravitational D) electromagnetic

182. A dry plastic rod is rubbed with wool cloth and then held near a thin stream of water from a faucet. The path of the stream of water is changed, as represented in the diagram below.



Which force causes the path of the stream of water to change due to the plastic rod? (Skill 35, 47)

A) nuclear B) magnetic C) electrostatic D) gravitational

183. A positively charged glass rod attracts object *X*. The net charge of object *X*. (Skill 33)

A) may be zero or negative
B) may be zero or positive
C) must be negative
D) must be positive

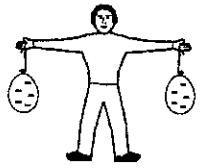
184. Two electrons are separated by a distance of 3.00×10^{-6} meter. What are the magnitude and direction of the electrostatic forces each exerts on the other? (Skill 35)

A) 2.56×10^{-17} N away from each other
B) 2.56×10^{-17} N toward each other
C) 7.67×10^{-23} N away from each other
D) 7.67×10^{-23} N toward each other

185. What is the approximate electrostatic force between two protons separated by a distance of 1.0×10^{-6} meter? (Skill 35)

A) 2.3×10^{-16} N and repulsive
B) 2.3×10^{-16} N and attractive
C) 9.0×10^{21} N and repulsive
D) 9.0×10^{21} N and attractive

186. The diagram below shows two negatively charged balloons suspended from nonconducting strings being held by a student.



What occurs as the student brings the balloons closer to each other without allowing them to touch? (Skill 33)

A) The magnitude of the electrostatic force between the balloons decreases, and they attract each other.

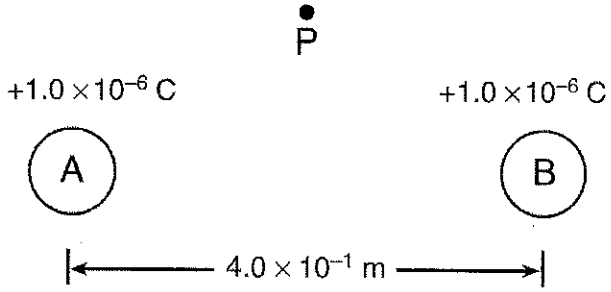
B) The magnitude of the electrostatic force between the balloons decreases, and they repel each other.

C) The magnitude of the electrostatic force between the balloons increases, and they attract each other.

D) The magnitude of the electrostatic force between the balloons increases, and they repel each other.

187. Base your answer to the following question on the information and diagram below.

Two small metallic spheres, *A* and *B*, are separated by a distance of 4.0×10^{-1} meter, as shown. The charge on each sphere is $+1.0 \times 10^{-6}$ coulomb. Point *P* is located near the spheres.



Which arrow best represents the direction of the resultant electric field at point *P* due to the charges on spheres *A* and *B*? (Skill 35)

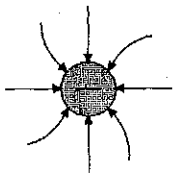
A)

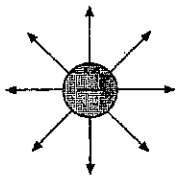
B)

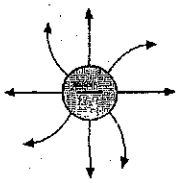
C)

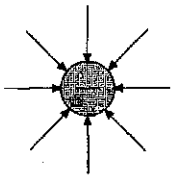
D)

188. Which diagram best represents the electric field around a negatively charged conducting sphere? (Skill 36)

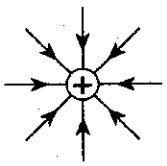
A) 

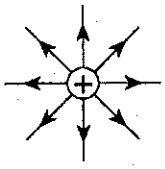
B) 

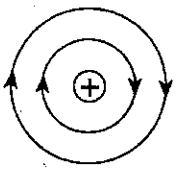
C) 

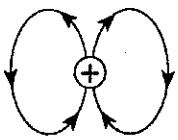
D) 

189. Which diagram best represents the electric field near a positively charged conducting sphere? (Skill 36)

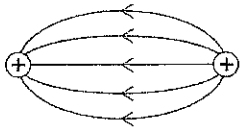
A) 

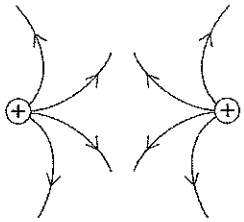
B) 

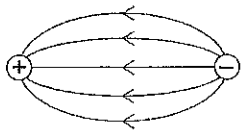
C) 

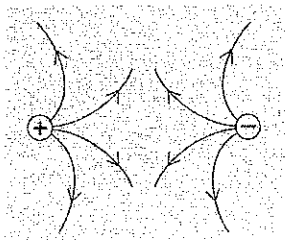
D) 

190. Which diagram represents the electric field lines between two small electrically charged spheres? (Skill 36)

A) 

B) 

C) 

D) 

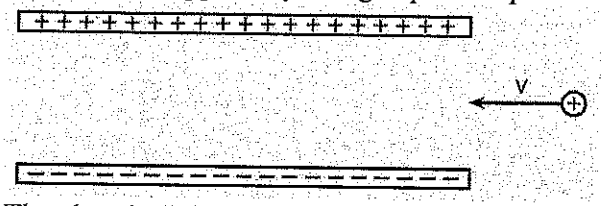
191. Two positively charged masses are separated by a distance, r. Which statement best describes the gravitational and electrostatic forces between the two masses? (Skill 35)

A) Both forces are attractive.
B) Both forces are repulsive.
C) The gravitational force is repulsive and the electrostatic force is attractive.
D) The gravitational force is attractive and the electrostatic force is repulsive.

192. Two protons are located one meter apart. Compared to the gravitational force of attraction between the two protons, the electrostatic force between the protons is (Skill 35, 26, 47)

A) stronger and repulsive
B) weaker and repulsive
C) stronger and attractive
D) weaker and attractive

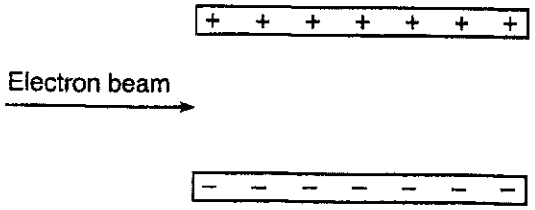
193. The diagram below represents a positively charged particle about to enter the electric field between two oppositely charged parallel plates.



The electric field will deflect the particle (Skill 36)

A) into the page
B) out of the page
C) toward the top of the page
D) toward the bottom of the page

194. A beam of electrons is directed into the electric field between two oppositely charged parallel plates, as shown in the diagram below.



The electrostatic force exerted on the electrons by the electric field is directed (Skill 35,36)

A) into the page
B) out of the page
C) toward the bottom of the page
D) toward the top of the page

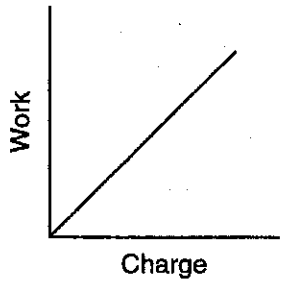
195. Gravitational field strength is to Newtons per kilogram as electric field strength is to (Skill 26, 35, 36)

A) coulombs per joule
B) coulombs per newton
C) joules per coulomb
D) newtons per coulomb

196. Which electrical unit is equivalent to one joule? (Skill 37)

A) volt per meter
B) ampere•volt
C) volt per coulomb
D) coulomb•volt

197. The graph below shows the relationship between the work done on a charged body in an electric field and the net charge on the body.



What does the slope of this graph represent? (Skill 37)

A) power
B) potential difference
C) force
D) electric field intensity

198. Compared to insulators, metals are better conductors of electricity because metals contain more free (Skill 33)

A) protons B) electrons
C) positive ions D) negative ions

199. Conductivity in metallic solids is due to the presence of free (Skill 33)

A) nuclei B) protons
C) neutrons D) electrons

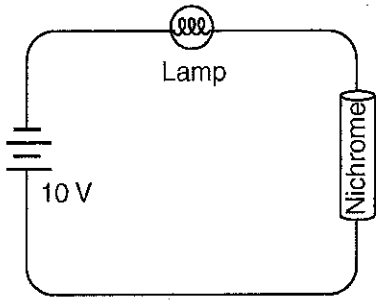
200. Electrical insulators are used to resist the flow of (Skill 33)

A) atoms B) molecules
C) neutrons D) electrons

201. One coulomb per second is equal to one (Skill 38)

A) watt B) ohm
C) volt D) ampere

202. The diagram below represents a lamp, a 10-volt battery, and a length of nichrome wire connected in series.



As the temperature of the nichrome is decreased, the brightness of the lamp will (Skill 39)

A) decrease B) increase
C) remain the same

203. The electrical resistance of a metal wire could be decreased by (Skill 39)

A) increasing its temperature
B) increasing its diameter
C) increasing its length

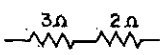
204. A student needs to increase the resistance in a circuit. All that is available for this task is a wide variety of wires of different lengths and thicknesses. To obtain the maximum resistance, the student should replace the wire with one that is (Skill 39)

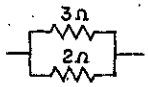
A) shortest and thickest
B) shortest and thinnest
C) longest and thickest
D) longest and thinnest

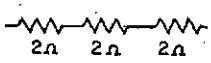
205. What is the minimum equipment needed to determine the power dissipated in a resistor of unknown value? (Skill 42)

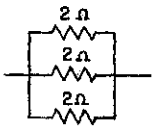
A) a voltmeter, only
B) an ammeter, only
C) a voltmeter and an ammeter, only
D) a voltmeter, an ammeter, and a stopwatch

206. Which circuit segment has an equivalent resistance of 6 ohms? (Skill 43, 44)

A) 

B) 

C) 

D) 

207. As more resistors are added in series across a battery, the potential drop across each resistor (Skill 43)

A) decreases
B) increases
C) remains the same

208. A 5-ohm and a 10-ohm resistor are connected in series. The current in the 5-ohm resistor is 2 amperes. The current in the 10-ohm resistor is (Skill 43)

A) 1 A B) 2 A
C) 0.5 A D) 8 A

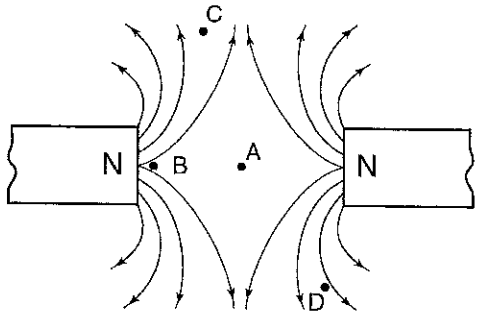
209. Which quantity must be the same for each component in any series circuit? (Skill 43)

A) voltage B) power
C) resistance D) current

210. In simple electrical circuits, connecting wires are assumed to have a resistance of (Skill 42-44)

A) one ohm
B) greater than one ohm
C) less than zero ohms
D) zero ohms

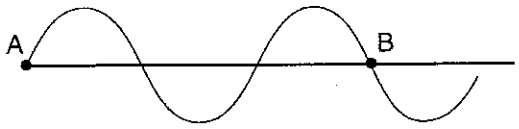
211. The diagram below shows the lines of magnetic force between two north magnetic poles.



At which point is the magnetic field strength greatest? (Skill 46)

A) *A* B) *B* C) *C* D) *D*

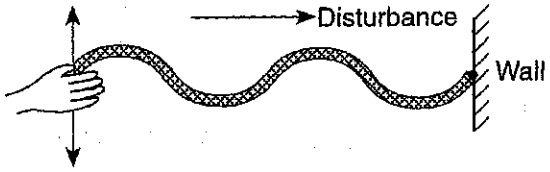
212. The diagram below shows two points, *A* and *B*, on a wave train.



How many wavelengths separate point *A* and point *B*? (Skill 48)

A) 1.0 B) 1.5 C) 3.0 D) 0.75

213. The diagram below shows a person shaking the end of a rope up and down, producing a disturbance that moves along the length of the rope.



Which type of wave is traveling in the rope? (Skill 49)

A) torsional B) longitudinal
C) transverse D) elliptical

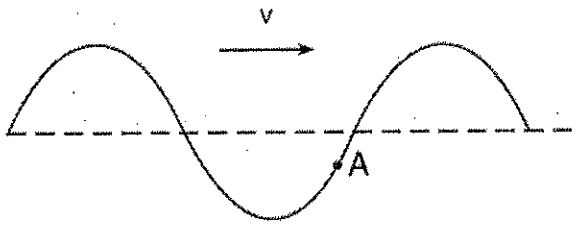
214. Which is a unit of wavelength? (Skill 48)

A) cycles/second B) meters/second
C) seconds D) meters/cycle

215. The energy of a sound wave is most closely related to the wave's (Skill 50)

A) frequency B) amplitude
C) wavelength D) speed

216. The diagram below represents a transverse wave traveling to the right through a medium. Point A represents a particle of the medium.



In which direction will particle A move in the next instant of time? (Skill 49)

A) up B) down
C) left D) right

217. As a transverse wave travels through a medium, the individual particles of the medium move (Skill 49)

A) perpendicular to the direction of wave travel
B) parallel to the direction of wave travel
C) in circles
D) in ellipses

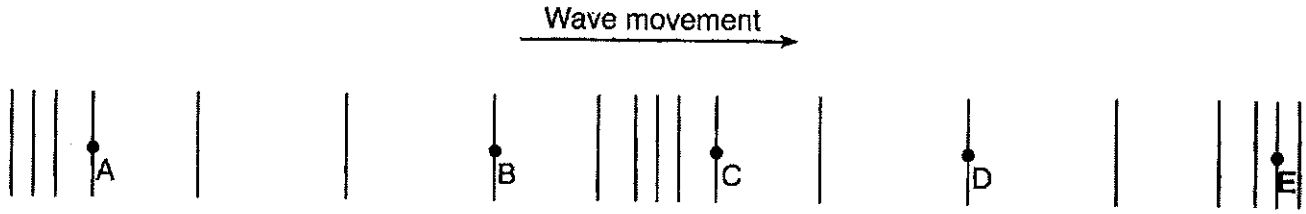
218. A sound wave traveling eastward through air causes the air molecules to (Skill 49 & 50)

A) vibrate east and west
B) vibrate north and south
C) move eastward, only
D) move northward, only

219. Base your answer to the following question on the information and diagram below.

A longitudinal wave moves to the right through a uniform medium, as shown below.

Point *A*, *B*, *C*, *D*, and *E* represent the positions of particles of the medium



The wavelength of this wave is equal to the distance between points (Skill 50)

A) *A* and *B* B) *A* and *C* C) *B* and *C* D) *B* and *E*

220. Which form(s) of energy can be transmitted through a vacuum? (Skill 51)

A) light, only
B) sound, only
C) both light and sound
D) neither light nor sound

221. As a longitudinal wave travels horizontally, the particles of the medium vibrate (Skill 49, 56)

A) in a circle B) in a spiral
C) vertically D) horizontally

222. The time required for a wave to complete one full cycle is called the wave's (Skill 48)

A) frequency B) period
C) velocity D) wavelength

223. The product of a wave's frequency and its period is (Skill 48)

A) one
B) its velocity
C) its wavelength
D) Planck's constant

224. If the frequency of a periodic wave is doubled, the period of the wave will be (Skill 48)

A) halved B) doubled
C) quartered D) quadrupled

225. What is the frequency of a wave if its period is 0.25 second? (Skill 48)

A) 1.0 Hz B) 0.25 Hz
C) 12 Hz D) 4.0 Hz

226. **Note that the question below has only three choices.**
If the amplitude of a wave is increased, the frequency of the wave will (Skill 48)

A) decrease B) increase
C) remain the same

227. The hertz is a unit that describes the number of (Skill 48)

A) seconds it takes to complete one cycle of a wave
B) cycles of a wave completed in one second
C) points that are in phase along one meter of a wave
D) points that are out of phase along one meter of a wave

228. **Note that the following question has only three choices.**
If the amplitude of a wave traveling in a rope is doubled, the speed of the wave in the rope will (Skill 48)

A) decrease B) increase
C) remain the same

229. If the velocity of a constant-frequency wave increases, the wavelength (Skill 48-51, 56)

A) decreases
B) increases
C) remains the same

230. A car's horn produces a sound wave of constant frequency. As the car speeds up going away from a stationary spectator, the sound wave detected by the spectator (Skill 54)

A) decreases in amplitude and decreases in frequency
B) decreases in amplitude and increases in frequency
C) increases in amplitude and decreases in frequency
D) increases in amplitude and increases in frequency

231. When observed from Earth, the wavelengths of light emitted by a star are shifted toward the red end of the electromagnetic spectrum. This redshift occurs because the star is (Skill 54)

A) at rest relative to Earth
B) moving away from Earth
C) moving toward Earth at decreasing speed
D) moving toward Earth at increasing speed

232. How are electromagnetic waves that are produced by oscillating charges and sound waves that are produced by oscillating tuning forks similar? (Skill 48)

A) Both have the same frequency as their respective sources.
B) Both require a matter medium for propagation.
C) Both are longitudinal waves.
D) Both are transverse waves.

