PHY2053 Spring 2018 Exam 2 Review Questions

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Chapters 7 & 8: Work and Energy Conservation

1. Under what conditions is the energy of a system conserved?
   (a) If there are conservative forces acting on the system
   (b) If conservative forces do work on the system
   (c) If there are no nonconservative forces acting on the system
   (d) If nonconservative forces do no work on the system

2. When a person is lifted upward by an elevator at a constant speed, the energy of the person is conserved.
   (a) True
   (b) False

3. A 12kg box is pushed along a horizontal surface by a force of 18N, applied at an angle 25^o above the horizontal. If the horizontal surface has and unknown coefficient of kinetic friction, and the crate is pushed for a distance 10m at a constant velocity, how much work is done, in total, on the box?

4. A 2000kg car drives along a horizontal road at an initial speed of 15m/s. While driving a distance of 1.2km, the car's engine does 12,000 J of work on the car. What is the speed of the car after traveling the 1.2km?

5. A skydiver will accelerate as the fall, obvious, but not forever; a skydiver will stop accelerating at a speed known as the terminal velocity for that skydiver. While the terminal velocity depends on things like the temperature and humidity of the air, the altitude of the skydiver, and the surface area of the skydiver's body, it turns out to be roughly the same for all humans: about 50 m/s, while falling "spread eagle." Say a 65kg skydiver jumps out of an airplane and reaches terminal velocity after falling 450m – taking roughly 12s – how much work does air resistance do on the skydiver during this time?

6. Imagine a 70kg person jumping from the floor: they do so by bending their knees and pushing off of the ground, causing the normal force the ground places on them to increase to a value larger than their weight, producing an upward acceleration and thus an upward velocity. If this person can jump to a height of 50cm, how much work would the ground have to do on the person during the jump? *Hint: think about the speed the person would need to leave the ground with to reach a height of 50cm.*

7. As a car's engine burns fuel, it produces work that drives the car forward. However, the work produced by the engine is produced on a part of the car known as the *crankshaft*. That energy has to be transferred from the engine to the wheels to drive the car forward. However, machines are inherently *inefficient*, meaning that energy is lost as it is being transferred from one place to another due to friction in the parts. Say that a 2500kg car has an efficiency of 50% – that is, 50% of the work produced by the engine makes it to the wheels of the car. How much work does the engine need to produce in order to accelerate the car from rest to a speed of 20 m/s?

Chapter 9: Linear Momentum and Collisions

1. Under what conditions is the momentum of a system conserved?

   (a) If there are no internal forces acting on the system

   (b) If there is no net internal force on the system

   (c) If there are no external forces acting on the system

   (d) If there is no net external force acting on the system

2. An object an object undergoes a motion that can be broken up into three parts. In part A, the object is released from rest, and rolls down a frictionless hill. In part B, the object rolls across a frictionless floor. In part C, the object encounters a rough patch of floor, eventually coming to rest. During which, if any, of these paths is the momentum of the object conserved?

   (a) A

   (b) B

   (c) C

   (d) None

3. A 1200kg car moves with a velocity of 15m/s moving to the west when a 2500kg truck, moving to the east with a speed of 10m/s, collides into the car. If the wreckage sticks together, in what direction will the wreckage move?

   (a) East

   (b) West

   (c) It will be stationary

   (d) None of the above

4. Two masses, $m_1 = 2$kg and $m_2 = 1.3$kg, collide head on. If m_1 were moving at 10m/s, and m_2 were moving at 15m/s, and the collision was elastic, what would be the speed of m_2 after the collision? If we said m_1 was initially moving to the left, in what direction would m_2 be moving after the collision?

5. Two masses, $m_1 = 2$kg and $m_2 = 1$kg, collide head on. Initially, m_1 moves with a speed of 3m/s and m_2 moves with a speed of 5m/s. After the collision, m_1 moves with a speed of 2.3m/s in the opposite direction, and m_2 moves with a speed of 5.7m/s, also in the opposite direction. What type of collision did these masses undergo?

6. Two pieces of clay are thrown horizontally at each other. One piece of clay has a mass of 200g, and moves with a speed of 2.5m/s. The other piece of clay has a mass of 350g, and moves with a speed of 1.2m/s. How fast do the lumps of clay move after the collision if they stick together?

7. A 500kg cannon, aimed horizontally, fires a 25kg cannonball. If the cannonball is fired at a speed of 50m/s, what is the recoil speed of the cannon?

8. A pendulum 0.8m long, with a 250g mass attached at the end, is dropped from an angle of 30^o measured from the vertical axis. When it reaches 0^o (i.e. when it's pointing straight down), it hits a 1.2kg block of wood. How fast does the block of wood move after being hit by the pendulum?

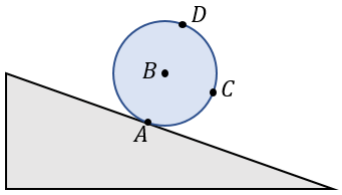
Chapters 10 & 11: Rotational Kinematics and Dynamics

1. Three objects are rolled down a hill: a solid sphere, a hollow sphere, and a solid cylinder. Each object has an identical mass and identical radius. If they all start at rest, and are released from the same height, which object hits the bottom of the hill first?

   (a) The solid sphere
   (b) The hollow sphere
   (c) The solid cylinder
   (d) They all reach the bottom at the same time

2. A solid cylinder and a box are released from rest at the top of the hill. If both objects have the same mass, which object is moving faster at the bottom of the hill?

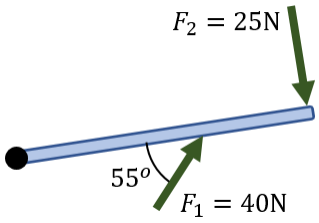
   (a) The solid cylinder
   (b) The box
   (c) They move at the same speed
   (d) Can't determine without knowing the numbers



3. A cylinder rolls without slipping along an inclined plane, as shown in the figure. Which of the points indicated on the figure acts as the axis of rotation for the cylinder?

   (a) A
   (b) B
   (c) C
   (d) D

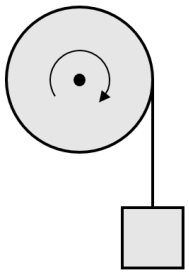
4. A record player rotates at an initial speed of 30 rad/s when it accelerates at 10 rad/s^2 until it reaches a final speed of 45 rad/s. How many revolutions did the record undergo during this acceleration?



5. A 15cm lever is fixed at one end, allowing it to rotate about that end, as shown in the figure. A force $F_1 = 40$N is applied halfway along the lever, at an angle of 55^o from the lever, and a force $F_2 = 25$N is applied at the opposite end of the lever, perpendicular to the lever. What is the net torque on this lever?

6. Suppose the wheel of a car has a radius of 17cm and a mass of 15kg. The axle passing through each wheel produces about 5Nm of torque due to friction. If the engine of a car produces 200Nm of torque, split evenly between its four wheels, what is the linear acceleration of the car assuming the wheels roll without slipping? Treat each wheel as a solid cylinder.

7. A hollow cylinder, with a mass of 1.3kg and a radius of 5cm, is released from rest at a height of 0.7m on a frictionless incline. If it rolls without slipping, what will its translational speed be at the bottom of the incline?



8. Imagine a 1.6kg mass hanging from a rope wound around a 2.5kg, solid cylinder with a 15cm radius, as shown in the figure above. If the block was released from rest and allowed to drop 1m, how fast would the cylinder be rotating? Note that the cylinder is fixed such that it rotates about an axis through its center.