June 24, Week 4

Today: Chapter 5, Applying Newton's Laws

Homework #4 is now available.

Equilibrium versus Dynamics

At equilibrium, the individual forces acting on an object add to zero.

Equilibrium versus Dynamics

At equilibrium, the individual forces acting on an object add to zero.

$$\sum F_x = 0, \quad \sum F_y = 0$$

Equilibrium versus Dynamics

At equilibrium, the individual forces acting on an object add to zero.

$$\sum F_x = 0, \quad \sum F_y = 0$$

When an object accelerates, the forces do not add to zero and Newton's Second Law becomes

$$\sum F_x = ma_x, \quad \sum F_y = ma_y$$

Equilibrium versus Dynamics

At equilibrium, the individual forces acting on an object add to zero.

$$\sum F_x = 0, \quad \sum F_y = 0$$

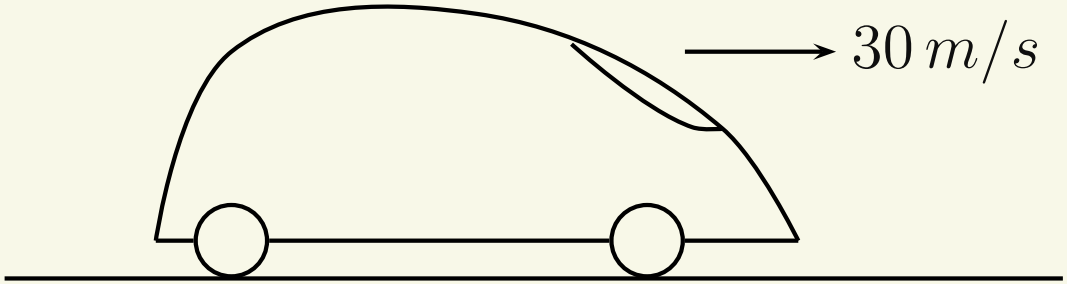
When an object accelerates, the forces do not add to zero and Newton's Second Law becomes

$$\sum F_x = ma_x, \quad \sum F_y = ma_y$$

But there are not necessarily any *NEW* forces acting on the object!

Dynamics Exercise I

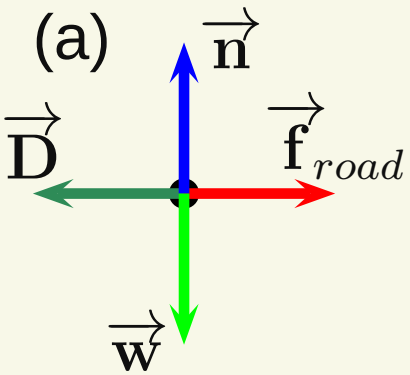
A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?

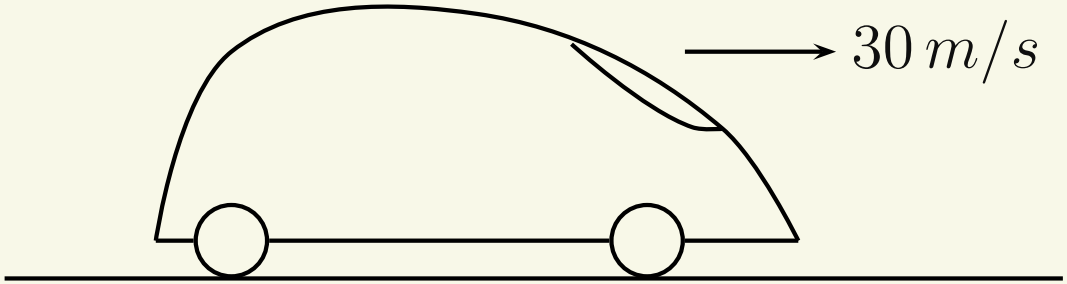


Dynamics Exercise I

A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?

