Course Name: College Physics I

2022 Fall Semester Final Exam paper A

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Exam Duration: 2 hours

Dept.: Physics

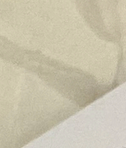
Exam Paper Setter: Physics teaching team

Question No.	1	2	3	4	5	6	7	8	9	10
Score	36	6	10	12	12	12	6	12		

This exam paper contains 7 questions and the score is 100 in total. (Please hand in your exam paper, answer sheet, and your scrap paper to the proctor when the exam ends.)

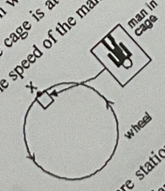
Q1. Multiple Choice Questions (3×12 = 36 points), there is only one correct answer for each question.

1) A 1 N pendulum bob is held at an angle θ from the vertical by a 2 N horizontal force F as shown. The tension in the string supporting the pendulum bob is:



A) $2/\sqrt{5}$ N
B) $2\sqrt{5}$ N
C) $\sqrt{5}$ N
D) 1 N

2) A giant wheel, 40 m in diameter, is fitted with a cage and platform on which a man can stand. The wheel rotates in the vertical plane at such a speed that when the cage is at X (as shown) the force exerted by the man on the platform is equal to his weight. The speed of the man is:



A) 14 m/s
B) 20 m/s
C) 28 m/s
D) 80 m/s

3) A 640 N hunter gets a rope around a 3200 N polar bear. They are stationary, 20 m apart, on frictionless level ice. When the hunter pulls the polar bear to him, the polar bear will move:

A) 3.3 m
B) 5 m
C) 15 m
D) 17 m

4) A solid wheel with mass M, radius R, and rotational inertia $MR^2/2$, rolls without sliding on a horizontal surface. A horizontal force F is applied to the axle and the center of mass has an acceleration a. The magnitudes of the applied force F and the frictional force f of the surface, respectively, are:

A) $F = Ma$, $f = 0$
B) $F = Ma$, $f = Ma/2$
C) $F = 2Ma$, $f = Ma$
D) $F = 3Ma/2$, $f = Ma/2$

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5) A climber leans out against a vertical ice wall that has negligible friction. Distance d is 0.90 m and distance L is 2.20 m. His center of mass is distance d = 0.90 m from the feet-ground contact point. If he is on the verge of sliding, what is the coefficient of static friction between feet and ground?

A) 0.20
B) 0.22
C) 0.41
D) 0.45

6) A projectile is fired straight upward from Earth's surface with a speed that is half the escape speed. If R is the radius of Earth, the highest altitude reached, measured from the surface, is:

A) $R/4$
B) $R/3$
C) $R/2$
D) R

7) Two separated sources emit sinusoidal traveling waves that have the same wavelength λ and are in phase at their respective sources. One travels a distance L_1 to get to the observation point while the other travels a distance L_2. The amplitude is a maximum at the observation point if $L_1 - L_2$ is:

A) a multiple of λ
B) an odd multiple of $\lambda/2$
C) a multiple of π
D) an odd multiple of $\pi/2$

8) A tuning fork produces sound waves of wavelength λ in air. This sound is used to cause resonance in an air column, closed at one end and open at the other. The length of this column CANNOT be:

A) $\lambda/4$
B) $\lambda/2$
C) $3\lambda/4$
D) $5\lambda/4$

9) The sound intensity 5.0 m from point source is 0.50 W/m^2. The power output of the source is:

A) 12.5 W
B) 39 W
C) 79 W
D) 157W

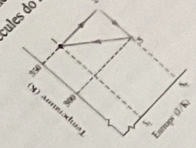
10) Object A, with heat capacity C_A and initially at temperature T_A, is placed in thermal contact with object B, with heat capacity C_B and initially at temperature T_B. The combination is thermally isolated. If the heat capacities are independent of the temperature and no phase changes occur, the final temperature of both objects is:

A) $(C_A T_A - C_B T_B)/(C_A + C_B)$
B) $(C_A T_A + C_B T_B)/(C_A + C_B)$
C) $(C_A T_A - C_B T_B)/(C_A - C_B)$
D) $(C_A - C_B)/(T_A - T_B)$

11) Assume that oxygen gas behaves as an ideal diatomic gas. If 2.0 moles of oxygen undergo a temperature increase of 100 K at constant pressure, how much work is done by the gas?

A) 0 J
B) 1662 J
C) 4155 J
D) 5817 J

12) Suppose 2.00 mol of a diatomic gas is taken reversibly around the cycle shown in the T-S diagram of Figure, where S_1 = 6.00 J/K and S_2 = 8.00 J/K. The molecules do not rotate or oscillate. What is the energy transferred as heat Q for the full cycle?



