Please fill in your computer answer sheet as follows:
1) In the NAME grid, fill in your last name, leave one blank space, then your first name.
2) Write your ID number in the IDENTIFICATION NUMBER section of the sheet.
3) Write your recitation section number in the spaces K,L in the SPECIAL CODES section. Single digits should be preceded by a 0 (e.g. section 1 is written as 01).
4) Fill in the circles on the sheet corresponding to the letters or numbers of your name, ID and section with a #2 pencil.

Unless otherwise specified in a problem:

g = 9.80 m/s²
Atmospheric pressure = 1.01 x 10⁵ Pa
density of water = 1000 kg/m³

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The acceleration due to gravity on the surface of Earth is g. Calling R the radius of Earth, at what distance from Earth’s center would the acceleration due to gravity drop to g/16?
   A) 2R      B) 16R      C) R/16     D) 4R     E) R/4

2) A satellite completes one full orbit around Earth. The work performed by Earth’s gravitational force on the satellite is
   A) positive most of the time.  
   B) zero J.  
   C) negative most of the time.  
   D) always positive.  
   E) always negative.

3) A planet has two small satellites in circular orbits around the planet. The first satellite has a period 18.0 hours and an orbital radius 2.00 x 10⁷ m. The second planet has an orbital radius 3.00 x 10⁷ m. What is the period of the second satellite?
   A) 27.0 hours    B) 12.0 hours    C) 60.8 hours    D) 33.1 hours    E) 9.80 hours

4) A sewing machine needle moves with a frequency of 2.5 Hz. Approximately how long does it take it to move from the highest point to the lowest point in its travel?
   A) 0.80 s    B) 0.20 s    C) 1.25 s    D) 0.40 s    E) 0.10 s

5) A simple harmonic oscillator is undergoing oscillations with an amplitude A. How far is it from its equilibrium position when the kinetic and potential energies are equal?
   A) A/3     B) A/√2     C) A/2     D) A     E) A/√3

6) A mass is attached to a spring and oscillates with a period T. If the mass is doubled, what is the new period?
   A) T/√2     B) √2 T     C) 2T     D) T     E) T/2
7) When a mass of 0.350 kg is attached to a vertical spring and lowered slowly, the spring stretches a distance $d$. The mass is now displaced from its equilibrium position and oscillates with an angular frequency $\omega = 12.85 \text{ rad/s}$. What is the stretch distance $d$?

A) 2.97 cm  
B) 2.35 cm  
C) 6.28 cm  
D) 4.71 cm  
E) 5.93 cm

8) A 15.0-m rope is pulled taut with a tension of 140 N. Waves propagate along the rope with a speed of 27.5 m/s. What is the mass of the rope?

A) 1.67 kg  
B) 5.09 kg  
C) 2.78 kg  
D) 3.19 kg  
E) 2.10 kg

9) The intensity level of a power mower at a distance of 1.0 m is 100 dB. You wake up one morning to find that four of your neighbors are mowing their lawn 20 m from your open bedroom window. What is the intensity level in your bedroom?

A) 40 dB  
B) 80 dB  
C) 50 dB  
D) 104 dB  
E) 400 dB

10) In many cartoon shows, a character runs of a cliff, realizes his predicament and lets out a scream. He continues to scream as he falls. If the physical situation is portrayed correctly, from the vantage point of an observer at the foot of the cliff, the pitch of the scream should be

A) lower than the original pitch and constant.  
B) lower than the original pitch and decreasing as he falls.  
C) higher than the original pitch and decreasing as he falls.  
D) higher than the original pitch and constant.  
E) It is impossible to predict.

11) A pipe of length $L$, that is open at both ends, is resonating at its fundamental frequency. Which statement is correct?

A) The wavelength is $2L$ and there is a displacement node at the pipe's midpoint.  
B) The wavelength is $L$ and there is a displacement antinode at the pipe's midpoint.  
C) The wavelength is $L$ and there is a displacement node at the pipe's midpoint.  
D) The wavelength is $2L$ and there is a displacement antinode at the pipe's midpoint.  
E) The wavelength is $3L/2$ and there are two displacement antinodes located inside the pipe.

12) In order to produce beats, the two sound waves should have

A) the same frequency.  
B) the same amplitude.  
C) slightly different amplitudes.  
D) the same period.  
E) slightly different frequencies.

13) The deepest point of the Pacific Ocean is 11,033 m, in the Mariana Trench. What is the water pressure at that point? The density of seawater is 1025 kg/m$^3$.

A) $2.22 \times 10^8$ Pa  
B) $5.55 \times 10^7$ Pa  
C) $8.88 \times 10^7$ Pa  
D) $3.33 \times 10^8$ Pa  
E) $1.11 \times 10^8$ Pa
14) When atmospheric pressure increases, what happens to the absolute pressure at the bottom of a pool?
   A) It increases by a lesser amount.
   B) It increases by a greater amount.
   C) It does not change.
   D) It depends on the depth of the pool.
   E) It increases by the same amount.

15) A person who weighs 550 N empties her lungs as much as possible and is then completely immersed in water while suspended from a harness. Her apparent weight is now 21.2 N. What is her density?
   A) 1030 kg/m³
   B) 56.1 kg/m³
   C) 1040 kg/m³
   D) 1050 kg/m³
   E) 960 kg/m³

16) Physicists often solve problems using ideas that can be applied in other similar situations. Here is an example of what I mean:
   In a certain one-lane road there are no entrances or exits. As the road passes through open country and populated areas, the speed limit changes. Assume that cars travel at the posted speed limit. In the open road, where the speed limit is 55 mph, the cars are spaced so there are 51 cars per mile (think of this as a linear density). If the flow of cars is steady, how many cars per mile are there in a stretch of road where the speed limit is 40 mph?
   A) 60 cars/mile
   B) 76 cars/mile
   C) 66 cars/mile
   D) 70 cars/mile
   E) 56 cars/mile

17) An incompressible fluid flows steadily through a pipe that has a change in diameter. The fluid speed at a location where the pipe diameter is 8.0 cm is 1.28 m/s. What is the fluid speed at a location where the diameter has narrowed to 4.0 cm?
   A) 1.28 m/s
   B) 0.32 m/s
   C) 0.64 m/s
   D) 5.12 m/s
   E) 2.56 m/s

18) Refer to the figure above. A bimetallic strip, consisting of metal G on the top and metal H on the bottom, is rigidly attached to a wall at the left. The coefficient of linear thermal expansion for metal G is greater than that of metal H. If the strip is uniformly heated, it will
   A) curve upward.
   B) remain horizontal, but get longer.
   C) remain horizontal, but get shorter.
   D) bend in the middle.
   E) curve downward.
19) A solid concrete wall 4.0 m by 2.4 m and 30 cm thick, with a thermal conductivity of 1.3 W/(m·°C), separates a basement at 18°C from the ground outside at 6°C. How much heat flows through the wall in one hour? 
A) 1.8 MJ  
B) 1.8 kJ  
C) 5.0 kJ  
D) 5.0 MJ  
E) 500 J

20) The process whereby heat flows by the mass movement of molecules from one place to another is referred to as 
A) convection.  
B) evaporation.  
C) radiation.  
D) conduction.  
E) inversion.