Five Easy Pieces

1. A $1.0\,kg$ mass is lifted vertically two meters (on Earth) with a constant $2.3\,m/s^2$ acceleration. How much work is done by the lifting force, $\vec{\mathbf{F}}$?

(a) $W = 19.6\,J$	(b) $W = -19.6\,J$	(c) $W = 24.2\,J$	(d) $W = -24.2\,J$

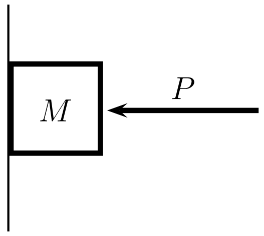
2. An $80\,kg$ man has an apparent weight of $1504\,N$ at the bottom of a circular dip. If his speed is $6.0\,m/s$, what is the radius of the circle?

(a) $r = 9\,m$	(b) $r = 1.26\,m$	(c) $r = 4\,m$	(d) $r = 9.8\,m$

3. A $700\,kg$ car is traveling with a speed of $30\,m/s$. If $5.2\,s$ later, its speed is $19.6\,m/s$, how much work, in total, was done to the car? Note the use of $kJ = kiloJoules$ to make the numbers smaller.

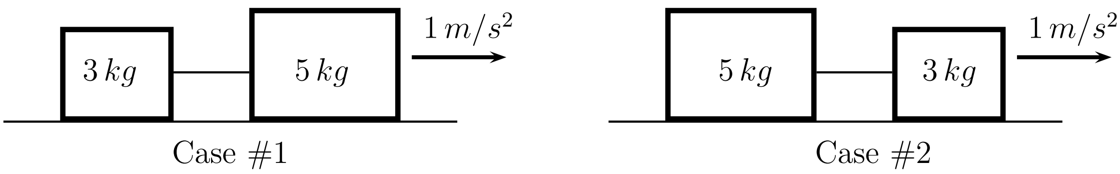
(a) $W = 1770\,kJ$	(b) $W = -35\,kJ$	(c) $W = 9.8\,kJ$	(d) $W = -180\,kJ$

4. A 5.0 kg mass is being held against a vertical wall as shown. If the coefficient of static friction between the mass and the wall is .64, what is the minimum horizontal force P needed to hold mass in place?



(a) $P = 49\,N$	(b) $P = 76.6\,N$	(c) $P = .64\,N$	(d) $P = 31.36\,N$

5. A 5 kg mass and a 3 kg mass are connected by a massless rope on a horizontal, frictionless surface. The masses are made to accelerate at $1\,m/s^2$ to the right as shown. In which case will the rope's tension have a larger magnitude?



(a) Case # 1	(b) Case # 2
(c) The tension is the same in both cases.	(d) It is impossible to determine.

Work, Work, Work

Questions 6 through 10 refer to the following setup.

Émilie du Châtelet drops a $.25\,kg$ ball from rest, $1.6\,m$ above a sand pit.

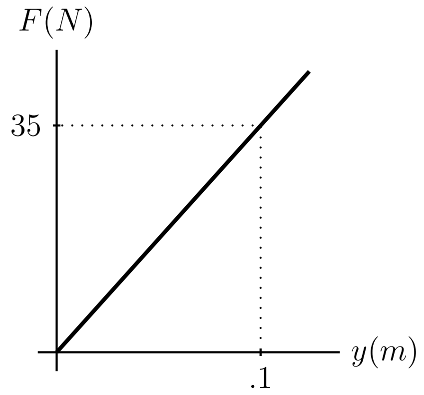
6. If the ball hits the sand going $3.2\,m/s$, how much work was done by air resistance during the ball's fall?

(a) $1.28\,J$	(b) $-3.92\,J$	(c) $-2.64\,J$	(d) $-1.28\,J$

7. Ignoring gravity, how much work must the sand do in order to stop the $3.2\,m/s$ ball?

(a) $1.28\,J$	(b) $-3.92\,J$	(c) $-2.64\,J$	(d) $-1.28\,J$

8. If the force exerted by the sand increases linearly with depth below the sand, as shown on the graph below ($y = 0$ is at the top of the sand pit and down is positive), how far will the ball sink below the surface before stopping? Again, ignore gravity in this calculation.



