FORM A

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PHYSICS 220

$$\pi = 3.14159 \qquad G = 6.673 \times 10^{-11} \; m^3 / (kg \bullet s^2) \qquad 1\,N = 1\,kg(m/s^2)$$

$$g = 9.81\,m/s^2 = 32\,ft/s^2 \qquad 1\,lb = 4.448\,N \qquad 1\,mile = 1.609\,km$$

$$k = 1.38 \times 10^{-23}\,J/K \quad ; \quad R = N_A k \qquad N_A = 6.022 \times 10^{23} / mole$$

$$1\,Pa = 1\frac{N}{m^2} \, ; 1\,atm = 1.013 \times 10^5 \, Pa = 14.7\frac{lb}{in^2}$$

$$F_{Grav} = G\frac{m_1 m_2}{r^2} \qquad F_{friction} = \mu N \qquad \vec{p} = m\vec{v} \qquad \vec{J} = \vec{I} = \vec{F}\Delta t = \Delta \vec{p}$$

$$x = x_0 + \frac{1}{2}(v_0 + v_f)t \qquad v_f = v_0 + at \qquad a_c = \frac{v^2}{r} \qquad F = -kX$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2 \qquad v_f^2 = v_0^2 + 2a(x - x_0)$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}I\omega^2 \qquad W = Fd\cos\theta \qquad \theta = \frac{s}{r} = \frac{vt}{r} \qquad \omega = \frac{\theta}{t}$$

$$\tau = FL\sin\theta \qquad a_T = \alpha r \qquad P = W/\Delta t$$

$$I_{Sphere} = \frac{2}{5}mR^2 \; ; \; I_{Hoop,pipe} = mR^2 \; ; \; I_{Disk,cylinder} = \frac{1}{2}mR^2$$

$$V_{sphere} = \frac{4}{3}\pi R^3 \qquad KE_{ave} = \frac{3}{2}kT = \frac{1}{2}m\overline{v^2}$$

$$\omega = \omega_0 + \alpha t \qquad \theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2 \qquad \omega_f^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$

$$T_F = \frac{9}{5}T_C + 32^\circ \; ; T_C = T_K - 273^\circ \qquad PV = NkT = nN_A kT = nRT$$

MULTIPLE CHOICE. Choose the <u>BEST</u> answers to the questions
**QUESTIONS 1 – 25 ARE EACH WORTH 4 POINTS.**

1) Two men, Joel and Jerry, push against a car that has stalled, trying unsuccessfully to get it moving. Jerry stops after 10 min, while Joel is able to push for 5.0 min longer. Compare the work they do on the car.
A) Joel does 25% more work than Jerry.   B) Joel does 75% more work than Jerry.
C) Joel does 50% more work than Jerry.   D) Jerry does 50% more work than Joel.
E) Neither of them does any work.

2) You and your friend, who has the same mass as you, want to go to the top of the Eiffel Tower. Your friend takes the elevator straight up. You decide to walk up the spiral stairway, taking longer to do so. Compare the gravitational potential energy of the system you-Earth and your friend-Earth, after you both reach the top.
A) It is impossible to tell, since the times you both took are unknown.
B) Both systems have the same amount of gravitational potential energy at the top.
C) The you-Earth system's gravitational potential energy is greater than the friend-Earth system, because you traveled a greater distance in getting to the top.
D) The friend-Earth system's gravitational potential energy is greater than the you-Earth system's gravitational potential energy, because he got to the top faster.
E) It is impossible to tell, since the distances you both traveled are unknown.

3) In the figure, determine the character of the collision. The masses of the blocks, and the velocities before and after, are shown. The collision is

1.8 m/s   0.2 m/s   0.6 m/s   1.4 m/s

| 4 kg | 6 kg | | 4 kg | 6 kg |
Before   After
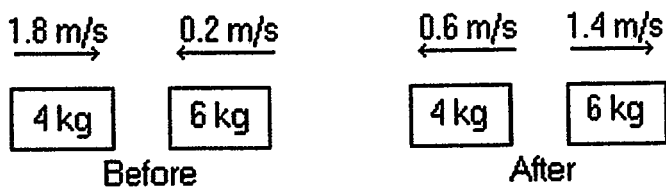
A) completely inelastic.   B) partially inelastic.   C) perfectly elastic.
D) not possible because momentum is not conserved.   E) characterized by an increase in kinetic energy.

