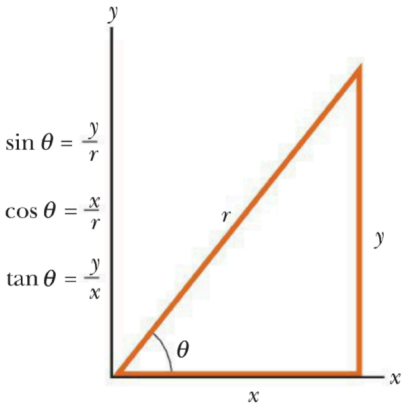
Name: SOLUTIONS MIDTERM 2, Spring 2019

Solutions in bold. Print your name clearly above, and write and bubble in your student 800 number on the provided scantron. There are 20 equally-weighted problems on this test, and there is only one correct answer per question. **Clearly circle your answer, AND also fill out the corresponding bubble on your scantron sheet.** The key will be posted online after all make-up tests are completed. Your test grade will appear on ecampus or WebAssign. If I decide to curve the test, your test grade online will be curved. Good luck!

POTENTIALLY USEFUL INFORMATION (**SOME EQUATIONS ARE ONLY VALID IN SPECIFIC SITUATIONS**):

Conversions: 1 m = 3.281 ft 1 mile = 1609 m 1 kg = 2.2 pounds $g = 9.8\ m/s^2 = 32\ ft/s^2$

1 pound = 4.45 N 1 hp = 746 W



$\sin\theta = \frac{y}{r}$

$\cos\theta = \frac{x}{r}$

$\tan\theta = \frac{y}{x}$

$r^2 = x^2 + y^2$

1D or 2D motion:

$$\bar{v} = \frac{\Delta x}{\Delta t} \quad \bar{a} = \frac{\Delta v}{\Delta t} \quad v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \quad a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t}$$

$$x = x_o + \bar{v}t = x_o + v_o t + \frac{1}{2}at^2 \qquad v = v_o + at$$

$$v^2 = v_o^{\,2} + 2a(x - x_o)$$

Quadratic formula:

$$ax^2 + bx + c = 0 \rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\vec{F} = \sum_i \vec{F}_i = m\vec{a} = \frac{\Delta \vec{p}}{\Delta t} \quad F_g = mg \quad F_{sp} = -kx \quad F_s \le \mu_s n \quad F_k = \mu_k n \quad \vec{F}_{AB} = -\vec{F}_{BA}$$

$$W = F_x \Delta x = \Delta KE + \Delta PE \quad KE = \tfrac{1}{2}mv^2 = \frac{p^2}{2m} \quad PE_g = mgy \quad PE_{sp} = \tfrac{1}{2}kx^2 \quad \bar{P} = \frac{W}{\Delta t} = F\bar{v}$$

$$\vec{p} = m\vec{v} \quad \vec{I} = \vec{F}\Delta t = \Delta \vec{p} = m\Delta \vec{v} \quad m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f} \quad KE_i + PE_i = KE_f + PE_f$$

$$v_f = \frac{m_1 v_{1i} + m_2 v_{2i}}{m_1 + m_2} \quad v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$$

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1. As a protest against the umpire's calls, a baseball pitcher throws a ball straight up into the air at an initial speed of 23.0 m/s. In the process, he moves his hand through a distance of 1.25 m. If the ball has a mass of 0.150 kg, find the force he exerts on the ball to give it this upward speed.

a.) 12.4 N **b.) 33.2 N** c.) 38.5 N d.) 23.2 N e.) unknown, need more information

2. Consider an object moving on a level surface. If the total work done on the object is positive, the kinetic energy of the object

a.) depends on the change in potential energy b.) decreases c.) stays the same **d.) increases**

3. A 2000 kg elevator is supported by a steel cable. If the elevator moves upward with a velocity of 5.0 m/s, what is the tension in the cable?

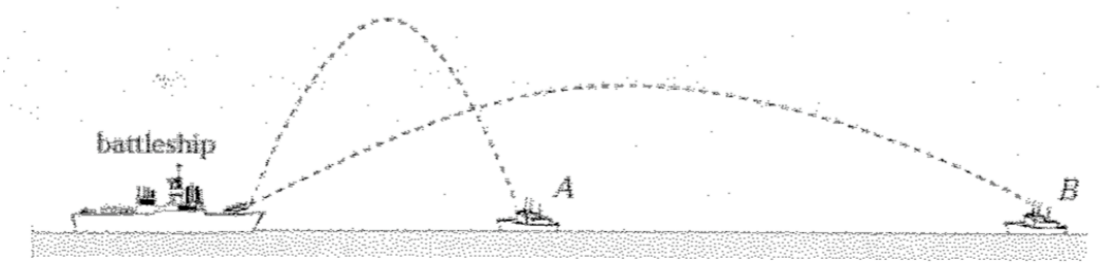
a.) 1000 N b.) 400 N **c.) 19600 N** d.) 25000 N e.) 98000 N

4. For the elevator in problem 4, how much power must be supplied to move the elevator?

a.) 1000 W b.) 400 W c.) 19600 W d.) 25000 W **e.) 98000 W**

5. A 1000 kg car is on the top of a 5 m tall hill with an inclination angle of 30 degrees relative to the flat ground. The car slides down 10 m as measured along the surface of the hill. If the car starts the slide at 5 m/s and ends at 15 m/s, how much energy was lost due to friction?

a.) 51000 J b.) 76000 J c.) 102000 J d.) 490000 J e.) 980000 J



Refer to the above figure for question 6.

