ACP PHYSICS MIDTERM REVIEW: KINEMATICS

1) $v_0 = +4\,m/s$

$v = +36\,m/s$

$t = 4\,s$

$a = ?$

$$V = V_0 + at$$

$$\frac{v - v_0}{t} = a$$

$$\frac{(+36\,m/s) - (+4\,m/s)}{4\,s} = a$$

$$\boxed{+8\,m/s^2 = a}$$

2) $v_0 = +36\,m/s$

$v = +15\,m/s$

$t = 3\,s$

$a = ?$

$$V = V_0 + at$$

$$\frac{v - v_0}{t} = a$$

$$\frac{(+15\,m/s) - (+36\,m/s)}{3\,s} = a$$

$$\boxed{-7\,m/s^2 = a}$$

3) $v_0 = +2.0\,m/s$

$a = -0.50\,m/s^2$

(a) $t = 2\,s$ (b) $t = 5\,s$

$v = ?$ $v = ?$

(a) $V = V_0 + at$

$$V = (+2.0\,m/s) + (-0.50\,m/s^2)(2\,s)$$

$$\boxed{V = +1.0\,m/s}$$

(b) $v = V_0 + at$

$$V = (+2.0\,m/s) + (-0.50\,m/s^2)(5\,s)$$

$$\boxed{V = -0.5\,m/s}$$

ROLLING DOWN HILL NOW

4) $v_0 = 0$

$a = +5.5\,m/s^2$

$v = +28\,m/s$

$t = ?$

$$V = V_0 + at$$

$$\frac{v - v_0}{a} = t$$

$$\frac{(+28\,m/s) - (0)}{+5.5\,m/s^2} = t$$

$$\boxed{5.09\,s = t}$$

5) $v_0 = +22\,m/s$

$a = -2.1\,m/s^2$

$t = 9.0\,s$

$v = ?$

$$v = V_0 + at$$

$$v = (+22\,m/s) + (-2.1\,m/s^2)(9.0\,s)$$

$$\boxed{= +3.1\,m/s}$$

6) $v_0 = 0$

$a = +3.5\,m/s^2$

$v = +25\,m/s$

$d = ?$

$$v^2 = v_0^2 + 2ad$$

$$\frac{v^2 - v_0^2}{2a} = d$$

$$\frac{(+25\,m/s)^2 - 0^2}{2(+3.5\,m/s^2)} = d$$

$$\boxed{+89.3\,m = d}$$

7) $v_0 = 0$

$\updownarrow^{+}_{-}$ $a = g = -9.8\,m/s^2$

$t = 1.5\,s$

(a) $v = ?$

(b) $d = ?$

(a) $v = v_0 + at$

$$v = 0 + (-9.8\,m/s^2)(1.5\,s)$$

$$\boxed{v = -14.7\,m/s \underset{(DOWN)}{\uparrow}}$$

(b) $d = v_0 t + \frac{1}{2}at^2$

$$d = 0 + \frac{1}{2}(-9.8\,m/s^2)(1.5\,s)^2$$

$$\boxed{d = -11.0\,m \underset{(DOWN)}{\uparrow}}$$

8) $v_0 = 0$

$a = g = -9.8\,m/s^2$

$t = 6.5\,s$

$d = ?$

$$d = v_0 t + \frac{1}{2}at^2$$

$$d = 0 + \frac{1}{2}(-9.8\,m/s^2)(6.5\,s)^2$$

$$= -207\,m$$

ROCK FELL 207m DOWN, SO CLIFF MUST BE 207m TALL.