(a) $.037\,m$	(b) $.191\,m$	(c) $.086\,m$	(d) $.060\,m$

9. If the sand provides $24\,Watt$ of average power, estimate the time it takes for the ball to stop.

(a) $.053\,s$	(b) $.025\,s$	(c) $9.8\,s$	(d) $3\,s$

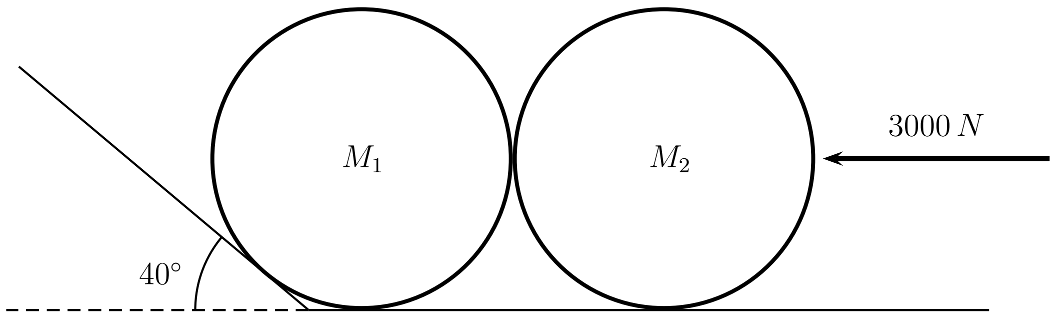
10. If we were to include the effect of gravity in the previous calculation, the ball would:

(a) go deeper into the sand.	(b) go the same distance into the sand.
(c) go less distance into the sand.	(d) bounce off the sand.

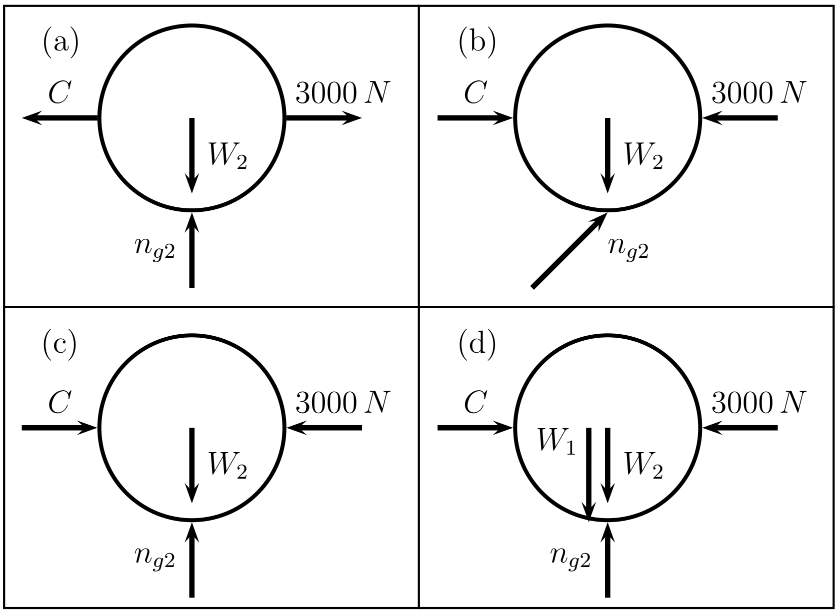
Superman Returns (to lift things)

Questions 11 through 15 refer to the following setup and figure.

The two gigantic globes (mass $M_1 = 765\,kg$ and $M_2 = 500\,kg$ respectively) from the top of the Daily Planet Headquarters have fallen down to the ground, and Superman has arrived to clean up for us (again). Miraculously, both globes are still round (in shape), lying as shown below, and have the same radius. Superman stretches to warmup and then applies a $3000\,N$ horizontal force to M_2. In all questions ignore friction.



11. The instant Superman applies his horizontal force, which of the following is the correct free body diagram for M_2? (Unlike Mastering Physics, I only care about direction!) In each case, n_{g2} is the normal force due to the ground while C is the normal force due to the contact between M_1 and M_2.



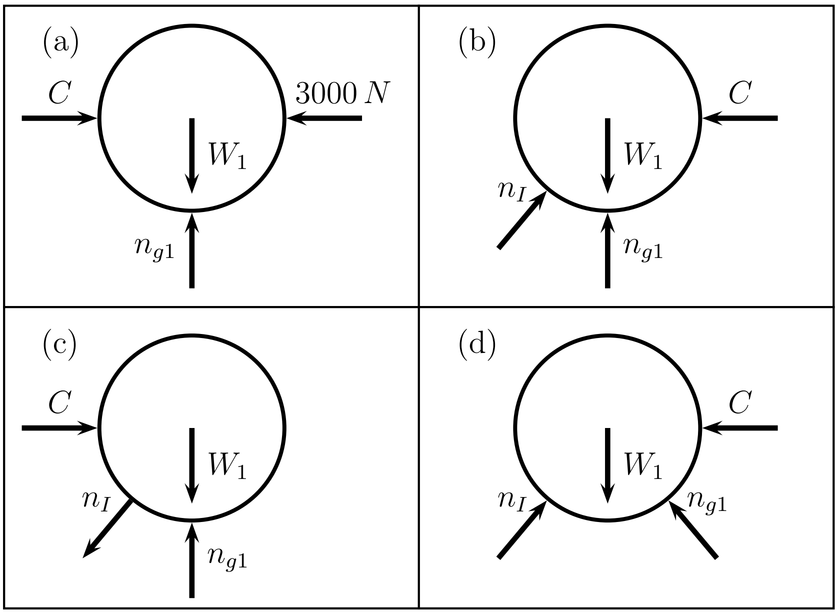
12. If Superman's force is unable to make the globes move, what is the magnitude of the force C?

