ex2f01q

Physics 103 Exam 2 1 November 2001

Name DEL ID#__________

Section # __________ TA Name __________

Fill in the above information on the scantron sheet. Use your student ID # and not your social security #. Fill the letters given for the first 5 questions on the scantron sheet. These letters determine which version of the test you took, and are IMPORTANT to get right.

1. A

2. D

3. B

4. E

5. C

6. A skier leaves the top of a slope with an initial speed of 5.0 m/s. Her speed at the bottom of the slope is 13 m/s. What is the height of the slope?

   A) 1.1 m
   B) 6.4 m
   C) 4.6 m
   D) 11 m
   E) 7.3 m

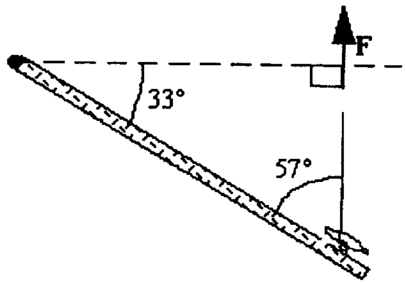
$$\frac{1}{2} m\, 13^2 - \frac{1}{2} m\, 5^2 = mgh$$

$$169 - 25 = 2gh$$

$$144 = 2 \cdot 9.8 \times h$$

$$h = \frac{72}{9.8} = 7.3\,m$$

7. A string is tied to a door knob 0.79 m from the hinge as shown in the figure. At the instant shown, the force applied to the string is 5.0 N. What is the torque on the door?



$\tau = F\ell \sin\theta = 5.0 \times 0.79 \sin 57°$

$= 3.31$ N - M

A) 3.3 N • m
B) 2.2 N • m
C) 0.40 N • m
D) 0.84 N • m
E) 1.1 N • m

8. Consider the following three objects, each of the same mass and radius:
(1) a solid sphere *(2)* a solid disk *(3)* a hoop
All three are released from rest at the top of an inclined plane. The three objects proceed down the incline undergoing rolling motion without slipping. In which order do the objects reach the bottom of the incline?

A) *3, 2, 1*
B) All three reach the bottom at the same time.
C) *3, 1, 2*
D) *1, 2, 3*
E) *2, 3, 1*

LARGEST $I \Rightarrow$ LAST

1, 2, 3

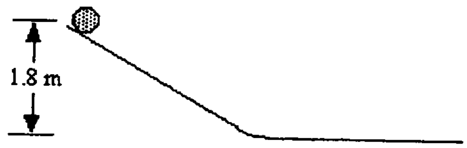
9. Which one of the following has the largest kinetic energy?

A) a jet airplane flying at maximum speed
B) a raindrop falling
C) the space shuttle orbiting the Earth
D) a woman swimming
E) the earth moving in its orbit around the sun ⇐ LARGEST MASS BY FAR

$\frac{1}{2} m v^2$

TRANSLATES AT $v = \omega r$ SINCE IT ROLLS WITHOUT SLIPPING

10. A solid cylinder of radius 0.35 m is released from rest from a height of 1.8 m and rolls down the incline as shown. What is the angular speed of the cylinder when it reaches the horizontal surface?



$$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh$$
$$\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}mr^2\right)\omega^2 = mgh$$
$$\frac{1}{2}(\omega r)^2 + \frac{1}{4}r^2\omega^2 = gh$$
$$3\omega^2 r^2 = 4gh$$
$$13.8\ \frac{\text{rad}}{\text{s}} = \omega = \sqrt{\frac{4gh}{3}}\,\frac{1}{r}$$

A) 8.2 rad/s
B) 34 rad/s
C) This cannot be determined because the mass is unknown.
D) 67 rad/s
E) 14 rad/s

11. A 100-kg cannon at rest contains a 10-kg cannon ball. When fired, the cannon ball leaves the cannon with a speed of 90 m/s. What is the recoil speed of the cannon?

A) 9 m/s
B) 45 m/s
C) 4.5 m/s
D) 90 m/s
E) zero

$MV + mv = 0$ (CONSERVE MOMENTUM)

$(100\text{ kg})V = -10\text{ kg}\,(90\text{ m/s})$

$V = -9\text{ m/s}$; SPEED 9 m/s

12. A 50-kg toboggan is coasting on level snow. As it passes beneath a bridge, a 20-kg parcel is dropped straight down and lands in the toboggan. If $(KE)_1$ is the original kinetic energy of the toboggan and $(KE)_2$ is the kinetic energy after the parcel has been added, what is the ratio $(KE)_2/(KE)_1$.

