PHYS I Sample Exam III

Solutions

MC 1) (C)

$P = C\, v^2$ with C some proportionality constant. Then,

$$\frac{P_{75}}{P_{50}} = \frac{75^2}{50^2} = 2.25 \quad \rightarrow \quad P_{75} = 2.25\, P_{50} = 2.25 * 3\% = 6.75\%$$

MC 2) (C)

The normal force in each case does no work. The kinetic energy remains about zero. All of the work done goes into the boxes' gravitational potential energy. Since the boxes have the sane mass and are raised through the same vertical distance, the PEs are increased by the same amount.

MC 3) (E)

In much the same way that a roller coaster slows as it moves away from the earth, the earth will slow as it moves away from the sun.

MC 4) (C)

If the force is perpendicular to the path of the object, then the work done by that force is zero.

MC 5) (A)

For each, the gravitational potential energy will be converted to kinetic energy:

$$KE_f = gmy_i$$

$$v_f = \sqrt{2gy_i}$$

Pot B has half the mass but four times the altitude as A so its KE will be twice that of A

Pot B has four times the altitude as A, so its speed will be twice that of A.

P I)

$$W_{TOTAL} = \sum_n W_n = \sum_n F_n\, \Delta x = \left(\sum_n F_n\right) \Delta x = (m\, a)\, \Delta x = m(\vec{a}\, \Delta\vec{x}\,) = m\left(\frac{v_f^2 - v_i^2}{2}\right)$$
$$= \tfrac{1}{2} m v_f^2 - \tfrac{1}{2} m v_i^2 = \Delta\left(\tfrac{1}{2} m v^2\right) = \Delta KE\ ,$$

P II)

I expect Andy's bullet to be travelling more quickly than Bonnie's. The speed is related to the kinetic energy of the bullet, and that depends on the work done by the gases in the barrel. Assuming everything else is the same, the force was applied over a longer distance in Andy's barrel than in Bonnie's. More work, more KE, higher v.

Having said that, in real life, too long a barrel will start to slow the bullet.

P III)

	v_i	convert	v_i'	Find v_f'	convert back to original frame by reversing the previous transformation	v_f
M_1	+15 m/s	+10	+25 m/s	$v'_{1xf} = \frac{m_1 - m_2}{m_1 + m_2} v'_{1xi} = \frac{3500 - 2000}{3500 + 2000} 25 = 6.82\ \mathrm{m/s}$.	-10	-3.18 m/s
M_2	-10 m/s	+10	0 m/s	$v'_{2xf} = \frac{2m_1}{m_1 + m_2} v'_{1xi} = \frac{2(3500)}{3500 + 2000} 25 = 31.82\ \mathrm{m/s}$.	-10	21.82 m/s

Check: 15 – (-10) = 25 -3.18 – 21.82 = -25

P IIII)

WE Thm: $W_{NC} = \Delta KE + \Delta PE$

W_{SP1} = CONS

W_{SP2} = CONS

$W_N = 0$ Normal force is perpendicular to the path

W_g = CONS

$W_{fk} = F_{fk} L \cos 180^o = - \mu_K gm L$ (need to show this)*

So,

$- \mu_K gm L = 1/2mv_f^2 – 1/2mv_i^2 + gmy_f – gmy_i + 1/2k_1x_{1f}^2 - 1/2k_1x_{1i}^2 + 1/2k_2x_{2f}^2 - 1/2k_2x_{2i}^2$

Terms in red are zero. The object starts and ends at rest, $y_i = y_f$, spring 1 is relaxed at the end and spring 2 is initially relaxed.

$- \mu_K gm L = - 1/2k_1x_{1i}^2 + 1/2k_2x_{2f}^2$

$1/2k_2x_{2f}^2 = 1/2k_1x_{1i}^2 - \mu_K gm L$

$x_{2f} = ((k_1 x_{1i}^2 - 2\mu_K\ gm\ L) / k_2)^{1/2} = ((300(0.2)^2 - 2(0.25)(10)(4)(0.4)) / 500)^{1/2} =$ 0.089 m

*Use NII in the vertical direction:

$+F_N - gm = ma_y = 0$

$F_N = gm$

$F_{fk} = \mu_K F_N = \mu_K gm$