Exam 2

Name KEY

21 Questions

"Forces do work..."

Select the one response that best answers each question.

$4 = \frac{1}{2}kx^2$ $\therefore x = \sqrt{8/2500}$ $= .057$

1) 4.0 J of work are performed in stretching a spring whose spring constant of 2500 N/m. By how much is the spring stretched? The spring begins in an unstretched, uncompressed position.

A) 3.2 m B) 3.2 cm C) 5.7 m D) 0.3 cm E) 5.7 cm ✓

2) A mass of 2.0 kg traveling at 3.0 m/s along a smooth, horizontal plane hits a relaxed spring. The mass is slowed to zero velocity when the spring has been compressed by 0.15 m. What is the spring constant of the spring?

A) 18 N/m B) 9.0 N/m C) 800 N/m ✓ D) 400 N/m E) 20 N/m

A B

$TE_{A} = TE_{B}$ $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$ $k = \frac{mv^2}{x^2}$

3) A constant net force acts on an object. The object has ______________.

✓ A) a constant, non–zero acceleration.
B) zero acceleration.
C) a decreasing acceleration.
D) a constant, non–zero velocity.
E) an increasing acceleration.

$\underbrace{\sum \vec{F}}_{\text{constant non-zero}} = m\vec{a}$ Then this must be constant, non-zero

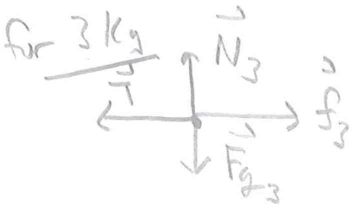
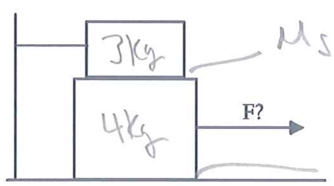
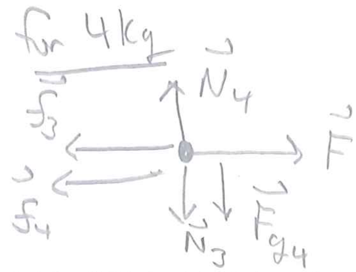


FIGURE 5-4





4) A 4.00–kg block rests between the floor and a 3.00–kg block as shown in Fig. 5–4. The 3.00–kg block is tied to a wall by a horizontal rope. If the coefficient of static friction is 0.800 between each pair of surfaces in contact, what force must be applied horizontally to the 4.00–kg block to make it move? To be clear, the top block is 3.00 kg and the bottom block is 4.00 kg.

A) 78.4 N ✓ B) 54.9 N C) 23.5 N D) 16.2 N E) 21.1 N

2nd law applied to 3 kg will give us $f_3 = 3\mu_s g$

2nd law applied to 4kg will give us $f_4 = \mu_s(4g + 3g)$

AND we see that just before the 4kg block starts to move, $|\vec{F}| = |\vec{f}_3| + |\vec{f}_4| = 78.4\,N$

for M_2

$\vec{T} = -T\hat{j}$

$\vec{F} = +m_2 g\hat{j}$

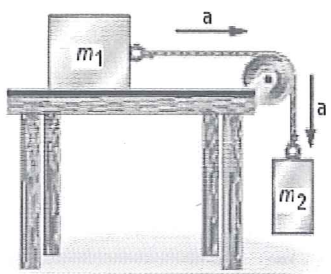
$f_g \downarrow$

$(\hat{j})$ $\sum F_y = M_2 a_y$

$M_2 g - T = M_2 a_y$

$T = M_2 g - M_2 a_y$

FIGURE 4–4



5) Two masses, m_1 and m_2, are connected to each other as shown in Fig. 4–4. Mass m_1 slides without friction on the table surface. Both masses have acceleration of magnitude a as shown. How does the tension in the string compare to the weight, $m_2 g$, of mass m_2? Hint: Apply the second law to m_2.

That makes it EASY!

