HOMEWOR 7: SOLUTIONS

PROBLEM 54

IT GOES IN THE DIRECTION OF $\vec{v}$, SO THE ANSWER IS B

PROBLEM 62

THE APPARENT WEIGHT IS GIVEN BY THE WEIGHT OF THE PERSON AT REST $W = m \cdot g$ ($m = 67$ kg ; $g = 9.8\ \frac{m}{s^2}$) PLUS THE FORCE EXERTED OVER THE PERSON DUE TO THE CENTRIPETAL ACCELERATION $W' = -m \cdot \frac{v^2}{R}$ ($v = 12\ \frac{m}{s}$; $R = 35$ m)

$$W + W' = m\left(g - \frac{v^2}{R}\right) = 380\ \text{N}$$

PROBLEM 2

SINCE WORK IS GIVEN BY $\vec{F} \cdot \vec{d}$ WE ONLY CARE ABOUT VERTICAL DISPLACEMENT.
($g = 9.8\ \frac{m}{s^2}$, $m = 3.2$ kg)

PATH 2: $W = -2 \cdot g m = -62.72$ J

PATH 1: $W = (-4 \cdot g + g + g)m = -2gm$

PATH 3: $W = (+g - 3g)m = -2gm$

AS EXPECTED, WORK IS INDEPENDENT OF THE PATH (SINCE GRAVITY IS A CONSERVATIVE FORCE)

PROBLEM 4

(a) SINCE THE FORCE IS CONSERVATIVE, THE AMOUNT OF WORK DONE DOESN'T DEPEND ON THE PATH, THEREFORE IS THE SAME FOR PATHS 1 OR 2 AND GIVEN BY (ASSUMING THE NATURAL LENGTH OF THE SPRING IS 2 CM)

$$W = -\frac{1}{2} K x^2 \qquad K = 550\ \text{N/m} \qquad x = 2 \cdot 10^{-2}\ \text{m}$$

$$= -0.11\ \text{J}$$

PROBLEM 14

(a) WE JUST SOLVE K FROM

$$\frac{1}{2} K x^2 = U_s \quad ; \quad x = 0.5 \cdot 10^{-2}\ \text{m}, \quad U_s = 0.0025\ \text{J}$$

SO

$$k = \frac{2U_s}{x^2} = 200\ \frac{\text{N}}{\text{m}}$$

(b)

NOW, WE SOLVE FOR x

$$U_s = \frac{1}{2} k x^2 \quad ; \quad k = 200 \frac{N}{m}$$

$$U_s = 0.08 \text{ J}$$

$$\Rightarrow \quad x = \sqrt{\frac{2U_s}{k}} = 0.028 \text{ m} = 2.8 \text{ cm}$$

PROBLEM 18

BOTH MUST HAVE THE SAME CHANGE IN KINETC ENRGY. THE BEST EXPLANATION IS III (SEE EXPLANATION AT THE END)

PROBLEM 27

AT THE DASHED LEVEL ALL THE BALLS HAVE THE SAME ~~KINETIC~~ SPEED, SO THE ANSWER IS (C). TO SEE THIS, CALL THE DASHED LEVEL HEIGHT h AND THE MASS OF THE BALL m_i, THEN, BY CONSERVATION OF ENERGY

$$\frac{1}{2} m_i \vec{v}_0^{\,2} = m_i g h + \frac{1}{2} m_i \vec{v}_f^{\,2}$$

$$\Rightarrow \quad \vec{v}_f^{\,2} = \vec{v}_0^{\,2} - 2gh$$

SO, $|\vec{v}_f|$ IS THE SAME FOR ALL BALLS.

PROBLEM 36

(a) WE USE CONSERVATION OF ENERGY. WE ARE FREE TO SET THE GRAVITATIONAL POTENTIAL ENERGY TO BE ZERO AT $y=0$, THEN (RECALL BOTH MASSES MUST HAVE THE SAME SPEED):

$$m_1 g h - m_2 g h + \frac{1}{2}(m_1 + m_2) v^2 = 0$$

$$\Rightarrow \quad v = \sqrt{\frac{2gh(m_2 - m_1)}{m_1 + m_2}}$$

(b) USING $h = 1.2$ m, $m_1 = 3.7$ kg AND $m_2 = 4.1$ kg WE GET

$$v = 1.1 \frac{m}{s}$$

PROBLEM 44

(a) THE CHANGE IN KINETIC ENERGY IS GIVEN BY

$\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$; $m = 1300$ kg

$v_i = 17 \frac{m}{s}$

$= -109,200$ J $\quad v_f = 11 \frac{m}{s}$

(b) THE "MISSING" ~~E~~ KINETC ENERGY CORRESPONDS TO THE WORK DONE BY THE BRAKES OF THE CAR.