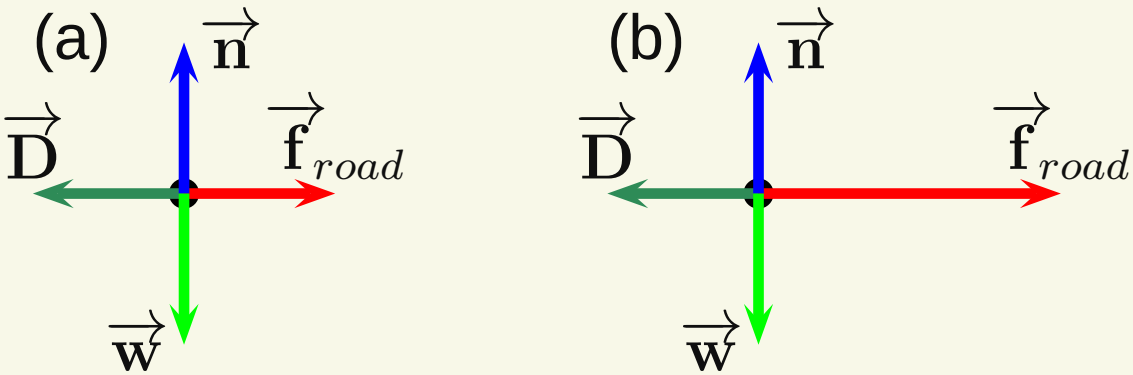
(a)

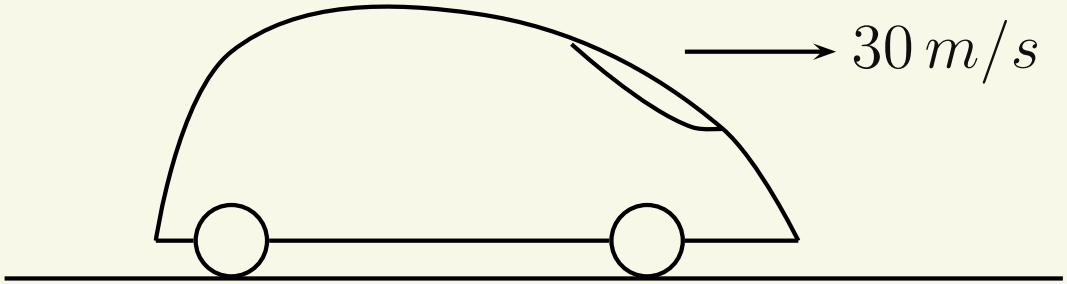




Dynamics Exercise I

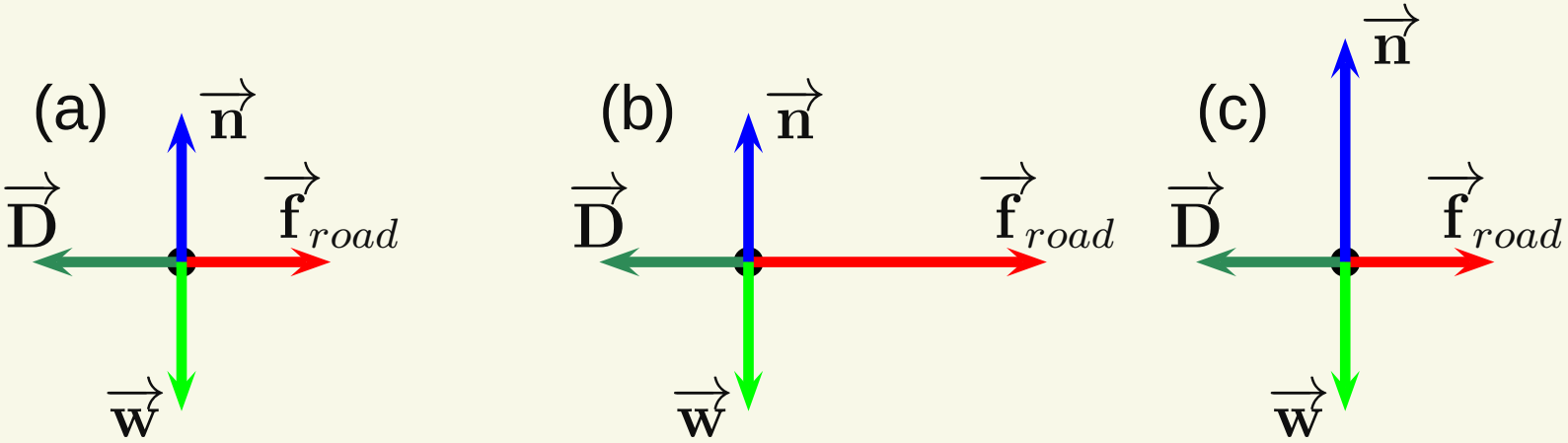
A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?

