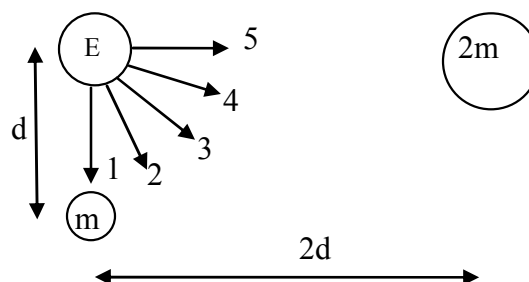


1) A planet of mass  $m$  is a distance  $d$  from Earth. Another planet of mass  $2m$  is a distance  $2d$  from Earth. Which force vector best represents the direction of the total gravitation force on Earth?

- A) 1
- B) 2**
- C) 3
- D) 4
- E) 5



2) A  $50\text{-cm}^3$  block of wood is floating partially submerged in water, and a  $50\text{-cm}^3$  block of iron is totally submerged in water. Which block has the greater buoyant force on it?

- A) the wood
- B) the iron**
- C) Both have the same buoyant force.
- D) The answer cannot be determined without knowing the densities of the blocks.

3) A block of ice at  $0^\circ\text{C}$  is floating on the surface of ice water in a beaker. The surface of the water just comes to the top of the beaker. When the ice melts the water level will:

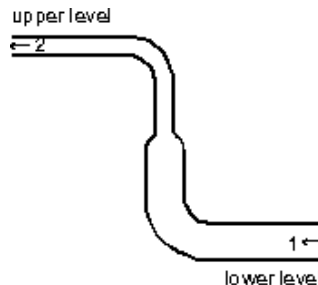
- A) rise and overflow will occur
- B) remain the same**
- C) fall
- D) depend on the initial ratio of water to ice
- E) depend on the shape of the block of ice

4) A piece of wood is floating in a bathtub. A second piece of wood sits on top of the first piece, and does not touch the water. If the top piece is taken off and placed in the water, what happens to the water level in the tub?

- A) It goes down.
- B) It does not change.**
- C) It goes up.
- D) This cannot be determined without knowing the volume of the top piece of wood.

5) Water is pumped through the hose shown below, from a lower level to an upper level. Compared to the water at point 1, the water at point 2:

- A) has greater speed and greater pressure
- B) has greater speed and less pressure**
- C) has less speed and less pressure
- D) has less speed and greater pressure
- E) can't tell from the information given



6) In simple harmonic motion, the acceleration must be proportional to the:

- A) amplitude
- B) frequency
- C) velocity
- D) displacement**
- E) displacement squared

7) An object attached to one end of a spring makes 20 vibrations in 10s. Its period is:

- A) 2 Hz
- B) 10 s
- C) 0.5 Hz
- D) 2 s
- E) 0.50 s**

8) A 0.25 kg ideal harmonic oscillator has a total mechanical energy of 9.6 J. If the oscillation amplitude is 20.0 cm, what is the oscillation frequency?

- A) 4.9 Hz
- B) 2.1 Hz
- C) 7 Hz**
- D) 3.5 Hz
- E) 14 Hz

9) A particle moves in simple harmonic motion according to  $x = 2\cos(50t)$ , where  $x$  is in meters and  $t$  is in seconds. Its **maximum** velocity in m/s is:

- A)  $100 \sin(50t)$
- B)  $100 \cos(50t)$
- C) 100**
- D) 200
- E) none of these

10) A particle is in simple harmonic motion along the  $x$  axis. The amplitude of the motion is  $x_m$ . When it is at  $x = 1/2x_m$ , its kinetic energy is  $K = 5\text{J}$  and its potential energy (measured with  $U = 0$  at  $x = 0$ ) is  $U = 3\text{J}$ . When it is at  $x = x_m$ , the kinetic and potential energies are:

- A)  $K = 5\text{J}$  and  $U = 3\text{J}$
- B)  $K = 5\text{J}$  and  $U = -3\text{J}$
- C)  $K = 8\text{J}$  and  $U = 0$
- D)  $K = 0$  and  $U = 8\text{J}$**
- E)  $K = 0$  and  $U = -8\text{J}$

11) A simple harmonic oscillator has an amplitude of 3.50 cm and a maximum speed of 10 cm/s. What is its speed when the displacement is 1.75 cm?