A) 700 J
B) 650 J
C) 50 J
D) 0 J

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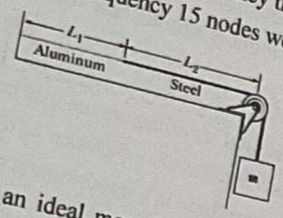
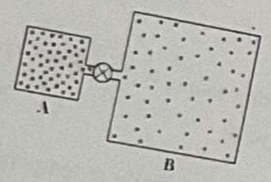
Q2. Blank-filling Questions. (Just write down the result, and the detailed process is not needed.)

1. **(3 points)** In figure, an aluminum wire, of length L_1 =60.0 cm, cross-sectional area 1.25×10^{-2} cm, and density 2.60 g/cm^3, is joined to a steel wire, of density 7.80 g/cm^3 and the same cross-sectional area. The compound wire, loaded with a block of mass m =10.0 kg, is arranged so that the distance L_2 from the joint to the supporting pulley is 86.6 cm. Transverse waves are set up on the wire by an external source of variable frequency, a node is located at the pulley, and another node is also located at the left boundary. Find the frequency that generates a standing wave having the joint as one of the nodes, and at this frequency 15 nodes were observed in all.

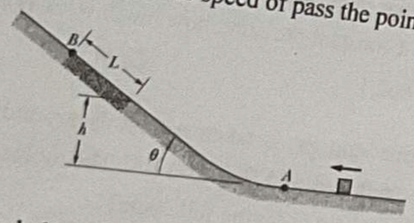


2. **(3 points)** Container A holds an ideal monatomic gas at a pressure of 5.0×10^5 Pa and a temperature of 300 K. It is connected by a thin tube (and a closed valve) to container B, with four times the volume of A. Container B holds the same ideal gas at a pressure of 1.0×10^5 Pa and a temperature of 400 K. The valve is opened to allow the pressure to equalize, but the temperature of each container is maintained. If container A holds 0.35 m^3 that gas, what is the net energy transferred as heat to the container during this process?

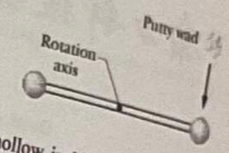


Text Questions: (Please write down the detailed process.)

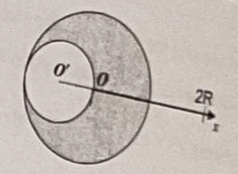
Q3. (10 points) In Figure, a block slides along a path that is without friction until the block reaches the section of length L=0.65 m, which begins at height h =2.00 m on a ramp of angle θ=30°. In that section, the coefficient of kinetic friction is 0.30. If the block just can reach point B (where the friction ends), (a) what is the speed of the block passes through point A? (b) Then the block slides back from the point B, what is its speed of pass the point A again?



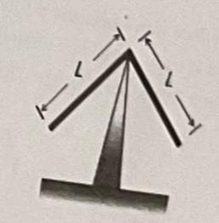
Q4. (12 points) Two 2.00 kg balls are attached to the ends of a thin rod of length 50.0 cm and negligible mass. The rod is free to rotate in a vertical plane without friction about a horizontal axis through its center. With the rod initially horizontal, a 100 g wad of wet putty(油灰) drops onto one of the balls, hitting it with a speed of 5.00 m/s and then sticking to it. (a) What is the angular speed of the system just after the putty wad hits? (b) What is the ratio of the kinetic energy of the system after the collision to that of the putty wad just before? (c) Through what angle will the system rotate just before it momentarily stops?



Q5. (12 points) A spherical hollow inside a uniform lead sphere of radius R =8.00 cm, the surface of the hollow passes through the center of the sphere and "touches" the left side of the sphere. The mass of the sphere before hollowing was M =24.34 kg. What is the magnitude of the gravitational force due to the hollow sphere on a particle of mass m =0.50 kg.
(a) When the particle is located at a distance of 2R from the center of the hollow sphere (point O).
(b) When the particle is located at any point in the cavity of the sphere.



Q6. (12 points) Two identical thin uniform rods, each of mass m and length L, are joined at right angle to form an L-shaped object. This object is balanced on top of a sharp edge. If the L-shaped object is deflected(偏离) the equilibrium position by a small angle, it oscillates in SHM. The angular displacement of this SHM follows the function $\theta(t)=\theta_m\cos(\omega t+\varphi)$. If the L =50.0 cm and θ_m =0.15 *rad*, find: (a) the angular frequency of the oscillation and (b) the maximum angular speed of the object.



Q7. (12 points) An ideal gas (1.0 mol) is the working substance in an engine that operates on the cycle shown in Figure. Processes BC and DA are reversible and adiabatic.
(a) Is the gas monatomic, diatomic, or polyatomic?
(b) What is the engine efficiency?