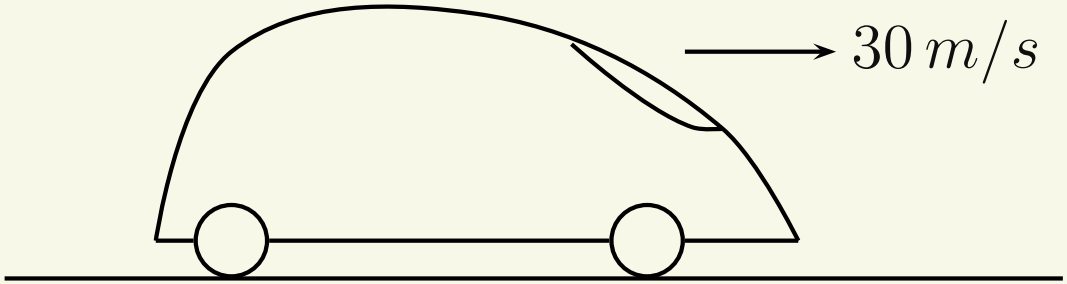




Dynamics Exercise I

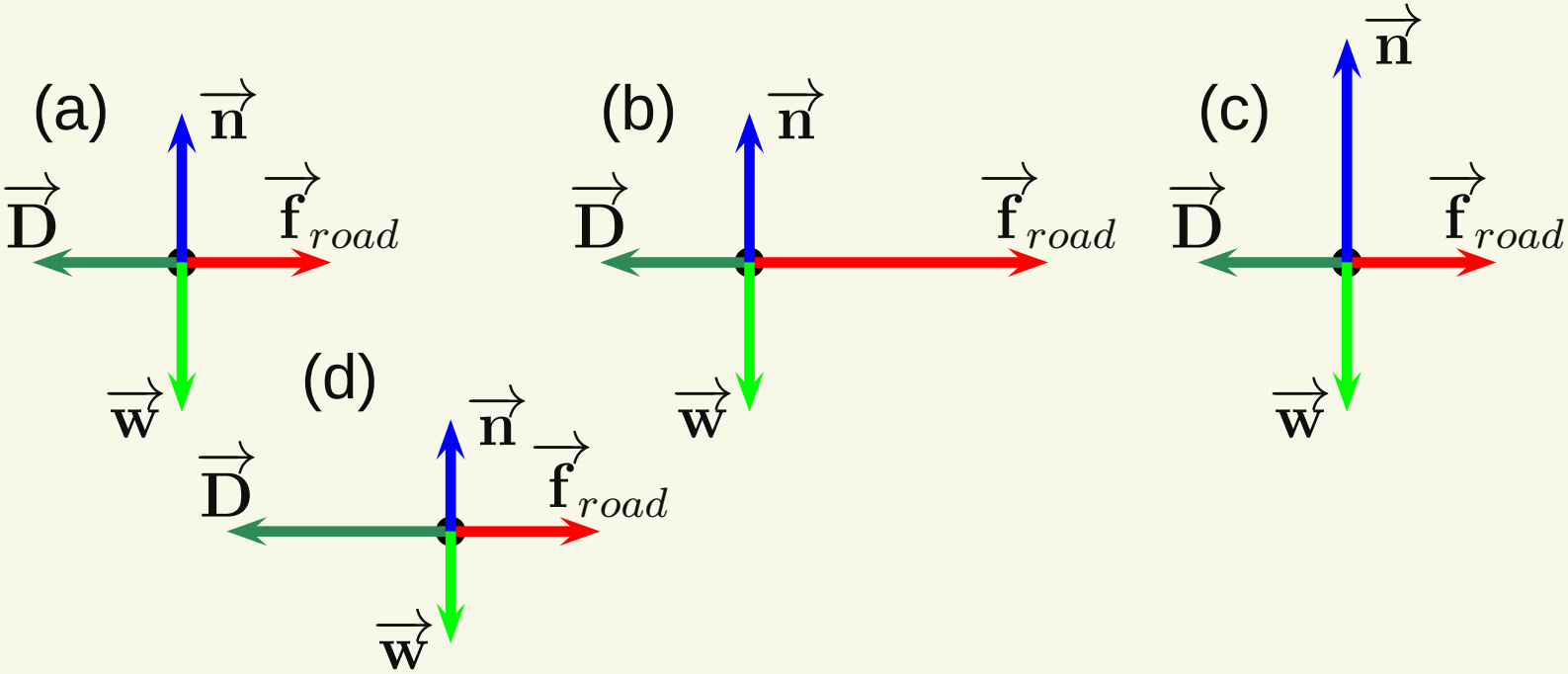
A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?

