103exA

EXAM KEY AAAAA

6. A rock is whirled on the end of a string in a horizontal circle of radius R with a constant period T. If the radius of the circle is reduced to $R/2$, while the period remains T, what happens to the centripetal acceleration of the rock?

A) It remains the same.
B) It increases by a factor of 2.
C) It increases by a factor of 4.
D) It decreases by a factor of 2.
E) It decreases by a factor of 4.

$F = ma = mr\omega^2 \Rightarrow a = r\omega^2$

T CONSTANT $\Rightarrow$ ω CONSTANT $\Rightarrow a \propto r$

7. Determine the minimum angle at which a road should be banked so that a car traveling at 20.0 m/s can safely negotiate the curve if the radius of the curve is 2.00×10^2 m.

A) 0.200° B) 0.581° C) 11.5° D) 19.6° E) 78.2°

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8. The earth's gravity provides the centripetal force on an orbiting satellite to keep it moving in a circle at constant speed. Which statement best explains why the speed of the satellite does not change even though there is a net force exerted on it?

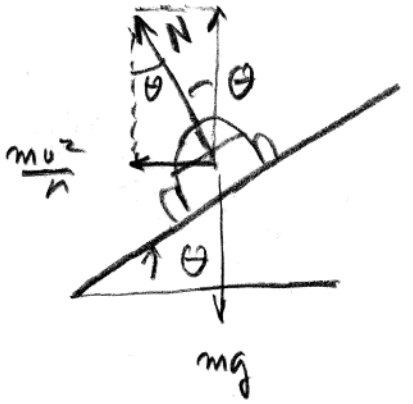
A) The satellite is in equilibrium.
B) The acceleration of the satellite is zero.
C) The centripetal force has magnitude mv^2/r.
D) The centripetal force is canceled by the reaction force.
E) The centripetal force is always perpendicular to the velocity.

9. An object weighs 10 N on the earth's surface. What is the weight of the object on a planet which has one tenth the earth's mass and one half the earth's radius?

A) 4 N B) 2 N C) 1 N D) 10 N E) 20 N

$$F = \frac{GMm}{r^2} = 10\ N$$

$$F' = \frac{G(0.1M)m}{(0.5r)^2} = \frac{0.1}{(0.5)^2}\frac{GMm}{r^2} = 0.4F$$



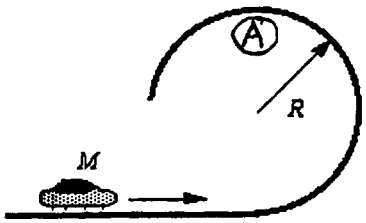
#7 FOR ZERO NET VERTICAL FORCE IT MUST BE THAT $N\cos\theta = mg$, FOR NO FRICTION NECESSARY, IT MUST ALSO BE THAT $N\sin\theta = mv^2/r$.

SO $N = mg/\cos\theta$ AND $\frac{mv^2}{r} = \frac{mg}{\cos\theta}\sin\theta$

THUS $\tan\theta = v^2/rg = 20^2/(2\times10^2\times9.8) = .204$

Use the following to answer question 10:

A small car of mass M travels along a straight, horizontal track.



As shown in the figure, the track then bends into a vertical circle of radius R. (Hint: Start by analyzing F_N reqired at point A).

$mg = mv^2/R \Rightarrow v^2 = gR$

10. Which expression determines the minimum speed that the car must have at the top of the track if it is to remain in contact with the track?

A) $v = MgR$ B) $v = 2gR$ C) $v^2 = 2gR$ (D) $v^2 = gR$ E) $v = gR$

11. A force of magnitude 25 N directed at an angle of 37° above the horizontal moves a 10-kg box along a horizontal surface at **constant velocity**. How much work is done by this force in moving the box a distance of 15 m?

