Applications of Newton’s Laws: Exercise 1

1. The center-of-mass of which of the following objects would not lie within the body itself?
   (a) A baseball.
   (b) A brick.
   (c) A Frisbee.
   (d) A paperback book.
   (e) None of the above.

2. A packing crate slides down an inclined ramp at constant velocity. We can deduce that
   (a) a frictional force is acting on it.
   (b) a net force is acting on it.
   (c) it may be accelerating.
   (d) gravity is not acting on it.
   (e) none of the above.

3. During the investigation of a traffic accident, police find skid marks 90 m long. They determine the coefficient of friction between the car’s tires and the roadway to be 0.5 for the prevailing conditions. To find the velocity of the car, they must
   (a) know the mass number of the car.
   (b) find the acceleration of the car.
   (c) know the mass number of the car and find the acceleration of the car.
   (d) know the dimensions of the tires.
   (e) none of the above.
4. A block is pulled with a constant horizontal force of magnitude $|\vec{F}|$ along a flat, horizontal surface which exerts a frictional force of constant magnitude $|\vec{f}|$ on the block. The graph of the magnitude of velocity $v$ as a function of time $t$ for the block is shown below.

Which of the following shows the graph of acceleration $a$ as a function of time $t$ for the block?

- (a)
- (b)
- (c)
- (d)
- (e)
- (f) None of the above.
5. If, instead, the block of the previous problem slides without friction but is pulled with the same horizontal force of magnitude $|\vec{F}|$, which of the following would be a possible new graph of magnitude of velocity $v$ as a function of time $t$? (The dashed line represents the old graph.)

(a) 
(b) 
(c) 
(d) 
(e) None of the above.

(f) None of the above.

6. An object is placed on an inclined plane. The angle of incline is gradually increased until the object begins to slide. The angle at which this occurs is $\phi$. What is the coefficient of static friction between the object and the plane?

(a) $\sin \phi$.
(b) $\cos \phi$.
(c) $\tan \phi$.
(d) Insufficient information to determine.
(e) None of the above.
Problems 7 - 10 refer to the figure below:

7. The force pulling block A down the plane is
   (a) $m_A |\vec{g}| \sin \theta$.
   (b) $m_A |\vec{g}| \sin \phi$.
   (c) $m_A |\vec{g}| \cos \theta$.
   (d) $m_A |\vec{g}| \cos \phi$.
   (e) none of the above.

8. The normal force on block B is
   (a) $m_B |\vec{g}| \sin \theta$.
   (b) $m_B |\vec{g}| \sin \phi$.
   (c) $m_B |\vec{g}| \cos \theta$.
   (d) $m_B |\vec{g}| \cos \phi$.
   (e) none of the above.

9. Assuming there is no friction, the net force acting to move the blocks together along the planes is
   (a) $m_B |\vec{g}| \sin \phi - m_A |\vec{g}| \sin \theta$.
   (b) $m_B |\vec{g}| \cos \phi - m_A |\vec{g}| \cos \theta$.
   (c) $m_B |\vec{g}| \sin \phi + m_A |\vec{g}| \sin \theta$.
   (d) $-m_B |\vec{g}| \sin \phi - m_A |\vec{g}| \sin \theta$.
   (e) none of the above
10. If the acceleration of the blocks in the figure is $|\vec{a}|$, which of the following does not correctly give the tension $|\vec{T}|$ in the connecting cord.

(a) $m_A |\vec{a}| + m_A |\vec{g}| \sin \theta$.
(b) $m_B |\vec{a}| + m_B |\vec{g}| \sin \phi$.
(c) $(m_A + m_B) |\vec{a}| + m_A |\vec{g}| \sin \theta$.
(d) $\frac{m_A m_B}{m_A + m_B} (\sin \phi + \sin \theta) |\vec{g}|$.
(e) None of the above.

11. Rain pours down with constant velocity $|\vec{v}_r|$ at an angle $\alpha$ from vertical. A person running into the rain with velocity $|\vec{v}_p|$ sees the rain at an angle $\beta$ from vertical. How are $\vec{v}_r$, $\vec{v}_p$, $\alpha$, and $\beta$ related? That is, what is the relation between $\alpha$ and $\beta$ for given velocities $\vec{v}_r$ and $\vec{v}_p$. [Hint: draw a vector diagram and use trig functions.]

12. Locate the center of mass of the three-particle system shown below:

![Diagram of three particles](image)

13. If $\theta$ is the angle a ski slope makes with respect to the horizontal, and $\mu_k$ is the coefficient of kinetic friction between skis and snow, what is the acceleration $a$ of a skier heading straight down the hill?