61. The density of a solid object is defined as the ratio of the mass of the object to its volume. The dimension of density is

A) [M]/[L].  
B) [L]^3/[M].  
C) [M]/[L]^3.  
D) [M][L][T].  
E) [M][L].

62. Refer to the above figure. Vector \( \mathbf{S} \) as expressed in terms of vectors \( \mathbf{M} \) and \( \mathbf{N} \) is given by

A) \( \mathbf{M} + \mathbf{N} \).  
B) \( \mathbf{M} - \mathbf{N} \).  
C) \( \mathbf{M} \).  
D) \( \mathbf{N} \).  
E) \( 2\mathbf{N} \).

63. A car traveling with velocity \( v \) is decelerated by a constant acceleration of magnitude \( a \). It travels a distance \( d \) before coming to rest. If its initial velocity were increased by a factor of two, the distance required to stop would

A) double.  
B) decrease by a factor of two.  
C) stay the same.  
D) quadruple.
E) decrease by a factor of four.

64. A ball with mass \( m = 1 \text{ kg} \) is thrown in the trajectory shown in the figure below with initial velocities \( V_{0x} = 40 \text{ m/s} \) and \( V_{0y} = 30 \text{ m/s} \) in the x- and y-axis respectively. (Use \( g = 10 \text{ m/s}^2 \)). Calculate the range \( R \), in meters,

\[

\begin{align*}
A) & \quad 30 \text{ m} \\
B) & \quad 120 \text{ m} \\
C) & \quad 150 \text{ m} \\
D) & \quad 200 \text{ m} \\
E) & \quad 240 \text{ m}
\end{align*}
\]

65. Refer to the above figure. Block A has a mass of \( 3.00 \text{ kg} \) and rests on a smooth table and is connected to block B, which has a mass of \( 2.00 \text{ kg} \), after passing over an ideal pulley, as shown. Block B is released from rest. How long does it take block B to travel 80.0 cm? (Use \( g = 9.8 \text{ m/s}^2 \))

A) 0.935 s \\
B) 0.639 s \\
C) 0.785 s \\
D) 0.594 s \\
E) 0.494 s

66. A locomotive is pulling three wagons along a level track with a force of \( F = 100,000 \text{ N} \). The wagon next to the locomotive has a mass of \( m_1 = 80,000 \text{ kg} \), the next one, \( m_2 = 50,000 \text{ kg} \), and the last one, \( m_3 = 70,000 \text{ kg} \). Neglect friction. What is the force between the 80,000-kg and 50,000-kg wagons?
67. The ratio of kinetic energy of object A to the kinetic energy of object B is 2:1. Object A is moving with a speed of 6.0 m/s and object B is moving with a speed of 2.0 m/s. If the mass of object A is 4.0 kg then what is the mass of object B?

A) 2.0 kg  
B) 4.0 kg  
C) 8.0 kg  
D) 18 kg  
E) 16 kg

68. An object is under the influence of a force as represented by the force vs. position graph as shown in the above figure. What is the work done as it moves from 0 to 10 m?

A) 25 J  
B) 50 J  
C) 100 J  
D) 80 J  
E) 125 J
69. Refer to figure above. What is the speed of the roller coaster at point C?

A) 0 m/s  
B) 34.6 m/s  
C) 69.2 m/s  
D) 20.0 m/s  
E) There is not enough information to solve this problem.

70. A 500-kg cannon fires a 4.0-kg projectile with a velocity of 500 m/s relative to the ground. What is the recoil speed of the cannon?

A) 1.0 m/s  
B) 2.0 m/s  
C) 4.0 m/s  
D) 6.0 m/s  
E) 8.0 m/s

71. A 47.0-kg box is being pushed along a horizontal surface. The coefficient of kinetic friction between the box and the ground is 0.360. What horizontal force must be exerted on the box for it to accelerate at 1.40 m/s²? (Use g=9.80 m/s²).

A) 232 N  
B) 60.0 N  
C) 363 N  
D) 116 N  
E) 171 N
72. Your mass is 70 kg. Suppose you are standing on a scale in an elevator, which starts moving down and accelerates and the reading of the scale is 490 N. What would be the acceleration of the elevator in units of $\text{m/s}^2$? (Use $g=10 \text{ m/s}^2$)

A) 7 m/s$^2$
B) 5 m/s$^2$
C) 3 m/s$^2$
D) 1 m/s$^2$
E) 0 m/s$^2$

73. A car with tires whose radius is 35 cm is traveling along a highway at 29.8 m/s. What is the angular speed of the tires?

A) 90 rad/s
B) 85 rad/s
C) 80 rad/s
D) 75 rad/s
E) 70 rad/s

74. An 82.0 kg-diver stands at the edge of a light 5.00-m diving board, which is supported by two pillars 1.60 m apart, as shown in the above figure. Find the force exerted by pillar A. (Use $g=9.80 \text{ m/s}^2$).

A) 1.71 kN downwards
B) 1.71 kN upwards
C) 2.51 kN downwards
D) 2.51 kN upwards
E) 3.44 kN upwards
75. A child is trying to stack two uniform wooden blocks, 12 cm in length, so they will protrude as much as possible over the edge of a table, without tipping over, as shown in the above figure. What is the maximum possible overhang distance $d$?

