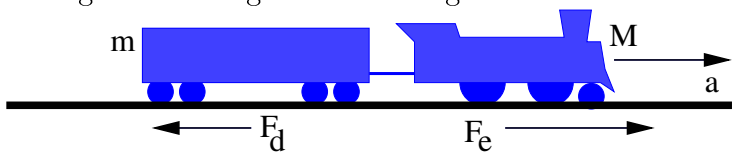
Physics 131 – Test 4 – Fall 2007

One-page reminder sheet allowed. *Show all work – no credit given if work not shown!*

1. A small train consisting of an engine of mass M and a single carriage of mass m accelerates to the right on a horizontal track with acceleration a as shown below. F_e is the (unknown) force of the track on the engine and F_d is the (known) drag force on the carriage. Ignore wind friction.

   (a) Compute the force of the engine on the carriage.

   (b) Can you use the above result and Newton's third law to compute the force of the carriage on the engine even though the train is accelerating? Explain.



2. A stationary mass M explodes into two equal pieces, each with mass m, moving away from each other with speed v. If M and v are known, compute m. (Be sure to do this problem relativistically.)

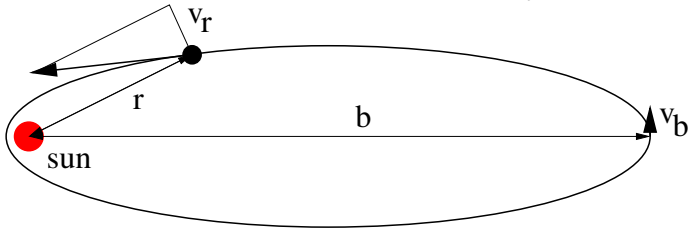
3. An escape hatch on the space station has area A. N air molecules per unit time, each with mass m and speed v, bounce elastically off the inside surface of the hatch. Compute the force needed to hold the hatch in place. (Draw a picture!)

4. A comet is in a counter-clockwise elliptical orbit around the sun with b being the maximum distance of the comet from the sun. Recall that gravity acts along the line of centers between two masses.

   (a) What direction does the comet's angular momentum vector point relative to the sun?

   (b) Compute the gravitational torque relative to the sun acting on the comet.

   (c) When the comet is a distance r from the sun, compute v_r, the component of its velocity perpendicular to the line from the sun to the comet. The speed of the comet when farthest from the sun is v_b.



5. The sun (assumed to have uniform density) has radius 7×10^8 m and a rotational period of 25 days. If it collapses into a spherical neutron star of radius 5×10^3 m without losing any mass or angular momentum, what would its rotational period be? Hint: The moment of inertia for a sphere is $I = 2MR^2/5$.