4) The momentum of an isolated system is conserved
A) only in elastic collisions.   B) in both elastic and inelastic collisions.   C) only in inelastic collisions.
D) only if the kinetic energy is conserved   E) only if there is no rotation

5) Swimmers at a water park have a choice of two frictionless water slides, as shown in the figure. Although both slides drop over the same height h, slide 1 is straight while slide 2 is curved, dropping quickly at first and then leveling out. How does the speed v_1 of a swimmer reaching the bottom of slide 1 compare with v_2, the speed of a swimmer reaching the end of slide 2?
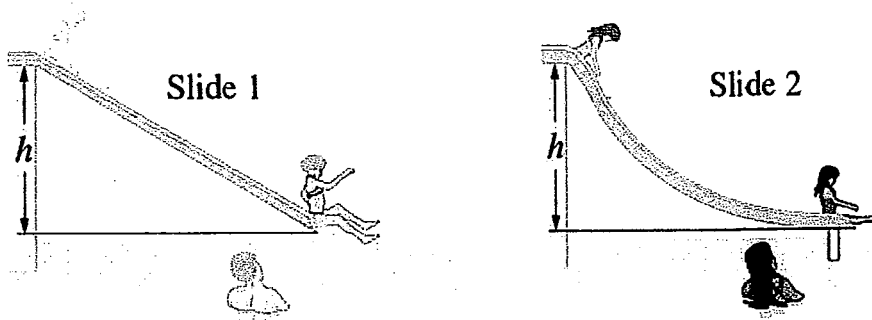

A) $v_1 = v_2$ B) $v_1 < v_2$ C) $v_1 > v_2$
D) The heavier swimmer will have a greater speed than the lighter swimmer, no matter which slide he uses.
E) No simple relationship exists between v_1 and v_2.

6) When you ride a bicycle forward, in what direction is the angular velocity of the wheels?
A) to your left   B) to your right   C) backwards   D) forwards   E) up

7) A stone is held at a height h above the ground. A second stone with two times the mass of the first one is held at the same height. The gravitational potential energy of the second stone-Earth system compared to that of the first stone-Earth system is
A) 1/4 as much.   B) the same.   C) 1/2 as much.   D) 4 times as much.   E) twice as much.

8) A circular disk initially at rest experiences a uniform angular acceleration through 2 revolutions in 10 s. If the angular velocity at the end of 10 s is 2.5 rad/s, what was the uniform angular acceleration?
A) 0.1 rad/s^2 B) 2.5 rad/s^2 C) 0.8 rad/s^2 D) 0.1 rad/s   E) 0.25 rad/s^2

9) Two equal-magnitude forces are exerted to a door at the doorknob. The first force is exerted perpendicular to the door, and the second force is exerted at 30° to the plane of the door. Which force exerts the greater torque about the door hinge?
A) the first force (exerted perpendicular to the door)   B) the second force (exerted at an angle)
C) Both forces exert equal non-zero torques.   D) Both forces exert zero torque.
E) Need to know if door moves

10) When a rigid object rotates about a fixed axis, what is true about all the points in the object?
A) They all have the same angular speed.   B) They all have zero angular acceleration.
C) They all have zero radial acceleration.   D) They all have the same tangential speed.
E) They all have the same tangential acceleration.

11) Two children, Ahmed and Jacques, ride on a merry-go-round. Ahmed is at a greater distance from the axis of rotation than Jacques.
A) Ahmed has a greater tangential speed than Jacques.   B) Jacques & Ahmed have the same tangential speed.
C) Jacques and Ahmed have zero angular speed.   D) Jacques has a greater angular speed than Ahmed.
E) Jacques has a smaller angular speed than Ahmed.