A) The tension is equal to $m_2 g$.

B) The tension is larger than $m_2 g$.

C) The tension is smaller than $m_2 g$.

D) It depends on m_1 being smaller than m_2.

E) It depends on m_1 being larger than m_2.

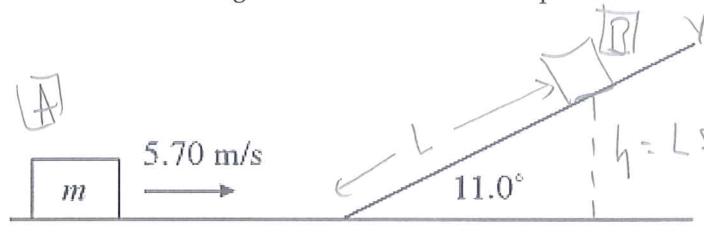
NOTE my choice of $+\hat{j}$ direction.

6) In the figure, a block of mass m is moving along the horizontal frictionless surface with a speed of 5.70 m/s. If the slope is 11.0° and the coefficient of kinetic friction between the block and the incline is 0.260, how far does the block travel up the incline? You are finding the maximum distance up the incline that the block will reach.

$TE_{(A)} + (W_f) = TE_B$

$\frac{1}{2}mv_A^2 - \mu mg\cos(11)L = mgL\sin(11)$ (A)

$L = \dfrac{v_A^2/2}{g\sin(11) + \mu g\cos(11)}$



from 2nd Law

$f = \mu mg\cos(11)$

A) 25.7 m

B) 3.72 m

C) 8.69 m

D) 6.89 m

E) No way to tell without knowing the mass.

for ball

$\vec{T}$ 25°

$\vec{F_g}$

7) A 1.20-kg ball is hanging on the end of a rope. The rope makes an angle 25.0° from the vertical when a 15.0 m/s horizontal wind blows. If the wind's force on the rope is negligible, what is the drag force on the ball? HINT: Draw a free body diagram for the ball.

A) 5.48 N B) 3.68 N C) 11.8 N D) 32.3 N E) 24.1 N

2nd ⇒ $(\hat{j})$ $\sum F_y = 0$ ∴ $T = mg/\cos(25)$ $(\hat{i})$ $\sum F_x = 0$ ∴ $f = T\sin(25) = mg\tan(25)$

8) A force on an object is given by $F(x) = -4.00\,x + 2.00\,x^3$. What is the change in potential energy in moving from $x = 1.00$ m to $x = 2.00$ m? All units are SI.

TWO WAYS

A) −10.0 J B) 12.0 J C) +1.50 J D) 10.0 J E) −1.50 J

$F(x) = -\dfrac{dPE}{dx}$

∴ $PE(x) = +\dfrac{4x^2}{2} - \dfrac{2x^4}{4} + \text{Constant} = +2x^2 - \dfrac{x^4}{2} + \text{Const}$

$\left[\overset{0\,J}{PE|_{x=2}} - \overset{1.5\,J}{PE|_{x=1}}\right] = -1.5\,J$

so $x=1$ is @ higher P.E.

OR use $W = \int_1^2 F\,dx$ NOTE: sign will be POSITIVE and you will need to apply physical explanation

Think about PE_g and F_g

$W = \int \vec{F} \cdot d\vec{s} = 20\cos(25)(2) = 36.3$

$\int |\vec{F}||d\vec{s}|\cos(25) = |\vec{F}|\cos(25)\boxed{\int ds}$

9) A constant force of 20 N is applied at an angle of 25° to an object of mass 8.0 kg. What is the work done by this force on the object if it causes a displacement of 2.0 m along the horizontal direction?

A) 0 J B) 19 J C) 17 J D) 36 J ✓ E) 40 J

10) An object travels at a fixed speed along a circular path. The acceleration of the object is ______.