9) $\overset{-}{\longleftrightarrow}\overset{+}{}$

$V_x = +900\,m/s$

$x = ?$

$t =$

$\updownarrow^{+}_{-}$

$v_0 = 0$

$v =$

$a = -9.8\,m/s^2$

$y = -1.2\,m$

$t =$

STEP I: USE VERTICAL INFO TO FIND t:

$$y = \overset{0}{\cancel{v_0 t}} + \frac{1}{2}at^2$$

$$\sqrt{\frac{2y}{a}} = t$$

$$0.495\,s = t$$

STEP 2: USE HORIZONTAL INFO TO FIND x:

$$x = v_x \cdot t$$

$$= (+900\,m/s)(0.495\,s)$$

$$\boxed{= +446\,m}$$

10) $\overset{-}{\longleftrightarrow}^{+}$

$V_x = +11.4 \text{ m/s}$

$x =$

$t =$

$\updownarrow$ (+ up, − down)

$V_0 = 0$

$V =$

$a = -9.8 \text{ m/s}^2$

$y = -15.5 \text{ m}$

$t:$

STEP 1: FIND VERTICAL VELOCITY OF GOLF BALL JUST BEFORE IT HITS THE WATER.

$$v^2 = v_0^2 + 2ay$$

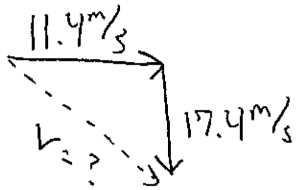
$$v = \pm\sqrt{v_0^2 + 2ay}$$

$$v = \pm\sqrt{0 + 2(-9.8 \text{ m/s}^2)(-15.5 \text{ m})}$$

$$= \pm 17.4 \text{ m/s}$$

BALL IS MOVING DOWN, SO $v = -17.4 \text{ m/s}$

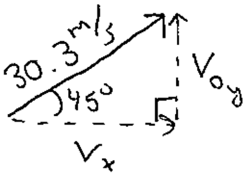
STEP 2: COMBINE HORIZONTAL + VERTICAL VELOCITIES.



$$v = \sqrt{(11.4 \text{ m/s})^2 + (17.4 \text{ m/s})^2}$$

$$\boxed{v = 20.8 \text{ m/s}}$$

11) STEP 1: COMPONENTS OF INITIAL VELOCITY.



$$V_x = (30.3 \text{ m/s}) \cos 45° = 21.4 \text{ m/s}$$

$$V_{0y} = (30.3 \text{ m/s}) \sin 45° = 21.4 \text{ m/s}$$

(a)

$\overset{-}{\longleftrightarrow}^{+}$

$V_x = +21.4 \text{ m/s}$

$x =$

$t =$

$\updownarrow$ (+ up, − down)

$V_{0y} = +21.4 \text{ m/s}$

$V =$

$a = -9.8 \text{ m/s}^2$

$t = ?$

$y = 0$ (SINCE IT RETURNS TO STARTING HEIGHT)

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

$$0 = 21.4t - 4.9t^2$$

$$0 = t(21.4 - 4.9t)$$

$$t = \{0, 4.37 \text{ s}\}$$

THERE ARE 2 MOMENTS WHEN THE BALL IS ON THE GROUND... AT $t = 0 \text{ s}$ (BEFORE LAUNCH) AND $\boxed{4.37 \text{ s}}$ LATER

ALTERNATE SOLUTION: FIND TIME TO PEAK (WHERE $V_y = 0$) AND DOUBLE IT.

$V_0 = +21.4 \text{ m/s}$

$V = 0$

$a = -9.8 \text{ m/s}^2$

$$v = v_0 + at$$

$$\frac{v - v_0}{a} = t$$

TOTAL TIME = 2.18 s × 2

$$\boxed{= 4.37 \text{ s}}$$

(b) HORIZONTAL

$v_x = +21.4 \text{ m/s}$

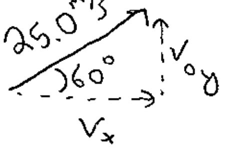
$t = 4.37 \text{ s}$

$x = ?$

$x = v_x t$

$\boxed{= +93.5 \text{ m}}$

12) STEP 1: COMPONENTS OF INITIAL VELOCITY.