233. An electromagnetic wave is produced by charged particles vibrating at a rate of 3.9×10^8 vibrations per second. The electromagnetic wave is classified as (Skill51)

A) a radio wave B) an infrared wave
C) an x ray D) visible light

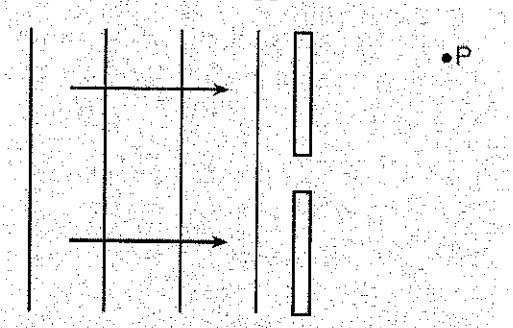
234. A single vibratory disturbance moving through a medium is called (Skill48)

A) a node B) an antinode
C) a standing wave D) a pulse

235. A series of pulses generated at regular time intervals in an elastic medium will produce (Skill54)

A) nodes B) antinodes
C) a polarized wave D) a periodic wave

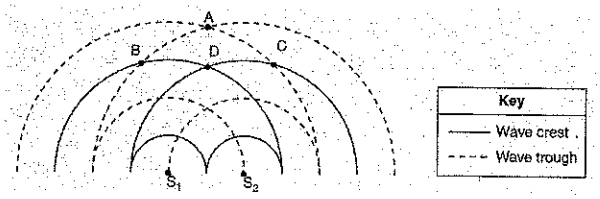
236. The diagram below shows a series of wave fronts approaching an opening in a barrier. Point *P* is located on the opposite side of the barrier.



The wave fronts reach point *P* as a result of (Skill52)

A) resonance B) refraction
C) reflection D) diffraction

237. Two speakers, S_1 and S_2, operating in phase in the same medium produce the circular wave patterns shown in the diagram below. (Skill52)



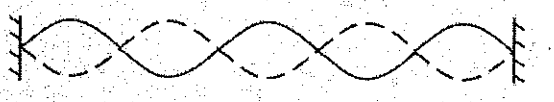
At which two points is constructive interference occurring?

A) *A* and *B* B) *A* and *D*
C) *B* and *C* D) *B* and *D*

238. Two waves having the same amplitude and frequency are traveling in the same medium. Maximum destructive interference will occur when the phase difference between the waves is (Skill53)

A) 0° B) 90° C) 180° D) 270°

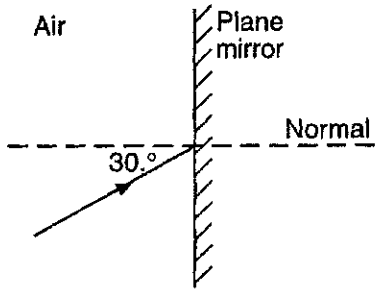
239. The diagram below represents a standing wave.



The number of nodes and antinodes shown in the diagram is (Skill53)

A) 4 nodes and 5 antinodes
B) 5 nodes and 6 antinodes
C) 6 nodes and 5 antinodes
D) 6 nodes and 10 antinodes

240. A ray of monochromatic light traveling in air is incident on a plane mirror at an angle of 30.°, as shown in the diagram below.



(Skill 55)

The angle of reflection for the light ray is

A) 15° B) 30.° C) 60.° D) 90.°

241. The diagram below shows parallel rays of light incident on an irregular surface.

Which phenomenon of light is illustrated by the diagram? (Skill 52, 55)

A) diffraction
B) refraction
C) regular reflection
D) diffuse reflection

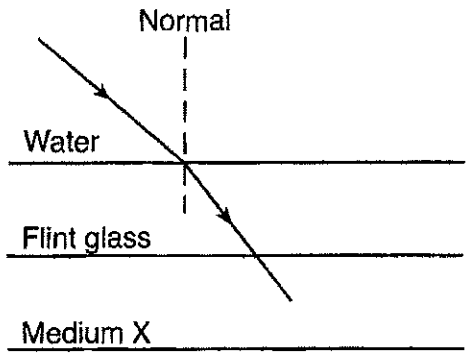
242. A light spring is attached to a heavier spring at one end. A pulse traveling along the light spring is incident on the boundary with the heavier spring. At this boundary, the pulse will be (Skill 52, 55, 56)

A) totally reflected
B) totally absorbed
C) totally transmitted into the heavier spring
D) partially reflected and partially transmitted into the heavier spring

243. A wave passes through an opening in a barrier. The amount of diffraction experienced by the wave depends on the size of the opening and the wave's (Skill 52)

A) amplitude B) wavelength
C) velocity D) phase

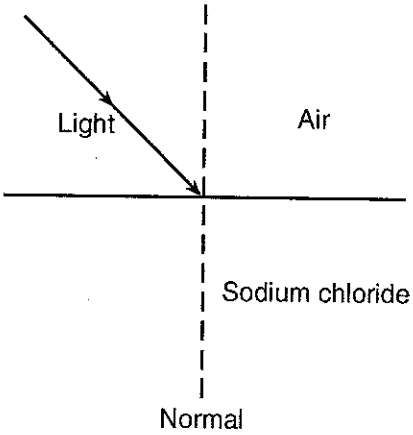
244. A ray of monochromatic yellow light ($f = 5.09\ 10^{14}$ Hz) passes from water through flint glass and into medium X, as shown below.



The absolute index of refraction of medium X is (Skill 56)

A) less than 1.33
B) greater than 1.33 and less than 1.52
C) greater than 1.52 and less than 1.66
D) equal to 1.66

245. A ray of monochromatic light is incident on an air-sodium chloride boundary as shown in the diagram below. At the boundary, part of the ray is reflected back into the air and part is refracted as it enters the sodium chloride.

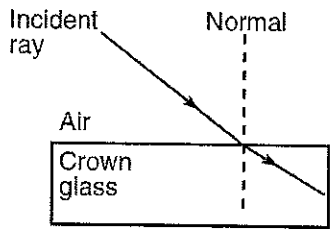


Compared to the ray's angle of refraction in the sodium chloride, the ray's angle of reflection in the air is (Skill 55,56)

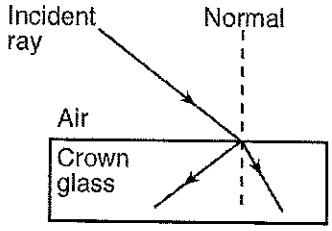
A) smaller B) larger
C) the same

246. Which diagram best represents the behavior of a ray of monochromatic light in air incident on a block of crown glass? (Skill 55,56)

A)



B)



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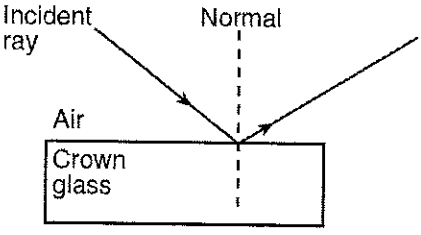

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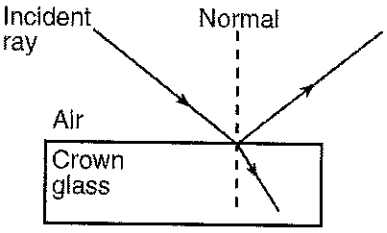


247. Sound waves are produced by the horn of a truck that is approaching a stationary observer. Compared to the sound waves detected by the driver of the truck, the sound waves detected by the observer have a greater (Skill 54)

A) wavelength B) frequency
C) period D) speed

248. Which statement correctly describes one characteristic of a sound wave? (Skill 50)

A) A sound wave can travel through a vacuum.
B) A sound wave is a transverse wave.
C) The amount of energy a sound wave transmits is directly related to the wave's amplitude.
D) The amount of energy a sound wave transmits is inversely related to the wave's frequency.

249. What is the wavelength of a 256-hertz sound wave in air at STP? (Skill 56)

A) 1.17×10^{6} m
B) 1.29 m
C) 0.773 m
D) 8.53×10^{-7} m

250. Which type of wave requires a material medium through which to travel? (Skill 50)

A) sound B) radio
C) television D) x ray

251. Compared to the speed of a sound wave in air, the speed of a radio wave in air is (Skill 50,51)

A) less B) greater
C) the same

252. One vibrating 256-hertz tuning fork transfers energy to another 256-hertz tuning fork, causing the second tuning fork to vibrate. This phenomenon is an example of (Skill 53)

A) diffraction B) reflection
C) refraction D) resonance

253. An opera singer's voice is able to break a thin crystal glass when the singer's voice and the vibrating glass have the same (Skill 53)

A) frequency B) speed
C) amplitude D) wavelength

254. The distance from the Moon to Earth is 3.9×10^{8} meters. What is the time required for a light ray to travel from the Moon to Earth? (Skill 48,51)

A) 0.65 s B) 1.3 s
C) 2.6 s D) 3.9 s

255. In a vacuum, all electromagnetic waves have the same (Skill 51)

A) speed B) phase
C) frequency D) wavelength

256. What is the speed of a radio wave in a vacuum? (Skill 51)

A) 0 m/s
B) 3.31×10^2 m/s
C) 1.13×10^3 m/s
D) 3.00×10^8 m/s

257. Which phenomenon provides evidence that light has a wave nature? (Skill 51)

A) emission of light from an energy-level transition in a hydrogen atom
B) diffraction of light passing through a narrow opening
C) absorption of light by a black sheet of paper
D) reflection of light from a mirror

258. Which phenomenon is best explained by the wave theory? (Skill 57)

A) reflection
B) illumination
C) interference
D) the photoelectric effect

259. Which phenomenon can *not* be exhibited by longitudinal waves? (Skill 52)

A) reflection
B) refraction
C) diffraction
D) polarization

260. What is the origin of the light emitted by a laser? (Skill 51)

A) thermionic emission from an incandescent filament
B) emission of mechanical waves from vibrating matter
C) emission of photoelectrons from a photo sensitive surface
D) emission of photons from excited atoms

261. A microwave and an x ray are traveling in a vacuum. Compared to the wavelength and period of the microwave, the x ray has a wavelength that is (Skill 51)

A) longer and a period that is shorter
B) longer and a period that is longer
C) shorter and a period that is longer
D) shorter and a period that is shorter

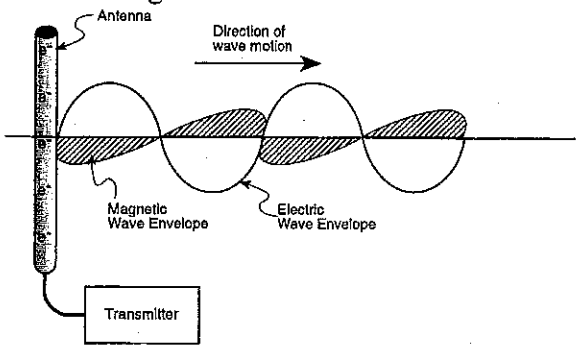
262. An electromagnetic AM-band radio wave could have a wavelength of (Skill 51)

A) 0.005 m
B) 5 m
C) 500 m
D) 5 000 000 m

263. Which statement best describes a proton that is being accelerated? (Skill 51)

A) It produces electromagnetic radiation.
B) The magnitude of its charge increases.
C) It absorbs a neutron to become an electron.
D) It is attracted to other protons.

264. The diagram below shows an antenna emitting an electromagnetic wave.



In what way did the electrons in the antenna produce the electromagnetic wave? (Skill 51)

A) by remaining stationary
B) by moving at constant speed upward, only
C) by moving at constant speed downward, only
D) by accelerating alternately upward and downward

265. Radiations such as radio, light, and gamma are propagated by the interchange of energy between (Skill 51)

A) magnetic fields, only
B) electric fields, only
C) electric and gravitational fields
D) electric and magnetic fields

266. Which is a source of electromagnetic radiation? (Skill 51)

A) a neutron at constant velocity
B) a neutron accelerating
C) a proton at constant velocity
D) a proton accelerating

267. Moving electrons are found to exhibit properties of (Skill 57)

A) particles, only
B) waves, only
C) both particles and waves
D) neither particles nor waves

268. Wave-particle duality is most apparent in analyzing the motion of (Skill 57)

A) a baseball
B) a space shuttle
C) a galaxy
D) an electron

269. Which phenomenon is most easily explained by the particle theory of light? (Skill 57)

A) photoelectric effect
B) constructive interference
C) polarization
D) diffraction

270. Which phenomenon can be explained by both the particle model and wave model? (Skill 57)

A) reflection
B) polarization
C) diffraction
D) interference

271. If a deuterium nucleus has a mass of 1.53×10^{-3} universal mass units less than its components, this mass represents an energy of (Skill 53)

A) 1.38 MeV
B) 1.42 MeV
C) 1.53 MeV
D) 3.16 MeV

272. A variable-frequency light source emits a series of photons. As the frequency of the photon increases, what happens to the energy and wavelength of the photon? (Skill 51, 57)

A) The energy decreases and the wavelength decreases.
B) The energy decreases and the wavelength increases.
C) The energy increases and the wavelength decreases.
D) The energy increases and the wavelength increases.

273. All photons in a vacuum have the same (Skill 51)

A) speed B) wavelength
C) energy D) frequency

274. The energy of a photon is inversely proportional to its (Skill 57)

A) wavelength B) frequency
C) speed D) phase

275. A quantum of light energy is a (Skill 47, 51, 57)

A) photon B) photoelectron
C) lumen D) spectra

276. Which transmits the energy in a light beam? (Skill 47, 51, 57)

A) electrons B) photons
C) protons D) neutrons

277. A photon is emitted as the electron in a hydrogen atom drops from the $n = 5$ energy level directly to the $n = 3$ energy level. What is the energy of the emitted photon? (Skill 57)

A) 0.85 eV B) 0.97 eV
C) 1.51 eV D) 2.05 eV

278. A photon having an energy of 9.40 electronvolts strikes a hydrogen atom in the ground state. Why is the photon *not* absorbed by the hydrogen atom? (Skill 57)

A) The atom's orbital electron is moving too fast.
B) The photon striking the atom is moving too fast.
C) The photon's energy is too small.
D) The photon is being repelled by electrostatic force.

