

PHYSICS 231, MIDTERM II, November 4, 2002

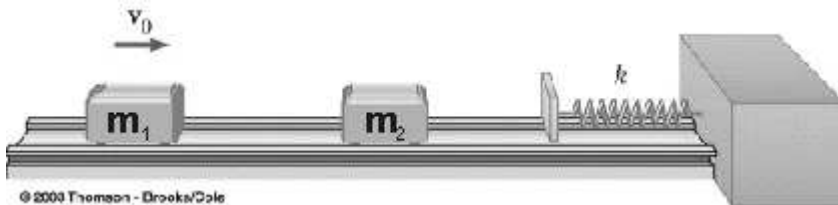
Name: _____

Useful constants: $\rho_{\text{water}}=1000 \text{ kg/m}^3$, $g=9.8 \text{ m/s}^2$, $1 \text{ hp} = 746 \text{ W}$, $R_{\text{earth}} = 6.38 \times 10^6 \text{ m}$, $G=6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$, $g=9.81 \text{ m/s}^2$, $k_B=1.38 \times 10^{-23} \text{ J/degK}$, Absolute Zero = -273.15 degC .

Choose the most nearly correct answer.

1. An object of mass m moves with a velocity of v . It collides head-on with an object of mass $3m$ moving with speed $2v/3$ in the opposite direction. If the two objects stick together, what is the velocity of the combined object after the collision?

- a) 0
- b) $v/2$
- c) $v/4$
- d) $-v/2$
- e) $-v/4$



2. The mass m_1 enters from the left with velocity v_0 , momentum p_0 and energy E_0 . It strikes a mass $m_2 > m_1$ which is initially at rest. The collision between the blocks is perfectly elastic. The mass m_2 then compresses the spring an amount x . Which statements are true?

- a) Immediately after the collision the mass m_1 will move to the left.
- b) Immediately after the collision the energy of m_2 will be less than E_0 .
- c) The maximum energy stored in the spring is less than E_0 .
- d) Immediately after the collision the magnitude of m_2 's momentum will be greater than p_0 .
- e) All of the above

3. A new planet “Horatio” has been discovered which is four times as far from the sun as Earth. What is the period of Horatio’s orbit?

- a) 8 years
- b) 4 years
- c) 2 years
- d) 1 year
- e) 6 months

4. Consider identical twins named Bert and Ernie who are visiting the planet Horatio. Bert stands at the top of the highest mountain on Horatio, while Ernie moves in a spaceship that is in circular orbit at the same distance from the center of the planet as Bert is stationed. Which of the following statements is true?

- a) Bert and Ernie experience equal accelerations. (equal in magnitude)
- b) Bert and Ernie experience equal gravitational forces. (equal in magnitude)
- c) If the twins were to step on bathroom scales, they would register the same weights. (Bert’s scale is on the mountain, while Ernie’s scale would be in the spaceship)
- d) If Bert were to climb a platform taking him to twice the radius of the planet’s surface, his weight would decrease by a factor of two.
- e) All of the above.

5. A block is dropped from a height $h=8000$ km above Earth's surface. Neglecting Earth's rotation and neglecting air resistance, which expression(s) gives the velocity of the block when it strikes the surface? R refers to Earth's radius.

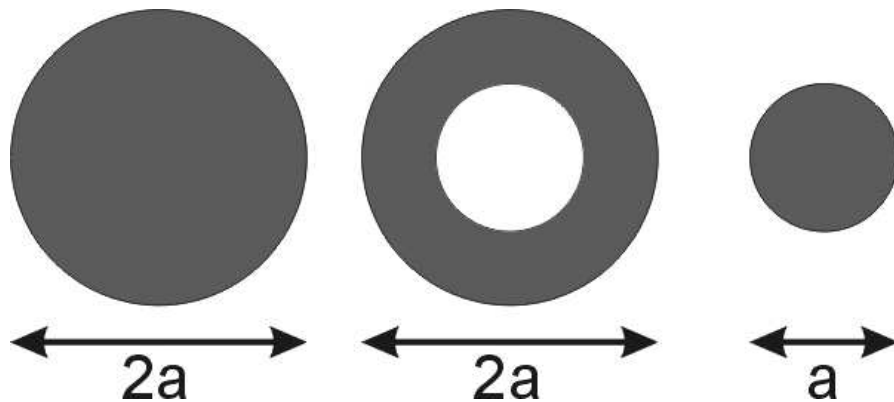
a) $v^2 = 2\left(\frac{GM}{R} - \frac{GM}{R+h}\right)$

b) $v^2 = 2gh$

c) $v^2 = g(R+h)$

d) All the above expressions work

e) None of the expressions work, because the answer depends on the mass of the block.



