PHY2048 Spring 2019 Exam 2 Review Questions

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Chapter 5: Applications of Newton's Laws

1. Two boxes are stacked, with box B placed on top of box A. If box A is pushed such that both boxes move at a constant velocity, is there any friction on either box?
   (a) Kinetic friction on box A and static friction on box B
   (b) Kinetic friction on box A and no friction on box B
   (c) Kinetic friction on box A and kinetic friction on box B
   (d) Static friction on box A and kinetic friction on box B
2. A 3kg box is placed on top of a 10kg box. If the 10kg box is pushed with a force of 70N, what is the force of friction on the 3kg box? Assume that there is negligible friction between the 10kg box and the ground.
3. A 5kg box slides down an incline of angle 40^o with an unknown coefficient of kinetic friction. If the box's acceleration is measured to be 3.58 m/s^2 down the slope, what is the value of the unknown coefficient of kinetic friction?
4. A 6kg box is placed on a surface with $\mu_s = 0.5$ and $\mu_k = 0.35$. If the box is pushed with a force of 20N, answer the following questions. *Note that this problem does not imply that the box is moving; you have to figure this out for yourself.*
   (a) What type of friction does the box feel?
   (b) What is the magnitude of that friction?
5. A 1.5kg box is pushed up a 30^o incline with a force $F = 20$N. If the incline surface has coefficients of friction $\mu_s = 0.4$ and $\mu_k = 0.2$, what is the acceleration on the box?
6. A 2.7kg box is placed on a ramp, with a coefficient $\mu_s = 0.4$, whose incline angle can be changed. At low angles, static friction will prevent the box from sliding down the incline, but if the angle is increased too much, eventually the box will slide down the ramp. What is the maximum incline angle before the box slides down the ramp?

Chapter 6: Work and Kinetic Energy

1. A 3.7kg mass is moving at a speed of 9 m/s when an unknown force acts on it. If, after some amount of time, the mass is moving at a speed of 14 m/s, how much work did the unknown force do? If the mass gained this speed along a distance of 15cm, moving in a straight line, what was the magnitude of the unknown force?

2. A 4.6kg boxes slides down a surface, inclined at 35^o, with a coefficient of kinetic friction of 0.3. If the box slides a distance of 10cm down the incline's surface, how much work was done by:

   (a) gravity?

   (b) the normal force?

   (c) friction?

3. A box is pushed along a path of some length, causing friction to do work on the box. If the box were pushed along a path with a greater length, then:

   (a) Friction would do less work, because it is conservative

   (b) Friction would do less work, because it is non-conservative

   (c) Friction would do more work, because it is conservative

   (d) Friction would do more work, because it is non-conservative

4. A 5kg mass is dropped from a height of 1.2m. If it takes 0.63s to hit the ground, how much work does air resistance do on the mass during the drop? *For this problem only, treat air resistance like a constant force.*

5. A 100g object, moving horizontally, feels a force:

$$\vec{F} = (3x^2 - 2x^4)\hat{i}$$

   where the numeric coefficients in $\vec{F}$ have the correct SI units implied.

   (a) How much work is done by $\vec{F}$ if the object moves from $x_1 = 0$ to $x_2 = 1$m?

   (b) If the object was at rest at x_1, how fast would it be moving at x_2?

Chapter 7: Conservation of Energy

1. Imagine you were loading up a moving truck with boxes, and you have two ways to put boxes in the truck: you could lift the box straight up into the truck, or you could push the boxes up a ramp into the truck. Which method would require less work? Ignore any friction and air resistance.

   (a) Pushing the boxes up the ramp, because it requires less force

   (b) Lifting the box straight up into the truck, because it's a shorter distance

   (c) The work would be the same either way

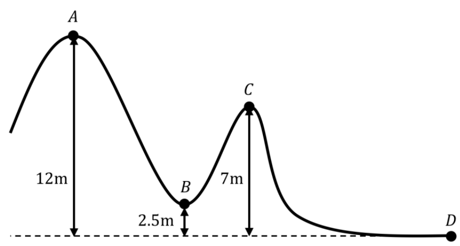
   (d) Impossible to answer without more information

2. A 65kg skateboarder rides his skateboard to a 0.7m tall ramp, starting at the bottom at 8.5 m/s. Assuming no friction or air resistance, what would the skateboarder's speed be when he reached the top of the ramp?

3. A spring is placed in front of a ramp, so that a ball can be fired from the spring and travel up the ramp to some maximum height. If a 55g ball is placed against a spring with a force constant of 150 N/m, and the spring is compressed by 15cm, how far up the ramp will the ball travel when it is released? Assume that there's no friction along the path.