PROBLEM 48

WHEN THE DEPTH OF THE ROCK BELOW THE WATER SURFACE IS h, WE HAVE:

$$W_{mc} = -F \cdot h \quad ; \quad F = 4.6 \text{ N}$$

$$\mathcal{U} = mg(h_0 - h) \quad ; \quad h_0 = 1.8 \text{ m}$$

$$K = \mathcal{U}|_{h=0} - \mathcal{U}(h) + W_{mc} = mg h_0 - mg(h_0 - h) - Fh = mgh - Fh$$

$$E = K + \mathcal{U} = mgh - Fh + mg(h_0 - h) = mgh_0 - Fh$$

MECHANICAL ENERGY

NOW, WE PLUG THE VALUES

(a) $m = 1.9$ kg, $g = 9.8 \frac{m}{s^2}$, $h = 0$ m

$W_{mc} = 0$ J

$\mathcal{U} = 33.5$ J

$K = 0$ J

$E = 33.5$ J

(b) $W_{mc} = -2.3$ J

$\mathcal{U} = 24.206$ J

$K = 7.01$ J

$E = 31.2$ J

(c) $W_{mc} = -4.6$ J

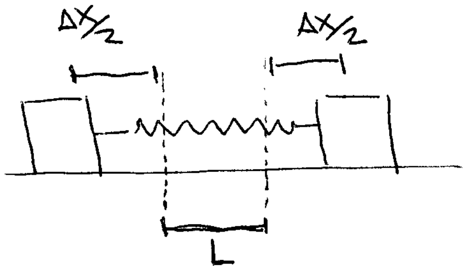
$\mathcal{U} = 14.896$ J

$K = 14.02$ J

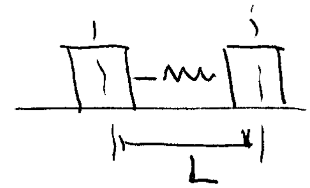
$E = 28.9$ J

PROBLEM 62

WHEN WE INITIALLY SEPARATE THE BLOCKS WE HAVE THE FOLLOWING SITUATION



EQUILIBRIUM POSITION :



BY CONSERVATION OF ENERGY, WE HAVE

$$E = \frac{1}{2}k(\Delta x)^2 = m v^2 + \frac{1}{2}k(\Delta x')^2$$

WHERE $\frac{\Delta x'}{2}$ IS THE SEPARATION OF EACH BLOCK FROM THE EQUILIBRIUM POSITION, AT A LATER TIME. WHEN E IS PURELY KINETIC ENERGY, WE MUST HAVE

$$E = m v_{max}^2 = \frac{1}{2}k(\Delta x)^2$$

THEN $$\Delta x = \sqrt{\frac{2m}{k}}\, v_{max}$$

THE MAX./MIN. SEPARATION OF THE BLOCKS OCCUR WHEN THE ENERGY IS PURELY POTENTIAL, SO

$$E = \frac{1}{2}k(\Delta x)^2 = \frac{1}{2}k(\Delta x')^2$$

SO $$\Delta x' = \pm \Delta x$$

THEN, THE MAXIMUM SEPARATION OF THE BLOCKS IS GIVEN BY $L + \Delta x$ AND THE MINIMUM BY $L - \Delta x$.

PROBLEM 18 (EXPLANATION)

THE INITIAL KINETIC ENERGY OF BALL 1 IS $\frac{1}{2}m v_1^2$ AND, OF BALL 2, IS 0. THEN, THE TOTAL (INITIAL) ENERGY OF BOTH BALLS IS

$$E_1 = \frac{1}{2}m v_1^2 + mgh$$
$$E_2 = mgh$$

WHEN THE FIRST BALL HITS THE GROUND, E_1 IS PURELY KINETIC, THEN

$$E_1 = \frac{1}{2}m v_1'^2 = \frac{1}{2}m v_1^2 + mgh$$

SO THE CHANGE OF KINETIC ENERGY OF THE FIRST BALL IS

$$\Delta KE_1 = \frac{1}{2} m v_1'^2 - \frac{1}{2} m v_1^2 = mgh$$

FOR THE SECOND BALL, WE HAVE, WHEN IT HITS THE GROUND

$$E_2 = \frac{1}{2} m v_2'^2 = mgh$$

SINCE ITS INITIAL KINETIC ENERGY WAS ZERO, WE GET

$$\Delta KE_2 = \frac{1}{2} m v_2'^2 = mgh = \Delta KE_1$$