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

1) The Figure above represents the position of a particle as it travels along the x-axis. What is the magnitude of the average velocity of the particle between \( t = 1 \) s and \( t = 4 \) s?

A) 1.0 m/s  
B) 0.50 m/s  
C) 0.25 m/s  
D) 1.3 m/s  
E) 0.67 m/s

2) 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 doubled, the distance required to stop would

A) quadruple.  
B) double as well.  
C) decrease by a factor of four.  
D) decrease by a factor of two.  
E) stay the same.
3) An airplane flies between two points on the ground that are 500 km apart. The destination is directly north of the origination of the flight. The plane flies with an air speed of 120 m/s. If a constant wind blows at 10.0 m/s towards due west during the flight, what direction must the plane fly relative to the air to arrive at the destination?
   A) 85.2° west of north
   B) 4.78° east of north
   C) 4.76° west of north
   D) 4.76° east of north
   E) 4.78° west of north

4) Marcia uses a bow to shoot an arrow with initial velocity of magnitude \(v_0\) and at an angle \(\theta\) above the horizontal. When the arrow returns to the same height from which it started,
   A) the speed of the arrow is \(\sqrt{2}v_0\).
   B) the speed of the arrow is twice \(v_0\).
   C) the speed of the arrow is \(v_0/\sqrt{2}\).
   D) the speed of the arrow is 9.8 times larger than \(v_0\).
   E) the speed of the arrow is again \(v_0\).

5) A fireman is sliding down a fire pole. As he speeds up, he tightens his grip on the pole, thus increasing the vertical frictional force that the pole exerts on the fireman. When this force equals the weight of the fireman, what happens?
   A) The fireman continues to descend, but with constant speed.
   B) The fireman descends with slower and slower speed.
   C) The fireman comes to a stop.
   D) The fireman descends with a smaller acceleration.
   E) Cannot be determined without additional information.

6) A 4.00-kg block slides down a frictionless inclined plane with an acceleration 3.00 m/s\(^2\). What is the angle of the incline above horizontal?
   A) 17.8°
   B) 53.7°
   C) 45.2°
   D) 35.3°
   E) 23.6°

7) Two masses, \(m_1\) and \(m_2\), are connected to each other as shown in the Figure above. Mass \(m_1\) slides without friction on the table surface. Both masses have acceleration of magnitude \(a\) as shown. How does the tension in the string compare to the weight, \(m_2g\), of mass \(m_2\)?
   A) The tension is larger than \(m_2g\).
   B) The tension is equal to \(m_2g\).
   C) The tension is smaller than \(m_2g\).
   D) It depends on \(m_1\) being smaller than \(m_2\).
   E) It depends on \(m_1\) being larger than \(m_2\).
8) John's mass is half the mass of Jill. They both start walking and John moves twice as fast as Jill. What is the ratio of the kinetic energy of Jill to the kinetic energy of John?
   A) 4        B) 2        C) 1/2       D) 1/8       E) 1

9) A 5.00-kg box slides 4.00 m across the floor before coming to rest. What is the coefficient of kinetic friction between the floor and the box if the box had an initial speed of 3.00 m/s?
   A) 0.115     B) 0.267     C) 0.587     D) 0.229     E) 1.13

10) Neglecting air resistance, when you toss a stone straight up in the air from Earth's surface, which of the following statements is true for the upward motion of the stone.
    A) The stone's kinetic and gravitational potential energies increase simultaneously.
    B) The stone's total energy increases.
    C) The stone's kinetic and gravitational potential energies decrease simultaneously.
    D) The stone's kinetic energy decreases while its gravitational potential energy increases.
    E) The stone's kinetic energy increases while its gravitational potential energy decreases.

11) An object of mass $m$ moving with a certain speed has a kinetic energy of 0.0124 J. The object collides with a horizontal spring and compresses it by 0.800 m before it is brought to rest. What is the spring constant of this spring?
    A) 0.150 N/m
    B) 0.315 N/m
    C) 0.0388 N/m
    D) 0.0235 N/m
    E) 0.194 N/m

12) In a collision between two unequal masses, how does the impulse imparted to the smaller mass by the larger mass compare with the impulse imparted to the larger mass by the smaller one?
    A) It is larger.
    B) They are equal.
    C) It is smaller.
    D) The answer depends on the ratio of the masses.
    E) The answer depends on how fast they are moving.

13) An object that is initially at rest breaks up into two pieces of unequal masses when a spring-loaded device is released. If you compare the kinetic energy of the larger mass to that of the smaller mass immediately after they separate, which of the following statements is correct?
    A) The total kinetic energy is zero J.
    B) The kinetic energy of the smaller mass is greater.
    C) The kinetic energy of the larger mass is greater.
    D) The kinetic energies of the two masses are equal.
    E) Need more information

14) A wheel that is rotating at 33.3 rad/s is given an angular acceleration of 2.15 rad/s$^2$. Through what angle has the wheel turned when its angular speed reaches 72.0 rad/s?
    A) 83.2 rad        B) 66.8 rad        C) 316 rad        D) 948 rad        E) 697 rad
15) A disk and a hoop of the same mass and radius are released at the same time at the top of an inclined plane and roll without slipping. Which object reaches the bottom of the incline first?
   A) The disk
   B) The hoop
   C) Both reach the bottom at the same time.
   D) It depends on the angle of inclination.
   E) It depends on the length of the inclined surface.