279. White light is passed through a cloud of cool hydrogen gas and then examined with a spectroscope. The dark lines observed on a bright background are caused by (Skill 57)

A) the hydrogen emitting all frequencies in white light
B) the hydrogen absorbing certain frequencies of the white light
C) diffraction of the white light
D) constructive interference

280. After electrons in hydrogen atoms are excited to the $n = 3$ energy state, how many different frequencies of radiation can be emitted as the electrons return to the ground state? (Skill 57)

A) 1 B) 2 C) 3 D) 4

281. What is the minimum energy needed to ionize a hydrogen atom in the n = 2 energy state? (Skill 57)

A) 13.6 eV
B) 10.2 eV
C) 3.40 eV
D) 1.89 eV

282. A mercury atom in the ground state absorbs 20.00 electronvolts of energy and is ionized by losing an electron. How much kinetic energy does this electron have after the ionization? (Skill 57)

A) 6.40 eV
B) 9.62 eV
C) 10.38 eV
D) 13.60 eV

283. Which particles are *not* affected by the strong force? (Skill 47)

A) hadrons
B) protons
C) neutrons
D) electrons

284. Baryons may have charges of (Skill 47)

A) +1e and $+\frac{4}{3}$e
B) +2e and +3e
C) –1e and +1e
D) –2e and $-\frac{2}{3}$e

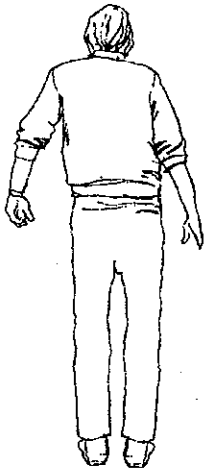
285. The tau neutrino, the muon neutrino, and the electron neutrino are all (Skill 47)

A) leptons
B) hadrons
C) baryons
D) mesons

286. The strong force is the force of (Skill 47)

A) repulsion between protons
B) attraction between protons and electrons
C) repulsion between nucleons
D) attraction between nucleons

287. In the diagram below, a stationary observer on the ground watches as a seagull flying horizontally to the right drops a clamshell.



Which diagram best represents the path of the falling clamshell as seen by the observer? [Neglect air resistance.] (Skill 16)

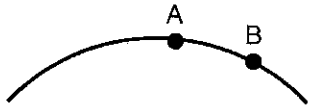
A) 

B) 

C) 

D) 

288. The diagram below represents the path of an object after it was thrown.



What happens to the object's acceleration as it travels from *A* to *B*? [Neglect friction.] (Skill 17)

A) It decreases.
B) It increases.
C) It remains the same.

289. A ball is thrown horizontally from the top of a building with an initial velocity of 15 meters per second. At the same instant, a second ball is dropped from the top of the building. The two balls have the same (Skill 16)

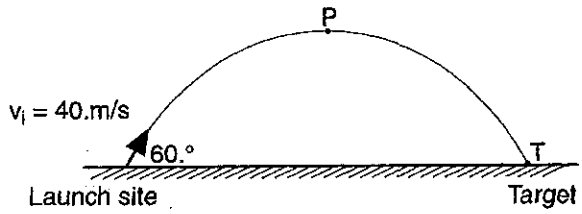
A) path as they fall
B) final velocity as they reach the ground
C) initial horizontal velocity
D) initial vertical velocity

290. A 1-kilogram object is thrown horizontally and a 2-kilogram object is dropped vertically at the same instant and from the same point above the ground. If friction is neglected, at any given instant both objects will have the same (Skill 14, 16)

A) kinetic energy
B) momentum
C) total velocity
D) height

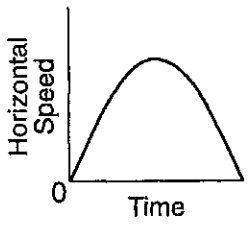
291. Base your answer to the following question on the information and diagram below. Skills 15-18)

A projectile is launched at an angle of 60.° above the horizontal at an initial speed of 40. meters per second, as shown in the diagram below. The projectile reaches its highest altitude at point *P* and strikes a target at point *T*. [Neglect air resistance.]



Which graph best represents the horizontal speed of the projectile as a function of time? [Neglect air resistance.]

A)



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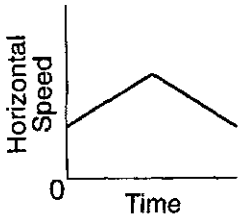
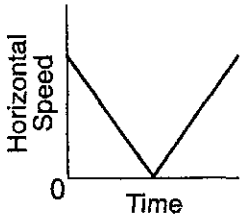
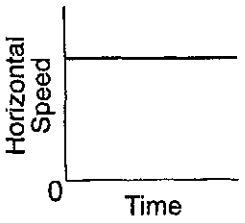


C)



D)



292. A golf ball is hit at an angle of 45° above the horizontal. What is the acceleration of the golf ball at the highest point in its trajectory? [Neglect friction.] (Skill 15-18)

A) 9.8 m/s^2 upward
B) 9.8 m/s^2 downward
C) 6.9 m/s^2 horizontal
D) 0.0 m/s^2

293. A ball is thrown at an angle of 38° to the horizontal. What happens to the magnitude of the ball's vertical acceleration during the total time interval that the ball is in the air? (Skill 17)

A) It decreases, then increases.
B) It decreases, then remains the same.
C) It increases, then decreases.
D) It remains the same.

294. An archer uses a bow to fire two similar arrows with the same string force. One arrow is fired at an angle of 60.° with the horizontal, and the other is fired at an angle of 45° with the horizontal. Compared to the arrow fired at 60.°, the arrow fired at 45° has a (Skill 18)

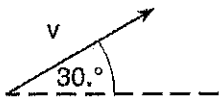
A) longer flight time and longer horizontal range
B) longer flight time and shorter horizontal range
C) shorter flight time and longer horizontal range
D) shorter flight time and shorter horizontal range

295. A student throws a stone upward at an angle of 45°. Which statement best describes the stone at the highest point that it reaches? (Skills 15-18)

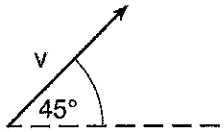
A) Its acceleration is zero.
B) Its acceleration is at a maximum.
C) Its potential energy is at a minimum.
D) Its kinetic energy is at a minimum.

296. Four identical projectiles are launched with the same initial speed, v, but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.] (Skill 18)

A)



B)



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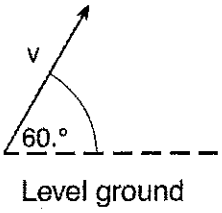
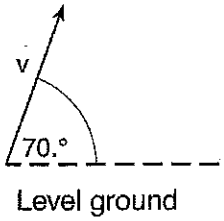


D)



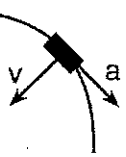
297. A projectile launched at an angle of 45° above the horizontal travels through the air. Compared to the projectile's theoretical path with no air friction, the actual trajectory of the projectile with air friction is (Skill 14-18)

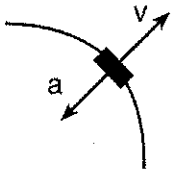
A) lower and shorter
B) lower and longer
C) higher and shorter
D) higher and longer

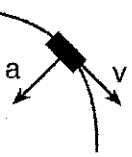
298. A machine launches a tennis ball at an angle of 25° above the horizontal at a speed of 14 meters per second. The ball returns to level ground. Which combination of changes *must* produce an increase in time of flight of a second launch? (Skill 15-18)

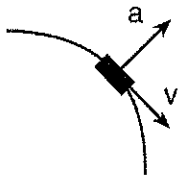
A) decrease the launch angle and decrease the ball's initial speed
B) decrease the launch angle and increase the ball's initial speed
C) increase the launch angle and decrease the ball's initial speed
D) increase the launch angle and increase the ball's initial speed

299. A car rounds a horizontal curve of constant radius at a constant speed. Which diagram best represents the directions of both the car's velocity, v, and acceleration, a? (Skill 25)

A) 

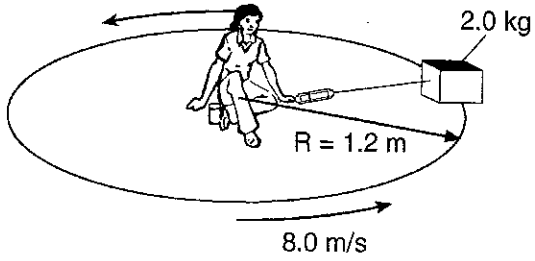
B) 

C) 

D) 

300. Base your answer to the following question on the information and diagram below.

The diagram shows a student seated on a rotating circular platform, holding a 2.0-kilogram block with a spring scale. The block is 1.2 meters from the center of the platform. The block has a constant speed of 8.0 meters per second. [Frictional forces on the block are negligible.] (Skill 25)



Which statement best describes the block's movement as the platform rotates?

A) Its velocity is directed tangent to the circular path, with an inward acceleration.
B) Its velocity is directed tangent to the circular path, with an outward acceleration.
C) Its velocity is directed perpendicular to the circular path, with an inward acceleration.
D) Its velocity is directed perpendicular to the circular path, with an outward acceleration.

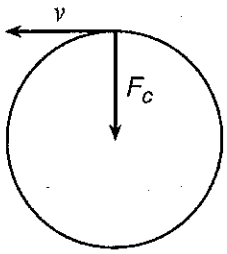
301. An object traveling with uniform circular motion has a centripetal acceleration due to the change in (Skill 25)

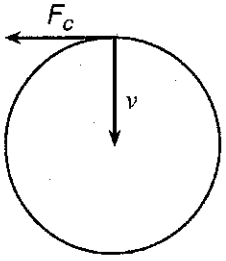
A) speed
B) direction
C) kinetic energy
D) mass

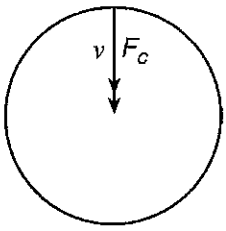
302. The centripetal force acting on the space shuttle as it orbits Earth is equal to the shuttle's (Skill25)

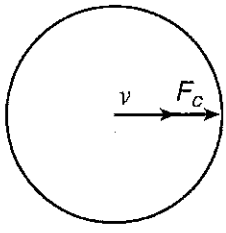
A) inertia B) momentum
C) velocity D) weight

303. A 1.0×10^3-kilogram car travels at a constant speed of 20. meters per second around a horizontal circular track. Which diagram correctly represents the direction of the car's velocity (v) and the direction of the centripetal force (F_c) acting on the car at one particular moment? (Skill25)

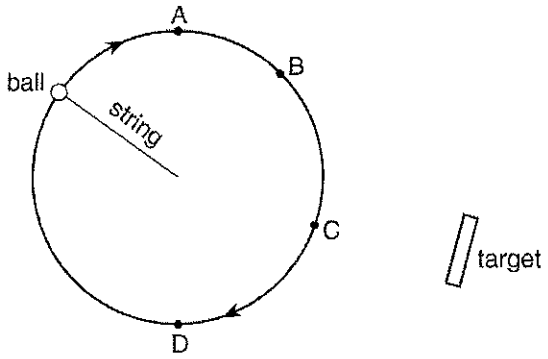
A)


B)


C)


D)


304. A ball attached to a string is moved at constant speed in a horizontal circular path. A target is located near the path of the ball as shown in the diagram.



At which point along the ball's path should the string be released, if the ball is to hit the target? (Skill25)

A) *A* B) *B* C) *C* D) *D*

305. A 5.0-newton force and a 7.0-newton force act concurrently on a point. As the angle between the forces is increased from 0° to 180°, the magnitude of the resultant of the two forces changes from (Skill22)

A) 0.0 N to 12.0 N B) 2.0 N to 12.0 N
C) 12.0 N to 2.0 N D) 12.0 N to 0.0 N

306. Two concurrent forces have a maximum resultant of 45 Newtons and a minimum resultant of 5 Newtons. What is the magnitude of each of these forces? (Skill22)

A) 0 N and 45 N B) 5 N and 9 N
C) 20. N and 25 N D) 0 N and 50. N

307. What is the total displacement of a student who walks 3 blocks east, 2 blocks north, 1 block west, and then 2 blocks south? (Skill 4#5)

A) 0
B) 2 blocks east
C) 2 blocks west
D) 8 blocks

308. A student on an amusement park ride moves in a circular path with a radius of 3.5 meters once every 8.9 seconds. The student moves at an average speed of (Skill 25)

A) 0.39 m/s B) 1.2 m/s
C) 2.5 m/s D) 4.3 m/s

309. An object starts from rest and falls freely. What is the velocity of the object at the end of 3.00 seconds? (Skill 14)

A) 9.81 m/s B) 19.6 m/s
C) 29.4 m/s D) 88.2 m/s

310. An object dropped from rest will have a velocity of approximately 30. meters per second at the end of (Skill 14)

A) 1.0 s B) 2.0 s C) 3.0 s D) 4.0 s

311. A baseball dropped from the roof of a tall building takes 3.1 seconds to hit the ground. How tall is the building? [Neglect friction.] (Skill 14)

A) 15 m B) 30. m
C) 47 m D) 94 m

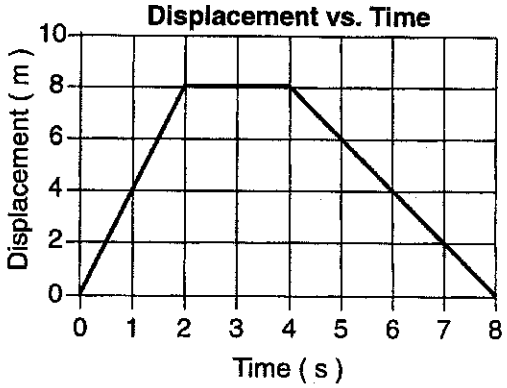
312. A 25-newton weight falls freely from rest from the roof of a building. What is the total distance the weight falls in the first 1.0 second? (Skill 14)

A) 19.6 m B) 9.8 m
C) 4.9 m D) 2.5 m

313. After a model rocket reached its maximum height, it then took 5.0 seconds to return to the launch site. What is the approximate maximum height reached by the rocket? [Neglect air resistance.] (Skill 15)

A) 49 m B) 98 m
C) 120 m D) 250 m

314. Base your answer to the following question on the graph below, which represents the relationship between the displacement of an object and its time of travel along a straight line.



What is the average speed of the object during the first 4.0 seconds? (Skill 6)

A) 0 m/s B) 2 m/s C) 8 m/s D) 4 m/s

315. An air bag is used to safely decrease the momentum of a driver in a car accident. The air bag reduces the magnitude of the force acting on the driver by (Skill 26)

A) increasing the length of time the force acts on the driver
B) decreasing the distance over which the force acts on the driver
C) increasing the rate of acceleration of the driver
D) decreasing the mass of the driver

316. A 75-kilogram hockey player is skating across the ice at a speed of 6.0 meters per second. What is the magnitude of the average force required to stop the player in 0.65 second? (Skill 20)

A) 120 N B) 290 N
C) 690 N D) 920 N

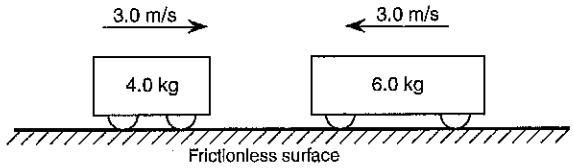
317. A 3.1 kilogram gun initially at rest is free to move. When a 0.015-kilogram bullet leaves the gun with a speed of 500. meters per second, what is the speed of the gun? (Skill 27)

A) 0.0 m/s B) 2.4 m/s
C) 7.5 m/s D) 500. m/s

318. At the circus, a 100.-kilogram clown is fired at 15 meters per second from a 500.-kilogram cannon. What is the recoil speed of the cannon? (Skill 27)

A) 75 m/s B) 15 m/s
C) 3.0 m/s D) 5.0 m/s

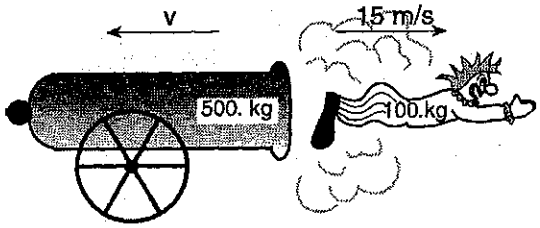
319. The diagram below shows a 4.0-kilogram cart moving to the right and a 6.0-kilogram cart moving to the left on a horizontal frictionless surface.