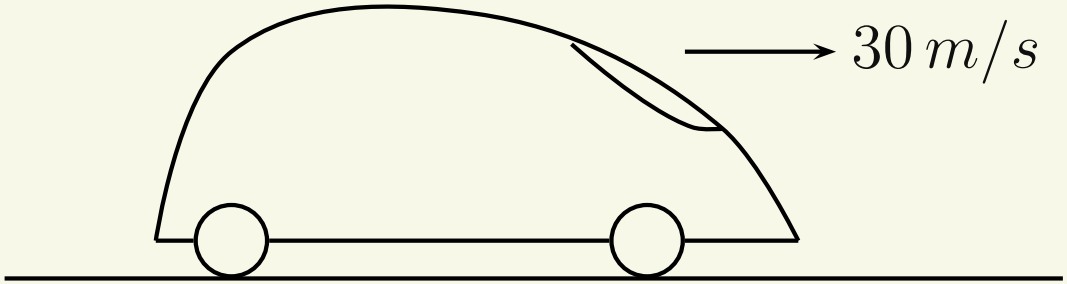




Dynamics Exercise I

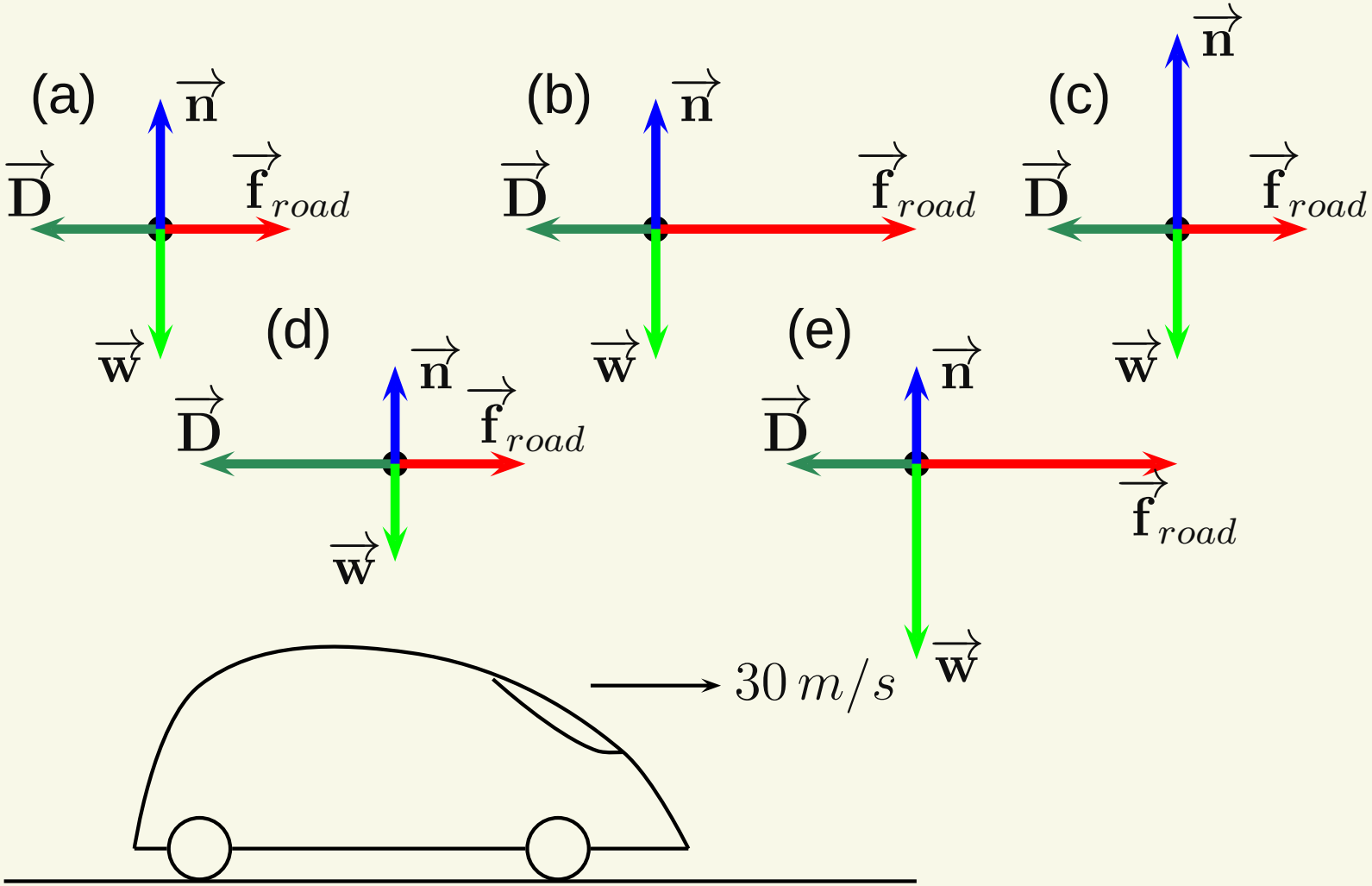
A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?