12) Consider a uniform hoop of radius R and mass M rolling without slipping. Which is larger, its translational kinetic energy or its rotational kinetic energy?
A) Rotational kinetic energy is larger.   B) Translational kinetic energy is larger.   C) Both are equal.
D) You need to know the speed of the hoop to tell.   E) You need to know the potential energy to tell

13) Five forces are exerted on a rod that is free to pivot at point P, as shown in the figure below. Which of these forces is producing a counter-clockwise torque about point P?
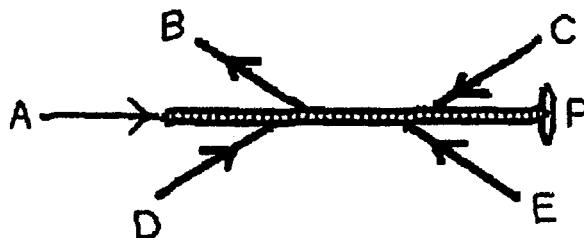
A) force A   B) force B   C) force C   D) force D   E) force E

14) A uniform ball is released from rest on a no-slip surface, as shown in the figure below. After reaching its lowest point, the ball begins to rise again, this time on a frictionless surface. When the ball reaches its maximum height on the frictionless surface, it is

No slip   Frictionless
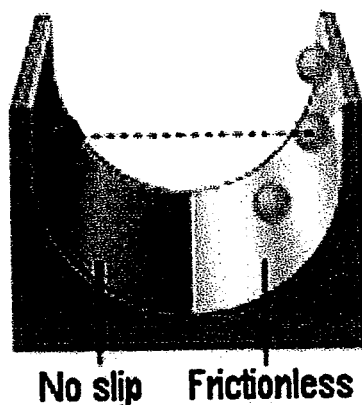
A) at the same height from which it was released.   B) lower than when it was released.
C) higher than when it was released.
D) It is impossible to tell without knowing the mass of the ball.
E) It is impossible to tell without knowing the radius of the ball.

15) When two pool balls collide, which of the following is/are correct?
A) Linear momentum is conserved   B) Kinetic energy is conserved   C) Velocity is conserved
D) Both (A) & (B)   E) Both (B) & (C)

16) A solid sphere, solid cylinder, and a hollow pipe all have equal masses and radii. If the three of them are released simultaneously at the top of an inclined plane and do not slip, which one will reach the bottom first?
A) cylinder   B) sphere   C) pipe   D) The pipe and cylinder arrive together before the sphere.
E) They all reach the bottom at the same time.

17) A person sits on a freely spinning lab stool that has no friction in its axle. When this person extends her arms,
A) her moment of inertia decreases and her angular speed increases.
B) her moment of inertia increases and her angular speed remains the same.
C) her moment of inertia decreases and her angular speed decreases.
D) her moment of inertia increases and her angular speed decreases.
E) her moment of inertia increases and her angular speed increases.

18) When is the angular momentum of a system constant?
A) Only when the linear momentum and the energy are constant.
B) Only when its total kinetic energy is constant.
C) Only when no net external torque is exerted on the system.
D) Only when the moment of inertia is constant.   E) Only when the moment of inertia is zero

19) Substance A has a density of 3 g/cm^3 and substance B has a density of 4 g/cm^3. In order to obtain equal masses of these two substances, what must be the ratio of the volume of A to the volume of B?
A) $\frac{V_A}{V_B} = 3/4$ B) $\frac{V_A}{V_B} = 3/1$ C) $\frac{V_A}{V_B} = 4/3$ D) $\frac{V_A}{V_B} = \sqrt{3/4}$ E) $\frac{V_A}{V_B} = 1/3$

20) A hollow sphere of negligible mass and radius R is completely filled with a liquid so that its density is ρ. You now enlarge the sphere so its radius is 2R and completely fill it with the same liquid. What is the density of the enlarged sphere?
A) 4 ρ B) ρ C) 8 ρ D) $\rho/2$ E) $\rho/8$

21) Which two temperature changes are equivalent?
A) 1 C° = 1 K   B) 1 K = 1 F°   C) 1 F° = 1 C°   D) 5 F° = 9 C°   E) none of the above

22) 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) $T_A = 2T_B$ B) $T_A = 1/\sqrt{2}\, T_B$ C) $T_A = 1/2\, T_B$ D) $T_A = 1/4\, T_B$ E) $T_A = T_B$

23) The absolute temperature of an ideal gas is directly proportional to which of the following quantities?
A) the average momentum of its molecules   B) the average speed of its molecules
C) the mass of its molecules   D) the average kinetic energy of its molecules
E) It is proportional to all of the above quantities.