A) 5 cm  
B) 6 cm  
C) 7 cm  
D) 8 cm  
E) 9 cm

76. The mass of Pluto is $1.25 \times 10^{22}$ kg and its radius is $1.14 \times 10^6$ m. What is the value of $g$ at the surface of Pluto? $G = 6.67 \times 10^{-11}$ N·m$^2$/kg$^2$.

A) 0.642 m/s$^2$  
B) 9.81 m/s$^2$  
C) 1.62 m/s$^2$  
D) 3.72 m/s$^2$  
E) 1.40 m/s$^2$

77. Two in-phase loudspeakers are placed along a wall and are separated by a distance of 4.00 m. They emit sound with a frequency of 514 Hz. A person is standing away from the wall, in front of one of the loudspeakers. What is the closest distance from the wall the person can stand and hear constructive interference? The speed of sound in air is 343 m/s.

A) 0.344 m  
B) 0.729 m  
C) 1.15 m  
D) 1.64 m
78. The sound of 40 decibels is

A) twice as intense as the sound of 20 decibels.
B) four times as intense as the sound of 20 decibels.
C) 10 times as intense as the sound of 20 decibels.
D) 100 times as intense as the sound of 20 decibels.
E) 1000 times as intense as the sound of 20 decibels.

79. A figure skater is spinning slowly with arms outstretched. She brings her arms in close to her body and her moment of inertia decreases by 1/3. By what factor does her rotational kinetic energy change?

A) 9
B) 3
C) 1/9
D) 1/3
E) It doesn't change.

80. In a section of horizontal pipe with a diameter of 3.00 cm the pressure is 100 kPa and water is flowing with a speed of 1.50 m/s. The pipe narrows to 2.00 cm in diameter. What is the speed in the narrower region?

A) 3.38 m/s
B) 2.25 m/s
C) 7.06 m/s
D) 10.6 m/s
E) 1.0 m/s

81. Consider a flat steel plate with a hole through its center as shown in the above figure. When the plate's temperature is decreased, the hole will

A) contract only if it takes up more than half the plate's surface area.
B) expand if it takes up less than half the plate's surface area.
C) contract.
D) expand.
E) remain the same size.

82. Two metal rods are to be used to conduct heat from a region at 100°C to a region at 0°C as shown in the above figure. The rods can be placed in parallel, as shown on the left, or in series, as on the right. The heat conducted in the series arrangement is

A) greater than the heat conducted with the rods in parallel.
B) the same as the heat conducted with the rods in parallel.
C) less than the heat conducted with the rods in parallel.
D) impossible to compare with the heat conducted with the rods in parallel.

83. 10-m long steel railroad rails are laid end to end, with no space between, on a hot day when the temperature is 35 °C. Six months later the temperature has dropped to -5 °C. How much space now exists between each rail? The coefficient of thermal expansion for steel is \( \alpha = 12 \times 10^{-6} \text{ (°C)}^{-1} \).

A) 0.042 cm
B) 0.42 cm
C) 0.048 cm
D) 0.48 cm
E) 0.06 cm

84. What is the net power that a dog with surface area of 0.075 m\(^2\) radiates if his emissivity is 0.75, his skin temperature is 315 K, and he is in a room with a temperature of 290 K? The Stefan-Boltzmann constant is \( 5.67 \times 10^{-8} \text{ W/(m}^2\cdot\text{K}^4) \).

A) 8.8 W
B) 6.0 W
C) 12 W
D) 15 W
E) 18 W
85. A car starts out when the air temperature is 288 K. The air pressure in the tires is 500 kPa. After driving a while, the temperature of the air in the tires increases to 298 K. What is the pressure in the tires at that point, assuming the volume remains constant?

A) 129 kPa  
B) 483 kPa  
C) 507 kPa  
D) 517 kPa  
E) 532 kPa

86. How much heat is required to change 456 g of ice at -25.0°C into water at 25.0°C? The specific heats of ice and water are 2090 J/(kg K) and 4186 J/(kg K), respectively, and the latent heat of fusion of water is $33.5 \times 10^4$ J/kg.

A) 224 kJ  
B) 153 kJ  
C) 112 kJ  
D) 71.5 kJ  
E) 72.5 kJ

87. An ideal gas absorbs 750 J of heat as it performs 625 J of work. What is the resulting change in temperature if there are 1.3 moles of an ideal gas in the system? [use Gas constant $R = 8.31 \text{ J/(mol K)}$]

A) 84.8 K  
B) 0 K  
C) 11.6 K  
D) 127 K  
E) 7.7 K
88. In the closed thermodynamic cycle shown in the P-V diagram, the work done by the gas is:

A) 0
B) $P_1(V_1-V_2)$
C) $P_2(V_2-V_1)$
D) $(P_2-P_1)(V_2-V_1)$
E) $(P_2+P_1)(V_1-V_2)$
An ideal monatomic gas undergoes the reversible expansion shown in the above figure, where $V_2 = 5V_1$ and $P_2 = 3P_1$. What is the change in internal energy of the gas in this process, in terms of the initial pressure and volume?

A) $7P_1V_1$
B) $14P_1V_1$
C) $21P_1V_1$
D) $15P_1V_1$
E) $29P_1V_1$

What is the change in entropy when 30.0 g of water at 100°C are turned into steam at 100°C? The latent heat of vaporization of water is $22.6 \times 10^5$ J/kg.

A) 678 J/K
B) -678 J/K
C) 182 J/K
D) -182 J/K
E) 0 J/K