6. Each of the three cylinders pictured above has the same mass, and each cylinder's mass is uniformly distributed throughout the colored regions. Order the cylinders according to their moment of inertia with the largest moment of inertia being first. Assume that the reference axis passes through the center of each cylinder and points out of the page.

a) large solid cylinder, large hollow cylinder, small cylinder

b) large hollow cylinder, large solid cylinder, small cylinder

c) small cylinder, large hollow cylinder, large solid cylinder

d) large solid cylinder, small cylinder, large hollow cylinder

e) large hollow cylinder, small cylinder, large solid cylinder

7. A copper wire of length 4 meters, cross sectional area $7.1 \times 10^{-6} \text{ m}^2$ and Young's modulus $1.1 \times 10^{10} \text{ N/m}^2$ has a 300 kg load hung on it. Its increase in length ΔL is 5.0 mm. Now, the wire is cut to a quarter of its original

length to 1m, and the load is increased to 600 kg. What is the increase in length ΔL ?

- a) 1.25 mm
- b) 2.5 mm
- c) 1.0 cm
- d) 5.0 mm
- e) 0.625 mm

8. A helicopter suspends a 2000-N probe into the ocean by a cable. After the weight is submerged, the tension in the cable is 800 N. What is the average density of the probe?

- a) 2800 kg/m³
- b) 3000 kg/ m³
- c) 2500 kg/ m³
- d) 1667 kg/ m³
- e) 2111 kg/ m³

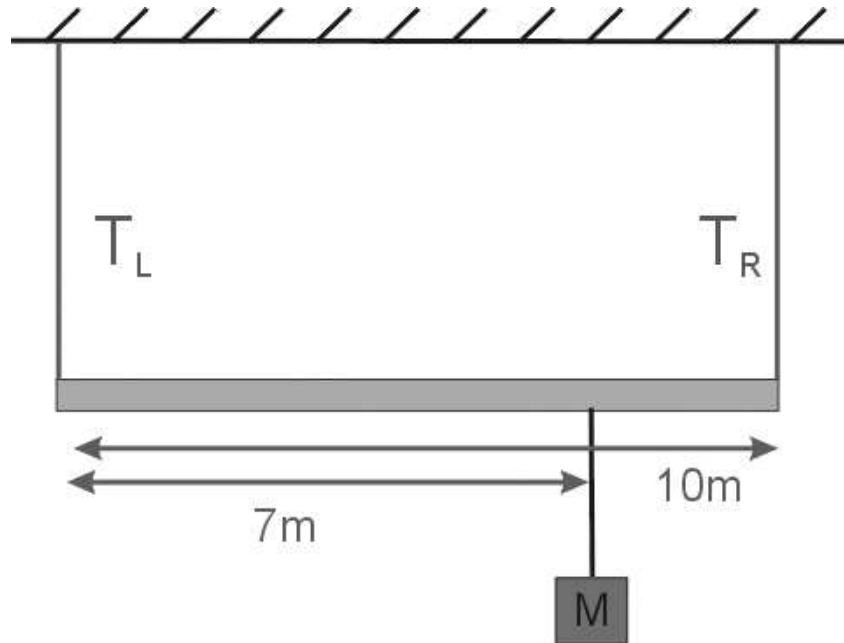
9. A tank having a volume of 0.3 m³ contains helium gas at 150 atm. How many balloons can the tank completely fill if each filled balloon has a volume of 0.015 m³ at an absolute pressure of 1.2 atm?

- a) 2500
- b) 150
- c) 200
- d) 1750
- e) 600

10. A gas contains NO₂ molecules at 45° C. What is the r.ms. (root-mean-square) speed of the molecules in m/s? The mass of a N₂ molecule is $1.53 \cdot 10^{-26}$ kg.

- a) 1234 m/s
- b) 2.998×10^8 m/s
- c) 23.4 m/s
- d) 928 m/s

e) 1.238×10^{-3} m/s



11. Consider a light beam hung by two cables as shown above. A weight, $Mg = 8000$ N is hung as shown. What is the tension T_R in the right-side cable?

- a) 10400 N
- b) 6333 N
- c) 5600 N
- d) 4000 N
- e) 3200 N

12. An incompressible fluid moves through a pipe which has a radius of 30 cm at point 'a' and then narrows to a radius of 20 cm at point 'b'. Which of the following is true? (Assume laminar flow).

- a) The amount of mass that passes point 'a' in one second equals the amount of mass that passes point 'b' in the same time.
- b) The velocity of the fluid at point 'a' equals the velocity of the fluid at point 'b'.
- c) The pressure of the fluid at point 'a' equals the pressure at point 'b'.

- d) The kinetic energy density at point 'a' equals the kinetic energy density at point 'b'.
- e) The pressure is larger at point 'b' where the pipe is smaller.