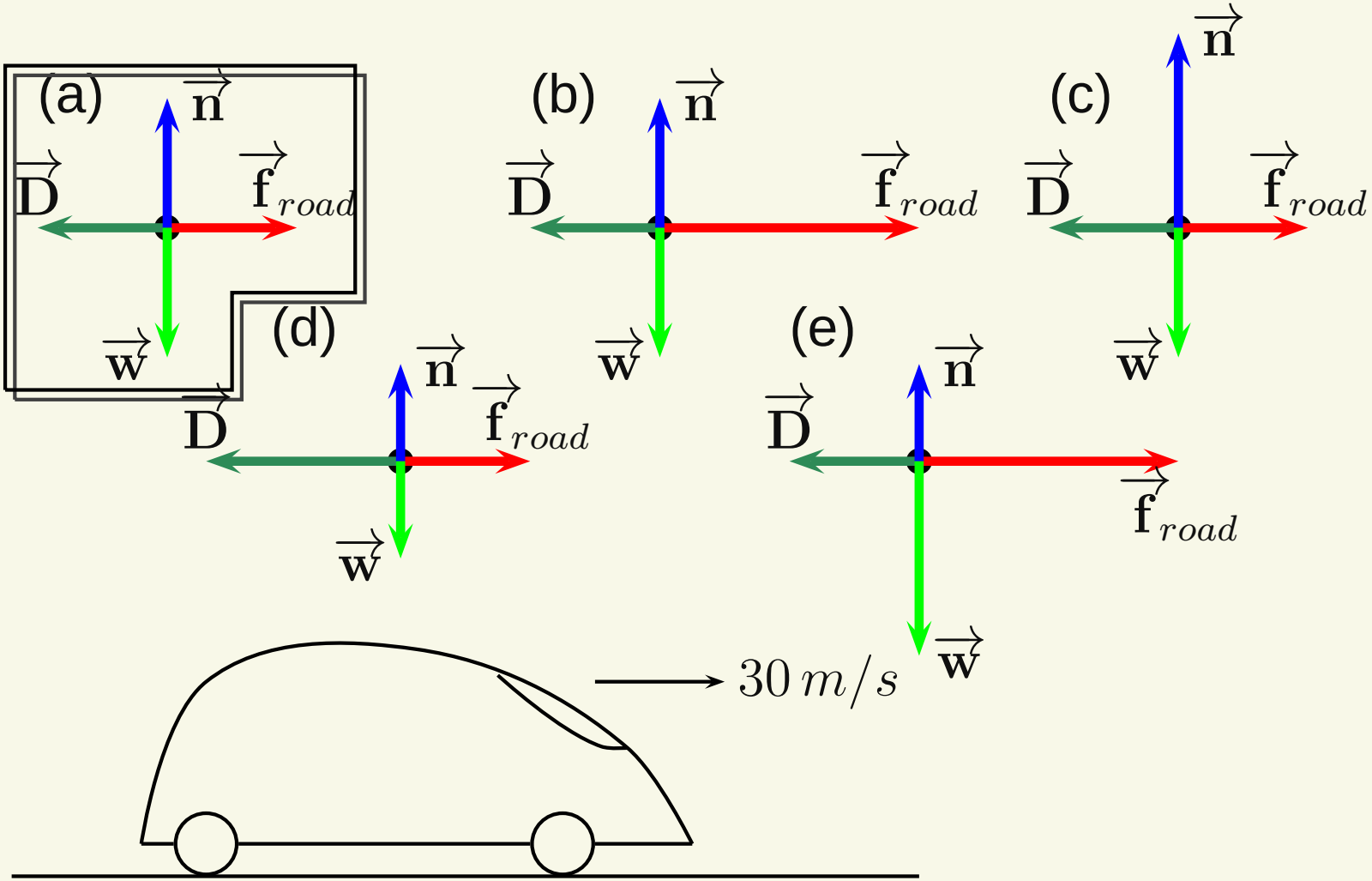
Dynamics Exercise I

A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?