$v_{oy} = (25.0 \text{ m/s}) \sin 60° = 21.7 \text{ m/s}$

$v_x = (25.0 \text{ m/s}) \cos 60° = 12.5 \text{ m/s}$

VERTICAL INFO: $\updownarrow$ + −

$v_0 = +21.7 \text{ m/s}$

$v = 0$ (AT PEAK)

$a = -9.8 \text{ m/s}^2$

$t = ?$

$y =$

TOTAL HANG TIME = TIME TO PEAK × 2

TIME TO PEAK:

$v = v_0 + at$

$2.21 \text{ s} = t$

$\boxed{\text{TOTAL TIME} = 4.43 \text{ s}}$

13) BALL A

$- \longleftrightarrow +$

$v_x = +20 \text{ m/s}$

(b) $x = ?$

$t =$

$\updownarrow$ + −

$v_{oy} = 0$

$v_y = ?$

$a = -9.8 \text{ m/s}^2$

(a) $t = ?$

$y = -15 \text{ m}$

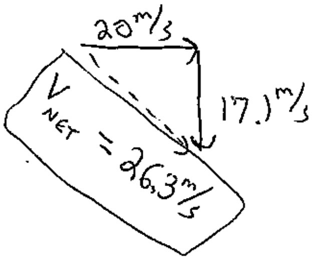
(a) $y = \cancel{v_0 t}^{0} + \frac{1}{2}at^2$

$\boxed{1.75 \text{ s} = t}$

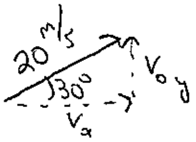
(b) $x = v_x \cdot t = \boxed{35.0 \text{ m}}$

(c) $v_y^2 = v_{oy}^2 + 2ay$

$v_y = -17.1 \text{ m/s}$



BALL B



$- \longleftrightarrow +$

$v_x = +17.3 \text{ m/s}$

(b) $x = ?$

$t =$

$\updownarrow$ + −

$v_{oy} = +10 \text{ m/s}$

$v_y = ?$

$a = -9.8 \text{ m/s}^2$

(a) $t = ?$

$y = -15 \text{ m}$

(a) $y = v_0 t + \frac{1}{2}at^2$ - OR - FIND v_y FIRST $(v_y^2 = v_{oy}^2 + 2ay)$

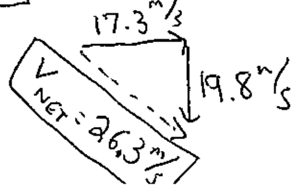
☆USE QUAD. FORMULA☆ THEN t

$\boxed{t = 3.05 \text{ s}}$

(b) $x = v_x \cdot t = \boxed{52.8 \text{ m}}$

(c) $v_y^2 = v_{oy}^2 + 2ay$

$v_y = -19.8 \text{ m/s}$

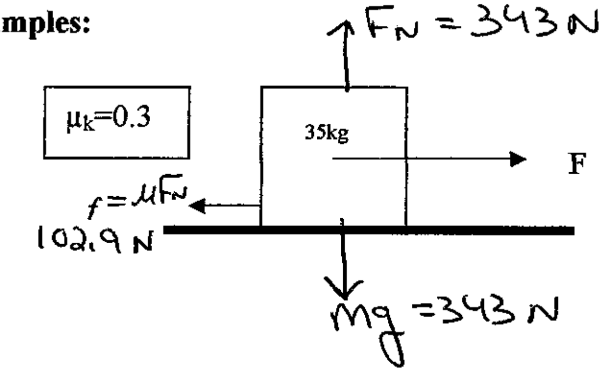


$\Sigma F_y = 0 \therefore F_N = mg$

Equations:

$\Sigma \vec{F} = m\vec{a}$ $W = mg$ $F_{f\,\text{KINETIC}} = \mu_k F_N$ $F_{f\,\text{STATIC}} \le \mu_s F_N$

Examples:

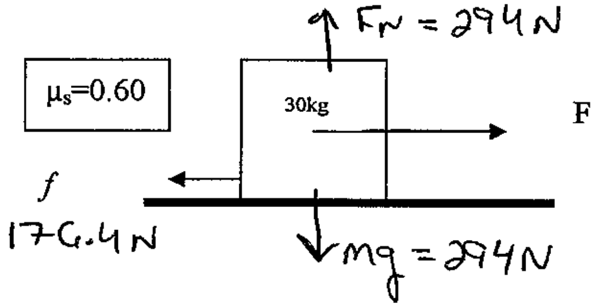


Find F if the object is moving with an acceleration of 4m/s²

$\Sigma F = ma$

$F - 102.9N = 35kg(4m/s^2)$

$\boxed{F = 37.1 N}$



Find F if the object is on the "Verge of slipping".