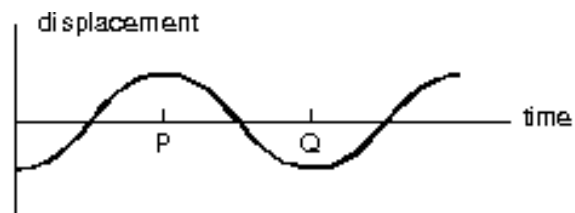
- A) 5.00 cm/s
- B) 7.07 cm/s
- C) 9.49 cm/s
- D) 8.66 cm/s

12) A sinusoidal force with a given amplitude is applied to an oscillator. To maintain the largest amplitude oscillation the frequency of the applied force should be:

- A) half the natural frequency of the oscillator
- B) the same as the natural frequency of the oscillator
- C) twice the natural frequency of the oscillator
- D) unrelated to the natural frequency of the oscillator
- E) determined from the maximum speed desired

13) In the diagram below, the interval PQ represents the:

- A) wavelength/2
- B) wavelength
- C) 2 x amplitude
- D) period/2
- E) period



14) A mass oscillates in simple harmonic motion with amplitude A. If the mass is doubled, but the amplitude is not changed, what will happen to the total mechanical energy of the system?

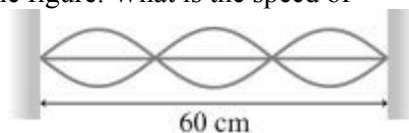
- A) total energy will increase
- B) total energy will decrease
- C) total energy will stay the same
- D) none of these

15) The transverse wave shown is traveling from left to right in a medium. The direction of the instantaneous velocity of the medium at point P is:

- A)  $\uparrow$
- B)  $\downarrow$
- C)  $\leftarrow$
- D)  $\rightarrow$
- E) no direction since  $v = 0$



16) A standing wave is oscillating at 980 Hz on a string, as shown in the figure. What is the speed of traveling waves on this string?



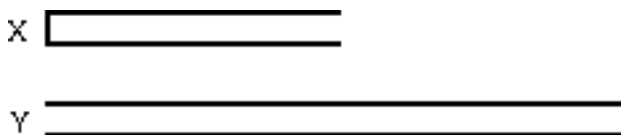
- A) 590 m/s
- B) 200 m/s
- C) 290 m/s
- D) 390 m/s**

17) A 5-m long wire with a mass of 50 g is under tension. A transverse wave for which the frequency is 620 Hz, the wavelength is 0.3 m, and the amplitude is 3.9 mm is propagating on the wire. The maximum transverse acceleration of a point on a wire is closest to:

- A)  $6.7 \times 10^4 \text{ m/s}^2$ .
- B)  $3.7 \times 10^4 \text{ m/s}^2$ .
- C)  $4.4 \times 10^4 \text{ m/s}^2$ .
- D)  $5.2 \times 10^4 \text{ m/s}^2$ .
- E)  $5.9 \times 10^4 \text{ m/s}^2$ .**

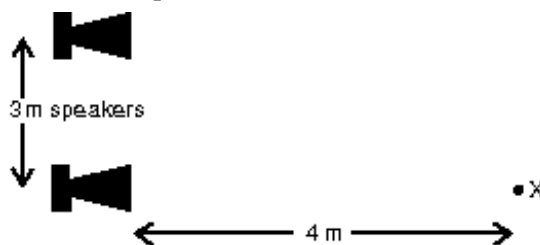
18) Organ pipe Y (open at both ends) is twice as long as organ pipe X (open at one end) as shown. The ratio of their fundamental frequencies  $f_X:f_Y$  is:

- A) 1:1**
- B) 1:2
- C) 2:1
- D) 1:4
- E) 4:1



19) Two small identical speakers are connected (in phase) to the same source. The speakers are 3 m apart and at ear level. An observer stands at X, 4 m in front of one speaker as shown. The sound he hears will be least intense if the wavelength is:

- A) 1 m
- B) 2 m**
- C) 3 m
- D) 4 m
- E) 5 m



20) The diagram shows four situations in which a source of sound S and a detector D are either moving or stationary. The arrows indicate the directions of motion. The speeds are all the same. Detector 3 is stationary. Rank the situations according to the frequency detected, lowest to highest.

- A) 1, 2, 3, 4**
- B) 4, 3, 2, 1
- C) 1, 3, 4, 2
- D) 2, 1, 2, 3
- E) None of the above

