Work, Power, Energy Review Name:______________________

Basic Work Problems. Equations used: $W = F d$

1) a) How much work does a weightlifter do to lift a 20 kg weight from the floor to a height of 2 m? b) How much work does the weightlifter do if he holds the weight above his head?

a) 400 J $W = F \cdot d = (20)(10)(2m)$

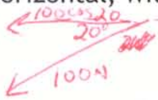
b) 0J

2) If the same weightlifter uses a different weight and does 15000 J of work, what is the mass of the new weight?

750 kg $W = 15000 J$, $d = 2m$ $W = F \cdot d$, $W = (mg)d$ $m = \frac{W}{gd} = \frac{15000J}{10(2)} = 750 kg$

3) One summer while mowing the lawn you wonder, "How much work am I actually doing?" You push the lawnmower down at an angle of 20° below the horizontal, with a force of 100 N a distance of 500 m. Answer your own question.

46984 J $W = F \cdot d$



F · d must be in same diagram

$W = (100 \cos 20)(500m) = 46984 J$

Basic Power Problems. Equations used: $P = W/t$

4) If the weightlifter from the first and second problem does 15000 J in 2 seconds, how powerful is he?

7500 W $W = 15000$, $t = 2s$ $P = \frac{W}{t} = \frac{15000J}{2s} = 7500 W$

5) Reading the paper this weekend, I noticed Value City was selling a 1500 W generator for $159. It was advertised to run 9 hours on one tank of gas. How much work/energy could it do/provide on one tank of gas?

$4.86 \times 10^7 J$ $t = 9 hrs \cdot \frac{3600s}{1 hr}$, $P = 1500W$ $P = \frac{W}{t}$ $W = P \cdot t = (1500 \frac{J}{s})(9 hrs)(\frac{3600s}{1hr})$

6) An 80kg freshman runs up the 3.45 m stairs in 5 seconds. How powerful is the freshman?

552 W $W = F \cdot d = mgd$ $P = \frac{W}{t} = \frac{(80kg)(10 m/s^2)(3.45)}{5s} =$

Basic Energy Problems. Equations used: $KE = .5 m v^2$ $PE_G = m g h$ $PE_E = .5 k x^2$

7) How fast is a 40 kg sledder moving if they have 20000J of energy?

31.6 m/s $KE = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(20000)}{40}}$

8) A 15 kg monkey is sitting in a branch. How high is the branch if the monkey has 10000 J of energy?

6.67 m $PE_G = mgh$ $h = \frac{PE}{mg} = \frac{10000}{(15)(10 m/s^2)}$

9) A mischievous student pulls a rubber band back .02 m. If the rubber band has 400 J of stored energy, what is the spring constant of the rubber band?

$2 \times 10^6 N/m$ $x = .02m$, $PE_E = 400J$, $k = ?$ $PE = \frac{1}{2}kx^2$ $k = \frac{2PE}{x^2} = \frac{(2)(400J)}{(.02)^2}$

Work/Energy Theorem Problems. Equations used: $W = \Delta NRG$

10) An 8kg bowling ball sits at rest on the ground. If you push the ball with a force of 10 N over a distance of 30 m, how fast is it going after the 30 m?

8.66 m/s $W = \Delta KE$, $W = KE_f - KE_i$ ($KE_i = 0$) $F = 10N$, $m = 8kg$, $d = 30m$ $W = F \cdot d = KE_f$ $(10N)(30m) = \frac{1}{2}(8kg)(v)^2$ $v = \sqrt{\frac{2(10)(30)}{8}}$

11) 4000 J is used in lifting a 20 kg crate. How high was the crate lifted?

20 m $W = 4000J$, $m = 20kg$, $g = 10$, $h = ?$ $W = \Delta PE$ $W = PE_f - PE_i$ ($PE_i = 0$) $= mgh_f$ $h = \frac{W}{mg} = \frac{4000J}{(20)(10)} =$

12) A race car takes off from rest and reaches a maximum speed of 100 m/s in a distance of 400m. What force is applied to the car? MASS OF RACECAR IS 1000 kg (OOPS!)

12500 N $W = F \cdot d = \Delta KE = KE_f - KE_i$ ($KE_i = 0$) $= \frac{1}{2}mv_f^2$ $F = \frac{\frac{1}{2}mv_f^2}{d} = \frac{\frac{1}{2}(1000)(100)^2}{400}$

Conservation of Energy Problems. Equations used: NRG bef = NRG during = NRG aft

13) A roller coaster starts at the top of a 200 m initial drop. How fast does the coaster travel at the bottom of the hill?