$a_{radial} = \frac{v^2}{R}$

A) in the same direction as the velocity of the object.
B) zero.
C) larger in magnitude the smaller the radius of the circle. ✓
D) smaller in magnitude the smaller the radius of the circle.
E) in the opposite direction of the velocity of the object.

11) You try to pull an object by tugging with a force $\vec{F}$ on a rope that is attached to the object. The object does not move at all. What does this imply?

$\sum \vec{F} = 0$
Must not be only force.

for the rest of pts

A) There are also one or more other forces that act on the object whose sum is $(-\vec{F})$. ✓
B) The rope is not transmitting the force to the object.
C) There are no other forces acting on the object.
D) The inertia of the object prevents it from accelerating.
E) The object has reached its natural state of rest and can no longer be set into motion.

12) A 60.0-kg person rides in elevator while standing on a scale. The elevator has an acceleration 2.00 m/s^2 upward. What is the reading on the scale? Note that the scale is reading the normal force experienced by the person. $\sum F_y = ma_y$ $N - mg = ma_y$ $\therefore N = m(+2) + m(9.8) = 708$

A) 469 N B) zero C) 589 N D) 349 N E) 708 N ✓

13) A batter hits a 0.140-kg baseball that was approaching him at 40.0 m/s and, as a result, the ball leaves the bat at 30.0 m/s in the direction of the pitcher. What is the magnitude of the impulse delivered to the baseball?

$40\,m/s$ $-30\,m/s$

$\Delta\vec{p} = -m30 - m40 = -9.8\hat{i}$

A) 5.60 Ns B) 1.40 Ns C) 7.00 Ns D) 4.90 Ns E) 9.80 Ns ✓

14) During a collision with a wall, the velocity of a 0.200-kg ball changes from 20.0 m/s toward the wall to 12.0 m/s away from the wall. If the time the ball was in contact with the wall was 60.0 ms, what was the magnitude of the average force applied to the ball?

A) 40.0 N B) 26.7 N C) 13.3 N D) 16.7 N E) 107 N ✓

$+20\,m/s$ $+\hat{i}$ $-12\,m/s$

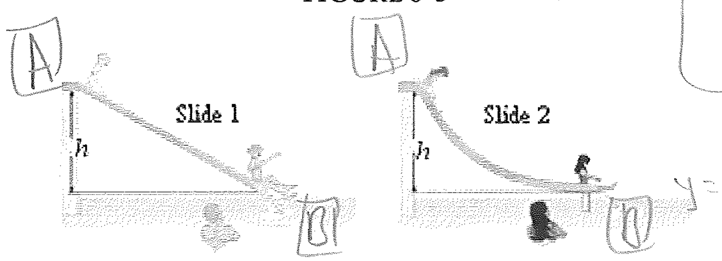
$\Delta\vec{p} = -12m - 20m = -6.4\hat{i}$

$\vec{F}_{AVG} = \frac{\Delta\vec{p}}{\Delta t} = -106.7\hat{i}$

$TE_{(A)} = KE_{(A)} + PE_{g(A)}$

$TE_{(B)} = KE_{(B)} + PE_{g(B)}$

FIGURE 8–3



15) Swimmers at a water park have a choice of two FRICTIONLESS water slides (see Fig. 8–3). 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 end of slide 1 compare with v_2, the speed of a swimmer reaching the end of slide 2?

Conservation of Energy is SAME for both problems, so long as no friction

A) $v_1 > v_2$
B) $v_1 = v_2$
C) $v_1 < v_2$
D) No simple relationship exists between v_1 and v_2.

16) Is it possible for a system to have negative potential energy?

SEE NOTES

A) Yes, since the choice of the zero of potential energy is arbitrary.
B) Yes, as long as the total energy is positive.
C) Yes, as long as the kinetic energy is positive.
D) No, because this would have no physical meaning.
E) No, because the kinetic energy of a system must equal its potential energy.

