Physics 101 **TEST #2** **October 1, 2014**

There are 20 equally-weighted problems on this test. There is only one correct answer per question. Clearly write your answer in the box to the left of the question number. The key will be posted online after all make-up tests are completed. You test grade will appear on WebAssign. If I decide to curve the test, your test grade on Webassign will already be curved. As I am working out of town, it may take longer for me to post these grades than for Test 1. For all problems, **ignore air resistance.**

NAME KEY

Possibly Useful Information:

$v = v_0 + a\,t$ $\Delta x = v_0 t + \frac{1}{2} a\,t^2$ $v^2 = v_0^2 + 2\,a\,\Delta x$

$W = m\,g$ $g = 9.8\ m/s^2$ $f_k = \mu_k\,n$ $f_s \le \mu_s\,n$

$\sin\theta$ = opposite/hyp $\cos\theta$ = adjacent/hyp $\tan\theta$ = opposite/adj $a^2 + b^2 = c^2$

1 kg = 2.2 pounds 1 m = 3.28 ft quadratic: $ax^2+bx+c=0$ $x=(-b\pm(b^2-4ac)^{\wedge}\frac{1}{2})/2a$

Newton's 1st Law: Every object continues in its state of rest, or of constant speed in a straight line, until a nonzero net force acts on it.

Newton's 2nd Law: net $F = m\,a$ This is a vector formula.

Newton's 3rd Law: When one object exerts a force on a second object, the second object exerts an equal and opposite force on the first object.

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Work = (component of force in the direction of displacement) (displacement)

Kinetic Energy: $KE = \frac{1}{2}\,m\,v^2$ Power = Work/time

Work-Energy Theorem ($W = \Delta KE$) Work done by all the forces = change in kinetic energy

Gravitational Potential Energy: $GPE = mgy$ where y is change in vertical height

$W_{nc} + KE_1 + PE_1 = KE_2 + PE_2$ where W_{nc} is work done by frictional forces

$KE_1 + PE_1 = KE_2 + PE_2$ if there is no friction

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[C] 1. The work done by gravity when you lift a heavy box up a flight of stairs is

a) Zero b) Positive c) Negative d) Depends on the direction I call positive y.

$W = F_{\perp}\,\Delta y$ If the force points opposite Δy, then one of these ($F_{\perp}$ or Δy) should be negative.

$$\frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = \frac{1}{2}(350\text{kg})(20\tfrac{m}{s})^2 + \frac{1}{2}(2000)(-18\tfrac{m}{s})^2$$

E

2. Find the kinetic energy of the following system of two vehicles. A 350 kg motorcycle traveling east at 20 m/s and a 2000 kg car traveling west at 18 m/s.

a) 29,700 J b) 70,000 J c) 254,000 J d) 324,000 J e) 394,000J

C

3. A 3000 kg elevator car is supported by a steel cable. If the elevator car is going up at a constant speed of 4.1 m/s, what is the tension in the cable? $\Sigma F_y = ma_y = 0 = T - mg$ $T = mg$ since $a = 0$

a) 12300 N b) 17100 N c) 29400 N d) 41700 N

D

4. A stone is thrown straight up. At the top of its path, the net force acting on it

a) is greater than its weight
b) is greater than zero, but less than its weight
c) is instantenously equal to zero
d) is equal to its weight

regardless of position during freefall

A

5. Consider an object moving from an initial to a final position along a level surface. If the total work done on the object is negative during this movement, the kinetic energy of the object $W = \Delta KE = KE_f - KE_i$ $KE_f = W + KE_i$ ↑ negative $KE_f < KE_i$

a) decreases b) stays the same c) increases

D

6. A football is thrown at 12 m/s at an angle of 35 degrees from the ground. What is the x component of the final velocity of the football (just before it hits the ground)?

a) 0 m/s b) 3.5 m/s c) 6.9 m/s d) 9.8 m/s e) 12 m/s

$v_{fx} = v_{ox}$

$v_{ox} = 12\cos 35^\circ$

C

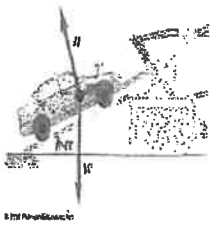
7. A projectile is fired from a gun near the surface of Earth. The initial velocity of the projectile has a vertical component of 98 meters per second and a horizontal component of 49 meters per second. How long will it take the projectile to reach the highest point in its path? $t = ?$ $a_y = -9.8\ m/s^2$ $v_{oy} = 98\frac{m}{s}$

a) 2.5 s b) 5 s c) 10 s d) 123 s e) 490 s

$v_f = v_o + at$ $t = \frac{v_f - v_o}{a} = \frac{0 - 98}{-9.8}$

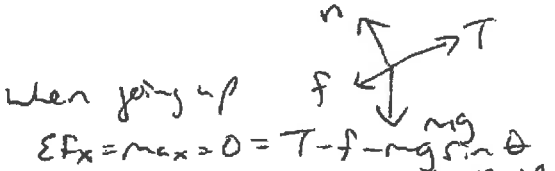
A

8. A tow truck either lowers or raises a car at a constant speed on an inclined ramp as shown in the figure along with all forces except friction, but there is friction. Would the tension in the cable be the same in both cases or larger for one?



