More Challenging Dynamics and Kinematics Problems

1. A stationary box of mass 4.2 kg is given a push of 8.2 N [S] along a surface where the frictional force acting is 5.8 N [N]. The push lasts for 3.6 s and then the box is allowed to slide on its own until it comes to rest.
   (a) Draw free-body diagrams to show the box being pushed and sliding on its own.
   (b) Determine the acceleration of the box as it is being pushed.
   (c) Calculate the speed of the box just as the push ceases.
   (d) Determine the acceleration of the box as it is sliding on its own.

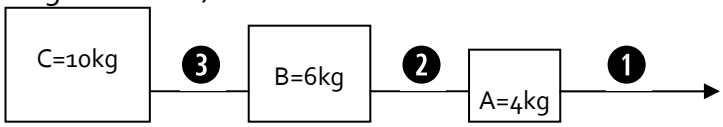
2. An elevator and its contents have a combined mass of 6000 kg. It is suspended by a single cable. (Assume 4 significant digits.)
   (a) Draw a free-body diagram of the elevator.
   (b) What force must the cable exert on the elevator when it is at rest?
   (c) What force must the cable exert on the elevator when it is moving upward at 2.0 m/s^2?
   (d) What force must the cable exert on the elevator when it is moving downward at 2.0 m/s?
   (e) If the cable snapped, what is the elevator's motion as it falls. Include a new free-body diagram.

3. A person throws a 2.0-kg object vertically upward and it reaches a position 4.0 m above the point of release 0.90 s later.
   (a) What speed must the object have had upon release? Include a free-body diagram.
   (b) If the person throws the object from rest through a vertical distance of 1.2 m, what acceleration must the object have during the throw?
   (c) What force must the person be exerting during the throw to reach the desired height? Provide another free-body diagram depicting the forces acting during the throw.

4. A box of mass 4.5 kg is pushed across a rough surface (μ_K = 0.18) for a distance of 2.0 m by a constant force of 10 N. If the object reaches a speed of 2.0 m/s by the end of the push, what was its speed at the beginning of the push? (Assume 2 significant digits.)

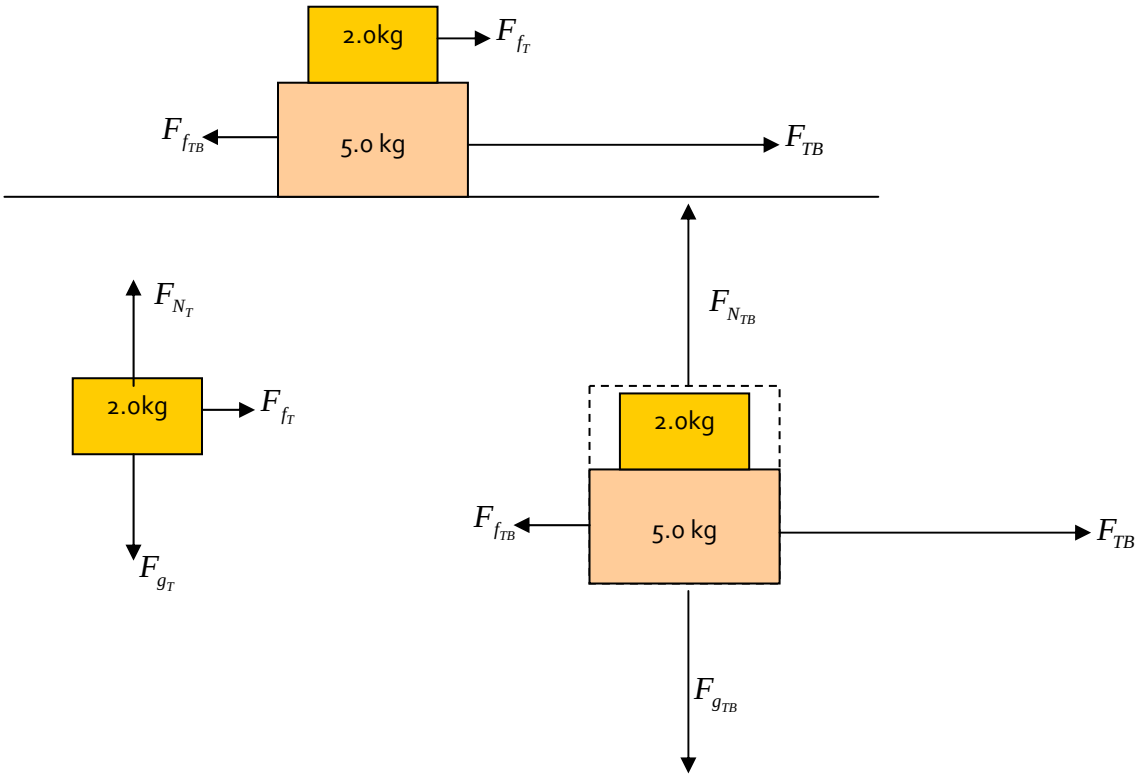
5. An object of mass 40.0 kg rests on the surface of a planet with a mass of 8.2×10^{22} kg and radius 3.6×10^5 m.
   (a) Calculate the force of gravity acting on the object.
   (b) Determine the gravitational field strength "*g*" at the planet's surface.
   (c) Calculate the force of gravity acting on the object if it is placed at a position 6.4×10^5 m above the planet's surface.

6. Three carts are being pulled by series of connecting ropes. Each cart is of different mass. (see diagram below)

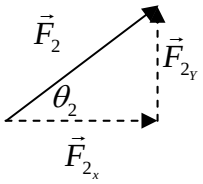
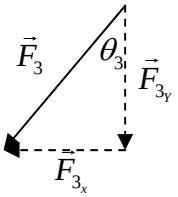


   If the entire system is accelerating at 0.5m/s^2 find
   (a) The tension in rope ❶
   (b) The tension in rope ❷
   (c) The tension in rope ❸

7. Two boxes are sitting on top of each other. The top box has a mass of 2.00kg and the bottom box has a mass of 5.00kg. The coefficient of static friction between the top box and the bottom box is 0.42. If the coefficient of kinetic friction between the floor and the bottom box is 0.25 determine.
   (a) The maximum acceleration of the system before the top box starts to slip.
   (b) The force applied to the bottom box to make the system accelerate at that rate.



8. A box sitting on a smooth frictionless surface is being pushed by 3 forces. $\vec{F}_1 = 20N\left[E\right]$, $\vec{F}_2 = 30N\left[E40^0N\right]$ and $\vec{F}_3 = 50N\left[S20^0W\right]$. If the mass of the box is 12.0kg:
   (a) Determine the net force acting on the box using components.
   (b) Determine the acceleration of the box.

Vector	x-comp	y-comp
$\vec{F}_1 = 20N\left[E\right]$	$\vec{F}_{1_x} = 20N\left[E\right]$	$\vec{F}_{1y} = \vec{0}N$
	$F_{2_x} = F_2\cos\left(\theta_2\right)$	$F_{2_y} = F_2\sin\left(\theta_2\right)$
	$F_{3_x} = F_3\sin\left(\theta_3\right)$	$F_{3_y} = F_3\cos\left(\theta_3\right)$