6. At some moment, one of the projectiles has an equal amount of kinetic and potential energy. A moment later, which is larger?

a.) kinetic b.) potential c.) they remain equal **d.) It depends on the direction of travel**

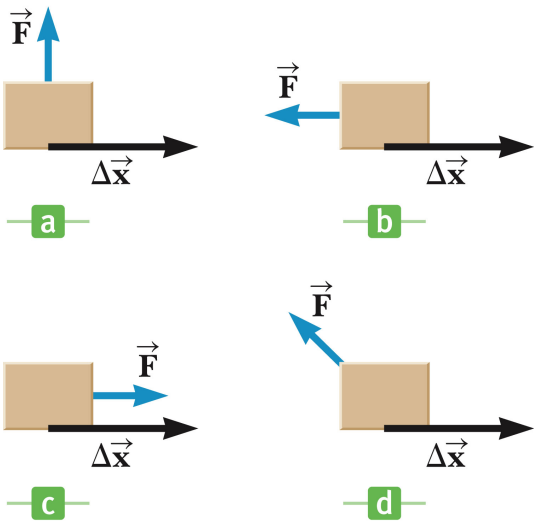
7. If a spring with spring constant 0.6 is compressed 10 cm away from equilibrium, how much work does it do to return to equilibrium?

a.) 0.06 N b.) 0.003 N **c.) 0.003 J** d.) 0.006 J e.) 0.006 W

8. How much power is required for a 100000 N helicopter to liftoff at 5 m/s?

a.) 100000 W b.) 250000 W **c.) 500000 W**

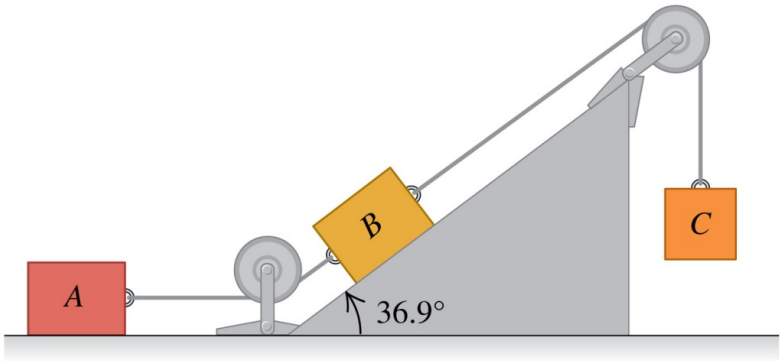
d.) It depends on how long it maintains that velocity



Refer to the above figure for question 9.

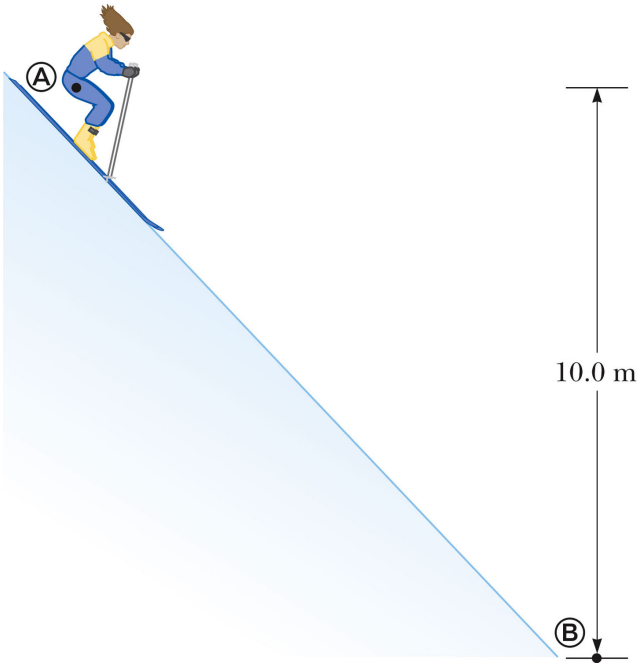
9. A block moves to the right in the positive x-direction while under the influence of a force as shown above. Which of the following is the correct order of the amount of work done by the force, from the most positive to the most negative?

a. d, c, a, b
b. c, a, b, d
c. c, a, d, b
d. b, a, c, d



Refer to the above figure for question 10.