When the two carts collide they lock together. The magnitude of the total momentum of the two-cart system after the collision is (Skill 27)

A) 0.0 kg•m/s B) 6.0 kg•m/s
C) 15 kg•m/s D) 30. kg•m/s

320. In the diagram below, a 100.-kilogram clown is fired from a 500.-kilogram cannon.



If the clown's speed is 15 meters per second after the firing, the recoil speed (v) of the cannon is (Skill 27)

A) 75 m/s B) 15 m/s
C) 3.0 m/s D) 0 m/s

321. A plane flying horizontally above Earth's surface at 100. meters per second drops a crate. The crate strikes the ground 30.0 seconds later. What is the magnitude of the horizontal component of the crate's velocity just before it strikes the ground? [Neglect friction.] (Skill 16)

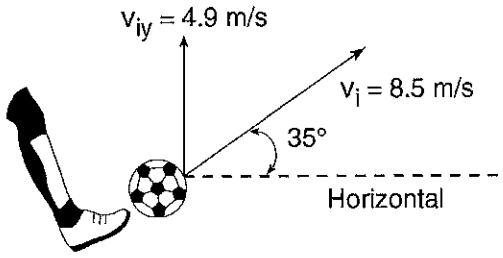
A) 0 m/s B) 100. m/s
C) 294 m/s D) 394 m/s

322. A 0.25-kilogram baseball is thrown upward with a speed of 30. meters per second. Neglecting friction, the maximum height reached by the baseball is approximately (Skill 15)

A) 15 m B) 46 m
C) 74 m D) 92 m

323. Base your answer to the following question on the information and diagram below.

A child kicks a ball with an initial velocity of 8.5 meters per second at an angle of 35° with the horizontal, as shown. The ball has an initial vertical velocity of 4.9 meters per second and a total time of flight of 1.0 second. [Neglect air resistance.] (Skill 15-17)



The maximum height reached by the ball is approximately

A) 1.2 m B) 2.5 m
C) 4.9 m D) 8.5 m

324. A golf ball is propelled with and initial velocity of 60. meter per second at 37° above the horizontal. The horizontal component of the golf ball's initial velocity is (Skill 8 & Skill 17)

A) 30. m/s
B) 36 m/s
C) 40. m/s
D) 48 m/s

325. Base your answer to the following question on the information below.

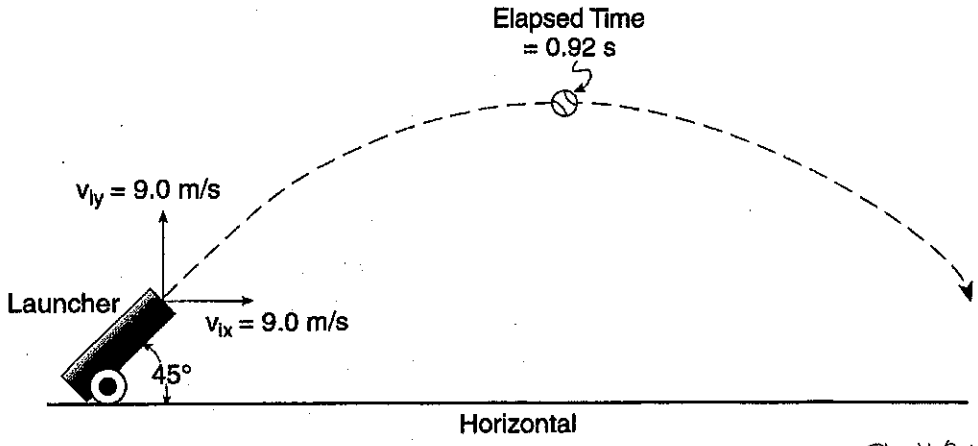
An outfielder throws a baseball to the first baseman at a speed of 19.6 meters per second and an angle of 30.° above the horizontal.

Which pair represents the initial horizontal velocity (vx) and initial vertical velocity (vy) of the baseball? (Skill 17)

A) $v_x = 17.0$ m/s, $v_y = 9.80$ m/s
B) $v_x = 9.80$ m/s, $v_y = 17.0$ m/s
C) $v_x = 19.4$ m/s, $v_y = 5.90$ m/s
D) $v_x = 19.6$ m/s, $v_y = 19.6$ m/s

326. Base your answer to the following question on the diagram and information below.

A machine launches a tennis ball at an angle of 45° with the horizontal, as shown. The ball has an initial vertical velocity of 9.0 meters per second and an initial horizontal velocity of 9.0 meters per second. The ball reaches its maximum height 0.92 second after its launch. [Neglect air resistance and assume the ball lands at the same height above the ground from which it was launched.]

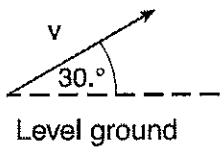


The speed of the tennis ball as it leaves the launcher is approximately Skill 8 & Skill 17

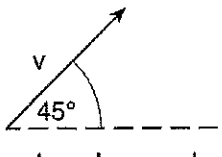
A) 4.5 m/s B) 8.3 m/s C) 13 m/s D) 18 m/s

327. Four identical projectiles are launched with the same initial speed, v, but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.] (Skill 18)

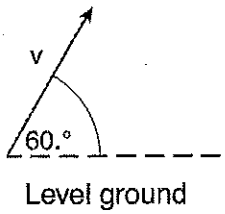
A)



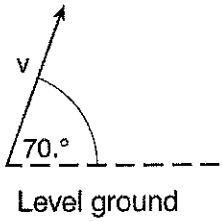
B)



C)



D)



328. A projectile launched at an angle of 45° above the horizontal travels through the air. Compared to the projectile's theoretical path with no air friction, the actual trajectory of the projectile with air friction is (Skill 18)

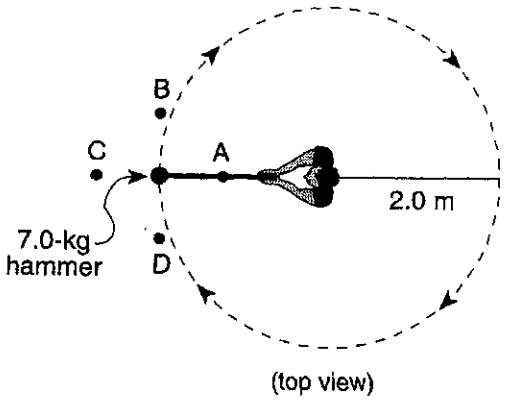
A) lower and shorter
B) lower and longer
C) higher and shorter
D) higher and longer

329. A basketball player jumped straight up to grab a rebound. If she was in the air for 0.80 second, how high did she jump? (Skill 15)

A) 0.50 m
B) 0.78 m
C) 1.2 m
D) 3.1 m

330. Base your answer to the following question on the information and diagram below.

An athlete in a hammer-throw event swings a 7.0-kilogram hammer in a horizontal circle at a constant speed of 12 meter per second. The radius of the hammer's path is 2.0 meters



(top view)

What is the magnitude of the centripetal acceleration of the hammer? (Skill 25)

A) 6.0 m/s^2
B) 24 m/s^2
C) 72 m/s^2
D) 500 m/s^2

331. Cart *A* has a mass of 2 kilograms and a speed of 3 meters per second. Cart *B* has a mass of 3 kilograms and a speed of 2 meters per second. Compared to the inertia and magnitude of momentum of cart *A*, cart *B* has (Skill 20)

A) the same inertia and a smaller magnitude of momentum
B) the same inertia and the same magnitude of momentum
C) greater inertia and a smaller magnitude of momentum
D) greater inertia and the same magnitude of momentum

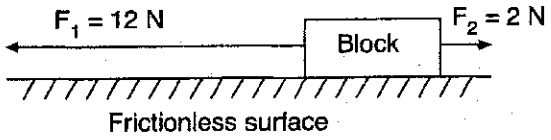
332. A 4.0-kilogram object is accelerated at 3.0 meters per second^2 north by an unbalanced force. The same unbalanced force acting on a 2.0-kilogram object will accelerate this object toward the north at (Skill 20)

A) 12 m/s^2 B) 6.0 m/s^2
C) 3.0 m/s^2 D) 1.5 m/s^2

333. On a small planet, an astronaut uses a vertical force of 175 newtons to lift an 87.5-kilogram boulder at constant velocity to a height of 0.350 meter above the planet's surface. What is the magnitude of the gravitational field strength on the surface of the planet? (Skill 22)

A) 0.500 N/kg B) 2.00 N/kg
C) 9.81 N/kg D) 61.3 N/kg

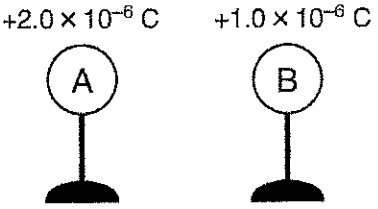
334. Two forces, F_1 and F_2, are applied to a block on a frictionless, horizontal surface as shown below. (Skill 22)



If the magnitude of the block's acceleration is 2.0 meters per second^2, what is the mass of the block?

A) 1 kg B) 5 kg C) 6 kg D) 7 kg

335. Two similar metal spheres, *A* and *B*, have charges of $+2.0 \times 10^{-6}$ coulomb and $+1.0 \times 10^{-6}$ coulomb, respectively, as shown in the diagram below.



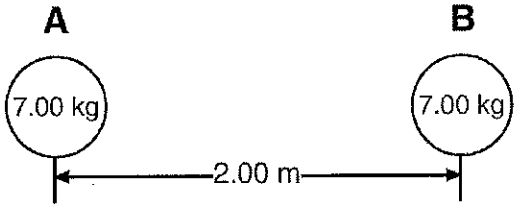
The magnitude of the electrostatic force on *A* due to *B* is 2.4 newtons. What is the magnitude of the electrostatic force on *B* due to *A*? (Skill 35)

A) 1.2 N B) 2.4 N
C) 4.8 N D) 9.6 N

336. A 400-newton girl standing on a dock exerts a force of 100 newtons on a 10 000-newton sailboat as she pushes it away from the dock. How much force does the sailboat exert on the girl? (Skill 20)

A) 25 N B) 100 N
C) 400 N D) 10 000 N

337. The diagram shows two bowling balls, *A* and *B*, each having a mass of 7.00 kilograms, placed 2.00 meters apart.



What is the magnitude of the gravitational force exerted by ball *A* on ball *B*? (Skill 26)

A) 8.17×10^{-9} N B) 1.63×10^{-9} N
C) 8.17×10^{-10} N D) 1.17×10^{-10} N

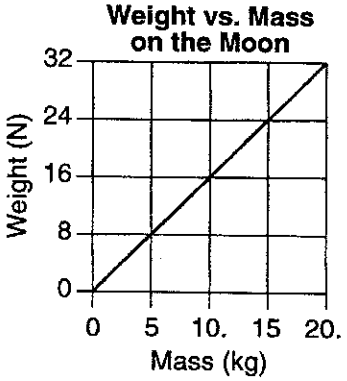
338. An astronaut weighs 8.00×10^2 newtons on the surface of Earth. What is the weight of the astronaut 6.37×10^6 meters above the surface of Earth? (Skill 26,22)

A) 0.00 N
B) 2.00×10^2 N
C) 1.60×10^3 N
D) 3.20×10^3 N

339. A person weighing 785 newtons on the surface of Earth would weigh 298 newtons on the surface of Mars. What is the magnitude of the gravitational field strength on the surface of Mars? (Skill 22)

A) 2.63 N/kg
B) 3.72 N/kg
C) 6.09 N/kg
D) 9.81 N/kg

340. The graph below shows the relationship between weight and mass for a series of objects on the Moon.



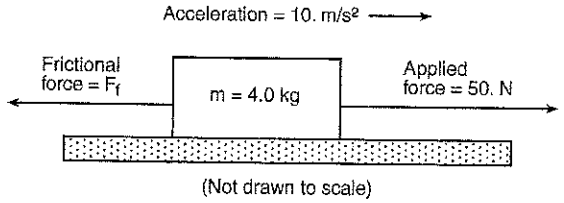
The acceleration due to gravity on the Moon is approximately (Skill 26,22)

A) 0.63 m/s^2
B) 1.6 m/s^2
C) 9.8 m/s^2
D) 32 m/s^2

341. An 8.0-newton wooden block slides across a horizontal wooden floor at constant velocity. What is the magnitude of the force of kinetic friction between the block and the floor? (Skill 23)

A) 2.4 N
B) 3.4 N
C) 8.0 N
D) 27 N

342. The diagram below shows a 4.0-kilogram object accelerating at 10. meters per second^2 on a rough horizontal surface.



What is the magnitude of the frictional force F_f acting on the object? (Skill 22,23)

A) 5.0 N
B) 10. N
C) 20. N
D) 40. N

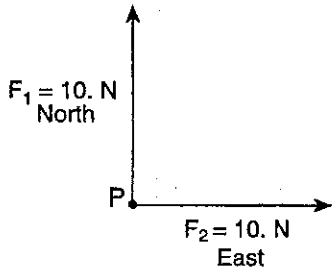
343. A 0.50-kilogram puck sliding on a horizontal shuffleboard court is slowed to rest by a frictional force of 1.2 newtons. What is the coefficient of kinetic friction between the puck and the surface of the shuffleboard court? (Skill 23)

A) 0.24 B) 0.42 C) 0.60 D) 4.1

344. What is the magnitude of the force needed to keep a 60.-newton rubber block moving across level, dry asphalt in a straight line at a constant speed of 2.0 meters per second? (Skill 22,23)

A) 40. N
B) 51 N
C) 60. N
D) 120 N

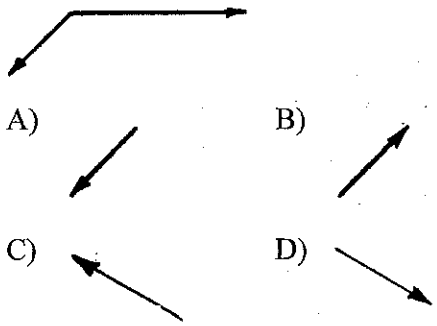
345. Forces F_1 and F_2 act concurrently on point P, as shown in the diagram below.



The **equilibrant** of F_1 and F_2 is (Skill 21)

A) 14 N southwest B) 14 N northeast
C) 20. N southwest D) 20. N southeast

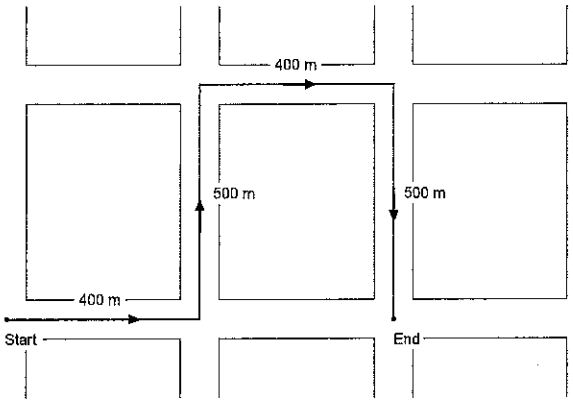
346. The diagram below represents two concurrent displacements acting on a point. Which vector best represents their resultant? (Skill 21)



347. If a woman runs 100 meters north and then 70 meters south in a time of 5 seconds, her velocity will be (Skill 10)

A) 6 m/s south B) 34 m/s south
C) 6 m/s north D) 34 m/s north

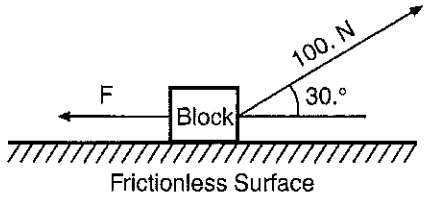
348. The map below shows the route traveled by a school bus.