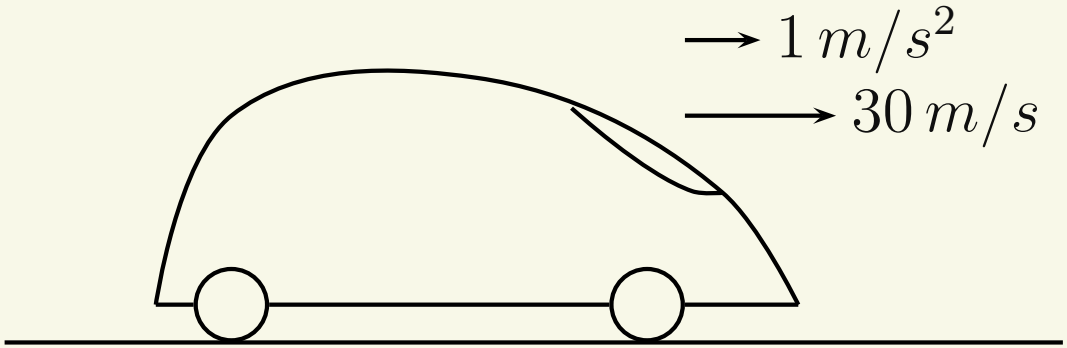
Dynamics Exercise I

A minivan is traveling with a constant speed of $30\,m/s$. Which of the following is the correct free-body diagram for the minivan?



Dynamics Exercise II

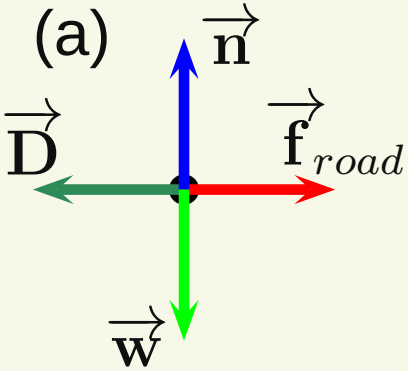
A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?

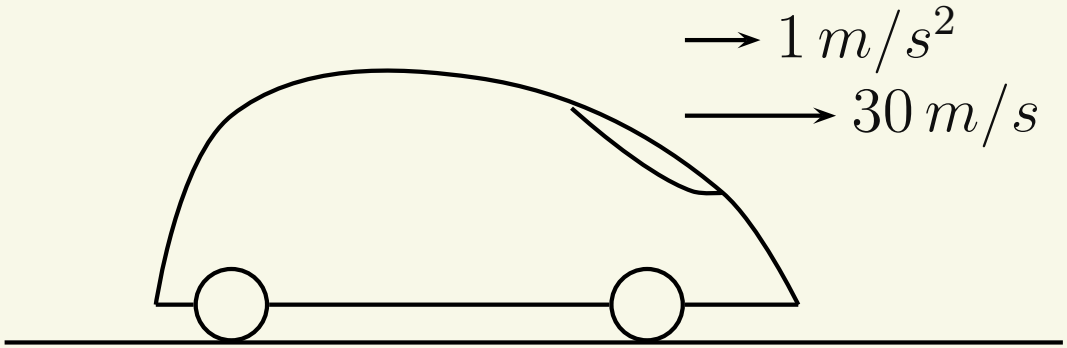


Dynamics Exercise II

A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?