A) zero B) 1.7 J C) 40 J D) 98 J (E) 300 J

$W = Fs\cos\theta = 25(15)\cos 37°$

12. A 0.01-kg bullet traveling horizontally at 755 m/s strikes a wall and stops after penetrating 0.145 m into the wall. What is the average force of the wall on the bullet?

(A) 1.97×10^4 N
B) 2.07×10^5 N
C) 6.26×10^3 N
D) 3.13×10^4 N
E) 3.93×10^4 N

FIRST FIND ACCELERATION OF BULLET

$v_f^2 = v_0^2 + 2ax \quad v_f = 0 \quad v_0 = 755\ m/s$

SO $755^2 + 2a(0.145) = 0 \quad (x = 0.145\ m)$

$a = -1.97 \times 10^6\ m/s^2$

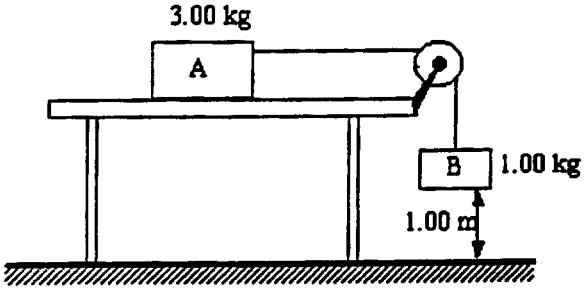
THEN $F = ma = 0.01 \times (-1.97 \times 10^6) = -1.97 \times 10^4\ N$

– SIGN BECAUSE F IS IN –x DIRECTION

13. A rock is thrown straight up from the earth's surface. Which one of the following statements describes the energy transformation of the rock as it rises? Neglect air resistance.

A) The total energy of the rock increases.
B) The kinetic energy increases and the potential energy decreases.
C) Both the potential energy and the total energy of the rock increase.
(D) The kinetic energy decreases and the potential energy increases.
E) Both the kinetic energy and the potential energy of the rock remain the same.

14. Two boxes are connected to each other as shown. The system is released from rest and the 1.00-kg box falls through a distance of 1.00 m. The surface of the table is **frictionless**. (Conservation of energy)



CHANGE IN PE IS $mgy = 1\,kg \times 9.8\,m/s^2 \times 1\,m$ OR 9.8 JOULES. THIS IS CONVERTED INTO KE FOR BOTH MASSES

What is the kinetic energy of box B **just before** it reaches the floor?

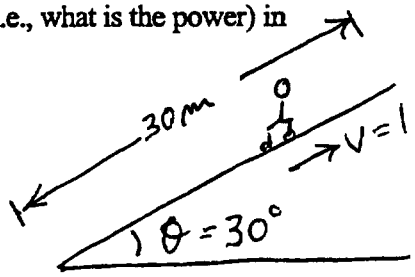
(A) 2.45 J
B) 4.90 J
C) 9.80 J
D) 29.4 J
E) 39.2 J

$KE = \frac{\text{TOTAL MASS}}{2} \times v^2$

BLOCK B HAS $\frac{1}{4}$ OF THE TOTAL MASS, GETS $\frac{1}{4}$ OF 9.8 J KE.

15. An escalator (moving stairway) is 30.0 meters long and is inclined 30.0° relative to the horizontal, and moves at 1.00 m/s. At what rate does it do work (i.e., what is the power) in lifting a 50.0 kg man from the bottom to the top of the escalator?

A) 49.3 W
B) 98.0 W
(C) 245 W
D) 292 W
E) 495 W



IN 1 SECOND, THE MAN MOVES 1 METER UP THE STAIRWAY, SO HE RISES $y = 1\,\text{METER} \times \sin 30°$

OR $y = \frac{1}{2}$ METER. HIS PE IS INCREASED BY $mgy = 50 \times 9.8 \times \frac{1}{2} = 245$ JOULES PER SEC.