Compared to the magnitude of the displacement, the distance traveled is (Skill 5, 7, 8)

A) $4x10^{-1}$ km greater
B) $4x10^{-1}$ km less
C) 1 km less
D) 1 km greater

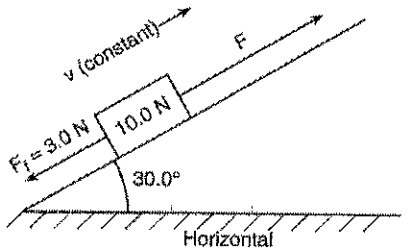
349. The diagram below shows a 25 kg block on a horizontal frictionless surface. A 100.- newton force acts on the block at an angle of 30.° above the horizontal.



What is the magnitude of *normal force acting on the block*? (Skill 22)

A) 50.0 N B) 195 N
C) 86.6. N D) 245 N

350. A block weighing 10.0 newtons is on a ramp inclined at 30.0° to the horizontal. A 3.0-newton force of friction, F_f, acts on the block as it is pulled up the ramp at constant velocity with force F, which is parallel to the ramp, as shown in the diagram below.



(Vectors not drawn to scale)

What is the magnitude of force F? (Skill 22)

A) 7.0 N B) 8.0 N
C) 10 N D) 13 N

351. If the kinetic energy of a given mass is to be doubled, its speed must be multiplied by..... (Hint: velocity is the dependent "y" variable and kinetic energy is the independent variable "x" in this question. Solve so solve in terms of the dependent variable) (Skill 28, Skill 19)

A) 8 B) 2 C) $\sqrt{2}$ D) 4

352. An object with a speed of 20. meters per second has a kinetic energy of 400. joules. The mass of the object is (Skill 28)

A) 1.0 kg B) 2.0 kg
C) 0.50 kg D) 40. kg

353. If the kinetic energy of a given mass is to be doubled, its speed must be multiplied by (Skill 28)

A) 8 B) 2 C) $\sqrt{2}$ D) 4

354. A 20.-newton block falls freely from rest from a point 3.0 meters above the surface of the Earth. With respect to the surface of the Earth, what is the gravitational potential energy of the block-Earth system after the block has fallen 1.5 meters? (Skill 28)

A) 20. J B) 30. J
C) 60. J D) 120 J

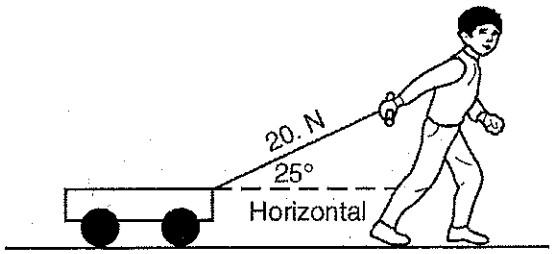
355. A spring gains 2.34 joules of elastic potential energy as it is compressed 0.250 meter from its equilibrium position. What is the spring constant of this spring? (Skill 28)

A) 9.36 N/m B) 18.7 N/m
C) 37.4 N/m D) 74.9 N/m

356. How much work is required to lift a 10.-newton weight from 4.0 meters to 40. meters above the surface of Earth? (Skill 29)

A) 2.5 J B) 3.6 J
C) 3.6×10^2 J D) 4.0×10^2 J

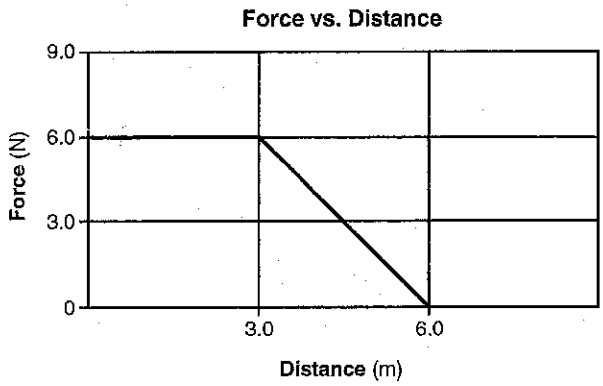
357. As shown in the diagram below, a child applies a constant 20.-newton force along the handle of a wagon which makes a 25° angle with the horizontal.



How much work does the child do in moving the wagon a horizontal distance of 4.0 meters? (Skill 29)

A) 5.0 J B) 34 J C) 73 J D) 80. J

358. A box is pushed to the right with a varying horizontal force. The graph below represents the relationship between the applied force and the distance the box moves.



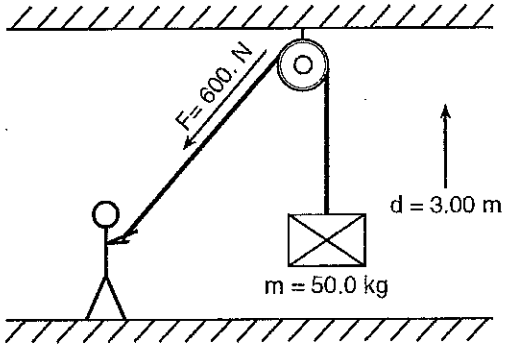
What is the total work done in moving the box 6.0 meters? (Skill 29)

A) 9.0 J B) 18 J C) 27 J D) 36 J

359. A horizontal force of 40 Newtons pushes a block along a level table at a constant speed of 2 meters per second. How much work is done on the block in 6 seconds? (Skill 29)

A) 80 J B) 120 J
C) 240 J D) 480 J

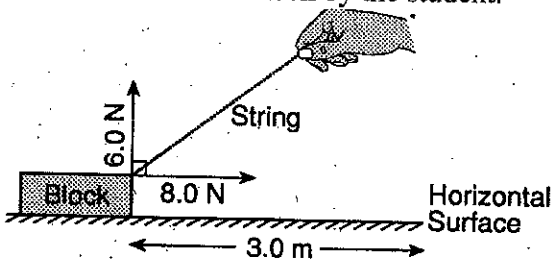
360. As shown in the diagram below, a student exerts an average force of 600. newtons on a rope to lift a 50.0-kilogram crate a vertical distance of 3.00 meters.



Compared to the work done by the student, the gravitational potential energy gained by the crate is (Skill 29, 32)

A) exactly the same B) 330 J less
C) 330 J more D) 150 J more

361. A student pulls a block 3.0 meters along a horizontal surface at constant velocity. The diagram below shows the components of the force exerted on the block by the student.



How much work is done against friction? (Skill 34)

A) 18 J B) 24 J C) 30. J D) 42 J

362. An electrical heater raises the temperature of a measured quantity of water. The water absorbs 6,000 joules of energy from the heater in 30.0 seconds. What is the minimum power supplied to the heater? (Skill 30)

A) 5.00×10^2 W B) 2.00×10^2 W
C) 1.80×10^5 W D) 2.00×10^3 W

363. A 70.-kilogram cyclist develops 210 watts of power while pedaling at a constant velocity of 7.0 meters per second east. What average force is exerted eastward on the bicycle to maintain this constant speed? (Skill 30)

A) 490 N B) 30. N
C) 3.0 N D) 0 N

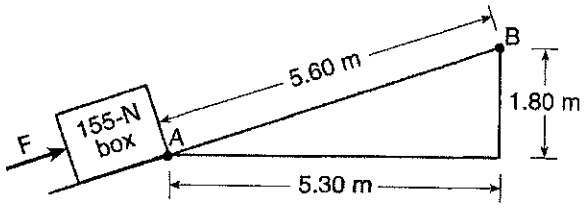
364. What is the power output of an electric motor that lifts a 2.0-kilogram block 15 meters vertically in 6.0 seconds? (Skill 30)

A) 5.0 J B) 5.0 W
C) 49 J D) 49 W

365. What is the average power developed by a motor as it lifts a 400.-kilogram mass at constant speed through a vertical distance of 10.0 meters in 8.0 seconds? (Skill 30)

A) 320 W B) 500 W
C) 4,900 W D) 32,000 W

366. The diagram below represents a 155-newton box on a ramp. Applied force F causes the box to slide from point A to point B.



What is the total amount of gravitational potential energy gained by the box? (Skill 29, 32)

A) 28.4 J B) 279 J
C) 868 J D) 2740 J

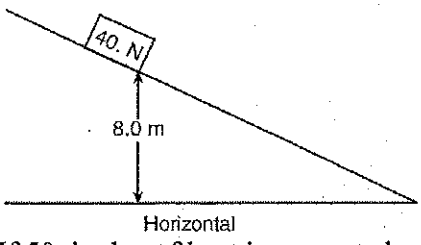
367. The diagram below shows a moving, 5.00-kilogram cart at the foot of a hill 10.0 meters high. For the cart to reach the top of the hill, what is the minimum kinetic energy of the cart in the position shown? [Neglect energy loss due to friction.] (Skill 31)

A) 4.91 J B) 50.0 J
C) 250. J D) 491 J

368. A 3.0-kilogram mass is attached to a spring having a spring constant of 30. newtons per meter. The mass is pulled 0.20 meter from the spring's equilibrium position and released. What is the maximum kinetic energy achieved by the mass spring system? (Skill 31)

A) 2.4 J B) 1.5 J
C) 1.2 J D) 0.60 J

369. A block weighing 40. newtons is released from rest on an incline 8.0 meters above the horizontal, as shown in the diagram below.



If 50. joules of heat is generated as the block slides down the incline, the maximum kinetic energy of the block at the bottom of the incline is (Skill 31)

A) 50. J B) 270 J
C) 320 J D) 3100 J

370. The current in a wire is 4.0 amperes. The time required for 2.5×10^{19} electrons to pass a certain point in the wire is (Skill 38, 34)

A) 1.0 s B) 0.25 s
C) 0.50 s D) 4.0 s

371. The current traveling from the cathode to the screen in a television picture tube is 5.0×10^{-5} ampere. How many electrons strike the screen in 5.0 seconds? (Skill 38, 34)

A) 3.1×10^{24} B) 6.3×10^{18}
C) 1.6×10^{15} D) 1.0×10^{5}

372. In a television set, an electron beam with a current of 5.0×10^{-6} ampere is directed at the screen. Approximately how many electrons are transferred to the screen in 60. seconds? (Skill 38, 34)

A) 1.2×10^{7} B) 5.3×10^{11}
C) 1.9×10^{15} D) 6.3×10^{18}

373. What is the resistance at 20.°C of a 2.0-meter length of tungsten wire with a cross-sectional area of 7.9×10^{-7} meter^2? (Skill 39)

A) $5.7 \times 10^{-1}\ \Omega$ B) $1.4 \times 10^{-1}\ \Omega$
C) $7.1 \times 10^{-2}\ \Omega$ D) $4.0 \times 10^{-2}\ \Omega$

374. What is the current in a 100.-ohm resistor connected to a 0.40-volt source of potential difference? (Skill 40)

A) 250 mA B) 40. mA
C) 2.5 mA D) 4.0 mA

375. Three identical lamps are connected in parallel with each other. If the resistance of each lamp is X ohms, what is the equivalent resistance of this parallel combination? (Skill 44)

A) $X\,\Omega$ B) $\frac{X}{3}\,\Omega$

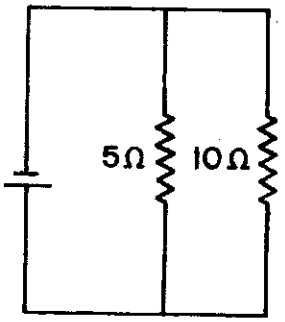
C) $3X\,\Omega$ D) $\frac{3}{X}\,\Omega$

376. A circuit consists of a 10.0-ohm resistor, a 15.0-ohm resistor, and a 20.0-ohm resistor connected in parallel across a 9.00-volt battery. What is the equivalent resistance of this circuit? (Skill 44)

A) 0.200 Ω B) 1.95 Ω

C) 4.62 Ω D) 45.0 Ω

377. The diagram below shows a resistor of 5 ohms and a resistor of 10 ohms connected in parallel in a circuit. What is the total resistance of the circuit? (Skill 44)



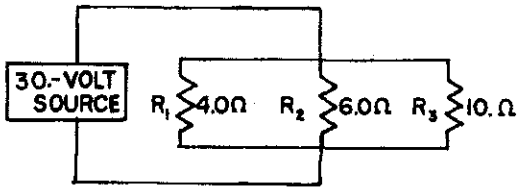
A) less than 5 ohms

B) 5 ohms

C) 15 ohms

D) greater than 15 ohms

378. Base your answer to the following question on the diagram below which represents an electrical circuit.



The current in R_1 is (Skill 44)

A) 3.8 A B) 7.5 A

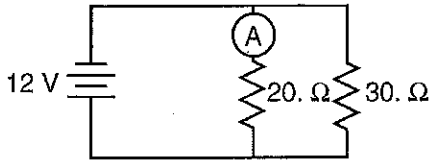
C) 15 A D) 60. A

379. In a series circuit containing two lamps, the battery supplies a potential difference of 1.5 volts. If the current in the circuit is 0.10 ampere, at what rate does the circuit use energy? (Skill 41)

A) 0.015 W B) 0.15 W

C) 1.5 W D) 15 W

Base your answers to questions **380** and **381** on the information and diagram below. A 20.-ohm resistor and a 30.-ohm resistor are connected in parallel to a 12-volt battery as shown. An ammeter is connected as shown.



