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 * 9.8 m/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.

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.  
\[F(\text{load}) = F(\text{effort}) \times MA\]  
\[= 30\text{N} \times MA = 1285.20\text{ N}\]

c.  
Actual = Efficiency \times Ideal  
= 34\% \times 1285.20\text{ N} = 436.97\text{ N}\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) \times MA(pulley) \times MA(inclined plane)  
= 2.5 \times 4 \times 3 = 30  
\[\text{Force(\text{load})} = \text{Force(\text{effort})} \times MA\]  
\[= 100\text{ N} \times 30\]  
\[= 3,000\text{ N}\]

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  
\[N(2)/N(1) = \text{GR (1,2)} \text{ and } N(4)/N(3) = \text{GR (3,4)}\]  
Since gear 2 and gear 3 are on the same axis  
\[N(2) = N(3)\]  
\[N(2)/N(1) \times N(4)/N(3) = N(4)/N(1) = \text{GR (1, 4)}\]  
\[\text{GR (1, 4)} = \text{GR (1, 2)} \times \text{GR (3, 4)} = 2 \times 5/4 = 5/2\]