Physics 116A, Section 2, Final Primary April 25, 2008 TIME LIMIT IS 2.5 HOURS

Name (Please print)_____

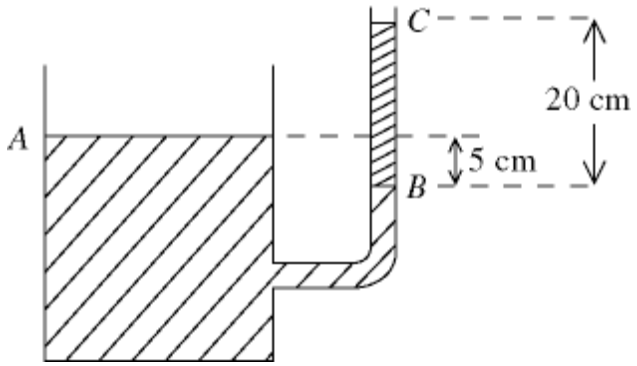
Mulitiple choice questions are worth 5 points each.
Mark your answers in the space provided at the right, and on the OPSCAN sheet
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A solid disk (I = MR*R/2) and a solid sphere (I = 2MR*R/5) , not necessarily having the same mass or radius, are released simultaneously at the top of an inclined plane. They roll down without slipping. Which will reach the bottom second? 1) _____
   A) the disk
   B) the one of smallest diameter
   C) the one of greatest mass
   D) the sphere
   E) They will reach the bottom at the same time.

2) If the torque on an object adds up to non–zero: 2) _____
   A) The object could be accelerating linearly but it could not be turning.
   B) The object is at rest.
   C) The object cannot be turning.
   D) The object could be both turning and accelerating linearly.
   E) The forces on it also add up to non–zero.

3) A 4.8–kg block attached to a spring executes simple harmonic motion on a frictionless horizontal surface. At time t = 0 s, the block has a displacement of –0.50 m, a velocity of –0.80 m/s, and an acceleration of +8.3 m/s^2. The force constant of the spring is closest to: 3) _____
   A) 80 N/m B) 56 N/m C) 73 N/m D) 62 N/m E) 67 N/m

Figure 1



4) A container has a vertical tube, whose inner radius is 32.00 mm, connected to it at its side. An unknown liquid reaches level *A* in the container and level *B* in the tube—level *A* being 5.0 cm higher than level *B*. The liquid supports a 20.0–cm high column of oil, between levels *B* and *C*, whose density is 460 kg/m3. In Fig. 1, the density of the unknown liquid is closest to: 4) _____

A) 1600 kg/m3
B) 1700 kg/m3
C) 2000 kg/m3
D) 1800 kg/m3
E) 1400 kg/m3

5) The equation $y(x,t) = 0.015 \cos(13.4x + 488t)$, where all quantities are in SI units, represents a traveling wave having: 5) _____

A) wavelength = 0.0746 m and period = 0.00205 s
B) frequency = 488 Hz and period = 12.9 ms
C) wavelength = 0.469 m and frequency = 3060 s
D) wavelength = 0.469 m and period = 12.9 ms
E) wavelength = 13.4 m and frequency = 488 Hz

6) An aluminum rod is 40.0 cm long and a steel rod is 30.0 cm long when both rods are at a temperature of 15°C. Both rods have the same diameter. The rods are joined end–to–end to form a rod 70.0 cm long. The coefficients of linear expansion of aluminum and steel are 2.4×10^{-5} K^{-1} and 1.2×10^{-5} K^{-1}, respectively. The temperature is raised to 110°C. The increase in the length of the joined rod, in mm, is closest to: 6) _____

A) 0.88 B) 1.3 C) 1.4 D) 1.1 E) 1.0

7) A sealed (constant volume) 21–m3 tank is filled with 6000 moles of oxygen gas (diatomic) at an initial temperature of 270 K. The gas is heated to a final temperature of 430 K. The heat transferred to the gas, in MJ, is closest to: 7) _____

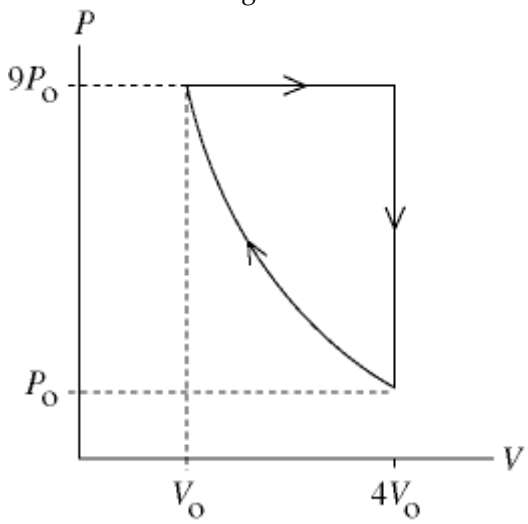
A) 24 B) 12 C) 20 D) 7.7 E) 16

Twenty moles of a monatomic ideal gas ($\gamma = 5/3$) undergo an adiabatic process. The initial pressure is 400 kPa and the initial temperature is 450 K. The final temperature of the gas is 320 K.