380. What is the equivalent resistance of the circuit? (Skill 44)

A) 10. Ω B) 12 Ω
C) 25 Ω D) 50. Ω

381. What is the power of the 30.-ohm resistor? (Skill 41)

A) 4.8 W B) 12 W
C) 30. W D) 75 W

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382. The resistance of a 60.-watt lightbulb operated at 120 volts is approximately (Skill 41)

A) 720Ω B) 240Ω
C) 120Ω D) 60Ω

383. An electric heater operating at 120. volts draws 8.00 amperes of current through its 15.0 ohms of resistance. The total amount of heat energy produced by the heater in 60.0 seconds is (Skill 41)

A) 7.20×10^3 J B) 5.76×10^4 J
C) 8.64×10^4 J D) 6.91×10^6 J

384. An operating 75-watt lamp is connected to a 120-volt outlet. How much electrical energy is used by the lamp in 60. minutes? (Skill 41)

A) 4.5×10^3 J B) 2.7×10^5 J
C) 5.4×10^5 J D) 3.2×10^7 J

385. An electron is accelerated from rest through a potential difference of 200. volts. The work done on the electron is (Skill 41)

A) 8.00×10^{-3} eV B) 3.20×10^{-17} eV
C) 320. eV D) 200. eV

386. A helium ion with +2 elementary charges is accelerated by a potential difference of 5.0×10^3 volts. What is the kinetic energy acquired by the ion? (Skill 37)

A) 32×10^{-19} eV B) 2.0 eV
C) 5.0×10^3 eV D) 1.0×10^4 eV

387. What is the period of a sound wave having a frequency of 340. hertz? (Skill 50)

A) 3.40×10^2 s B) 1.02×10^0 s
C) 9.73×10^{-1} s D) 2.94×10^{-3} s

388. A beam of light has a wavelength of 4.5×10^{-7} meter in a vacuum. The frequency of this light is (Skill 51, 48)

A) 1.5×10^{-15} Hz
B) 4.5×10^{-7} Hz
C) 1.4×10^2 Hz
D) 6.7×10^{14} Hz

389. Orange light has a frequency of 5.0×10^{14} hertz in a vacuum. What is the wavelength of this light? (Skill 51)

A) 1.5×10^{23}m B) 1.7×10^{6}m
C) 6.0×10^{-7} m D) 2.0×10^{-15} m

390. How long will it take a light wave to travel a distance of 100. meters? (Skill 48, 51)

A) 3.00×10^{10} s B) 3.00×10^{8} s
C) 3.33×10^{-7} s D) 3.33×10^{7} s

391. What is the wavelength of a 2.50-kilohertz sound wave traveling at 326 meters per second through air? (Skill 50, 48)

A) 0.130 m B) 1.30 m
C) 7.67 m D) 130. m

392. At an outdoor physics demonstration, a delay of 0.50 seconds was observed between the time sound waves left a loudspeaker and the time these sound waves reached a student through the air. If the air is at STP, how far was the student from the speaker? (Skill 50)

A) 1.5×10^{-3} m B) 1.7×10^{2} m
C) 6.6×10^{2} m D) 1.5×10^{8} m

393. What is the total energy released when 9.11×10^{-31} kilogram of mass is converted into energy? (Skill 58)

A) 2.73×10^{-22} J
B) 8.20×10^{-14} J
C) 9.11×10^{-31} J
D) 1.01×10^{-47} J

394. What total mass must be converted into energy to produce a gamma photon with an energy of 1.03×10^{-13} joule? (Skill 58)

A) 1.14×10^{-30} kg
B) 3.43×10^{-22} kg
C) 3.09×10^{-5} kg
D) 8.75×10^{29} kg

395. The energy equivalent of the rest mass of an electron is approximately (Skill 58)

A) 5.1×10^{5} J B) 8.2×10^{-14} J
C) 2.7×10^{-22} J D) 8.5×10^{-28} J

396. What is the energy of a photon with a frequency of 5.00×10^{14} hertz? (Skill 57)

A) 3.32 eV B) 3.20×10^{-6} eV
C) 3.00×10^{48} J D) 3.32×10^{-19} J

397. An atom changing from an energy state of –0.54 eV to an energy state of –0.85 eV will emit a photon whose energy is (Skill 57)

A) 0.31 eV B) 0.54 eV
C) 0.85 eV D) 1.39 eV

398. A roller coaster, traveling with an initial speed of 15 meters per second, decelerates uniformly at –7.0 meters per second^2 to a full stop. Approximately how far does the roller coaster travel during its deceleration? (Skill 13)

A) 1.0 m B) 2.0 m
C) 16 m D) 32 m

399. A book of mass m falls freely from rest to the floor from the top of a desk of height h. What is the speed of the book upon striking the floor? (Skill 13, 14, 28)

A) $\sqrt{2gh}$ B) $2gh$
C) mgh D) mh

400. A ball is thrown straight downward with a speed of 0.50 meter per second from a height of 4.0 meters. What is the speed of the ball 0.70 second after it is released? [Neglect friction.] (Skill 14)

A) 0.50 m/s B) 7.4 m/s
C) 9.8 m/s D) 15 m/s

401. A 5.0-kilogram sphere, starting from rest, falls freely 22 meters in 3.0 seconds near the surface of a planet. Compared to the acceleration due to gravity near Earth's surface, the acceleration due to gravity near the surface of the planet is approximately (Skill 14 & 19)

A) the same
B) twice as great
C) one-half as great
D) four times as great

402. A rock falls from rest a vertical distance of 0.72 meter to the surface of a planet in 0.63 second. The magnitude of the acceleration due to gravity on the planet is (Skill 13)

A) 1.1 m/s^2 B) 2.3 m/s^2
C) 3.6 m/s^2 D) 9.8 m/s^2

403. Starting from rest, object A falls freely for 2.0 seconds, and object B falls freely for 4.0 seconds. Compared with object A, object B falls (Skill 13, 19)

A) one-half as far
B) twice as far
C) three times as far
D) four times as far

404. A laboratory cart with a mass of 5 kilograms rolls through a distance of 2 meters in 10 seconds. Which of the following mathematical statements can be used to determine the momentum? (Skill 20)

A) 5 kg × 2m/10s B) 5 kg × 10s/2m
C) 5kg + 2m/10s D) 5 kg + 10s/2m

405. A motorcycle being driven on a dirt path hits a rock. Its 60.-kilogram cyclist is projected over the handlebars at 20. meters per second into a haystack. If the cyclist is brought to rest in 0.50 second, the magnitude of the average force exerted on the cyclist by the haystack is (Skill 20)

A) 6.0×10^1 N B) 5.9×10^2 N
C) 1.2×10^3 N D) 2.4×10^3 N

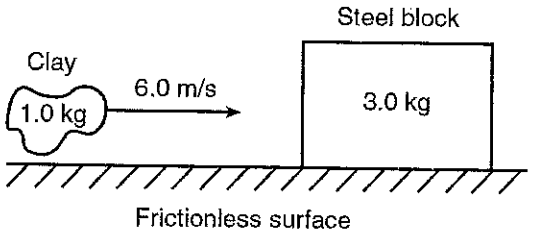
406. A 6.0-kilogram block, sliding to the east across a horizontal, frictionless surface with a momentum of 30. kilogram•meters per second, strikes an obstacle. The obstacle exerts an impulse of 10. newton•seconds to the west on the block. The speed of the block after the collision is (Skill 20)

A) 1.7 m/s B) 3.3 m/s
C) 5.0 m/s D) 20. m/s

407. A 2.0-kilogram laboratory cart is sliding across a horizontal frictionless surface at a constant velocity of 4.0 meters per second east. What will be the cart's velocity after a 6.0-newton westward force acts on it for 2.0 seconds? (Skill 20)

A) 2.0 m/s east B) 2.0 m/s west
C) 10. m/s east D) 10. m/s west

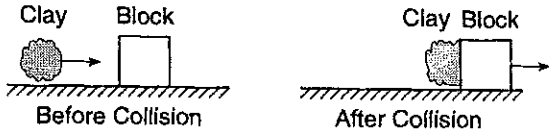
408. A 3.0-kilogram steel block is at rest on a friction-less horizontal surface. A 1.0-kilogram lump of clay is propelled horizontally at 6.0 meters per second toward the block as shown in the diagram below.



Upon collision, the clay and steel block stick together and move to the right with a speed of (Skill 27)

A) 1.5 m/s B) 2.0 m/s
C) 3.0 m/s D) 6.0 m/s

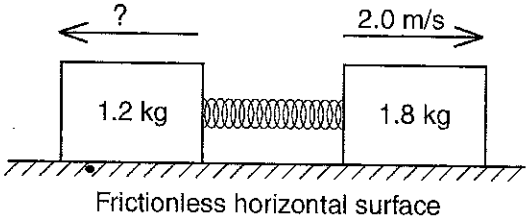
409. As shown in the diagrams below, a lump of clay travels horizontally to the right toward a block at rest on a frictionless surface. Upon collision, the clay and the block stick together and move to the right.



Compared to the total momentum of the clay and the block before the collision, the momentum of the clay-block system after the collision is (Skill 27)

A) less B) greater
C) the same

410. A 1.2-kilogram block and a 1.8-kilogram block are initially at rest on a frictionless, horizontal surface. When a compressed spring between the blocks is released, the 1.8-kilogram block moves to the right at 2.0 meters per second, as shown.



What is the speed of the 1.2-kilogram block after the spring is released? (Skill 26)

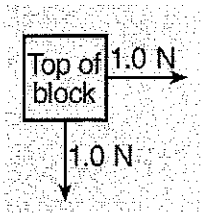
A) 1.4 m/s B) 2.0 m/s
C) 3.0 m/s D) 3.6 m/s

411. A rock is thrown straight up into the air. At the highest point of the rock's path, the magnitude of the net force acting on the rock is (Skill 5)

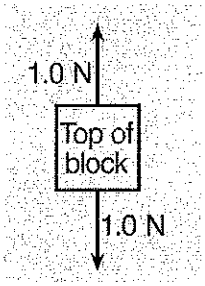
A) less than the magnitude of the rock's weight, but greater than zero
B) greater than the magnitude of the rock's weight
C) the same as the magnitude of the rock's weight
D) zero

412. A number of 1.0-newton horizontal forces are exerted on a block on a frictionless, horizontal surface. Which top-view diagram shows the forces producing the greatest magnitude of acceleration of the block? (Skill 21)

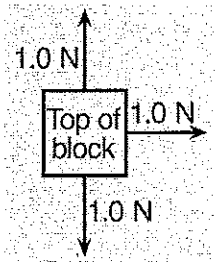
A)



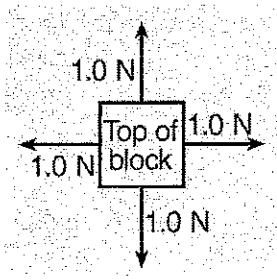
B)



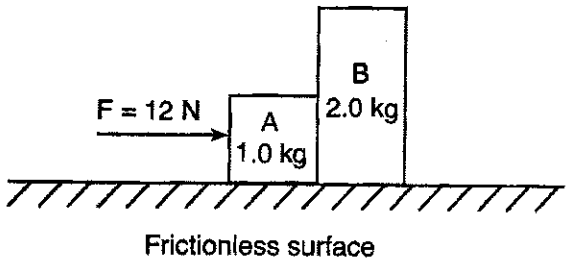
C)



D)



413. The diagram below shows a horizontal 12-newton force being applied to two blocks, *A* and *B*, initially at rest on a horizontal, frictionless surface. Block *A* has a mass of 1.0 kilogram and block *B* has a mass of 2.0 kilograms.



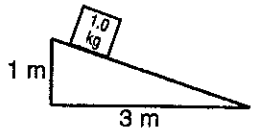
The magnitude of the acceleration of block *B* is (Skill 20)

A) 6.0 m/s^2 B) 2.0 m/s^2

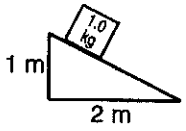
C) 3.0 m/s^2 D) 4.0 m/s^2

414. A 1.0-kilogram block is placed on each of four frictionless planes inclined at different angles. On which inclined plane will the acceleration of the block be greatest? (Skill 22)

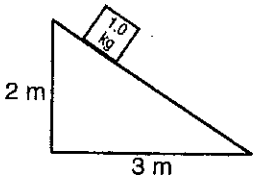
A)



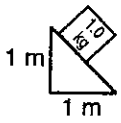
B)



C)



D)



415. As a meteor moves from a distance of 16 Earth radii to a distance of 2 Earth radii from the center of Earth, the magnitude of the gravitational force between the meteor and Earth becomes (Skill 9, 26)

A) $\frac{1}{8}$ as great B) 8 times as great

C) 64 times as great D) 4 times as great

416. A 2.00-kilogram object weighs 19.6 newtons on Earth. If the acceleration due to gravity on Mars is 3.71 meters per second^2, what is the object's mass on Mars? (Skill 20)

A) 2.64 kg B) 2.00 kg
C) 19.6 N D) 7.42 N

417. Base your answer to the following question on the information and table below.

The weight of an object was determined at five different distances from the center of Earth. The results are shown in the table below. Position *A* represents results for the object at the surface of Earth.

Position	Distance from Earth's Center (m)	Weight (N)
A	6.37×10^6	1.0×10^3
B	1.27×10^7	2.5×10^2
C	1.91×10^7	1.1×10^2
D	2.55×10^7	6.3×10^1
E	3.19×10^7	4.0×10^1

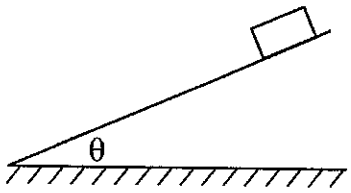
At what distance from the center of Earth is the weight of the object approximately 28 newtons? (Skill 26)

A) 3.5×10^7 m B) 3.8×10^7 m C) 4.1×10^7 m D) 4.5×10^7 m

418. An 8.0-newton wooden block slides across a horizontal wooden floor at constant velocity. What is the magnitude of the force of kinetic friction between the block and the floor? (Skill 23)

A) 2.4 N B) 3.4 N
C) 8.0 N D) 27 N

419. The diagram below shows a block sliding down a plane inclined at angle θ with the horizontal.



As angle θ is increased, the coefficient of kinetic friction between the bottom surface of the block and the surface of the incline will (Skill 23&22)

A) decrease B) increase
C) remain the same

420. What is the minimum horizontal force needed to start a 300. kilogram steel block on a steel table in motion? (Skill 23)

A) 5.70 N B) 7.40 N
C) 1710 N D) 2220 N

421. Jim wishes to push a 100. N wood crate across a wood floor. What is the minimum horizontal force that would be required to start the crate moving? (Skill 23)

A) 30. N B) 42 N
C) 72 N D) 100 N

422. Two 20.-newton forces act concurrently on an object. What angle between these forces will produce a resultant force with the greatest magnitude? (Skill 22)

A) 0° B) 45°
C) 90.° D) 180.°

423. Two concurrent forces have a maximum resultant of 45 Newtons and a minimum resultant of 5 Newtons. What is the magnitude of each of these forces? (Skill 22)

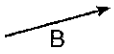
A) 0 N and 45 N B) 5 N and 9 N
C) 20. N and 25 N D) 0 N and 50. N

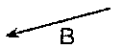
424. An airplane flies with a velocity of 750. kilometers per hour, 30.0° south of east. What is the magnitude of the eastward component of the plane's velocity? (Skill 8 & 10)

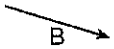
A) 866 km/h B) 650 km/h
C) 433 km/h D) 375km/h

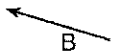
425. The diagram below represents a force vector, A and resultant vector, R.

Which force vector B below could be added to force vector A to produce resultant vector, R. (Skill 22)

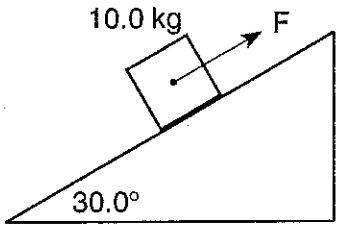
A) 

B) 

C) 

D) 

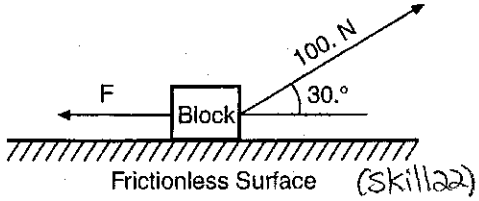
426. The diagram below shows a 10.0-kilogram mass held at rest on a frictionless 30.0° incline by force F.



What is the approximate magnitude of force F? (Skill 22)

A) 9.81 N
B) 49.1 N
C) 85.0 N
D) 98.1 N

427. The diagram below shows a block on a horizontal frictionless surface. A 100.- newton force acts on the block at an angle of 30.° above the horizontal.



(Skill 22)

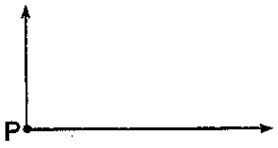
What is the magnitude of force F if it establishes equilibrium?

A) 50.0 N
B) 86.6 N
C) 100. N
D) 187 N

428. The vector below represents the resultant of two forces acting concurrently on an object at point P.

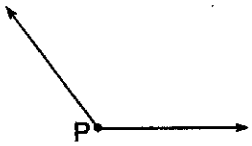
Which pair of vectors best represents two concurrent forces that combine to produce this resultant force vector? (Skill 21)

A)

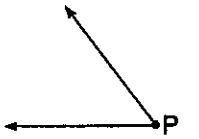


B)

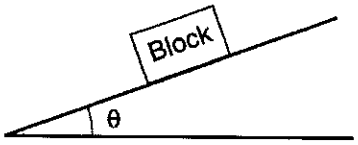
C)



D)



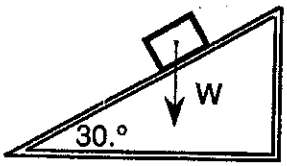
429. In the diagram below, a block rests on a ramp, making angle Θ with the horizontal.



