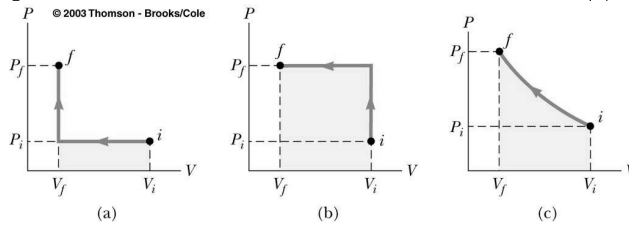


PHY 231C, INTRODUCTORY PHYSICS I
FINAL EXAM, Dec. 10, 2003

Choose the best answer. For T/F problems, choose only ONE answer.

1. Consider the following PV diagrams. Note that the arrows on the diagrams represent the order in which the processes occur. Which single statement is TRUE? If all are true choose (e)



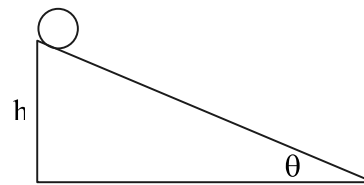
- (a) The work performed to take the gas from the initial to the final state is the same in all cases.
 (b) The heat transferred to the gas is the same in all cases.
 (c) Diagram (c) can represent an isothermal process.
 (d) Diagram (a) consists of an isothermal process followed by an adiabatic process.
 (e) All the above statements are true.

2. A pendulum clock that works well on Earth is taken to a different planet. Knowing that the clock in the unknown planet ticks at twice the frequency, what can you conclude about the gravitational acceleration at the surface of this planet in terms of the acceleration at the surface of Earth, g ?

- (a) $2g$
 (b) $4g$
 (c) $g/2$
 (d) g
 (e) $g/4$

3. A long pipe 1.715 m long is open on one end and closed at the other. What are the frequencies of the first three harmonics? (The speed of sound is 343 m/s)

- (a) 100 Hz, 200 Hz, 300 Hz
 (b) 200 Hz, 600 Hz, 600 Hz
 (c) 100 Hz, 300 Hz, 500 Hz
 (d) 50 Hz, 100 Hz, 150 Hz
 (e) 50 Hz, 150 Hz, 250 Hz



4. A solid cylinder of mass M and radius R (moment of inertia $I = MR^2/2$), rolls without slipping down an inclined plane of height $h = 64\text{cm}$ and angle $\theta = \text{unknown}$. The linear velocity of the center of the cylinder when it reaches the base of the triangle is closest to:

- (a) 2.89 m/s
 (b) 1.92 m/s
 (c) 1.61 m/s
 (d) 0.85 m/s
 (e) Not enough information since θ is not given

5. A window has a glass surface of 0.16 m^2 and a thickness of 3.00 mm. The thermal conductivity of the glass is $0.84\text{ J/s m}^\circ\text{C}$. Determine the rate of energy transfer by conduction through this pane in the summer, when the temperature of the inside surface of the glass is 70°F and the outside temperature is 100°F is: (Note temperatures were given in Fahrenheit!)

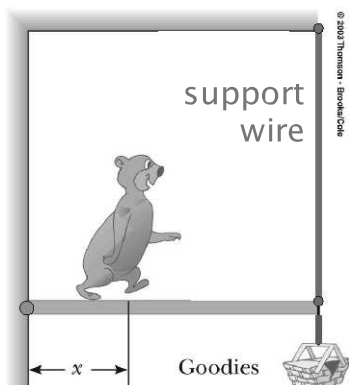
- (a) 747 J/s
 (b) 1932 J/s
 (c) 3099 J/s
 (d) 2199 J/s
 (e) 5376 J/s

6. A student uses a 150 W electric immersion heater to heat 0.2 kg of water from 20°C to 100°C to make tea. How long will it take?

- (a) 1.0 min
 (b) 3.0 min
 (c) 447 s
 (d) 5.0 min
 (e) 107 s

7. Pure Argon gas is confined to a leak-proof cylinder containing a movable piston. The initial volume, pressure and temperature of the gas are 15 L, 2.0 atm, and 300 K. If the piston is moved so that the volume is decreased to 10 L and the pressure is increased to 4 atm, find the final temperature of the gas.