8) In the above example, the final volume of the gas, in SI units, is closest to: 8) _____

A) 0.19 B) 0.35 C) 0.27 D) 0.31 E) 0.23

Figure 2



9) In Fig. 2, a diatomic ideal gas with $C_p/C_V = 1.4$ is carried through the cycle illustrated here. The one (and only) compression step is adiabatic. What is the efficiency of an engine utilizing this cycle? (HINT: the gas draws in heat Qin during the isobaric expansion step which you can calculate based on knowing the constant pressure molar heat capacity value for a diatomic gas. Similarly, the gas expels heat Qout during the isochoric step, which you can also calculate.) 9) _____

A) 21% B) 26% C) 31% D) 15% E) 37%

10) Which of the following is an accurate statement? 10) _____

A) Because a Diesel engine requires no fuel ignition system and operates at lower pressures, Diesel engines tend to be much lighter than a comparable gasoline engine.
B) The efficiency of the Otto cycle gasoline engine does not depend on the compression ratio.
C) An important distinction between the Diesel cycle and the Otto cycle is that in a Diesel engine there is no fuel in the cylinder at the beginning of the compression stroke and no spark plug is used.
D) A typical car's gasoline engine has a thermodynamic efficiency of about 95%.
E) An important distinction between the Diesel cycle and the Otto cycle is that for the Diesel cycle high efficiencies may be obtained with very low compression ratios.

A car on a road parallel to and right next to a railroad track is approaching a train. The car is traveling eastward at 30.0 m/s while the train is going westward at 50.0 m/s. There is no wind, and the speed of sound is 344 m/s. The car honks its horn at a frequency of 1.00 kHz as the train toots its whistle at a frequency of 1.50 kHz.

11) From the above the frequency that the car's driver hears from the train's whistle is closest to: 11) _____

A) 1.18 kHz B) 1.95 kHz C) 1.91 kHz D) 1.20 kHz E) 1.15 kHz

12) When an ideal gas is expanded in volume at constant pressure, the average kinetic energy of the gas molecules 12) _____

A) decreases.
B) increases.
C) does not change.
D) may either increase or decrease, depending on whether or not the process is carried out adiabatically.
E) may or may not change, but insufficient information is given to make such a determination.

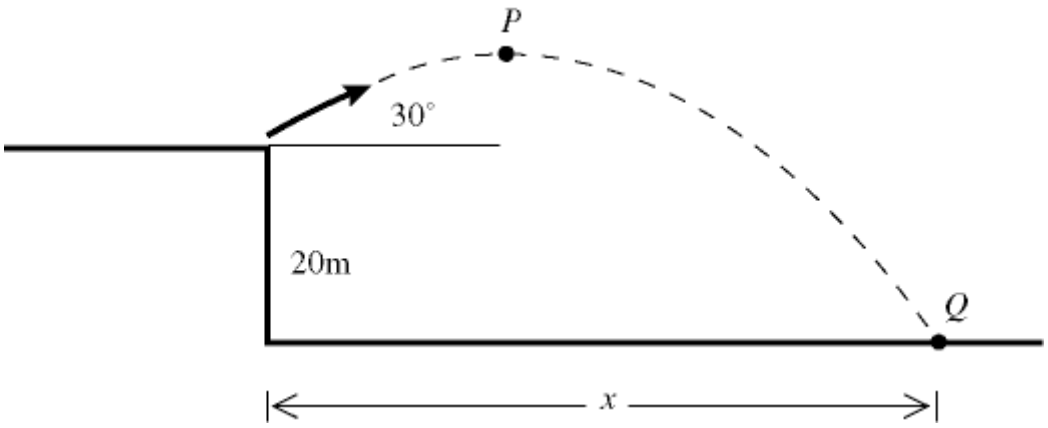
13) A wire, 9.0 m long, with a mass of 60 g, is under tension. A transverse wave is propagated on the wire, for which the frequency is 120 Hz, the wavelength is 0.30 m, and the amplitude is 2.3 mm. The tension in the line, in SI units, is closest to: 13) _____

A) 8.6 B) 9.9 C) 14 D) 11 E) 13

14) A train starts from rest and accelerates uniformly, until it has traveled 5.4 km and acquired a velocity of 31 m/s. The train then moves at a constant velocity of 31 m/s for 400 s. The train then decelerates uniformly at 0.065 m/s2, until it is brought to a halt. The distance traveled by the train during deceleration, in km, is closest to: 14) _____

A) 6.7 B) 6.0 C) 7.0 D) 7.4 E) 6.3

Figure 3



15) A projectile is fired from the origin (at $y = 0$ m) as shown in the figure. The initial velocity components are $v_{ox} = 110$ m/s and $v_{oy} = 62$ m/s. The projectile reaches maximum height at point P, then it falls and strikes the ground at point Q. In Fig. 3, the x–component of the velocity of the shell at point P is closest to: 15) _____

A) zero B) 55 m/s C) 83 m/s D) 28 m/s E) 110 m/s

16) Consider what happens when you jump straight up in the air from a horizontal ground surface. Which of the following is the most accurate statement? 16) _____

A) Since the ground is stationary, it cannot exert the upward force necessary to propel you into the air. Instead, it is the internal forces of your muscles acting on your body itself that propels your body into the air.

