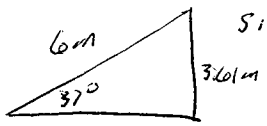
Solutions

Physics 2414
Midterm #3 – Spring 2012

Version A

Multiple choice (6 points each)

1) A 30 N box is pulled 6.0 m up a 37 degree frictionless inclined plane. What is the work done by gravity on the box?



A) -11 J
B) -110 J
C) -140 J
D) -80 J
E) -50 J

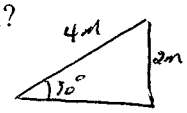
$\sin 37^\circ = \frac{opp}{6m}$ $opp = 3.61m$

work ind of path so go straight up

$W = mg\ell\cos\theta = (30N)(3.61m)\cos 180^\circ$

$W = -110J$

2) An 800 N box is pushed up a 30 degree inclined plane. The plane is 4.0 m long. It requires 3000 J of work to get the box to the top of the plane. What was the magnitude of the average friction force on the box?



A) 0 N
B) non-zero, but less than 400 N
C) 400 N
D) greater than 400 N but less than 800 N
E) greater than 800 N

$\sin 30^\circ = 0.5$

work with no friction

$(800N)(2m) = 1600J$

work by friction $3000J - 1600J = 1400J$

$1400J = F\ell$

$F = \frac{1400J}{4m} = 350N$

3) Two equal mass balls (one red and the other blue) are dropped from the same height, and rebound off the floor. The red ball rebounds to a higher position. Which ball was subjected to the greater magnitude of impulse (change in momentum) during its collision with the floor?

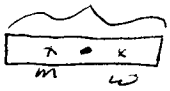
A) Both balls have the same magnitude impulse
B) Blue Ball
C) Red Ball
D) It's impossible to tell since the time interval of the collision is unknown
E) It's impossible to tell since the forces are unknown

$\Delta p = m\Delta v$

red has larger Δv

4) A Ping-pong ball moving east at a speed of 4 m/s collides with a stationary bowling ball. The ping-pong ball bounces back to the west, and the bowling ball moves very slowly to the east. Which object experiences the greater magnitude change in momentum during the collision?

A) They both experience the same magnitude change in momentum
B) Ping-pong ball
C) Bowling ball
D) Impossible to determine, since the velocities after the collision are unknown
E) Impossible to determine, since it is not stated if the collision is elastic or inelastic.



$C.m = \frac{(m_c \frac{L}{2}) + m_m(\frac{L}{2} - 1.5m) + m_\omega(\frac{L}{2} + 1.5m)}{m_c + m_m + m_\omega}$ before

$\frac{m_c(\frac{L}{2} - .4m) + m_m(\frac{L}{2} + 1.5m - .4m) + m_\omega(\frac{L}{2} - 1.5m - 0.4m)}{m_c + m_m + m_\omega}$ after

5) A man, with a mass 80 kg, and a woman, who is lighter, are sitting on a canoe of mass 30 kg. When the canoe is at rest, they change seats, which are 3.0 m apart and symmetrically located with respect to the canoe's center. The man notices the canoe moved 0.40 m relative to a submerged log. Based on this information, what is the woman's mass?

Set equal

$m_c(\frac{L}{2}) + m_m(\frac{L}{2} - 1.5m) + m_\omega(\frac{L}{2} + 1.5m) = m_c(\frac{L}{2} - 0.4m) + m_m(\frac{L}{2} + 1.5m - .4m) + m_\omega(\frac{L}{2} - 1.5m - 0.4m)$

A) 45 kg
B) 52 kg
C) 32 kg
D) 67 kg
(E) 58 kg

$m_m(-1.5m) + m_\omega(1.5m) = m_c(-0.4m) + m_m(1.1m) + m_\omega(-1.9m)$

$m_m(-2.6m) + m_c(0.4m) = m_\omega(-3.4m)$ $\quad m_\omega = \frac{80(2.6) + 30(0.4)}{-3.4} = 58kg$

6) A small bomb of mass 10 kg is moving toward the North with a velocity of 4.0 m/s. It explodes into three fragments: a 5.0 kg fragment moving West with a speed of 8.0 m/s, and a 4.0 kg piece moving East with a speed of 10 m/s. What is the velocity of the third fragment?