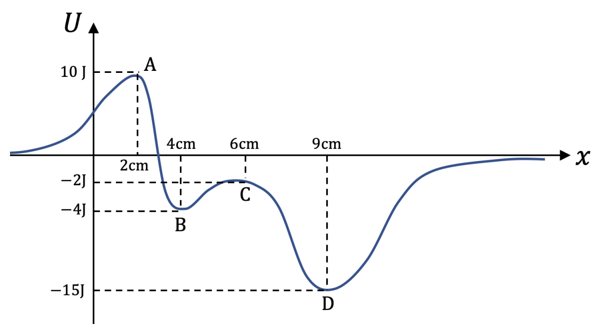
4. A box is released from rest at the top of an 18cm tall ramp. If the box is moving at 1 m/s when it reaches the bottom of the ramp, how much work did friction do on the box during its descent?

5. A 1750kg car starts at the bottom of a 20m tall hill traveling at 15 m/s. During the trip up the hill, air resistance does -50 kJ of work on the car, and friction does an additional -120 kJ of work on the car. What is the minimum amount of work the engine must do in order for the car to reach the top of the hill?



6. Consider the roller coaster shown in the figure above. People ride the coaster in a 600kg cart that can carry 500kg of passengers. Unless stated otherwise, assume that the cart moves along the track without friction.

   (a) If the cart drops from A at rest, what is its speed at B?
   (b) What would the speed of the cart be at C?
   (c) If the cart needed to arrive at D at rest, and there was some sort of braking mechanism between C and D, how much work would the brakes need to do on the cart so that the cart arrives at D at rest?



7. A 250g mass moves under the influence of some potential energy $U(x)$, graphed above.

   (a) Identify all equilibrium points. Which are stable? Which are unstable?
   (b) If the mass has a speed of 5 m/s at point A, what will its speed be at point B?
   (c) If the mass has is moving at 7 m/s to the left at point D, does it have enough energy to make it up to point C?

8. An object moves under the influence of the following conservative force:

$$\vec{F} = (3x^2 - 2x^4)\hat{\imath}$$

where the numeric coefficients in $\vec{F}$ have the correct SI units implied. What would the formula for the potential energy $U(x)$ associated with $\vec{F}$ be? *Hint: define* $U = 0$ *wherever* $\vec{F} = 0$.

Chapter 8: Momentum

1. A 5kg mass moving at 13 m/s, to the right, collides with a 7kg mass moving at 10 m/s, to the left. If the 7kg mass recoils at 12 m/s, to the right, in what direction and at what speed does the 5kg mass move after the collision?
2. A 50g piece of clay, rolling at 25 cm/s, collides with a 75g piece of clay, initially at rest. After the collision, the two pieces of clay stick together. How fast does the new lump of clay move?
3. A 1500kg car, moving to the right at 25 m/s, collides with a 3200kg truck, moving to the left at 17 m/s. If the car fuses together with the truck during the collision, so their wreckage moves as one, how much heat is released during this collision?
4. A 15kg mass moves to the right at 10m/s, while a 12kg mass moves to the left at 15m/s. If the masses collide elastically, what is:
   (a) The final speed, and direction, of the 15kg mass?
   (b) The final speed, and direction, of the 12kg mass?
   (c) The amount of heat released during the collision?
5. A 1.2kg ball hits a wall at 20 m/s and bounces off the wall at 15 m/s, in the opposite direction. If the collision with the wall took 2.5 ms, what was the average force exerted on the ball by the wall?

Chapter 9: Rotation of Rigid Bodies

1.

ANSWERS:

Chapter 5

1. b
2. 16.2N
3. 0.37
4. Static, 20N
5. 6.74 m/s^2
6. 21.8^o

Chapter 6

1. 212.8J, 1420N
2. 2.64J, 0J, -1.13J
3. (d)
4. -24.3J
5. 0.6J, 3.46 m/s

Chapter 7

1. (d)
2. 7.63 m/s
3. 3.1m
4. -4.55J
5. 323 kJ
6. 13.6 m/s, 9.9 m/s, $-129{,}360$J
7. B and D are stable while A and C are unstable, 11.7 m/s, No
8. $U(x) = \frac{2}{5}x^5 - x^3$

Chapter 8

1. 17.8 m/s, to the left
2. 10 cm/s
3. 900 kJ
4. 12.2 m/s to the left, 12.8 m/s to the right, 0 J
5. 16,800 N

Chapter 9

1.