63.2 m/s

$PE_{TOP} = KE_{BOT}$ $mgh = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2mgh}{m}} = \sqrt{2(10)(200)}$

14) How high will an 0.2 kg arrow shoot if it is pulled back 0.3m in a bow that has a spring constant of 500 N/m?

11.3 m

$PE_{BOT} = PE_{TOP}$ $\frac{1}{2}kx^2 = mgh$ $h = \frac{\frac{1}{2}kx^2}{mg} = \frac{\frac{1}{2}(500)(.3)^2}{(.2)(10)}$

15) How fast would that same arrow be going as soon as it leaves the bow?

15 m/s

$PE_{OUT} = KE_{OUT}$ $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$ $v = \sqrt{\frac{kx^2}{m}} = \sqrt{\frac{500(.3)^2}{.2}}$

Basic Momentum Problems. Equations used: p = mv

16) How fast is a 12 kg car moving if it has a momentum of 900 Ns?

75 m/s

$p = mv$ $v = \frac{p}{m} = \frac{900}{12}$

17) What is the momentum of a 12 kg shopping cart moving at 3 m/s?

36 N·s

$p = mv = (12)(3)$

Momentum/Impulse Problems. Equations used: $F t = \Delta p = m(v_f - v_i)$

18) A force of 6 N acts on a 3 kg object for 10 s. What is the object's change in momentum? b) What is its change in velocity?

60 N·s

$F \cdot t = \Delta p$ $(6N)(10s) = \Delta p$

20 m/s

$F \cdot t = m(\Delta v)$ $\Delta v = \frac{F \cdot t}{m} = \frac{(6)(10)}{3}$

19) What force is needed to bring a 2000kg car moving at 20.0 m/s to a halt in 20 s?

-2000 N

$v_i = 20$ m/s $t = 20$ s $F = ?$ $v_f = 0$ $m = 2000$ kg

$F \cdot t = m(v_f - v_i) \Rightarrow F = \frac{m(v_f - v_i)}{t}$ $F = \frac{(2000)(0-20)}{20}$

20) A net force of 5000N acts on a rocket of mass 1000kg. How long does it take this force to increase the rocket's velocity from 0 to 200 m/s?

40 s

$F = 5000N$ $t = ?$ $m = 1000$ kg $v_i = 0$ $v_f = 200$ m/s

$F \cdot t = m(v_f - v_i)$ $t = \frac{m(v_f - v_i)}{F}$ $t = \frac{1000(200-0)}{5000}$

Conservation of Momentum Problems...Explosions. Equations used: $p_{bef} = p_{aft}$

21) A 40kg projectile leaves a 2000kg launcher with a velocity of 800 m/s. What is the recoil velocity of the launcher?

16 m/s

$P_{BEF} = 0$ so $P_{AFT} = 0$ so $mv_{LEFT} = mv_{RIGHT}$ $(40)(800) = 2000(v)$

22) You have a mass of 50 kg, and you are standing on a 3 kg skateboard. You decide to leap forward off the skateboard. It shoots back at a velocity of 13 m/s, how fast do you move forward?

.78 m/s

$P_{BEF} = 0$ so $P_{AFT} = 0$ so $mv_{LEFT} = mv_{RIGHT}$ $50(v) = 3(13)$

Conservation of Momentum Problems...Collisions. Equations used:

	Before	After
elastic collision	$m_1v_1 + m_2v_2$	$= m_1v_1 + m_2v_2$
inelastic collision	$m_1v_1 + m_2v_2$	$= (m_1 + m_2)v$

23) Moving at 30m/s, a 600 kg truck slams into a stationary car of mass 400kg. If they become stuck together, what velocity do they fly off at?

18 m/s

INELASTIC so ~~$m_1v_1 + m_2v_2 = m_1v_1$~~

BEF: m_1v_1 (TRUCK) $+ m_2v_2^0$ (CAR) = AFT: $(m_1 + m_2)V$

$600(30) + 0 = (600 + 400)V$

24) A plastic ball of mass 0.200 kg moves with a velocity of 0.3m/s. This plastic ball collides with a second plastic ball of mass 0.100kg that is moving along the same line at a velocity of 0.10m/s. After the collision, the velocity of the 0.100 kg ball is 0.26 m/s. What is the velocity of the second ball?

.22 m/s

ELASTIC BEF: $m_1v_1 + m_2v_2$ = AFT: $m_1V_1 + m_2V_2$

$(.2)(.3) + (.1)(.1) = (.2)V + (.1)(.26)$