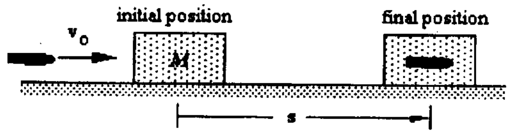
A) 0.60
B) 0.36
C) 0.71
D) 1.00
E) 1.67

CONSERVE MOMENTUM

$$(50\text{ kg})v_i = (50\text{ kg} + 20\text{ kg})v_f$$
$$v_f = \frac{5}{7}v_i$$
$$KE_1\ \text{BEFORE} = \frac{1}{2}(50)v_i^2$$
$$KE_2\ \text{AFTER} = \frac{1}{2}(50+20)v_f^2$$

$$\frac{KE_2}{KE_1} = \frac{\frac{1}{2}(70)\left(\frac{5}{7}v_i\right)^2}{\frac{1}{2}(50)v_i^2} = \frac{7}{5}\left(\frac{5}{7}\right)^2 = \frac{5}{7} = 0.714$$

13. A bullet of mass m is fired at speed v_0 into a wooden block of mass M. The bullet instantaneously comes to rest in the block. The block with the embedded bullet slides along a horizontal surface with a coefficient of kinetic friction μ.



Which one of the following expressions determines how far the block slides before it comes to rest (the magnitude of displacement s in the figure)?

A) $\frac{v_0^2}{\mu g}$

B) $\left(\frac{m}{m+M}\right)^2 \frac{v_0^2}{2\mu g}$

C) $\left(\frac{m}{m+M}\right) \frac{v_0^2}{\mu g}$

D) $\left(\frac{m}{m+M}\right)^2 \sqrt{\frac{v_0^2}{2\mu g}}$

E) $\frac{m v_0^2}{M \mu g}$

CONSERVE MOMENTUM | $mV_0 = (m+M)V_f$

FINAL KE, $\frac{(m+M)}{2}V_f^2 = \frac{m+M}{2}\left(\frac{m}{m+M}V_0\right)^2$

$= \frac{1}{2}\frac{m^2}{(m+M)}V_0^2$

FRICTION $= \mu N = \mu(m+M)g$

WORK DONE BY FRICTION $= S \cdot \mu(m+M)g$

$\mu(m+M)gS = \frac{1}{2}\left(\frac{m^2}{M+m}\right)V_0^2 \quad S = \frac{1}{2}\left(\frac{m}{M+m}\right)^2 \frac{V_0^2}{\mu g}$

14. What happens when a spinning ice skater draws in her outstretched arms?

A) Her angular momentum increases.
B) Her moment of inertia decreases causing her to speed up.
C) The torque that she exerts increases her moment of inertia.
D) Her moment of inertia decreases causing her to slow down.
E) Her angular momentum decreases.

CONSERVATION OF ANGULAR MOMENTUM

HER MOMENT OF INERTIA DECREASES

SO HER ANGULAR VELOCITY MUST

INCREASE

15. A certain string just breaks when it is under 400 N of tension. A boy uses this string to whirl a 10-kg stone in a horizontal circle of radius 10 m. The boy continuously increases the speed of the stone. At approximately what speed will the string break?

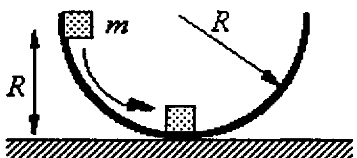
A) 10 m/s
B) 20 m/s
C) 100 m/s
D) 400 m/s
E) 80 m/s

$\frac{mv^2}{r} = 400\ N \qquad v^2 = \frac{(400N)\ r}{m}$

$v = \sqrt{\frac{400 \times 10m}{10kg}} = 20\ m/s$

Use the following to answer question 16:

A block of mass m is released from rest at a height R above a horizontal surface. The acceleration due to gravity is g.



The block slides along the inside of a frictionless circular hoop of radius R.

16. What is the magnitude of the centripetal acceleration ~~exerted on the block by the hoop~~ OF THE BLOCK when the block has reached the bottom?

A) 2 g
B) g
C) g^2/R
D) 3 g
E) zero

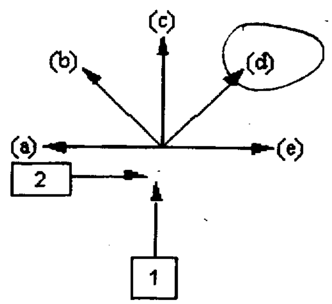
KE AT BOTTOM $= mgh = mgR$

$\frac{1}{2}mv^2 = mgR$

$F_c = \frac{mv^2}{R} = \frac{2mgR}{R} = ma_c$

$a_c = 2g$

17. Car One is traveling due north and Car Two is traveling due east. After the collision shown, Car One rebounds due south. Which of the lettered arrows is the only one which can represent the final direction of Car Two?



d) BECAUSE THERE IS AN INITIAL MOMENTUM IN → THIS DIRECTION. CAR 1 HAS NONE OF THIS WHEN IT REBOUNDS, SO CAR 2 MUST HAVE IT.