$p_i = 40\ kg\text{-}m/s$ North

p_f 40 kg-m/s, 40 kg-m/s needs to be 40 kg-m/s North

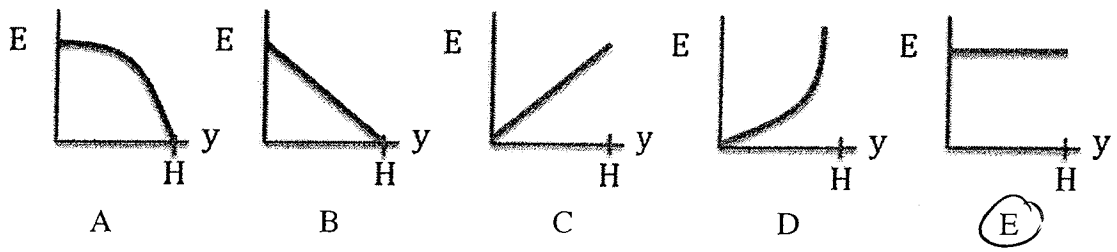
A) 0
B) 33 m/s 45 degrees North of East
C) 33 m/s 45 degrees South of West
(D) 40 m/s North
E) None of the above

so 3rd mass = 1kg

so $1kg \cdot v = 40\ kg\text{-}m/s\ N$

7) In which case is the momentum of the CAPITALIZED SYSTEM conserved?
A) A BALL falling freely with no friction
B) A RUBBER BALL as it bounces from the floor
C) A CAR making a turn at constant speed
D) A BULLET AND THE GUN from which it was fired when the gun is firmly held
(E) TWO BALLS colliding at right angles

8) A ball is held at a height H above a floor. It is then released and falls to the floor. If air resistance can be ignored, which of the five graphs correctly gives the mechanical energy E of the Earth-ball system as a function of the altitude y of the ball?



9) A 5 kg mass resting on a horizontal table compresses a horizontal spring 6 cm. The spring has a spring constant of 3000 N/m. After being released, the spring stretches to a maximum distance of 4 cm. What is the coefficient of kinetic friction between the mass and the table?

A) 0.33
B) 0.54
C) 0.61
D) 0.22
E) 0.67

$\frac{1}{2}kx_1^2 - \mu_k mg(x_1+x_2) = \frac{1}{2}kx_2^2$

$\mu_k = \frac{\frac{1}{2}k(x_1^2 - x_2^2)}{mg(x_1+x_2)} = 0.61$

10) A mass of 10 kg is dropped from a height of 40 cm above a spring. The spring compresses by 20 cm when the mass is dropped on the spring. What is the spring constant for the spring in N/m? (Do not neglect the change in gravitational potential energy as the spring compresses)

A) 2940
B) 2233
C) 3434
D) 1256
E) 1960

$E_i = mg(0.4m)$

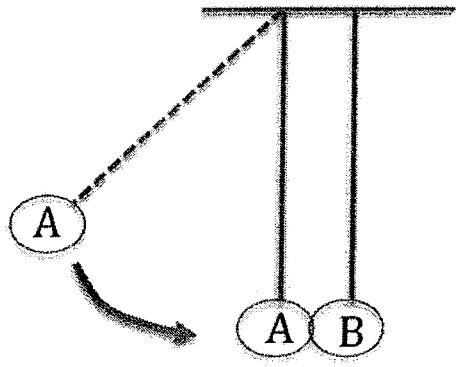
$E_f = \frac{1}{2}kx^2 - mgx$

$0.4mg = \frac{1}{2}kx^2 - mgx$

$\frac{1}{2}kx^2 = 0.4mg + mgx$

$k = \frac{mg(0.6)}{\frac{1}{2}(0.2)^2} = 2940$

11) The pendulum bobs shown in the picture are made of clay so they stick together after impact. The mass of bob A is half of bob B. Bob B is initially at rest. What is the ratio of the kinetic energy of the combined bobs just after impact to the kinetic energy of bob A just before impact?