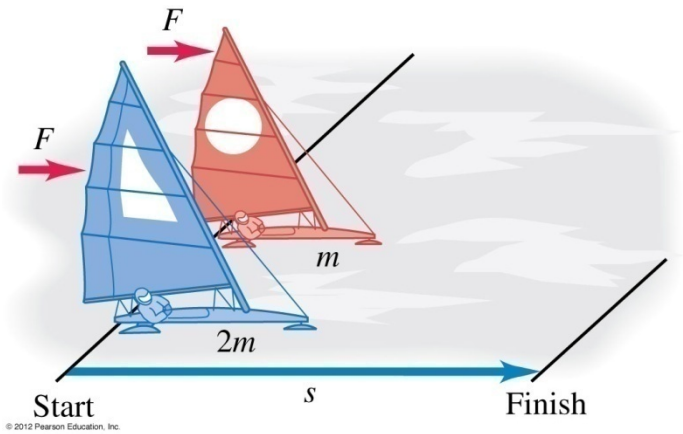
10. Three blocks are connected as shown. The ropes and pulleys are of negligible mass. When released, block *C* moves downward, block *B* moves up the ramp, and block *A* moves to the right. After each block has moved a distance *d*, the force of gravity has **directly** done:
a. positive work on *A*, *B*, and *C*.
b. zero work on *A,* positive work on *B*, and negative work on *C*.
c. **zero work on *A*, negative work on *B*, and positive work on *C*.**
d. none of these



Refer to the above figure for questions 11 and 12.

11. A 60 kg skier starts from rest at position A, as shown. Halfway down the slope (i.e. halfway between position A and position B), the gravitational force has done how much work on the skier?
a. 0 J
b. 2940 J
c. -2940 J
d. 9800 J
e. -9800 J

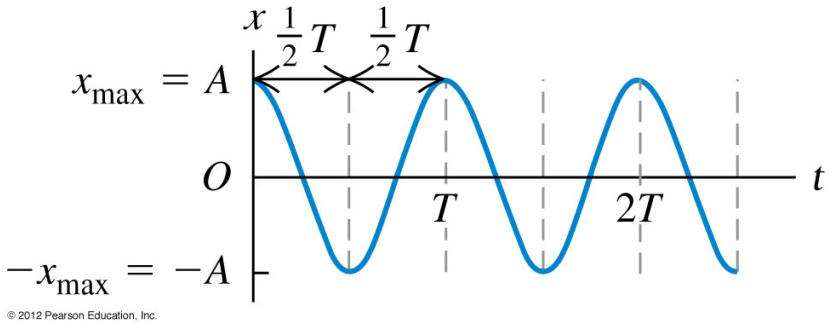
12. At position B, the skier's speed is
a. 0 m/s
b. 7 m/s
c. 10 m/s
d. 14 m/s
e. 20 m/s



Refer to the above figure for questions 13 and 14. Two iceboats (one of mass *m,* one of mass 2*m*) hold a race on a frictionless, horizontal, frozen lake. Both iceboats start at rest, and the wind exerts the same constant force on both iceboats.

13. Which iceboat crosses the finish line with more kinetic energy (KE)?
a. The iceboat of mass *m*: it has twice as much KE as the other.
b. The iceboat of mass *m*: it has 4 times as much KE as the other.
c. The iceboat of mass 2*m*: it has twice as much KE as the other.
d. The iceboat of mass 2*m*: it has 4 times as much KE as the other.
e. They both cross the finish line with the same kinetic energy.

14. Which iceboat crosses the finish line at higher speed?
a. The iceboat of mass *m*.
b. The iceboat of mass 2*m*.
c. Both boats have the same speed, when they cross the finish line.



Refer to the above figure for questions 15 and 16. This is an x-t diagram for an object attached to an oscillating spring. Friction is neglected, i.e. there are no non-conservative forces.

15. At which of the following times is the potential energy of the spring the greatest?
a. t = T/8
b. t = T/4
c. t = 3T/8
d. t = T/2
e. more than one of the above

16. At which of the following times is the kinetic energy of the object the greatest?
a. t = T/8
b. t = T/4
c. t = 3T/8
d. t = T/2
e. more than one of the above

17. Weightlifter A lifts a 100-kg weight to a height of 2.5 m above the ground in 0.5 s. Weightlifter B lifts a 75-kg weight to a height 2.5 m above the ground in 1.0 s. Which of the two weightlifters uses more power to lift the weights?
a. A
b. B
c. the same
d. cannot be determined

18. Two objects have the same momentum. Which has the greater kinetic energy?
a. the one with the larger mass
b. the one with the larger velocity
c. they have the same kinetic energy as well
d. cannot be determined

19. Let $m_1 = m_2 = 1$ kg. Let's say you hit ball 1 with $v_{1i} = 10$ m/s into stationary ball 2, $v_{2i} = 0$ m/s. Let's say that after the collision, ball 1 is stationary. What is the impulse on ball 2?
a. 5 m/s
b. 10 m/s
c. 20 m/s
d. 5 kg m/s
e. 10 kg m/s

20. An object of mass 3m moves to the right with a speed 2v. It collides head-on with an object of mass m moving with speed 2v in the opposite direction. If the two objects stick together, what is the speed of the combined object after the collision?
a. 0
b. v
c. 2v
d. 4v
e. 6v