24) Oxygen molecules are 16 times more massive than hydrogen molecules. At a given temperature, how do their average molecular speeds compare? The oxygen molecules are moving
A) at 1/4 the speed of the hydrogen molecules.   B) 16 times faster than the hydrogen molecules.
C) at 1/16 the speed of the hydrogen molecules.   D) 4 times faster than the hydrogen molecules.
E) at 1/√2 the speed of the hydrogen molecules.

25) A child does 350 J of work while pulling a box from the ground up to his tree house at a steady speed with a light rope. The tree house is 4.0 m above the ground. What is the mass of the box?
A) 8.9 kg   B) 5.3 kg   C) 6.7 kg   D) 8.0 kg   E) none of the above

26) Find how much mechanical energy was converted to internal energy in the system box-surface-Earth when a box moves in a complete circle of radius 1.82 m on a uniform horizontal floor. The coefficient of kinetic friction between the floor and the box is 0.25, and the box weighs 65.0 N.

A) 186 J   B) 0 J   C) 93J   D) 370 J   E) 1823 J

27) The figure shows a person's foot. In that figure, the Achilles tendon exerts a force of magnitude $F = 720$ N. What is the magnitude of the torque that this force produces about the ankle joint?
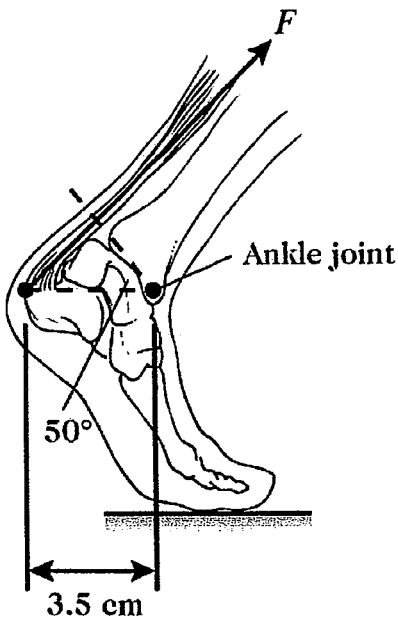

A) 12 N · m   B) 16 N · m   C) 21 N · m   D) 26 N · m   E) 36 N · m

28) An ideal gas is held in a container of volume V at pressure P. The rms speed of a gas molecule under these conditions is v. If now the volume and pressure are changed to 2V and 2P, the rms speed of a molecule will be

A) v/2   B) v   C) v/4   D) 2v   E) 4v

29) As shown in the figure, a 10.0 m long bar is attached by a frictionless hinge to a wall and held horizontal by a light rope that makes an angle $\theta = 49°$ with the bar. The bar is uniform and weighs 66.5 N. What distance x from the hinge should a 10.0 kg object be suspended for the tension in the rope to be 174 N?
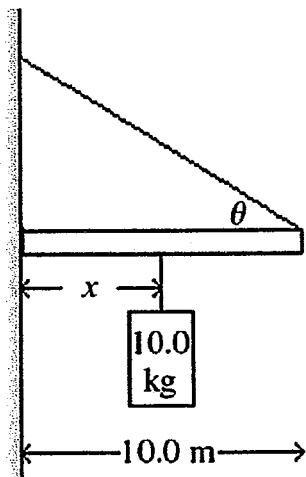
A) 10.0 m   B) 6.8 m   C) 5.1 m   D) 8 m   E) none of the above

30) A bicycle wheel has an outside diameter of 66 cm. Through what distance does a point on the rim move as the wheel rotates through an angle of 70°?
A) 40 cm   B) 80 cm   C) 13 cm   D) 6.5 cm   E) 20 cm

31) A car starts out when the air temperature is 288 K and the absolute (total) air pressure in the tires is 500 kPa. After driving a while, the temperature of the air in the tires increases to 298 K. What is the pressure in the tires at that point, assuming their volume does not change?
A) 129 kPa   B) 483 kPa   C) 507 kPa   D) 517 kPa   E) 532 kPa

32) A solid uniform disk of diameter 3.20 m and mass 42 kg rolls without slipping to the bottom of a hill, starting from rest. If the angular speed of the disk is 4.27 rad/s at the bottom, how high did it start on the hill?

A) 3.57 m   B) 2.68 m   C) 3.14 m   D) 4.28 m   E) 2.14 m