18. A warehouse worker uses a forklift to lift a crate of pickles on a platform to a height 2.75 m above the floor. The combined mass of the platform and the crate is 207 kg. If the power expended by the forklift is 1440 W, how long does it take to lift the crate?

A) 5.81 s
B) 3.87 s
C) 37.2 s
D) 1.86 s
E) 18.6 s

WORK = mgh = 207 (9.8) 2.75

WORK = 5.579×10^3 J

POWER = WORK / TIME = 1440 W

$t = W/P = 5.579 \times 10^3 / 1.44 \times 10^3 = 3.87$ s

19. A wheel, originally rotating at 126 rad/s undergoes a constant angular deceleration of 5.00 rad/s^2. What is its angular speed after it has turned through an angle of 628 radians?

A) 98 rad/s
B) 19 rad/s
C) 150 rad/s
D) 15 rad/s
E) 121 rad/s

$\omega_f^2 = \omega_o^2 + 2\alpha\theta$

$\omega_f^2 = (126)^2 + 2(-5)\,628 = 9596$

$\omega_f = 97.96$ rad/s

20. A woman stands on the edge of a cliff and throws a stone *vertically downward* with an initial speed of 10 m/s. The instant before the stone hits the ground below, it has 450 J of kinetic energy. If she were to throw the stone *horizontally outward* from the cliff with the same initial speed of 10 m/s, how much kinetic energy would it have just before it hits the ground?

A) 950 J
B) 800 J
C) 100 J
D) 50 J
E) 450 J

FINAL KE = INITIAL KE + mgh
EITHER WAY

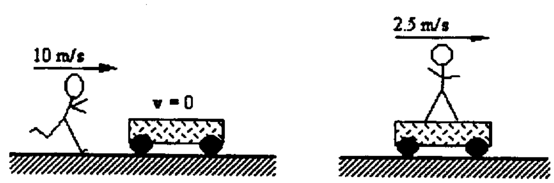
21. A bicycle with wheels of radius 0.4 m travels on a level road at a speed of 8 m/s. What is the angular speed of the wheels?

A) 20 rad/s
B) (10π) rad/s
C) 10 rad/s
D) $(20/\pi)$ rad/s
E) $(\pi/10)$ rad/s

$\omega = v/r \quad (v = r\omega)$

$\omega = 8/0.4 = 20$ rad/s

22. A 50.0-kg boy runs at a speed of 10.0 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest.



If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?

A) 175 kg
B) 210 kg
C) 150 kg
D) 300 kg
E) 260 kg

$mv = (m + M)V$

$50 \cdot 10 = (50 + M)\,2.5$

$50 + M = 200$

$M = 150$ kg

CONSERVE MOMENTUM

23. Complete the following statement: A collision is *elastic* if

A) the objects stick together. INELASTIC
B) the final velocities are zero. ← NO, ALL K.E. GONE
C) the total kinetic energy is conserved. ← YES, ELASTIC
D) the final kinetic energy is zero. ← ALL K.E. GONE
E) the final momentum is zero. ← MAYBE, MAYBE NOT

24. Two balls of equal size are dropped from the same height from the roof of a building. One ball has twice the mass of the other. When the balls reach the ground, how do the kinetic energies of the two balls compare? $KE_f = mgh$ or $2mgh$

A) The lighter one has the same kinetic energy as the other.
B) The lighter one has twice as much kinetic energy as the other.
C) The lighter one has four times as much kinetic energy as the other.
D) The lighter one has one half as much kinetic energy as the other.
E) The lighter one has one fourth as much kinetic energy as the other.

25. A mother is holding her 4.5-kg baby in her arms while riding in a car moving at 22 m/s. The car is involved in a head-on collision and stops within 1.5 seconds. What is the magnitude of the force exerted by the baby on his mother's arms?

A) 99 N
B) 150 N
C) 90 N
D) 66 N
E) 45 N

$$F = \frac{\Delta p}{\Delta t} = \frac{(4.5)(22)}{1.5} = 66\ N$$

ABOUT 12 POUNDS
HOPEFULLY, THE BABY IS OK.