$\Delta p = m\Delta v$, HERE $\Delta v = v_f - v_i = (-15) - (15)$

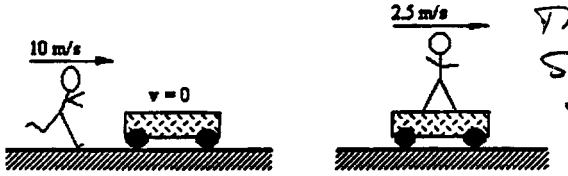
$\Delta v = -30$ m/s SO $\Delta p = .065(-30)$

16. A 0.065-kg tennis ball moving to the right with a speed of 15 m/s is struck by a tennis racket, causing it to move to the left with a speed of 15 m/s. If the ball remains in contact with the racquet for 0.020 s, what is the magnitude of the average force experienced by the ball?

A) zero (B) 98 N C) 160 N D) 1.6×10^5 N E) 9.8×10^4 N

$F\Delta t = \Delta p$ SO $F = \Delta p/\Delta t = .065(-30)/.020 = -97.5$ N

17. 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. CONSERVATION OF MOMENTUM MEANS THAT IF THE SPEED IS $\times \frac{1}{4}$ THE MASS MUST BE $\times 4$.

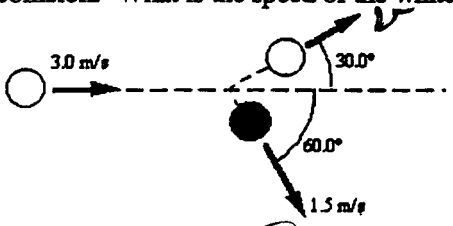


If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?

(A) 150 kg B) 175 kg C) 210 kg D) 260 kg E) 300 kg $4 \times 50 = 200$ kg

SO CART IS 150 kg

18. The two balls shown below have the same mass (0.17 kg). The white ball strikes the black ball such that it follows the path shown. The black ball has a speed of 1.5 m/s immediately after the collision. What is the speed of the white ball after the collision?



A) 1.5 m/s B) 1.8 m/s (C) 2.6 m/s D) 4.3 m/s E) 5.2 m/s

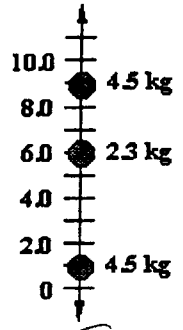
CONSERVATION OF MOMENTUM, IN PARTICULAR THE X COMPONENT OF MOMENTUM, SAYS

$m(3.0 \text{ m/s}) = m(1.5 \frac{\text{m}}{\text{s}} \cos 60°) + m(v \sin 30°)$

$$v = \frac{3.0 - 1.5\cos 60°}{\cos 30°} = 2.6 \text{ m/s}$$

IT'S NICE WHEN THE MASSES ARE ALL EQUAL!

19. The drawing shows two 4.5-kg balls located on the y axis at 1.0 and 9.0 m, respectively; a third ball with a mass 2.3 kg is located at 6.0 m. What is the location of the center of mass of this system?



$$x_{cm} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$

$$= \frac{4.5 \times 1 + 2.3 \times 6 + 4.5 \times 9}{4.5 + 2.3 + 4.5}$$

$$= 5.2 \text{ m}$$

A) 4.8 m (B) 5.2 m C) 5.6 m D) 6.0 m E) 6.4 m

Use the following to answer question 20:

CONSERVATION OF MOMENTUM MEANS IF MASS $\times \frac{1}{2}$, $v \times 2$.

A space vehicle of mass m has a speed v. At some instant, it separates into two pieces, each of mass $0.5m$. One of the pieces is at rest just after the separation. SO WE GO FROM $KE_i = \frac{mv^2}{2}$ TO $KE_f = \frac{1}{2}\left(\frac{1}{2}m\right)(2v)^2 = mv^2$

20. How much work was done by the internal forces that caused the separation?

A) zero B) $(1/4)mv^2$ (C) $(1/2)mv^2$ D) mv^2 E) $2mv^2$

AND $W = KE_f - KE_i = \frac{1}{2}mv^2$

21. The earth takes slightly less than one day to complete one rotation about the axis passing through its poles. The actual time is 8.616×10^4 s. Given this information, what is the angular speed of the earth about its axis?