- (a) 200 K
- (b) 300 K
- (c) 400 K
- (d) 500 K
- (e) 600 K

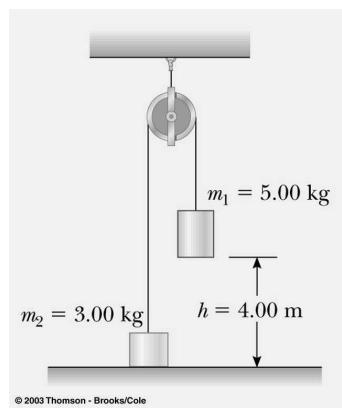


8. A hungry bear with weight $W_1=1000$ N walks out on a beam in an attempt to retrieve some “goodies” weighing $W_2=50$ N. The beam has length $L = 5$ m, and its weight is assumed to be negligible. If the tension on the supporting string is $T = 350$ N, how far is the bear along on the beam? That is, what is x ?

- (a) 1.0 m
- (b) 1.5 m
- (c) 2.0 m
- (d) 2.5 m
- (e) 3.0 m

9. A 600 kg satellite is in circular motion around Earth at a radius equal to twice Earth’s mean radius. What is the speed at which the satellite is orbiting? $R_{\text{earth}} = 6.38 \times 10^6$ m, $M_{\text{earth}} = 5.98 \times 10^{24}$ kg.

- (a) 482 m/s
- (b) 903 m/s
- (c) 2090 m/s
- (d) 5590 m/s
- (e) 6080 m/s



10. Two objects are connected by a light string passing over a light frictionless pulley. Object $m_1 = 5.0$ kg is released from rest at a point $h = 4.0$ m above the floor where $m_2 = 3.0$ kg rests. Determine the magnitude of the acceleration of m_1 after m_2 has left the floor.

- (a) 1.72 m/s²
- (b) 2.45 m/s²
- (c) 2.98 m/s²
- (d) 3.11 m/s²
- (e) 7.02 m/s²

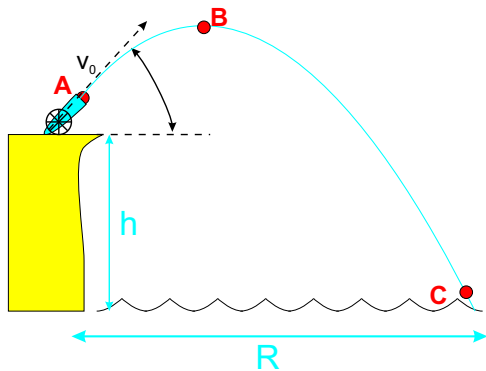
11. A car starts to accelerate from rest and feels a force of 8.0×10^4 N. What is its velocity after 100 m?

- (a) 2.5 m/s
- (b) 5.0 m/s
- (c) 10 m/s
- (d) 20 m/s
- (e) Unknown because the mass of the car is not given.

12. Consider a length x , a velocity v , a mass m and an acceleration a . The quantity G is given by the expression, $P = max/t$. In SI units, what are the dimensions of P ?

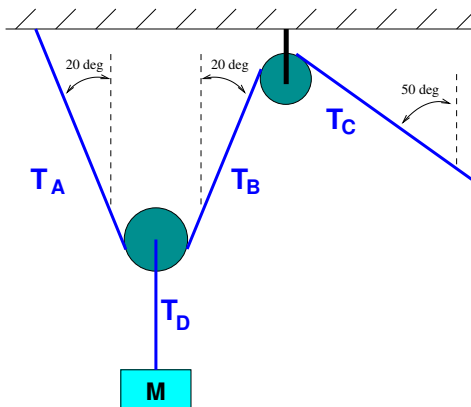
- (a) W
- (b) kg·m²/s³
- (c) J/s
- (d) N·m/s
- (e) All of the above

13. A helicopter is capable of moving at a speed of 100 m/s in still air. Despite a strong wind of 30 m/s from the north, the plane flies directly eastward. What is the resulting speed of the plane relative to the ground?
- 80.2 m/s
 - 95.4 m/s
 - 100 m/s
 - 104.4 m/s
 - 119.3 m/s