(a) $C = 6000\,N$	(b) $C = 7900\,N$	(c) $C = 4900\,N$	(d) $C = 3000\,N$

13. How large is the normal force due to the ground, n_{g2}?

(a) $12397\,N$	(b) $7900\,N$	(c) $4900\,N$	(d) $3000\,N$

14. Which of the following is the correct free body diagram for M_1? In each case, n_{g1} is the normal force due to the ground, n_I is the normal force due to the incline, C is the normal force due to the contact between M_1 and M_2.



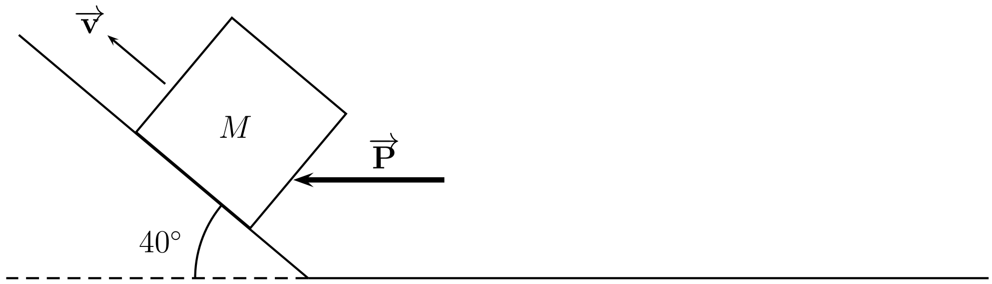
15. From M_1's free body diagram, we can conclude that:

(a) $n_{g1} = W_1$	(b) $n_{g1} > W_1$	(c) $n_{g1} < W_1$	(d) n_{g1} and W_1 are unrelated.

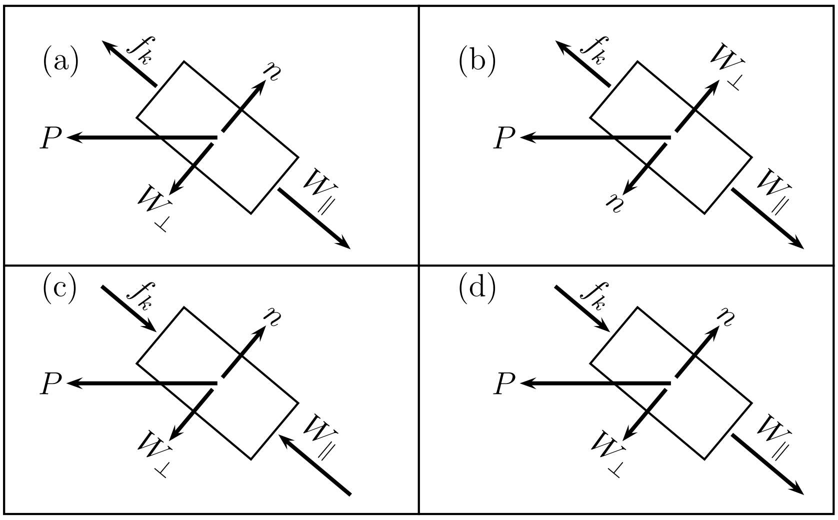
Still Lifting

Questions 16 through 20 refer to the following setup and figure.

