PHY 110 Practice Exam 2

1. A marble is released from rest in a jar of honey and reaches a speed equal to half its terminal velocity 1.7 s after it is released. At what time after its release will it reach 95% of its terminal velocity?

a) 2.95 s b) 4.18 s **[c) 7.35 s]** d) 9.22 s

Recall $v(t) = v_T\left(1 - e^{\frac{-t}{\tau}}\right)$ *for small objects and low speeds. Set* $v(t) = 0.5v_T$ *at t = 1.7 and solve for* τ.
Then use that number to solve for t required to give $v(t) = 0.95v_T$.

2. A 10-kg sled is pulled from rest by a constant 30 N horizontal force over a horizontal ice rink ($\mu_k = 0.12$). After the sled has moved 5 m, what is its velocity?

a) 1.26 m/s b) 2.83 m/s c) 3.96 m/s **[d) 4.27 m/s]**

Use $W_{net} = \Delta K$ *with* $W_{net} = (30)(5) - (0.12)(10)(9.81)(5)$ *and* $\Delta K = \frac{1}{2}(10)v_f^2$.

3. A horizontal circular turntable rotates at a constant $33.\overline{3}$ rpm (revolutions per minute). If a coin is placed 10 cm from the center of the turntable, what minimum value of μ_s is required to keep the coin from sliding?

a) 0.036 b) 0.089 **[c) 0.12]** d) 0.23

Set the friction force μmg *equal to* $m\frac{v^2}{r}$, *using* $v = r\omega$ *and making sure to convert the units correctly.*

4. If the total mechanical energy of an object decreases, you may safely conclude that (circle all that apply)

a) the kinetic energy of the object must have increased.
b) the kinetic energy of the object must have decreased.
c) the potential energy of the object must have increased.
d) the potential energy of the object must have decreased.
e) no conservative forces acted on the object.
[f) none of these statements is correct.]

5. A 2-kg block on a 30° incline ($\mu_k = 0.1$) is pressed against a spring (k = 200 N/m) at the bottom of the incline. The spring is compressed 20 cm and the block is released from rest. How far along the incline from its starting position does the block move before momentarily coming to rest?

a) 0.25 m **[b) 0.35 m]** c) 0.45 m d) 0.55 m

Set $U_g = 0$ *at the block's lowest position. Then use* $W_{nc} = E_f - E_i$ *with* $W_{nc} = -(\mu mg\cos\theta)D$,

$E_f = mgD\sin\theta$ *and* $E_i = \frac{1}{2}k(0.2)^2$.

6. For the block whose motion is described in the previous problem, which of the following statement(s) is (are) true? Circle all that apply.

a) The total mechanical energy of the block is conserved.
b) The linear momentum of the block is conserved.
c) The horizontal component of the block's linear momentum is conserved.
d) The vertical component of the block's linear momentum is conserved.
e) Both the total mechanical energy and the linear momentum of the block are conserved.
f) None of these statements is true.

7. A boat travels at a constant speed of 8 m/s on a lake. The magnitude of the drag force caused by the water is given by the expression $|F_{drag}| = 50v^2$, where v is the velocity of the boat relative to the water (in m/s). What is the power delivered to the boat by the motor/propeller system?

a) 25.6 kW b) 38.1 kW c) 42.2 kW d) 57.3 kW

For a constant force moving at a constant velocity, $P = Fv$. *The force delivered by the motor/propeller system must be equal to the drag force in order for the boat to move with constant velocity.*

8. A 70-kg runner jumps horizontally onto a stationary 30-kg plank originally at rest on a frozen pond ($\mu_k = 0.09$ between the plank and the ice). If the plank+runner slides 8 m before coming to rest, with what velocity did the runner land on the plank? Ignore the impulse given to the system by friction during the short time of the collision.

a) 3.4 m/s b) 5.4 m/s c) 7.4 m/s d) 9.4 m/s

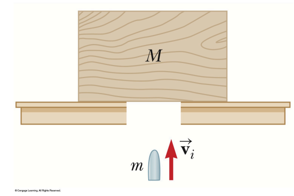
Linear momentum is conserved in the "collision", so we have $m_{runner}v = (m_{runner} + M_{plank})V$. *Then* $W_{net} = \Delta K$ *with* $W_{net} = -\mu(m_{runner} + M_{plank})gD$ *and* $\Delta K = 0 - \frac{1}{2}(m_{runner} + M_{plank})V^2$. *Work the second part first to solve for V, then solve for v from the first part.*

9. A grinding wheel $\left(I = 0.2\, kg\cdot m^2\right)$ is spinning at 1000 rpm when the motor is turned off. If the wheel stops after 35 s, what is the magnitude of the frictional torque (assumed constant) that acted on the system?

a) 0.3 N•m b) 0.4 N•m c) 0.5 N•m d) 0.6 N•m

Convert the speed in rpm to rad/s, then use $\omega = \omega_0 + \alpha t$ *to get* α, *then use* $\tau = I\alpha$ *to find the torque.*

10. A bullet (m = 10 g) with an initial velocity of 200 m/s passes vertically through the 2-kg block shown and exits the block with a velocity of 70 m/s. To what maximum height will the block rise?



a) 1.0 cm b) 2.2 cm c) 3.6 cm d) 4.1 cm

Use conservation of momentum to find velocity of block just after collision: $m_{bullet}v_i = m_{bullet}v_f + M_{block}V$.

Then use conservation of energy for the block after the collision: $Mgh = \frac{1}{2}MV^2$.

11. A meter stick is allowed to rotate about a horizontal axis that passes through the 25 cm mark. If the stick is held in a horizontal position and released from rest, what is the velocity of the 100 cm mark when the stick is vertical? $I_{CM} = \frac{1}{12}ML^2$ for a uniform stick of mass *M* and length *L*.

a) 1.1 m/s b) 2.6 m/s c) 3.2 m/s d) 4.3 m/s

First, find moment of inertia of stick rotated about 25 cm mark using parallel axis theorem: $I_{25} = I_{CM} + Md^2 = \frac{1}{12}ML^2 + M\left(\frac{L}{4}\right)^2 = \frac{7}{48}ML^2$. *(You may set L = 1 m any time you like.) Then use conservation of energy, noting that gravity only cares about the position of the center of mass of the stick, which is at the 50 cm mark.*

$$E_f = E_i$$

$$\frac{1}{2}I_{25}\omega^2 = Mg(0.25)$$

Now recall that $v_{100} = r\omega = (0.75)\omega$.