

Physics 1408-H01 Exam #2 – sample questions

Instructions: Do real good. Show your work for all problems, even the multiple choice. Partial credit will be assigned for things that make sense. Use energy methods when possible.

1. A 2.5 kg particle has an initial velocity of $\vec{v}_1 = (2.3 \text{ m/s})\hat{i} - (1.2 \text{ m/s})\hat{j}$ and a final velocity of $\vec{v}_2 = (4.7 \text{ m/s})\hat{i} - (3.8 \text{ m/s})\hat{j}$. Find the net work done on the particle.
2. A 2.5 kg object is initially at the top of a frictionless ramp of height 1.5 m. It begins to slide down the ramp, and after it reaches the bottom it travels a distance of 7.5 m on a non-frictionless surface before stopping. Find the coefficient of sliding friction between the object and the surface.
3. Find the work done by the force $F(x) = (3.0 \text{ N/m}^2)x^2 - (4.5 \text{ N/m})x + 9.0 \text{ N}$ when it moves an object from $x = 2.0 \text{ m}$ to $x = 3.0 \text{ m}$.
4. A stationary 5.0 kg block is struck from the left by a 2.0 kg block moving at 15 m/s. When they hit, a blasting cap stuck on the front of the 2.0 kg block explodes. After the collision, the 2.0 kg block is moving to the left at 25 m/s. What is the final velocity of the 5.0 kg block?
5. An 950 kg elevator car is initially at a height of 65 m when the cable holding it up breaks. The elevator falls vertically freely for a distance of 50 m, at which point emergency brakes activate which stop the elevator at a height of 0 m. How much work was done by the friction of the emergency brakes?

6. A baseball bat exerts an average force of 1200 N on a 0.070 kg baseball for 1.2 ms. If the ball is pitched at 15 m/s, what speed will it have when it leaves the bat?

7. A 1.8 kg mass moving at 2.5 m/s on a horizontal frictionless surface strikes an unknown mass and they stick together. If the combined masses move at 2.0 m/s after the collision, what is the unknown mass?

8. A 2.5 kg mass on a frictionless horizontal table is connected by a string through a hole in the table to a hanging 1.0 kg mass. If the 2.5 kg mass moves in a circle of radius 0.40 m, what must its speed be if the 1.0 kg mass hangs at rest?

Long problems

1. Mass 1 has a mass of 5.0 kg and a position given by
$$\vec{r}_1(t) = 3.5\hat{m}\hat{i} - (2.7\text{ m/s})t\hat{i} + (0.080\text{ m/s}^3)t^3\hat{j}$$
while mass 2 has a mass of 3.5 kg and a position given by
$$\vec{r}_2(t) = 2.0\hat{m}\hat{i} - (3.5\text{ m/s})t\hat{i} + (0.090\text{ m/s}^3)t^3\hat{j}.$$

a) Find the position of the center of mass at $t = 8.0$ s.

b) Find the velocity of the center of mass at the same time as in a)

c) What is the total vector external force acting on the system of particles at the same time as in a) and b)?

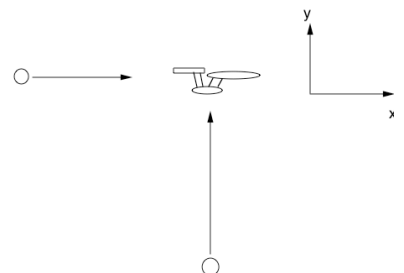
2. A spring with spring constant of 20 N/m is compressed some distance by a 2.0 kg block. After the block is released, it slides a distance of a horizontal frictionless surface before encountering a ramp which is angled 30 degrees to the horizontal. The coefficient of sliding friction between the block and the ramp is 0.30 .

If the block slides a

a) If the block slides a distance of 4.5 m up the ramp before stopping, find the initial distance that the spring was compressed.

b) Now suppose you have the same spring and initial compression as in a), but the ramp is frictionless, has a height of 0.2 m and is angled 30 degrees above the horizontal. The mass flies off the ramp into an abyss. Find its speed when it is 20 m below the top of the ramp, using energy.

3. The starship Enterprise (mass = $5.0 \times 10^6 \text{ kg}$) has been tragically crippled by an attack by Khan. Warp and impulse engines are out, and Scotty is too drunk to effect repairs. Worse still, William



Shatner no longer looks so great in a Star Fleet uniform. Even worse, a meteor with mass 1.5×10^7 kg is headed straight for the center of the ship at 24 km/s along the x axis. In a cruel twist of fate, a 3.0×10^7 kg meteor is headed towards the ship's center along the y axis at 32 km/s. As a result of incredible coincidence (written into the plot at great expense), the meteors will strike the ship simultaneously, forming a single tangled mass.

a) What will be the speed of the tangled mangled object?

b) What angle will the velocity of the object have with respect to the x axis?

c) Optional: How will they get out of this one? Will "Search for Spock" never be made? Will we notice, if not?