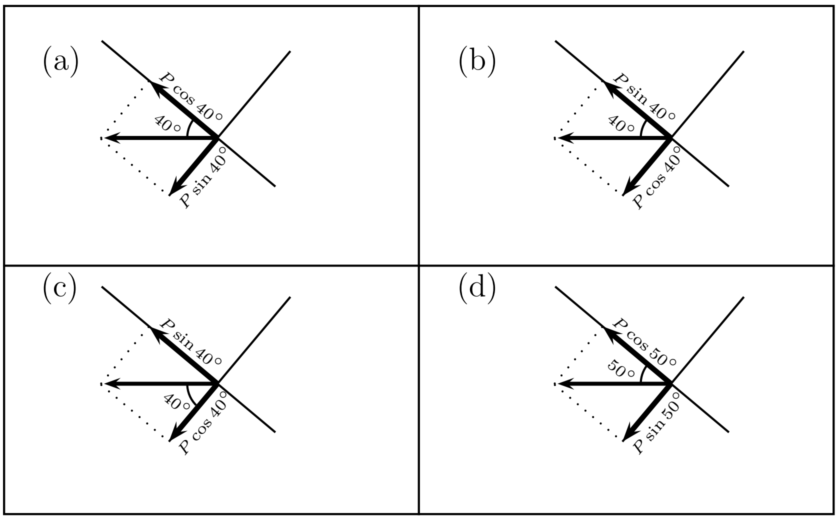
Tired of dealing with the two globes, Superman uses his X-ray vision (or whatever it's called) to melt them together to form one $M = 1200\,kg$, rectangular mass. Being Super-persistent, Superman continues to apply a horizontal force, $\vec{\mathbf{P}}$, to the mass even after it starts to slide up the incline.



16. If we include friction, which of the following is the correct free body diagram for M? (Unlike Mastering Physics, I always split weight into components on an incline.)



17. Which of the following graphs shows how to correctly split P into its perpendicular and parallel components?



18. Which of the following is the correct listing of the parallel and perpendicular weight of the $M = 1200\,kg$ mass on the $40°$ incline? Note the use of $kN = kiloNewtons$ to make the numbers smaller.

(a) $W_{\parallel} = 9.0\,kN$, $W_{\perp} = 7.6\,kN$	(b) $W_{\parallel} = 7.6\,kN$, $W_{\perp} = 9.0\,kN$
(c) $W_{\parallel} = 11.8\,kN$, $W_{\perp} = 9.0\,kN$	(d) $W_{\parallel} = 0\,kN$, $W_{\perp} = 11.8\,kN$

19. If $P = 21\,kN$, what is the magnitude of the normal force acting on the mass?

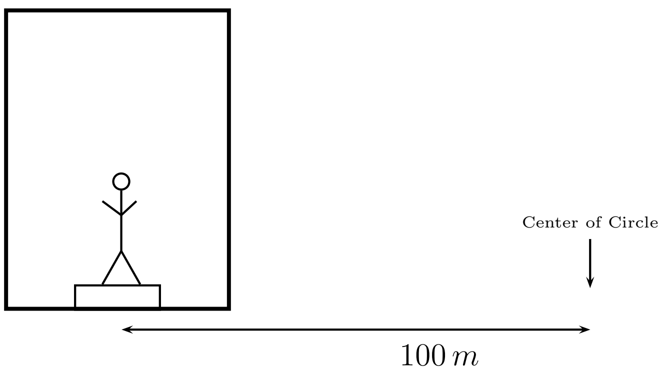
(a) $n = 9.0\,kN$	(b) $n = 7.6\,kN$	(c) $n = 22.5\,kN$	(d) $n = 21\,kN$

20. If $P = 21\,kN$ and $\mu_k = .35$, what is the mass's acceleration? Use "up" the incline as the positive direction.

(a) $a = .5\,m/s^2$	(b) $a = -1.7\,m/s^2$	(c) $a = 17.5\,m/s^2$	(d) $a = .26\,m/s^2$

21. **The Great Glass Elevator**

One day finds little Charlie Bucket (mass $48\,kg$) and Willy Wonka riding around (on Earth) in their fabulous great glass elevator. If you've never read the book, the great glass elevator is an elevator that can move in any direction you might wish. Sometime during their trip, little Charlie Bucket and Willy Wonka turn a corner in the great glass elevator by zooming around a $100\,m$ radius circle with a speed of $22.2\,m/s$. For reasons that only make sense to Willy Wonka (and your instructor), Charlie is riding in the elevator standing on a scale.



(a) If the coefficient of static friction between Charlie Bucket and his scale is .39, will he be able to remain not-sliding as he travels around this circle? Assume, as shown above, that the center of the circle is directly to the right of Charlie Bucket. (You must do a calculation of some sort to get full credit on this problem which is why there is an extra page provided.) *(10pts)*

(b) By fiddling with some buttons, Willy Wonka discovers that he can tilt the great glass elevator to any angle that he wishes. To what angle θ should Willy Wonka tilt the elevator so that no friction is necessary for Charlie Bucket to go around a $100\,m$ radius circle (whose center is still directly to his right) with a speed of $22.2\,m/s$? What would the scale read in this case? (There's an extra page for this one too.) *(10pts)*