17) A force is given by $(4.00\,x)\,\hat{i} + (2.0\,x\,y\,)\,\hat{j}$. Note that this force is a function of position. An object begins at the origin. How much work is done by this force on the object as it moves in a straight line to $x = 1.00$ m, $y = 0.00$ m? All units are SI. W

A) 3.00 J B) 1.50 J C) 0.00 J D) 2.50 J E) 2.00 J

$W = \int \vec{F}\cdot d\vec{s} = \int (4x\hat{i} + 2xy\hat{j})\cdot dx\hat{i} = \int_0^1 4x\,dx = \frac{4x^2}{2}\Big|_0^1 = 2\,J$

$d\vec{s} = dx\hat{i}$

18) A potential energy function is given by $PE(x) = 3.00\,x + 1.00\,x^3$. What is the force that is associated with this potential energy function? All units are SI.

$F(x) = -\frac{d}{dx}PE(x) = -3 - 3x^2$

A) $0.500\,x^2 + 1.00\,x^4$
B) $-0.500x^2 - 1.00\,x^4$
C) $-3.00 - 3.00\,x^2$
D) $-3.00 - 1.00\,x^2$
E) $3.00 + 1.00\,x^2$

19) A mass of 3.0 kg is subject to a force F(x) = 8.0 – 4.0 x. The potential energy of the mass is 4 at x = 0. What is the potential energy of the mass at x = 2.0 m? All units are SI.

A) 0.0 J B) –4.0 J C) 8.0 J D) 4.0 J E) –8.0 J

$PE(x) = -\int F\,dx = -8x + \frac{4x^2}{2} + \text{const.}$

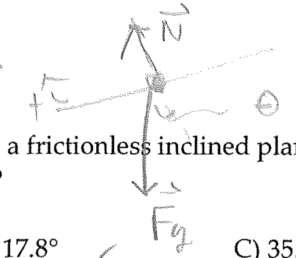
$PE(x=0) = 4 = -0 + 0 + \text{const}$

$\therefore \text{const} = 4$

So we have $PE(x) = -8x + 2x^2 + 4$

$PE(x=2) = -16 + 8 + 4 = -4\,J$

for block



$\boxed{\hat{i}}$ $\sum F_x = ma_x$

$mg\sin\theta = ma_x$

$\sin\theta = \frac{a_x}{g} = 3/9.8$

$\therefore \theta = 17.8°$

20) A 4.00-kg block slides down a frictionless inclined plane with an acceleration 3.00 m/s^2. What is the angle of the incline above horizontal?

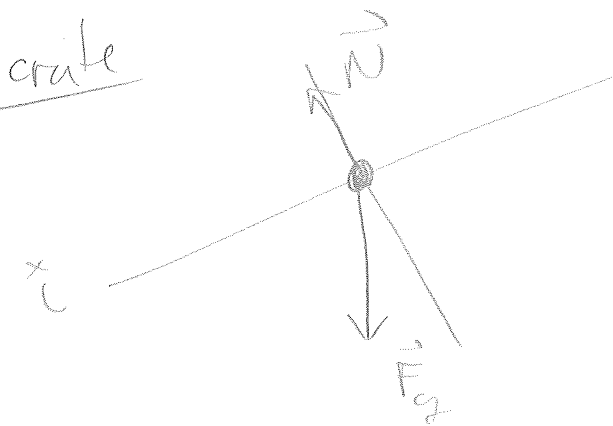
A) 53.7° B) 17.8° C) 35.3° D) 23.6° E) 45.2°

21) A packing crate slides down an inclined ramp at constant velocity. Which of the following statements must be true?

$a_x = 0$

A) A net downward force is acting on the crate.
B) A net upward force is acting on the crate.
C) The crate is not acted on by a significant gravitational force.
D) A frictional force is acting on the crate.
E) The crate is not acted on by a significant normal force.

for crate



2nd Law

$\boxed{\hat{i}}$ $\sum F_x = ma_x$
$\hookrightarrow 0$

Must have another force along $\boxed{\hat{i}}$ axis. Friction is the only option.