(A) 7.292×10^{-5} rad/s
B) 2.321×10^{-6} rad/s
C) 9.951×10^{-5} rad/s
D) 6.334×10^{-4} rad/s
E) 1.990×10^{-7} rad/s

$$\omega = \frac{2\pi \text{ RAD}}{8.616 \times 10^4 \text{ s}} = 7.292 \times 10^{-5} \frac{\text{RAD}}{\text{s}}$$

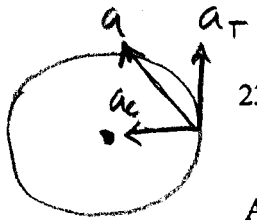
22. A wheel with a radius of 0.10 m is rotating at 35 rev/s and slows down uniformly to 15 rev/s over a 3.0 s interval. What is the angular acceleration of a point on the wheel?

A) -2.0 rev/s^2 B) 0.67 rev/s^2 (C) -6.7 rev/s^2 D) 42 rev/s^2 E) -17 rev/s^2

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{15 \frac{\text{REV}}{\text{s}} - 35 \frac{\text{REV}}{\text{s}}}{3 \text{ s}} = -\frac{20}{3} \frac{\text{REV}}{\text{s}^2}$$

$a_T = r\alpha = 2.0 \times 20 \frac{m}{s^2} = 40.0 m/s^2$

$a_c = r\omega^2 = 2.0 \times (2\pi \frac{rad}{s})^2 = 79.0 m/s^2$



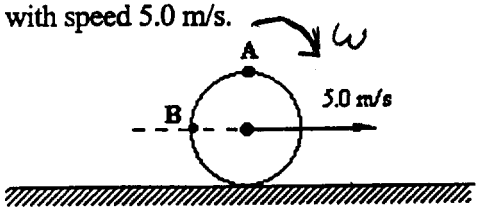
23. A circular disk of radius 2.0 m rotates with a constant angular acceleration of 20.0 rad/s^2. What is the **acceleration of a point on the edge of the disk** at the instant that its angular speed is 1.0 rev/s?

A) 40 m/s^2 B) 79 m/s^2 C) 110 m/s^2 D) 120 m/s^2 E) zero

$a = \sqrt{a_T^2 + a_c^2} = 88.5 m/s^2$ NOT ONE OF THE CHOICES! (SORRY)

Use the following to answer questions 24-25:

A 2.0-kg solid disk rolls without slipping on a horizontal surface so that its center proceeds to the right with speed 5.0 m/s.



The point **A** is the uppermost point on the disk and the point **B** is along the horizontal line that connects the center of the disk to the rim.

24. Which one of the following statements concerning the direction of the disk's ***angular velocity vector*** is true?

A) It points to the left.
B) It points to the right.
C) It points into the paper.
D) It points out of the paper.
E) It varies from point to point on this disk.

USE RIGHT HAND RULE.

25. What is the *instantaneous* speed of point **B** *with respect to the ground*?

A) zero B) 5.0 m/s C) 7.1 m/s D) 7.5 m/s E) 10.0 m/s

THE POINT AT THE BOTTOM OF THE WHEEL MUST HAVE A TANGENTIAL SPEED EQUAL AND OPPOSITE TO THE 5.0 M/S, SINCE IT IS NOT MOVING. ALL POINTS ON THE RIM HAVE THE SAME TANGENTIAL SPEED, SO B HAS 5.0 M/S, UPWARD, ADD THIS TO 5.0 M/S TO THE RIGHT TO GET TOTAL SPEED $\sqrt{5^2+5^2} = 7.1$ M/S