Machines - Answer Key
Written by West Windsor-Plainsboro High School South

Matching:

1. C	2. J	3. B	4. F	5. I
6. D	7. H	8. G	9. E	10. A

Multiple Choice:

1. C, D	2. C	3. B	4. C	5. C	6. A, C
7. A	8. B	9. B	10. A	11. D	12. B

Free Response:

1. (Answers for the third part may vary, use your judgement when grading)
   a. ___Class 2_____, 8/3 ,_____Wheelbarrow_____
   b. ___Class 1_____, 3 ,_____See Saw_____
   c. ___Class 3_____,4/7 ,____Human forearm_____

2.
Class 1 lever
(Use your own judgement when grading answers for the second part. An example of an acceptable reason would be: the load arm and the effort arm never overlap in a class 1 lever)

3. a.	b.

MA= (effort)/(load) = 150cm/20cm = 7.5	F(e)=F(l)/MA = 52.26 N F(l)=(40 kg*9.8m/s^2); MA = 7.5
4. MA = R(effort)/R(load) = 20cm/4cm = 5 F(effort) = F(load)/MA F(load) = 50 kg *9.8 m/s^2 F(effort) = 98 N	
5. 2	 6
6. a. 2 [F(Bob)] = 700 N F(Bob) = 350 N	b. 700 N
c. MA of system = 2; F(new) = F(Bob)/2 = 175 N Answer to b would still be 700 N. Bob doesn't get fatter or anything.	
7. a. E(f) = E(i) + W mgh=(½)mv^2 - μmgcos(θ)*d mgdsin(θ)=(½)mv^2 - μmgcos(θ)*d Rearranging for μ gives: μ= ((½)v^2 - gdsin(θ))/(gdcos(θ)) Substituting g=9.8 m/s^2; d=6m, θ= 30, v =8 μ=0.05	b. IMA = hypotenuse/height = 6 m/(6sin30) m = 2

8. a.
IMA = Circumference/Pitch
= $2\pi l/p = 2\pi(150)/22 = 42.84$

b.
F(load) = F(effort)*MA
= 30N * MA = 1285.20 N

c.
Actual = Efficiency * Ideal
= 34% * 1285.20 N = 436.97 N

9.
MA(winch) = r(handle)/r(axle) = 0.25 m/0.10 m = 2.5
MA(pulley) = 4 [# of movable pulleys = 2, multiply by 2 to get 4]
MA(inclined plane) = hypotenuse/height = 9 m/3 m = 3

Total Mechanical Advantage = MA(winch)*MA(pulley)*MA(inclined plane)
= 2.5 * 4 * 3 = 30
Force(load) = Force(effort)*MA
= 100 N * 30
= 3,000 N

10.
GR (1, 2) = # teeth out/# teeth in = 20/10 = 2
GR (3, 4) = # teeth out/# teeth in = 15/12 = 5/4

If N = number of revolutions
N(2)/N(1) = GR (1,2) and N(4)/N(3) = GR (3,4)
Since gear 2 and gear 3 are on the same axis
N(2) = N(3)

N(2)/N(1) * N(4)/N(3) = N(4)/N(1) = GR (1, 4)

GR (1, 4) = GR (1, 2) * GR (3, 4) = 2 * 5/4 = 5/2