$\Sigma F = 0$

$F - 176.4N = 0$

$\boxed{F = 176.4N}$

Q1) Does surface area change the amount of friction? (Explain)

$f = \mu F_N$ (NO)

Q2) What is the advantage of antilock brakes? (Why is not locking to your advantage?)

Tire remains in static friction static > kinetic

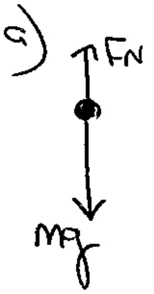
Q3) If the Earth exerts 1500N of force on a satellite, how much force does the satellite exert on the earth?

Third law $F_{S,E} = 1500N$ then $F_{E,S} = 1500N$

Q4) Your mass is 80kg. You stand on a scale in an elevator as it accelerates downward at -2m/s².

- a) Draw the F.B.F.D.
- b) What is the value of the Net Force (F_{net})?
- c) What is the direction of the Net Force?
- d) What is your weight (F_g)?
- e) What is the value of the Normal Force (F_N)?

a)



b) $F_{net} = ma$

$F_{net} = (80kg)(-2m/s^2)$

$\boxed{F_{net} = -160N}$

c) down

d) $\boxed{Weight = mg = 784N}$

$\Sigma F_y = ma$

e) $F_N - mg = ma$

$F_N = ma + mg$

$F_N = 80kg(-2m/s^2) + 80kg(9.8m/s^2)$

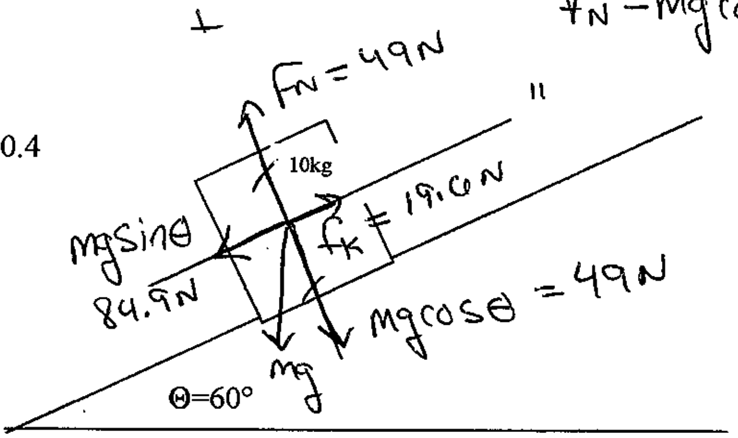
$\boxed{F_N = 624 N}$

$F_N - mg\cos\theta = 0$

$F_N = 49N$

$\mu_k=0.4$

Find the rate of acceleration down the plane.



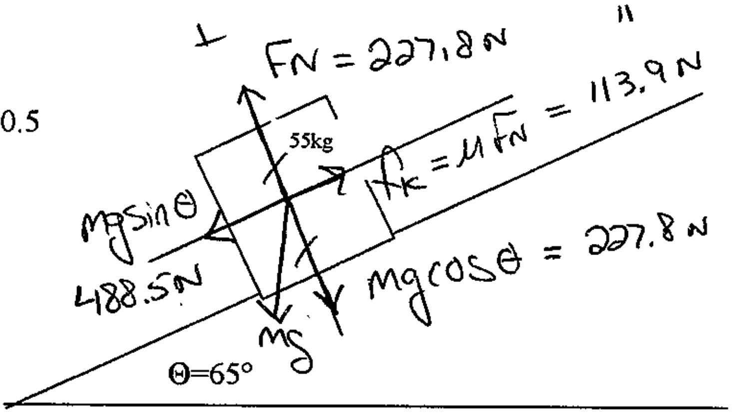
$\Sigma F_{\parallel} = ma$

$(84.9N - 19.6N) = 10kg\,(a)$

$\boxed{a = 6.53\,m/s^2}$

$\mu_k=0.5$

Find the rate of acceleration down the plane.



