

Physics 31A Midterm (150pts)

Fall 2003

Show your work with diagrams, explanations, and clear writing. No credit will be given for answers without diagrams, explanations, and clear writing.

- (a) A 2000-kg car is traveling east at 20.0 m/s when it's rammed in the rear by a 1000-kg car that was traveling at 30.0 m/s just before impact. The two cars tangle together and move off together at a speed that we now wish to determine – please do so.
(b) A particle has a momentum given by $\vec{p}(t) = (4.00t^3 + 7.21)\hat{i}$ in SI units. What is the net external force acting on the particle at $t = 2.00$ s?
- A force acting along the z -axis on a vehicle is 20.00 kN at $t = 0$, whereupon it decreases linearly to 5.000 kN at $t = 2.000$ s. (a) Make a graph of $F(t)$ versus t , and from the geometry determine the area under the curve between $t = 0$ and $t = 1.000$ s. (b) Write an equation for $F(t)$, and use the calculus to determine the net impulse applied to the vehicle between $t = 0$ and $t = 1.000$ s. (c) Compare your two answers.
- A golfer's club hits a 47.0-g golf ball from rest to a speed of 60.0 m/s in a collision lasting 1.00 ms. The force on the ball rises to a peak value of F_{\max} and then drops to zero as it leaves the club. Compute a rough value for this maximum force by approximating the force-time curve, with a triangle of altitude F_{\max} .
- On being dropped from a window of a tall building, the height of a ball above ground is given by $h(t) = (100.0 \text{ m}) - \frac{1}{2}(9.81 \text{ m/s}^2)t^2$. Determine the time rate-of-change of the ball's gravitational potential energy as it falls.
- A catapult exerts a force given by the formula $F(x) = (24.0 \text{ N/m})x + (9.00 \text{ N/m}^2)x^2$, where at $t = 0$, $x = 0$. How much work is done on a 10.0-kg projectile by the device if the launch path is 10.0-m long?
- (a) show that $\frac{d}{dt}(\text{KE}) = Fv$.
(b) A 0.200-kg rock is thrown straight up from the roof of a building. Its height above ground is given in SI units by the formula $h(t) = -4.905t^2 + 6.02t + 23.7$. What's its initial kinetic energy?
- Someone at a third-floor window (12.0 m above the ground) hurls a ball downward at 45.0° at a speed of 25.0 m/s. How fast will it be traveling when it strikes the sidewalk?
- A crate is being transported on a flatbed truck. The coefficient of static friction between the crate and the bed is 0.50. What is the minimum stopping distance if the truck, traveling at 50.0 km/h, is to decelerate uniformly and the crate is not to slide forward on the bed?
- The speed of a 10.0-kg vehicle moving along the x -axis is given by $v(x) = (4.0 \text{ m}^{-1}\text{s}^{-1})x^2$. Determine the net force acting on the vehicle as a function of x .
- Each of two runners at either end of a 1000-m straight track jogs toward the other at a constant 5.00 m/s. How long will it take before they meet?