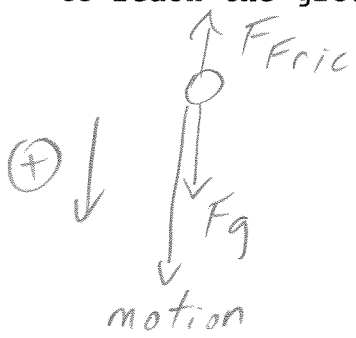
Physics 10154 - Exam #2b

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 2.5 kg ball is dropped from rest from the top of a 320 meter high tower. As the ball falls, it feels an average frictional force due to air resistance of 6.3 Newtons directed upwards. How many seconds does it take for the ball to reach the ground?



Ch 4 method

$\Sigma F_y = mg - F_{Fric} = ma$

$(2.5)(9.8) - 6.3 = 2.5a$

$24.5 - 6.3 = 2.5a$

$a = 7.28\ m/s^2$

$v_0 = 0$

$\Delta s = 320\ m$

$\Delta s = v_0 t + \frac{1}{2} a t^2$

$320 = 0 + \frac{1}{2}(7.28) t^2$

$\boxed{t = 9.4\ s}$

Ch 5 method

$W_g = +mg\Delta s = (2.5)(9.8)(320) = 7840\ J$

$W_{Fric} = (6.3)(320)\cos 180° = -2016\ J$

$\Sigma W_F = 7840 - 2016 = \frac{1}{2}(2.5)v^2 - \cancel{0}$ ← starts from rest

$v = 68.26\ m/s$

$v_0 = 0$

$\Delta s = 320$

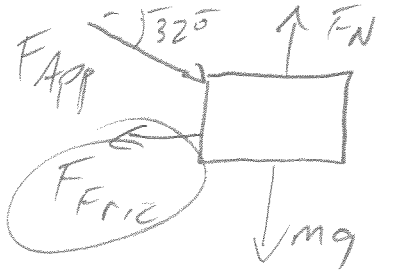
$\Delta s = \frac{1}{2}(v + v_0)t$

$320 = \frac{1}{2}(68.26 + 0)t$

$\boxed{t = 9.4\ s}$

2. (35 pts) A 35 kg box is at rest on a rough horizontal surface. The coefficient of static friction between the box and surface is 0.45. The coefficient of kinetic friction is 0.31. A worker tries to move the box by pushing with an applied force of 220 Newtons directed 32° below the horizontal.

Does the box move? If yes, determine its acceleration (and indicate its direction on a free-body diagram). If no, determine the magnitude of the force of static friction (And indicate its direction on a free-body diagram).



$$\Sigma F_y = F_N - mg - F_{App}\sin 32^\circ = 0$$

$$F_N = mg + F_{App}\sin 32^\circ$$

$$= 343 + 116.6 = 459.6\,N$$

$$F_{SF,MAX} = \mu_s F_N = 206.8\,N$$

Assume $a = 0$

$$\Sigma F_{//} = F_{App}\cos 32^\circ - F_{SF} = 0$$

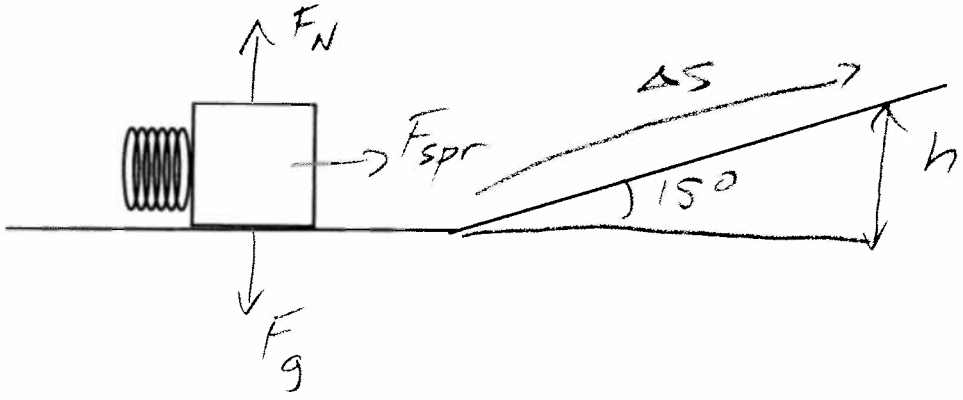
$$F_{SF} = 220\cos 32^\circ = 186.6\,N$$

Since F_{SF} (186.6) < $F_{SF,MAX}$ (206.8), box doesn't move.

$F_{SF} = 190\,N$, $-x$ dir

3. (35 pts) A 0.500 kg block rests on a horizontal, frictionless surface against a horizontally oriented spring (k = 750 N/m), compressing the spring by 12 cm. The block is released and travels up a 15° frictionless incline. How fast is the block moving after it has traveled 75 cm along the ramp?

$v_0 = 0$



$$W_N = 0$$

$$W_{spr} = +\frac{1}{2}kx^2 = 5.4\ \text{J}$$

$$W_{grav} = -mgh = -mg\Delta s \sin 15^\circ$$

$$= -1.27\Delta s$$

$$= -0.95\ \text{J}$$

$$\Sigma W_F = 0 + 5.4 - 0.95 = \frac{1}{2}(0.5)v^2 - 0$$

$$4.45 = 0.25v^2$$

$$\boxed{v = 4.2\ \text{m/s}}$$