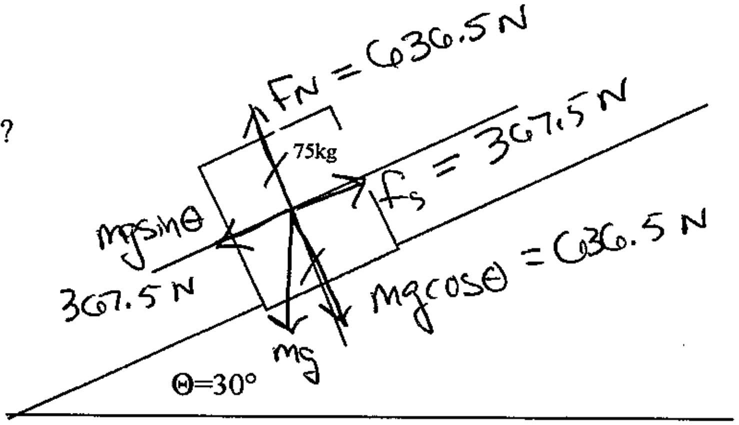
$\Sigma F_{\parallel} = ma$

$[488.5N - 113.9N] = 55kg\,(a)$

$\boxed{a = 6.8\,m/s^2}$

$\mu_s=?$

Find μs that will keep the object at rest on the plane.



$\Sigma F_{\parallel} = 0$

$367.5N - f_s = 0$

$f_s = 367.5N$

$367.5N = \mu_s F_N$

$\boxed{\mu_s = \frac{367.5N}{636.5N} = .58}$

Distinguish whether a mass is experiencing a net push/pull or no net push/pull in the following circumstances. Ignore the effect of air resistance unless otherwise stated.

Circumstance	Possible Push/Pull	Definite Push/Pull	Definite Net Push/Pull	No Net Push/Pull	Name the Forces
A mass is rising, after being tossed-up.		✓	✓		Fg
A mass is resting on a book, which is sliding with constant velocity across a frictionless surface.				✓	Fg, FN fk?
A mass is moving with constant velocity through a gravity-free region of space.				✓	?
A mass on the end ~~of a string~~ is whirled around in a circle. ac			✓		F_T
A mass accelerates down an inclined plane.			✓		FN, Fg fk?
A mass is at rest on a table, which is on the Moon.				✓	FN, Fg
A mass accelerates down an inclined plane, which is on the Moon.			✓		FN, Fg fk?
A mass is "moving".	No way to know-				?
A mass is "descending" through water, toward the bottom of a pool. ?	No way to know				Fg FD
A mass is falling straight down from an airplane with terminal velocity. (Air resistance is significant)				✓	Fg, FD

Weight = F_g
Sliding Friction = F_f
Normal Force = F_N
Tension = F_T
Drag force (Air, water or any fluid resistance) = F_D

ACP PHYSICS MIDTERM REVIEW: UCM

1) $v = \frac{2\pi r}{T} \rightarrow T = \frac{2\pi r}{v} = \frac{2\pi(2850 m)}{110 m/s} = \boxed{163 s}$

2) $v = \frac{2\pi r}{T} = \frac{2\pi(2600 m)}{360 s} = 45.4 m/s$

$a_c = v^2/r = \boxed{0.792 m/s^2}$

3) $a_c = v^2/r = \frac{(8.8 m/s)^2}{25 m} = \boxed{3.10 m/s^2}$

4) $45 \frac{rev}{min} \longrightarrow \frac{1 min}{45 rev} \times \frac{60 s}{1 min} = 1.33 s/rev = T$