If angle Θ is increased, what will occur? (Skill 22)

A) The block's mass will decrease.
B) The block's weight will increase.
C) The block's component of weight parallel to the ramp will decrease.
D) The block's component of weight parallel to the ramp will increase.

430. In the diagram below, the weight of a box on a plane inclined at 30. is represented by the vector W.



What is the magnitude of the component of the weight (W) that acts parallel to the incline? (skill22)

A) W B) 0.50 W
C) 0.87 W D) 1.5 W

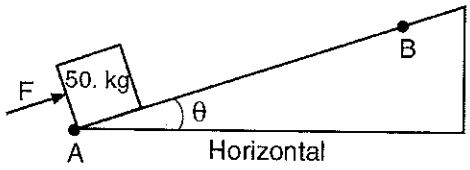
431. During an emergency stop, a 1.5×10^3-kilogram car lost a total of 3.0×10^5 joules of kinetic energy. What was the speed of the car at the moment the brakes were applied? (Skill 28)

A) 10. m/s B) 14 m.s
C) 20. m/s D) 25 m/s

432. Which statement describes the kinetic energy and total mechanical energy of a block as it is pulled at constant speed up an incline? (Skill 31)

A) Kinetic energy decreases and total mechanical energy increases.
B) Kinetic energy decreases and total mechanical energy remains the same.
C) Kinetic energy remains the same and total mechanical energy increases.
D) Kinetic energy remains the same and total mechanical energy remains the same.

433. The diagram below shows a 50.-kilogram crate on a frictionless plane at angle θ to the horizontal. The crate is pushed at constant speed up the incline from point A to point B by force F.



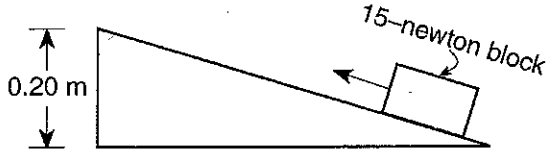
If angle θ were increased, what would be the effect on the magnitude of force F and the total work W done on the crate as it is moved from A to B? (Skill 29, 30)

A) W would remain the same and the magnitude of F would decrease.
B) W would remain the same and the magnitude of F would increase.
C) W would increase and the magnitude of F would decrease.
D) W would increase and the magnitude of F would increase.

434. A horizontal force of 40 Newtons pushes a block along a level table at a constant speed of 2 meters per second. How much work is done on the block in 6 seconds? (Skill 29)

A) 80 J B) 120 J
C) 240 J D) 480 J

435. A block weighing 15 Newtons is pulled to the top of an incline that is 0.20 meter above the ground, as shown below.



If 4.0 joules of work are needed to pull the block the full length of the incline, how much work is done against friction? (Skill 29, 30)

A) 1.0 J B) 0.0 J C) 3.0 J D) 7.0 J

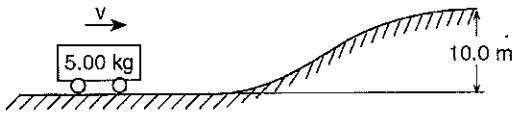
436. The rate at which work is done is measured in (Skill 30)

A) Newtons B) joules
C) calories D) watts

437. A 95-kilogram student climbs 4.0 meters up a rope in 3.0 seconds. What is the power output of the student? (Skill 30)

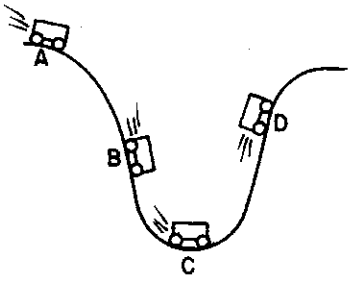
A) 1.3×10^2 W B) 3.8×10^2 W
C) 1.2×10^3 W D) 3.7×10^3 W

438. The diagram below shows a moving, 5.00-kilogram cart at the foot of a hill 10.0 meters high. For the cart to reach the top of the hill, what is the minimum kinetic energy of the cart in the position shown? [Neglect energy loss due to friction.] (Skill 31)



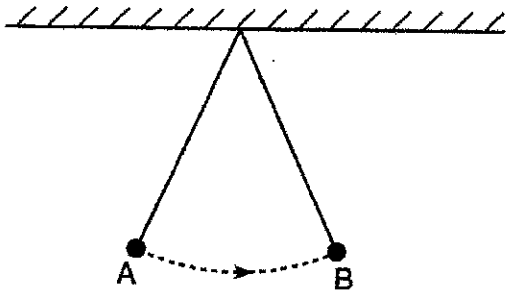
A) 4.91 J B) 50.0 J
C) 250. J D) 491 J

439. The diagram below shows a cart at four positions as it moves along a frictionless track. At which positions is the sum of the potential energy and kinetic energy of the cart the same? (Skill 31)



A) *A* and *B*, only
B) *B* and *C*, only
C) *C* and *D*, only
D) all positions, *A* through *D*

440. In the diagram below, an ideal pendulum released from position A swings freely to position B.



As the pendulum swings from A to B, its total mechanical energy (Skill 31)

A) decreases , then increases
B) increases, only
C) increases, then decreases
D) remains the same

441. A 55.0-kilogram diver falls freely from a diving platform that is 3.00 meters above the surface of the water in a pool. When she is 1.00 meter above the water, what are her gravitational potential energy and kinetic energy with respect to the water's surface? (Skill 31)

A) $PE = 1620$ J and $KE = 0$ J
B) $PE = 1080$ J and $KE = 540$ J
C) $PE = 810$ J and $KE = 810$ J
D) $PE = 540$ J and $KE = 1080$ J

442. As an object falls freely, the kinetic energy of the object (Skill 31)

A) decreases
B) increases
C) remains the same

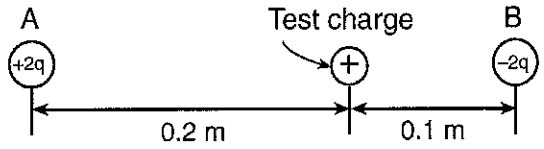
443. As a block slides across a table, its speed decreases while its temperature increases. Which two changes occur in the block's energy as it slides? (Skill 32)

A) a decrease in kinetic energy and an increase in internal energy
B) an increase in kinetic energy and a decrease in internal energy
C) a decrease in both kinetic energy and internal energy
D) an increase in both kinetic energy and internal energy

444. A metal sphere having an excess of +5 elementary charges has a net electric charge of (Skill 34)

A) 1.6×10^{-19} C
B) 8.0×10^{-19} C
C) 5.0×10^{0} C
D) 3.2×10^{19} C

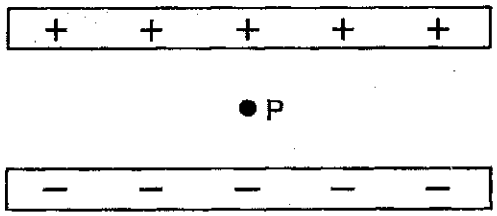
445. In the diagram below, a positive test charge is located between two charged spheres, A and B. Sphere A has a charge of $+2q$ and is located 0.2 meter from the test charge. Sphere B has a charge of $-2q$ and is located 0.1 meter from the test charge.



If the magnitude of the force on the test charge due to sphere A is F, what is the magnitude of the force on the test charge due to sphere B? (Skill 35)

A) $\frac{F}{4}$ B) 2F C) $\frac{F}{2}$ D) 4F

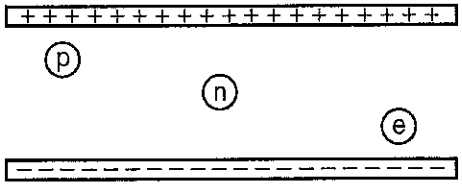
446. The diagram below shows a point, P, located midway between two oppositely charged parallel plates.



If an electron is introduced at point P, the electron will (Skill 36)

A) travel at constant speed toward the positively charged plate
B) travel at constant speed toward the negatively charged plate
C) accelerate toward the positively charged plate
D) accelerate toward the negatively charged plate

447. In the diagram below, proton p, neutron n, and electron e are located as shown between two oppositely charged plates.



The magnitude of acceleration will be greatest for the (Skill 36)

A) neutron, because it has the greatest mass
B) neutron, because it is neutral
C) electron, because it has the smallest mass
D) proton, because it is farthest from the negative plate

448. What is the current in a wire if 3.4×10^{19} electrons pass by a point in this wire every 60. seconds? (Skill 38)

A) 1.8×10^{-18} A B) 3.1×10^{-11} A
C) 9.1×10^{-2} A D) 11 A

449. The current through a lightbulb is 2.0 amperes. How many coulombs of electric charge pass through the lightbulb in one minute? (Skill 38)

A) 60. C B) 2.0 C
C) 120 C D) 240 C

450. A manufacturer recommends that the longer the extension cord used with an electric drill, the thicker (heavier gauge) the extension cord should be. This recommendation is made because the resistance of a wire varies (Skill 39)

A) directly with length and inversely with cross-sectional area
B) inversely with length and directly with cross-sectional area
C) directly with both length and cross-sectional area
D) inversely with both length and cross-sectional area

451. Which change decreases the resistance of a piece of copper wire? (Skill 39)

A) increasing the wire's length
B) increasing the wire's resistivity
C) decreasing the wire's temperature
D) decreasing the wire's diameter

452. An incandescent light bulb is supplied with a constant potential difference of 120 volts. As the filament of the bulb heats up, its resistance (Skill 39)

A) increases and the current through it decreases
B) increases and the current through it increases
C) decreases and the current through it decreases
D) decreases and the current through it increases

453. If the diameter of a wire were halved, its electrical resistance would (Skill 39)

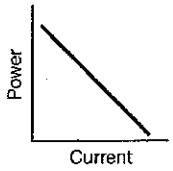
A) quarter
B) quadruple
C) double
D) halve

454. A 400.-ohm resistor is connected to a 9.00-volt battery. The current through the resistor is (Skill 40)

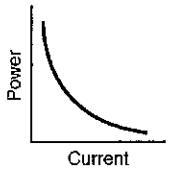
A) 0.225 mA
B) 22.5 mA
C) 44.4 mA
D) 3600 mA

455. Which graph best represents the relationship between the electrical power and the current in a resistor that obeys Ohms Law? (Skill 40)

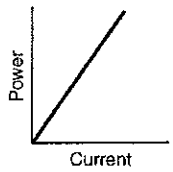
A)



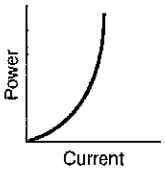
B)



C)



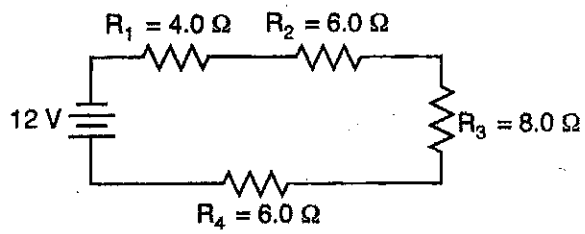
D)



456. As more resistors are added in series across a battery, the potential drop across each resistor (Skill 43)

A) decreases
B) increases
C) remains the same

457. The circuit diagram below represents four resistors connected to a 12-volt source.



What is the total current in the circuit? (Skill 43)

A) 0.50 A
B) 2.0 A
C) 8.6 A
D) 24 A

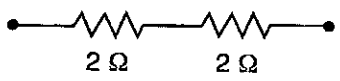
458. A 3-ohm resistor and a 6-ohm resistor are connected in parallel across a 9-volt battery. Which statement best compares the potential difference across each resistor? (Skill 44)

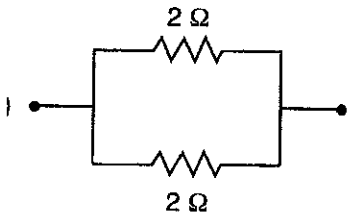
A) The potential difference across the 6-ohm resistor is the same as the potential difference across the 3-ohm resistor.
B) The potential difference across the 6-ohm resistor is twice as great as the potential difference across the 3-ohm resistor.
C) The potential difference across the 6-ohm resistor is half as great as the potential difference across the 3-ohm resistor.
D) The potential difference across the 6-ohm resistor is four times as great as the potential difference across the 3-ohm resistor.

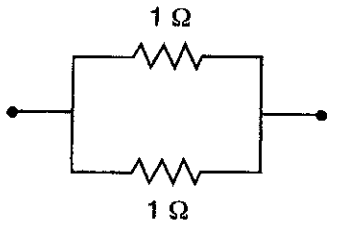
459. As the number of resistors connected in parallel to a constant voltage source is increased, the potential difference across each resistor (Skill 44)

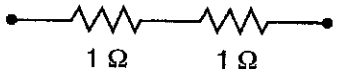
A) decreases
B) increases
C) remains the same

460. Which combination of resistors has the *smallest* equivalent resistance? (Skill 43 & 44)

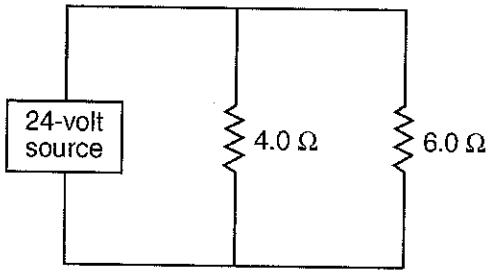
A)


B)


C)


D)


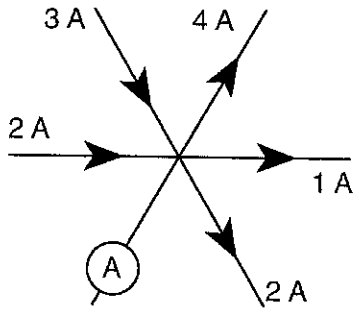
461. Base your answer to the following question on the circuit diagram below, which shows two resistors connected to a 24-volt source of potential difference.



What is the total resistance of the circuit?

A) 0.42 B) 2.4 C) 5.0 D) 10 (Skill 44)

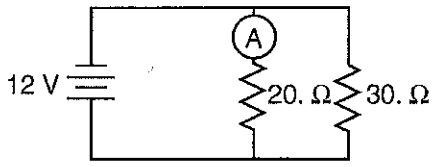
462. The diagram below represents currents in a segment of an electric circuit.



What is the reading of ammeter *A*? (Skill 45)

A) 1 A B) 2 A C) 3 A D) 4 A

463. Base your answer to the following question on the information and diagram below. A 20.-ohm resistor and a 30.-ohm resistor are connected in parallel to a 12-volt battery as shown. An ammeter is connected as shown.



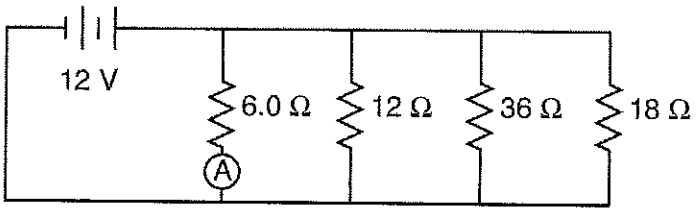
What is the current reading of the ammeter? (Skill 44)

A) 1.0 A
B) 0.60 A
C) 0.40 A
D) 0.20 A

464. As the number of resistors in a parallel circuit is increased, what happens to the equivalent resistance of the circuit and total current in the circuit? (Skill 44)

A) Both equivalent resistance and total current decrease.
B) Both equivalent resistance and total current increase.
C) Equivalent resistance decreases and total current increases.
D) Equivalent resistance increases and total current decreases.

465. Base your answer to the following question on the diagram below, which represents an electric circuit consisting of four resistors and a 12-volt battery.