16) A 15.0-kg child is sitting on a playground teeter-totter, 1.50 m from the pivot. What force, applied 0.300 m on the other side of the pivot, is needed to make the child lift off the ground?
   A) 66.2 N  B) 75.0 N  C) 22.5 N  D) 44.1 N  E) 735 N

17) An astronaut is in a capsule in a stable orbit, about two Earth radii from the center of Earth. Her weight is
   A) the same as on the surface of Earth.
   B) zero N.
   C) about one-half of her weight on the surface of Earth.
   D) about one-third of her weight on the surface of Earth.
   E) about one-quarter of her weight on the surface of Earth.

18) 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.

19) Doubling only the amplitude of a vibrating mass–and–spring system produces what effect on the system’s mechanical energy?
   A) increases the energy by a factor of two
   B) increases the energy by a factor of three
   C) increases the energy by a factor of four
   D) increases the energy by a factor of square root of two
   E) produces no change

20) A pendulum that was originally erected by Foucault at the Pantheon in Paris for the Paris Exhibition in 1851 was restored in 1995. It has a 28.0 kg sphere suspended from a 67.0-m light cable. If the amplitude of the swing is 5.00 m, what is the maximum speed of the sphere?
   A) 1.91 m/s  B) 3.57 m/s  C) 4.16 m/s  D) 13.1 m/s  E) 3.65 m/s

21) The wavelengths corresponding to the harmonics of a string with fixed ends can be found by saying that the length of the string must be equal to
   A) an odd number of half-wavelengths.
   B) an odd number of third-wavelengths.
   C) an odd number of quarter-wavelengths.
   D) an integer number of wavelengths.
   E) an integer number of half-wavelengths.
22) Two people are talking at a distance of 3.0 m from where you are and you measure the sound intensity as $1.1 \times 10^{-7}$ W/m². Another student is 4.0 m away from the talkers. What sound intensity does the other student measure?

A) $7.8 \times 10^{-7}$ W/m²  
B) $6.2 \times 10^{-8}$ W/m²  
C) $1.5 \times 10^{-7}$ W/m²  
D) $8.3 \times 10^{-8}$ W/m²  
E) $2.5 \times 10^{-8}$ W/m²

23) A boat carrying a large chunk of steel is floating on a lake. The chunk is then thrown overboard and sinks. What happens to the water level in the lake (with respect to the shore)?

A) rises  
B) drops  
C) remains the same  
D) depends upon the salinity of the water  
E) depends upon the temperature of the water

24) 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. What is the pressure in the narrower region? Take the density of water to be 1000 kg/m³.

A) 95.4 kPa  
B) 225 kPa  
C) 47.7 kPa  
D) 66.7 kPa  
E) 44.4 kPa

25) Object 1 has three times the specific heat capacity and four times the mass of Object 2. The two objects are heated from the same initial temperature, $T_0$, to the same final temperature $T_f$. You determine that the amount of heat gained by Object 1 is $Q$. The amount of heat absorbed by Object 2 will be

A) $\frac{4}{3}Q$.  
B) $12Q$.  
C) $6Q$.  
D) $\frac{3}{4}Q$.  
E) $\frac{1}{12}Q$. 

26) Two containers of equal volume each hold samples of the same ideal gas. Container A has twice as many molecules as container B. If the gas pressure is the same in the two containers, the correct statement regarding the absolute temperatures $T_A$ and $T_B$ in containers A and B, respectively, is

A) $T_A = \frac{1}{\sqrt{2}}T_B$.  
B) $T_A = 2T_B$.  
C) $T_A = T_B$.  
D) $T_A = \frac{1}{2}T_B$.  
E) $T_A = \frac{1}{4}T_B$. 

27) How much heat must be removed from 456 g of water at 25.0°C to change it into ice at -10.0°C? The specific heat of ice is 2090 J/(kg K) and the latent heat of fusion of water is $33.5 \times 10^4$ J/kg.

A) 210 kJ  
B) 105 kJ  
C) 47.7 kJ  
D) 153 kJ  
E) 57.3 kJ
28) What is meant by "the heat death of the universe"?
   A) The radiation from the stars will continuously heat up the universe.
   B) The universe will end in a giant inferno.
   C) Some day the sun will explode and we will all burn.
   D) The universe will reach thermal equilibrium.
   E) Some day the sun will cease to provide electromagnetic radiation.

29) A certain gas is compressed adiabatically. The amount of work done on the gas is 800 J. What is the change in the internal energy of the gas?
   A) –800 J
   B) 0 J
   C) 800 J
   D) 400 J
   E) More information is needed to answer this question.

30) A heat engine operating at maximum efficiency has an efficiency of 35.0%. The temperature of the hot reservoir is 700 K. What is the temperature of the cold reservoir?
   A) 600 K
   B) 455 K
   C) 245 K
   D) 350 K
   E) 200 K