(a) $v = \frac{2\pi r}{T} = \frac{2\pi(.05 m)}{1.33 s} = 0.236 m/s$

$a_c = v^2/r = \frac{(0.236 m/s)^2}{0.05 m} = \boxed{1.11 m/s^2}$

(b) $v = 0.471 m/s$ $\quad a_c = \boxed{2.22 m/s^2}$

(c) $v = 0.707 m/s$ $\quad a_c = \boxed{3.33 m/s^2}$

5) $v = \frac{2\pi r}{T} = 7.90 m/s$

(a) $F_c = m\frac{v^2}{r} = \boxed{7.48 N}$

(b) DOUBLING v QUADRUPLES F! $\quad \boxed{F_c = 29.9 N}$

6) $v = \frac{2\pi r}{T} = 8.17 m/s$

(a) $a_c = v^2/r = \boxed{51.3 m/s^2}$

(b) F_T IS THE NET CENTRIPETAL FORCE $\quad F_T = F_c = m a_c$

$\boxed{= 359 N}$

7) $v = \frac{2\pi r}{T} = 4.95\,\text{m/s}$

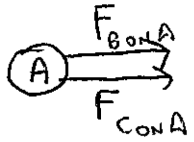
TENSION <u>IS</u> THE NET CENTRIPETAL FORCE: $F_c = m\frac{v^2}{r} = \boxed{0.343\,\text{N}}$

8) (a) $F_g = \frac{Gm_1m_2}{r^2} = \frac{(6.67\times10^{-11}\,\text{N m}^2/\text{kg}^2)(363\,\text{kg})(517\,\text{kg})}{(0.5\,\text{m})^2} = \boxed{5.01\times10^{-5}\,\text{N}}$

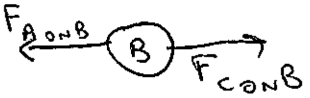
(b) $F_g = \frac{(6.67\times10^{-11}\,\text{N m}^2/\text{kg}^2)(363\,\text{kg})(154\,\text{kg})}{(0.75\,\text{m})^2} = \boxed{6.63\times10^{-6}\,\text{N}}$

(c) $F_g = \frac{(6.67\times10^{-11}\,\text{N m}^2/\text{kg}^2)(517\,\text{kg})(154\,\text{kg})}{(0.25\,\text{m})^2} = \boxed{8.50\times10^{-5}\,\text{N}}$

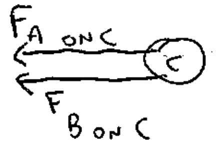
(d) $\Sigma F_{\text{ON A}} = 5.67\times10^{-5}\,\text{N}$ TO THE RIGHT



$\Sigma F_{\text{ON B}} = 3.49\times10^{-5}\,\text{N}$ TO THE RIGHT



$\Sigma F_{\text{ON C}} = 9.16\times10^{-5}\,\text{N}$ TO THE LEFT



9) $F_{\text{SUN ON EARTH}} = \frac{(6.67\times10^{-11}\,\text{N m}^2/\text{kg}^2)(2.00\times10^{30}\,\text{kg})(5.98\times10^{24}\,\text{kg})}{(1.50\times10^{11}\,\text{m})^2} = \boxed{3.55\times10^{22}\,\text{N}}$

$F_{\text{MOON ON EARTH}} = \frac{(6.67\times10^{-11}\,\text{N m}^2/\text{kg}^2)(7.35\times10^{22}\,\text{kg})(5.98\times10^{24}\,\text{kg})}{(3.85\times10^{8}\,\text{m})^2} = \boxed{1.98\times10^{20}\,\text{N}}$