$K_i = \frac{p_i^2}{2m_A}$ $K_f = \frac{p_f^2}{2(m_A+m_B)}$ $p_i = p_f$

$m_A = \frac{1}{2}m_B$

$\frac{K_f}{K_i} = \frac{\frac{p_i^2}{2(m_A+m_B)}}{\frac{p_i^2}{2m_A}} = \frac{m_A}{m_A+m_B}$

$\frac{K_f}{K_i} = \frac{\frac{1}{2}m_B}{\frac{1}{2}m_B+m_B} = \frac{\frac{1}{2}}{3/2} = \frac{1}{3}$

A) 1/2
B) 1/3
C) 1/4
D) 1/5
E) 1/6

12) An object of mass 5.0 kg is projected into the air at a 55 degree angle. It hits the ground 3.6 s later. What is the change in the magnitude of the objects momentum while it is in the air? Ignore air resistance,

A) 0 kg-m/s
B) 80 kg-m/s
C) 176 kg-m/s
D) 135 kg-m/s
E) 156 kg-m/s

at top $v_y = 0$ $t = 1.8s$

$v_y = v_{oy} - gt$

$0 = v_{oy} - (9.8 m/s^2)(1.8s)$

$v_{oy} = 17.64 m/s \uparrow$

$v_{fy} = 17.64 m/s \downarrow$

$\Delta p = m\Delta v$

$= (5kg)(17.64 m/s + 17.64 m/s)$

$= 176 kg\text{-}m/s$

13) Two pucks are pushed along a frictionless air hockey board. Puck A has three times the mass of puck B. Each puck is pushed for the same distance from the start line to the finish line with the same amount of force. Which of the following statements is true at the finish line.

same F
same d
same work
so
same ΔK

A) The momentum and kinetic energy of the pucks are equal.
B) The momentum of the pucks is equal but the kinetic energy of the pucks is not equal.
C) The momentum of the pucks is not equal but the kinetic energy of the pucks is equal.
D) Neither the momentum nor the kinetic energy of the pucks are equal.
E) The time it takes to push the pucks from the start to the finish line is the same for *A* and *B*.

14) My car accelerates from 0 to 20 mph in 3.0 s. How long does it take for it to accelerate from 0 to 60 mph assuming the power of the engine to be independent of velocity and neglecting friction?

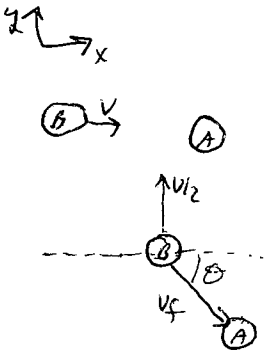
$P = \frac{W}{t}$ $W_{net} = \Delta K$

A. 3.0 s
B. 9.0 s
C. 12 s
D. 18.0 s
E. 27.0 s

$V_f = 20$ mph or $V_f = 60$ mph

V 3 times larger so $\frac{1}{2}m(3)^2 \rightarrow 9$ times larger ΔK

so time 9 times longer



15) Two balls A and B, having different but unknown masses, collide. A is initially at rest when B has a speed v. After the collision, B has a speed of v/2 and moves at a right angle to its original motion. What is the direction in which ball A moves after the collision?

$p_{ix} = m_B v$ $p_{fx} = m_A \cos\theta v_f$
$p_{iy} = 0$ $p_{fy} = m_B \frac{v}{2} - m_A \sin\theta v_f$

A) 78 degrees from the final direction of B
B) 90 degrees from the final direction of B
C) 102 degrees from the final direction of B
D) 117 degrees from the final direction of B
E) Cannot be determined since the masses are not given

set equal
$m_B v = m_A v_f \cos\theta$
$m_B v/2 = m_A v_f \sin\theta$

take ratio
$\tan\theta = \frac{1}{2}$
$\theta = 26.56°$
so $90° + 26.56° = 117$

16) A woman stands on the edge of a cliff. She throws a stone *vertically downward* with an initial speed of 15 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 15 m/s, how much kinetic energy would it have just before it hits the ground?

A. 50 J
B. 150 J
C. 450 J
D. 900 J
E. Not enough information was given to answer the question