B) When you push down on the earth with a force greater than your weight, the earth will push back with the same magnitude force and thus propel you into the air. The earth moves slightly in the opposite direction when you jump to conserve linear momentum.

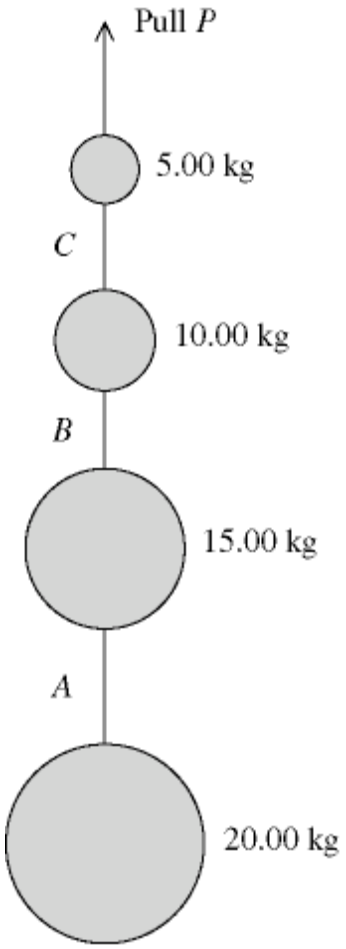
C) At the moment when you jump up the earth exerts a force F_1 on you and you exert a force F_2 on the earth. You get to go up because $F_1 > F_2$.

D) You are able to spring up because the earth exerts a force upward on you that is stronger than the downward force you exert on the earth.

E) The upward force exerted by the ground pushes up on you, but this force can never exceed your own weight. Hence jumping up is impossible and the NCAA basketball tournament is all optical illusion.

A series of weights connected by very light cords are given an upward acceleration of 4.00 m/s^2 by a pull P, as shown in Fig. 4. A, B, and C are the tensions in the connecting cords.

Figure 4



17) In Figure 4, the pull P is closest to: 17) _____

A) 690 N B) 50 N C) 200 N D) 490 N E) 290 N

18) An object is subject to a force in Newtons given by $F = 8x3$, where x is the displacement of the object from its equilibrium position. How much work does the force do when it moves the object from $x = 0$ to $x = 0.27$ m? 18) _____

A) 1.06×10^{-2} J

B) 4.25×10^{-2} J

C) 1.57×10^{-1} J

D) 4.72×10^{-1} J

E) 3.94×10^{-2} J

19) Two objects, one of mass m and the other of mass $2m$, are dropped from the top of a building. When they hit the ground: 19) _____

A) The heavier one will have twice the kinetic energy of the lighter one.
B) The heavier one will have four times the kinetic energy of the lighter one.
C) The heavier one will have half the kinetic energy of the lighter one.
D) The heavier one will have one–fourth the kinetic energy of the lighter one.
E) Both will have the same kinetic energy.

20) In a completely *inelastic* collision: 20) _____

A) Neither kinetic nor momentum is conserved.
B) The initial kinetic energy is all converted to heat.
C) Momentum is conserved but kinetic energy is not conserved.
D) Both kinetic energy and momentum are conserved.
E) Kinetic energy is conserved but momentum is not conserved.

21) (Extra credit, 5 points). In the last class demonstration of the imploding Coke can ("you can try this at home"), what was the main reason that the heated can with steam inside imploded after it was immersed upside down in the beaker of water? 21) _____

A) There was a chemical reaction between the heated can and the water, proving that drinking warm diet Coke is dangerous to your health.
B) The water in the beaker was initially super–heated (above 100 degrees C) which caused the steam inside the can to expand violently.
C) There was no implosion, but instead an explosion occurred where pieces of the Coke can flew up into the air and landed apparently randomly on the floor of the classroom. So this was really a demonstration of the conservation of momentum in the center–of–mass.
D) Immediately after being immersed in the beaker of water, the steam inside the Coke can quickly condensed thus leaving a partial vacuum inside the Coke can. The Coke can was not mechanically strong enough then to hold back the external pressure.
E) Nothing happened to the Coke can. The demonstration only works with Pepsi cans whose thermal expansion coefficient is significantly different from that of Coke cans.