$F_{\text{SUN ON EARTH}} \approx 100 \times F_{\text{MOON ON EARTH}}$

ACP PHYSICS MIDTERM REVIEW

ENERGY PROBLEMS

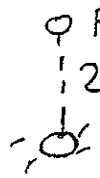
1) a) $K = \frac{1}{2}mv^2 = \frac{1}{2} \cdot 1000\,kg \cdot (20)^2 = \underline{200{,}000\,J}$

b) $W = F \cdot d = 500\,N \cdot 10\,m = \underline{5000\,J}$

c) $W = \Delta K = \underline{-5000\,J}$

d) THERMAL ENERGY DUE TO FRICTION

2) $PE = mgh = 2\,kg \cdot 10\,N/kg \cdot 20\,m = \frac{1}{2} \cdot 2\,kg \cdot V^2$



$PE = 0$

$KE = \frac{1}{2}mv^2$

$V = \sqrt{2gh}$

$= \sqrt{400} = \underline{20\,\frac{m}{s}}$

3) $P = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{mgh}{t}$

$= \frac{60\,kg \cdot 10\,\frac{N}{kg} \cdot 3\,m}{4\,s} = \boxed{450\text{ WATTS}} \quad \frac{450\,W}{747\,W/HP} = \boxed{0.6\,HP}$

4) $P.E. = mgh = 90\,kg \cdot 10\,\frac{N}{kg} \cdot 3.2\,m = \boxed{2880\,J}$

$h = 8\text{ STEPS} \cdot 0.4\,m/\text{STEP} = 3.2\,m$

5) $\text{WORK} = \Delta KE$

$F \cdot d = \frac{1}{2}mv^2 \Rightarrow d = \frac{mV^2}{2F} = \frac{82\,kg\,(4.2\,\frac{m}{s})^2}{2 \cdot 140\,N} = \boxed{5.2\,m}$

6) $F \cdot d = \frac{1}{2}mv^2 \Rightarrow F = \frac{mV^2}{2d} = \frac{1.8 \times 10^6\,kg\,(14\,m/s)^2}{2 \cdot 1500\,m} = \boxed{1.18 \times 10^5\,N}$

7) SPRING PE = GRAVITATIONAL PE

$F_{AV} \cdot d = mgh \Rightarrow h = \frac{F_{AV} \cdot d}{mg} = \frac{5\,N \cdot .08\,m}{.002\,kg \cdot 10} = \boxed{20\,m}$

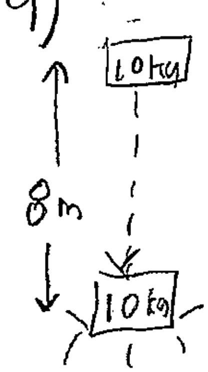
8) $P = \frac{W}{t} \quad W = \Delta KE = \frac{1}{2}1000\,kg\,(40\,\frac{m}{s})^2 - 0 = 8 \times 10^5\,J$

$\frac{8 \times 10^5\,J}{4\,s} = 2 \times 10^5\,W = \boxed{200\,kW}$

ACP PHYSICS MIDTERM REVIEW

ENERGY PROBLEMS (CONT'D)

9)



KE=0 PE=800J

KE=800J PE=0

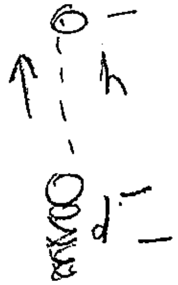
$800J = \frac{1}{2}(10kg)v^2$

$\frac{800J}{5kg} = v^2 = 160\ \frac{m^2}{s^2}$

$v = \boxed{12.8\ m/s}$

10) $w = F \cdot d = 10{,}000\ kg \times 10\ \frac{N}{kg} \times 1500m = \boxed{1.5 \times 10^8 J}$

11)



$F_{av} \cdot d = mgh$

$h = \frac{F_{AV} \cdot d}{mg} = \frac{2.8N \cdot .15m}{0.18\ kg \times 10\ \frac{N}{kg}} = \boxed{.233m}$

12) $\eta = \frac{\text{POWER OUT}}{\text{POWER IN}} = \frac{\frac{600kg \cdot 10\ N/kg \cdot 3m}{60s}}{600W} = \boxed{50\%}$