How much power is dissipated in the 36-ohm resistor? (Skill 41, 44)

A) 110 W B) 48 W C) 3.0 W D) 4.0 W

466. A light bulb operating at 120 volts draws a current of 0.50 ampere for 240 seconds. The power rating of the light bulb is (Skill 41)

A) 30. W B) 60. W
C) 75 W D) 120 W

467. A potential drop of 50. volts is measured across a 250-ohm resistor. What is the power developed in the resistor? (Skill 41)

A) 0.20 W B) 5.0 W
C) 10. W D) 50. W

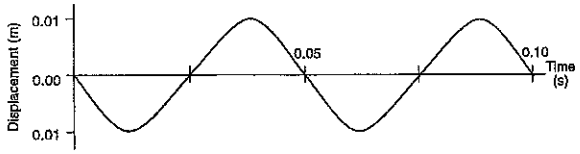
468. Which object will have the greatest change in electrical energy? (Skill 41)

A) an electron moved through a potential difference of 2.0 V
B) a metal sphere with a charge of 1.0×10^{-9} C moved through a potential difference of 2.0 V
C) an electron moved through a potential difference of 4.0 V
D) a metal sphere with a charge of 1.0×10^{-9} C moved through a potential difference of 4.0 V

469. An elementary charge is accelerated by a potential difference of 9.0 volts. The total energy acquired by the charge is

A) 9.0 eV B) 12 eV
C) 3.0 eV D) 27 eV

470. The graph below shows displacement versus time for a particle of a uniform medium as a wave passes through the medium.



What is the frequency of the wave? (Skill 48)

A) 10 Hz B) 20 Hz
C) 50 Hz D) 100 Hz

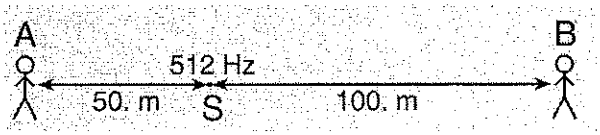
471. A sound wave traveling eastward through air causes the air molecules to (Skill 50)

A) vibrate east and west
B) vibrate north and south
C) move eastward, only
D) move northward, only

472. A distance of 1.0×10^{-2} meter separates successive crests of a periodic wave produced in a shallow tank of water. If a crest passes a point in the tank every 4.0×10^{-1} second, what is the speed of this wave? (Skill 48)

A) 2.5×10^{-4} m/s B) 4.0×10^{-3} m/s
C) 2.5×10^{-2} m/s D) 4.0×10^{-1} m/s

473. In the diagram below, a stationary source located at point S produces sound having a constant frequency of 512 hertz. Observer A, 50. meters to the left of S, hears a frequency of 512 hertz. Observer B, 100. meters to the right of S, hears a frequency lower than 512 hertz.



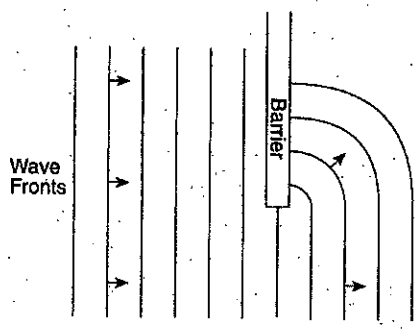
Which statement best describes the motion of the observers? (Skill 54)

A) Observer A is moving toward point S, and observer B is stationary.
B) Observer A is moving away from point S, and observer B is stationary.
C) Observer A is stationary, and observer B is moving toward point S.
D) Observer A is stationary, and observer B is moving away from point S.

474. A source of waves and an observer are moving relative to each other. The observer will detect a steadily increasing frequency if (Skill 54)

A) he moves toward the source at a constant speed
B) the source moves away from him at a constant speed
C) he accelerates toward the source
D) the source accelerates away from him

475. The diagram below shows a wave phenomenon.



The pattern of waves shown behind the barrier is the result of (Skill 52)

A) reflection
B) refraction
C) diffraction
D) interference

476. The time required for light to travel a distance of 1.5×10^{11} meters is closest to (Skill 51, 48)

A) 5.0×10^{2} s
B) 2.0×10^{-3} s
C) 5.0×10^{-1} s
D) 4.5×10^{19} s

477. Which phenomenon provides evidence that light has a wave nature? (Skill 57)

A) emission of light from an energy-level transition in a hydrogen atom
B) diffraction of light passing through a narrow opening
C) absorption of light by a black sheet of paper
D) reflection of light from a mirror

478. Which phenomenon is best explained by the wave theory? (Skill 52, 57)

A) reflection
B) illumination
C) interference
D) the photoelectric effect

479. Which phenomenon can *not* be exhibited by longitudinal waves? (Skill 52)

A) reflection
B) refraction
C) diffraction
D) polarization

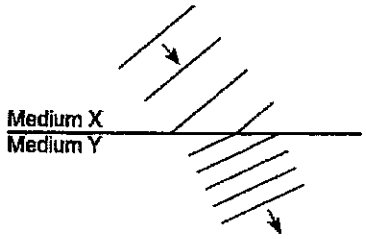
480. A change in the speed of a wave as it enters a new medium produces a change in (Skill 52, 56)

A) frequency
B) period
C) wavelength
D) phase

481. What happens to the frequency and the speed of an electromagnetic wave as it passes from air into glass? (Skill 52 to 56)

A) The frequency decreases and the speed increases.
B) The frequency increases and the speed decreases.
C) The frequency remains the same and the speed increases.
D) The frequency remains the same and the speed decreases.

482. The diagram below represents wave fronts traveling from medium *X* into medium *Y*.



All points on any one wave front shown must be (Skill 52-56)

A) traveling with the same speed
B) traveling in the same medium
C) in phase
D) superposed

483. What is the speed of light ($f = 5.09 \times 10^{14}$ Hz) in ethyl alcohol? (Skill 51)

A) 4.53×10^{-9} m/s B) 2.43×10^{2} m/s
C) 1.24×10^{8} m/s D) 2.21×10^{8} m/s

484. As yellow light ($f = 5.09 \times 10\ 14$ Hz) travels from zircon into diamond, the speed of the light (Skill 51)

A) decreases
B) increases
C) remains the same

485. What is the speed of light in a medium having an absolute index of refraction of 2.3? (Skill 51)

A) 0.77×10^{8} m/s B) 1.3×10^{8} m/s
C) 1.5×10^{8} m/s D) 2.3×10^{8} m/s

486. Moving electrons are found to exhibit properties of (Skill 57)

A) particles, only
B) waves, only
C) both particles and waves
D) neither particles nor waves

487. Light demonstrates the characteristics of (Skill 57)

A) particles, only
B) waves, only
C) both particles and waves
D) neither particles nor waves

488. What is the energy equivalent of a mass of 0.026 kilogram? (Skill 58)

A) 2.34×10^{15} J B) 2.3×10^{15} J
C) 2.34×10^{17} J D) 2.3×10^{17} J

489. A photon is emitted as the electron in a hydrogen atom drops from the $n = 5$ energy level directly to the $n = 3$ energy level. What is the energy of the emitted photon? (Skill 57)

A) 0.85 eV B) 0.97 eV
C) 1.51 eV D) 2.05 eV

490. Which type of photon is emitted when an electron in a hydrogen atom drops from the $n = 3$ to the $n = 2$ energy level? (Skill 57)

A) ultraviolet B) infrared
C) radio wave D) visible light

491. The bright-line emission spectrum of an element can best be explained by (Skill 57)

A) electrons transitioning between discrete energy levels in the atoms of that element
B) protons acting as both particles and waves
C) electrons being located in the nucleus
D) protons being dispersed uniformly throughout the atoms of that element

492. A top quark has an approximate charge of (Skill 47)

A) -1.07×10^{-19} C B) -2.40×10^{-19} C
C) $+1.07 \times 10^{-19}$ C D) $+2.40 \times 10^{-19}$ C

493. The composition of a meson with a charge of –1 elementary charge could be (Skill 47)

A) $s\bar{c}$ B) dss
C) $u\bar{b}$ D) $\bar{u}\,\bar{c}\,\bar{d}$

494. Compared to the mass and charge of a proton, an antiproton has (Skill 47, 58)

A) the same mass and the same charge
B) greater mass and the same charge
C) the same mass and the opposite charge
D) greater mass and the opposite charge

495. The concept that electrons exhibit wave properties can best be demonstrated by the (Skill 57)

A) emission of photoelectrons
B) scattering of alpha particles by electrons
C) collisions between photons and electrons
D) production of electron interference patterns

496. What is the minimum total energy released when an electron and its antiparticle (positron) annihilate each other? (Skill 58)

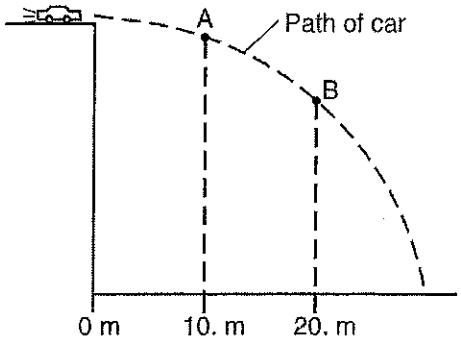
A) 1.64×10^{-13}J B) 8.20×10^{-14}J
C) 5.47×10^{-22}J D) 2.73×10^{-22}J

497. A golf ball is hit at an angle of 40.0° above the horizontal. The horizontal component of the golf ball's initial velocity is 16.0 meters per second. What is the magnitude of the ball's initial velocity? (Skill 18)

A) 12.3 m/s B) 24.9 m/s
C) 20.9 m/s D) 10.3 m/s

498. **Note that the question below only has three choices.**

The diagram below represents the path of a stunt car that is driven off a cliff, neglecting friction.

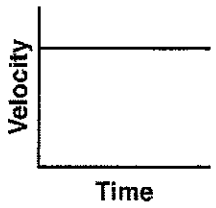


Compared to the horizontal component of the car's velocity at point A, the horizontal component of the car's velocity at point B is (Skill 16)

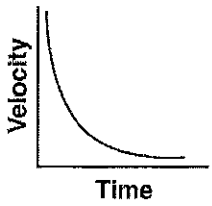
A) smaller
B) greater
C) the same

499. Which graph best represents the relationship between the velocity of an object thrown straight upward from Earth's surface and the time that elapses while it is in the air? [Neglect friction.] (Skill 15)

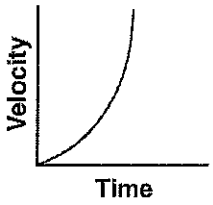
A)



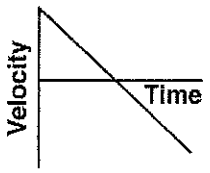
B)



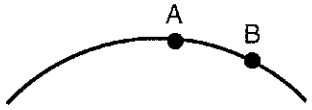
C)



D)



500. The diagram below represents the path of an object after it was thrown.



What happens to the object's acceleration as it travels from *A* to *B*? [Neglect friction.] (Skill 17)

A) It decreases.
B) It increases.
C) It remains the same.

501. A projectile is launched at an angle above the ground. The horizontal component of the projectile's velocity, v_x, is initially 40. meters per second. The vertical component of the projectile's velocity, v_y, is initially 30. meters per second. What are the components of the projectile's velocity after 2.0 seconds of flight? [Neglect friction.] (Skill 17)

A) $v_x = 40.$ m/s and $v_y = 10.$ m/s
B) $v_x = 40.$ m/s and $v_y = 30.$ m/s
C) $v_x = 20.$ m/s and $v_y = 10.$ m/s
D) $v_x = 20.$ m/s and $v_y = 30.$ m/s

502. A soccer ball kicked on a level field has an initial vertical velocity component of 15.0 meters per second. Assuming the ball lands at the same height from which it was kicked, what is the total time the ball is in the air? [Neglect friction.] (Skill 17)

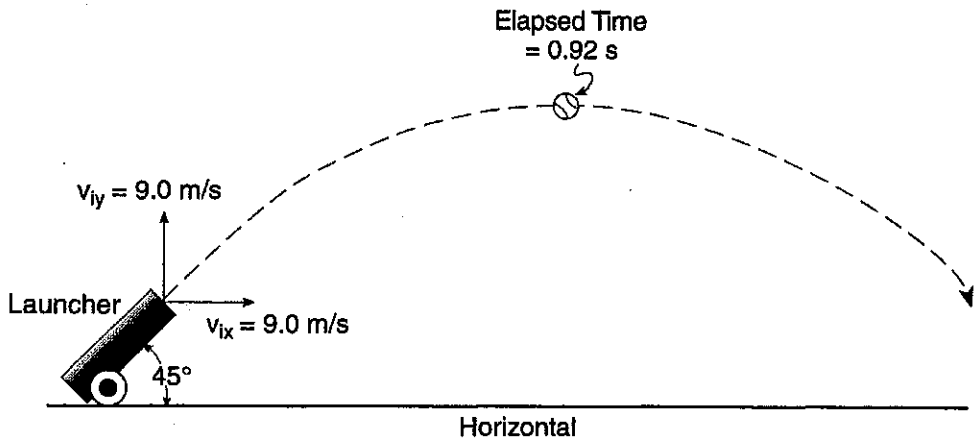
A) 0.654 s
B) 1.53 s
C) 3.06 s
D) 6.12

503. A ball thrown vertically upward reaches a maximum height of 30. meters above the surface of Earth. At its maximum height, the speed of the ball is (Skill 15)

A) 0.0 m/s
B) 9.8 m/s
C) 3.1 m/s
D) 24 m/s

504. Base your answer to the following question on the diagram and information below.

A machine launches a tennis ball at an angle of 45° with the horizontal, as shown. The ball has an initial vertical velocity of 9.0 meters per second and an initial horizontal velocity of 9.0 meters per second. The ball reaches its maximum height 0.92 second after its launch. [Neglect air resistance and assume the ball lands at the same height above the ground from which it was launched.]



The speed at which the launcher fires tennis balls is constant, but the angle between the launcher and the horizontal can be varied. As the angle is decreased from 45° to 30.°, the range of the tennis balls (Skill 7)

A) decreases
B) increases
C) remains the same

505. Four cannonballs, each with mass M and initial velocity V, are fired from a cannon at different angles relative to the Earth. Neglecting air friction, which angular direction of the cannon produces the greatest projectile height? (Skill 7)

A) 90° B) 70° C) 45° D) 20°

506. Base your answer to the following question on the information below.

A ball is projected vertically upward from the surface of the Earth with an initial speed of +49 meters per second. The ball reaches its maximum height in 5.0 seconds. (Disregard air resistance.)

What is the maximum height reached by the ball? (Skill 15)

A) 24.5 m B) 49.0 m
C) 122.5 m D) 245 m

507. An object travels in a circular orbit. If the speed of the object is doubled, its centripetal acceleration will be (Skill 25)

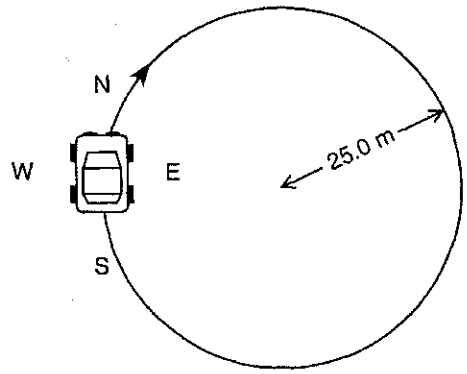
A) halved B) doubled
C) quartered D) quadrupled

508. The magnitude of the centripetal force acting on an object traveling in a horizontal, circular path will *decrease* if the (Skill 25)

A) radius of the path is increased
B) mass of the object is increased
C) direction of motion of the object is reversed
D) speed of the object is increased

509. Base your answer to the following question on the information and diagram below.

A 1.00×10^3 -kilogram car is driven clockwise around a flat circular track of radius 25.0 meters. The speed of the car is a constant 5.00 meters per second.



What minimum friction force must exist between the tires and the road to prevent the car from skidding as it rounds the curve? (Skill 25)

A) 1.25×10^5 N B) 9.80×10^4 N
C) 5.00×10^3 N D) 1.00×10^3 N