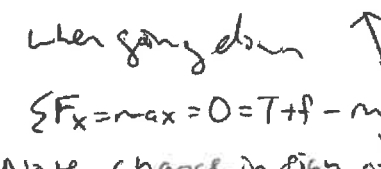
a) Tension in cable is larger when the car is raised up incline
b) Tension in cable is larger when the car is lowered down
c) Tension in cable is the same for both cases

see extra clicker questions on friction lecture to step through this



When going up $\Sigma F_x = ma_x = 0 = T - f - mg\sin\theta$

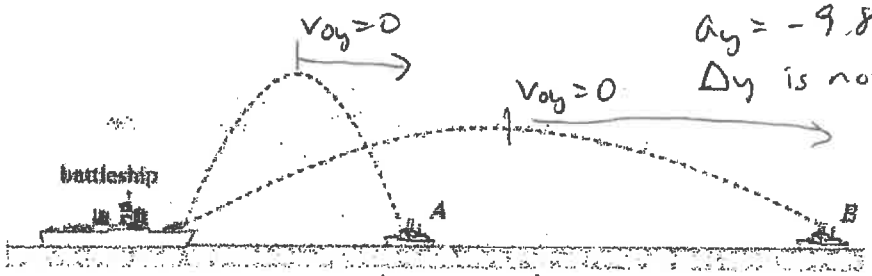
Solve for tension in each case



When going down $\Sigma F_x = ma_x = 0 = T + f - mg\sin\theta$

Note change in sign of friction

$T = mg\sin\theta \pm f$



$v_{oy}=0$ $v_{oy}=0$

$a_y = -9.8\ m/s^2$

Δy is not the same

Only use y info. If info will confuse you

$\Delta y = \cancel{v_{oy}^{0}}t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2\Delta y}{a}}$

This was an extra Clicker problem

B 9. A battleship simultaneously fires two shells at enemy ships as shown above. If the shells follow the parabolic trajectories shown (where one shell goes higher vertically than the other), which ship gets hit first? Let's say Ship B is more than twice as far away as ship A. (The initial speeds of the two shells is not necessarily the same.)

Question asks about time. Let's look at half the trip (from top height)

a) Ship A gets hit first b) Ship B gets hit first c) They hit at the same time

D 10. Wiley Coyote travels horizontally at 3 m/s before running off of a straight cliff that is 51 m high. How far horizontally will he land from the base of the cliff?

Need time to solve for Δx. Use y side to get time

x	y
$\Delta x = ?$	$\Delta y = -51m$
$v_{ox} = 3\frac{m}{s}$	$v_{oy} = 0$
$a_x = 0$	$a_y = -9.8\frac{m}{s^2}$

a) 0 m b) 3.2 m c) 5.2 m d) 9.7 m e) 17 m

$\Delta y = \cancel{v_{oy}^{0}}t + \frac{1}{2}a_y t^2$ $t = \sqrt{\frac{2\Delta y}{a}} = 3.22$ $\Delta x = v_{ox}t = (3)(3.22) = 9.7m$

D 11. Superman is playing catch with Batman's sidekick Robin. Robin is standing on top of a 12 meter platform while Superman is on the ground below. (Assume they are equally tall.) If Robin throws the ball a speed of 10 m/s at an angle of 45 degrees, what is the y component of the final velocity of the ball just before Superman catches it on the ground? $v_{fy}^2 = v_{oy}^2 + 2a\Delta y$ Use only y info!

x	y
$a_x = 0$	$a_y = -9.8\frac{m}{s^2}$
$v_{ox} = 7.07\frac{m}{s}$	$v_{oy} = 7.07\frac{m}{s}$
	$\Delta y = -12m$
	$v_{fy} = ?$

a) 0 m/s b) -1.2 m/s c) -7.07 m/s d) -16.9 m/s e) -18.3 m/s

D 12. A baseball is thrown straight up. As it moves upward, what happens to its kinetic energy and its gravitational potential energy?