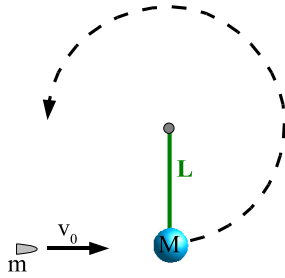


14. Consider the cannonball fired off a high cliff with the trajectory shown above. Which ONE statement is FALSE?
- The acceleration at B is equal to the acceleration at C
 - The x -component of the velocity at B is equal to the x -component of the velocity at C .
 - The y -component of the velocity at B is zero.
 - The smallest speed occurs when the projectile is at B .
 - The magnitude of the y -component of the velocity at A is equal to the magnitude of the y -component of the velocity at C .
15. Nolan Ryan throws a baseball with an initial velocity of 42 m/s. The ball leaves his hand moving horizontally at a height of 2.1 m above the ground. What horizontal distance will the ball have traveled when it hits the ground?
- 19.7 m
 - 22.0 m
 - 25.1 m
 - 27.5 m
 - 31.3 m

16. The rotor on a helicopter has a radius of 6.0 m. What angular velocity is required for the motion of the tip of the blade to become supersonic? ($v_{\text{sound}} = 343$ m/s)
- 366 rpm (rotations per minute)
 - 415 rpm
 - 490 rpm
 - 546 rpm
 - 612 rpm

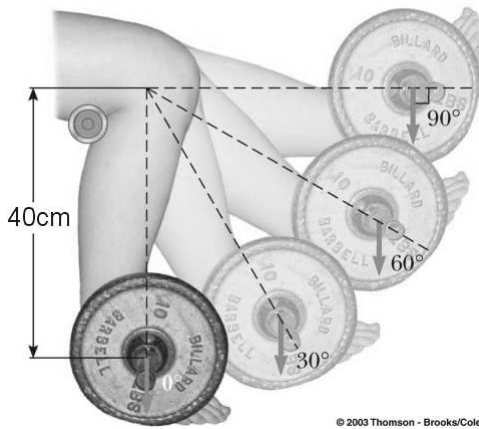


17. Consider the pulley system above which is holding the mass M in equilibrium. Assume each pulley is massless. Choose the ONE statement which is TRUE. If all the statements are true, choose (e)
- $T_D = Mg$
 - $T_A = T_C$
 - $T_A + T_B > Mg$
 - $T_C < Mg$.
 - All the statements are true.
18. Choose the single FALSE statement. If all statements are true, choose (e).
- If heat is taken out of a container of ideal gas while the volume remains constant, no work is done by the gas.
 - If an ideal gas expands at constant temperature, the internal energy must remain fixed.
 - A heat pump operating between two different temperatures requires work input.
 - If a compressor in an air conditioner does an amount of work W , the amount of heat moved from the inside of a home to the outside must be less than W .
 - All these statements are true.



19. A bullet of mass $m = 5$ g moving with an initial velocity v_0 is shot into a pendulum bob of mass $M = 25$ g. The bullet becomes lodged into the bob. The pendulum bob is suspended by a light stiff rod of length $L = 1.089$ m. What is the minimum value of v_0 such that the pendulum bob will barely swing through a complete vertical circle?

- (a) 39.2 m/s
- (b) 27.7 m/s
- (c) 23.4 m/s
- (d) 20.7 m/s
- (e) 11.9 m/s



20. As part of a physical therapy program following a knee operation, a 30-kg object is attached to an ankle and leg lifts are done as sketched in the figure above. What is the torque exerted by the knee when the weight is at the 60-degree angle shown above?

- (a) 59.2 Nm
- (b) 69.3 Nm
- (c) 81.0 Nm
- (d) 86.7 Nm
- (e) 102 Nm

21. A simple harmonic wave is given by the formula $y(x, t) = (4\text{cm}) \cdot \cos 2\pi(0.125x - 7.0t)$, where x is required to be in cm and t is required to be in seconds. The frequency and wavelength of this wave are respectively:

- (a) 0.1429 Hz and 0.637 cm
- (b) 0.1429 Hz and 4.0 cm
- (c) 1.11 Hz and 8.0 cm
- (d) 0.333 Hz and 4.0 cm
- (e) 7.0 Hz and 8.0 cm

22. The range of human hearing extends from approximately 20 Hz to 20,000 Hz. If the speed of sound is 343 m/s, what is the SHORTEST audible wavelength?

- (a) 17.15 nm
- (b) 17.15 μm
- (c) 17.15 mm
- (d) 17.15 cm
- (e) 17.15 m