$GPE = mgy$

As y ↑, so does GPE

a) kinetic energy increases and potential energy decreases

b) kinetic energy decreases and potential energy decreases $KE = \frac{1}{2}mv^2$

c) kinetic energy increases and potential energy increases ball slows down so v ↓

d) kinetic energy decreases and potential energy increases so KE ↓

C 13. A 15 kg object is moved from a height of 7 m above the floor to a height of 12 m above the floor. What is the increase in its gravitational potential energy?

a) 75 J b) 180 J c) 735 J d) 1029 J e) 1764 J

$\Delta GPE = GPE_f - GPE_i$

$= mg(12m) - mg(7m)$

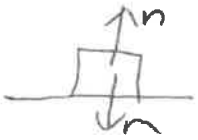
$= (15kg)(9.8\frac{m}{s^2})(5m)$

5

12-7

A 14. Consider two identical blocks, one resting on a horizontal surface and the other resting on an incline. In which case is the normal force greater?

a) The horizontal surface. b) The incline. c) The same for both.



$\Sigma F_y = 0 = n - mg$

$n = mg$

$\Sigma F_y = 0 = n - mg\sin\theta$

$n = mg\sin\theta$

$\sin\theta < 1$

C

15. A big truck crashes into a small car. Which force is greater in magnitude?

a) The force of the small car on the large truck.

b) The force of the large truck on the small car.

c) The two forces have equal magnitude. ← Newton's 3rd law

d) It depends on the starting velocities of the car and truck (for example, if one was 0)

Energy problem

B

16. A 2000 kg car is on a 5 m tall hill with an incline angle of 30 degrees. The car slides 10 m down the inclined hill. If the car starts from rest and ends at 5 m/s, how much energy was lost due to friction? $W_{total} = W_C + W_{NC} = \Delta KE$ $W_C = -\Delta PE$

$W_{NC} = \Delta KE + \Delta PE$ will be negative

a) 25,000 b) 73,000J c) 100,000 J d) 196,000 J

$\Delta PE = -mgh$ $\Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$ $v_0 = 0$

$W_{NC} = -(2000)(9.8)(5m) + \frac{1}{2}(2000)(5m/s)^2 = -73,000J$

D

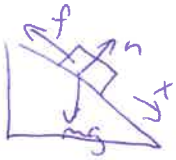
17. In Newton's Third Law, the two forces referred to as action-reaction forces

a) always cause objects to slow down ← not necessarily

b) always result in objects at rest

c) always are equal in magnitude and point in the same direction ← not same direction

d) always act on different objects (different free body diagrams) ← yep



C

18. A 2 kg book is at rest on an incline. The incline makes an angle of 20 degrees with the ground. The static coefficient of friction is 0.5 in this example. What is the amount of static friction force needed to keep the book at rest?

$\Sigma F_x = 0$

a) 0 N b) 3.35 N c) 6.7 N d) 9.2 N e) 18 N $0 = mg\sin\theta - f$

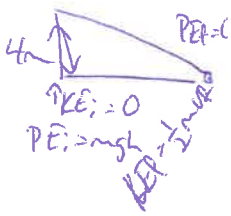
$f = mg\sin\theta = 2(9.8)\sin 20^\circ$

Energy problem

D

19. On an icy day (ignore friction), a car starts from rest and slides down a 4 m tall hill. What is the car's velocity at the bottom of the hill? (I am purposely not telling you the car's mass or angle of the hill as it's not required to solve the problem.)

Without the angle, you'll need energy conservation to solve.



a) 0.41 m/s b) 2.45 m/s c) 2.83 m/s d) 8.85 m/s e) 78.4 m/s

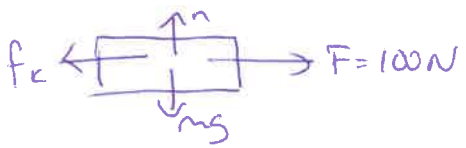
$\frac{1}{2}mv_f^2 = mgh_i$ mass cancels

$v_f = \sqrt{2gh_i}$

C

20. Let's say I horizontally push on an 8 kg box with a constant force of 100 N. The coefficient of kinetic friction between the box and the floor is 0.4. What is the resulting acceleration of the box?

a) 0 m/s^2 b) 3.14 m/s^2 c) 8.58 m/s^2 d) 31.4 m/s^2 e) 78.4 m/s^2



$\Sigma F_y = 0 \Rightarrow n = mg$

$\Sigma F_x = ma_x = 100\,N - 0.4(mg)$

$a_x = \frac{100\,N}{8k} - \frac{0.4(8kg)(9.8)}{8k}$