(a)

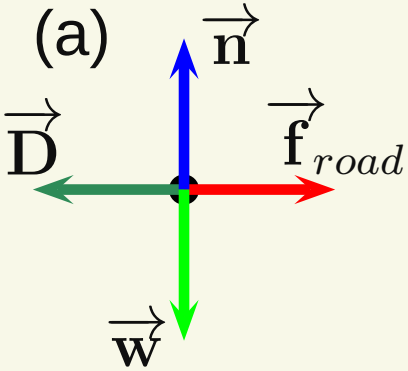




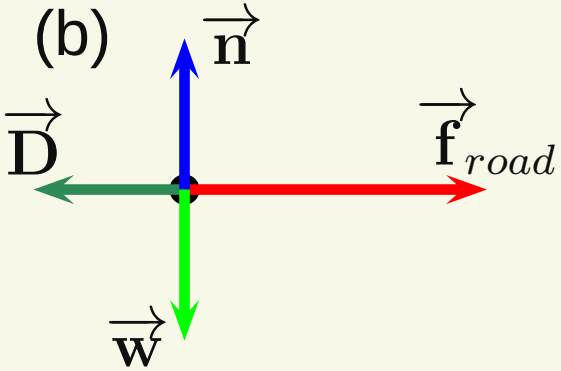
Dynamics Exercise II

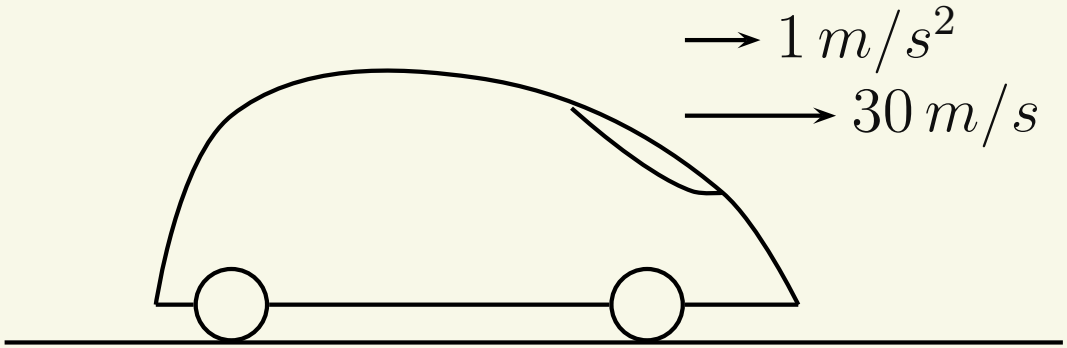
A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?

(a)



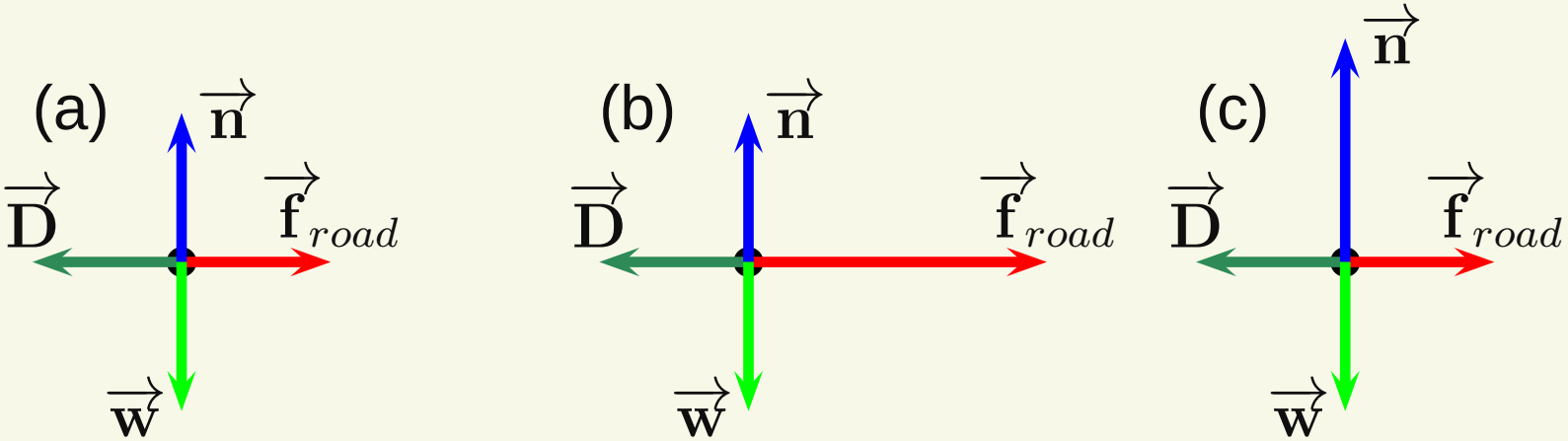
(b)

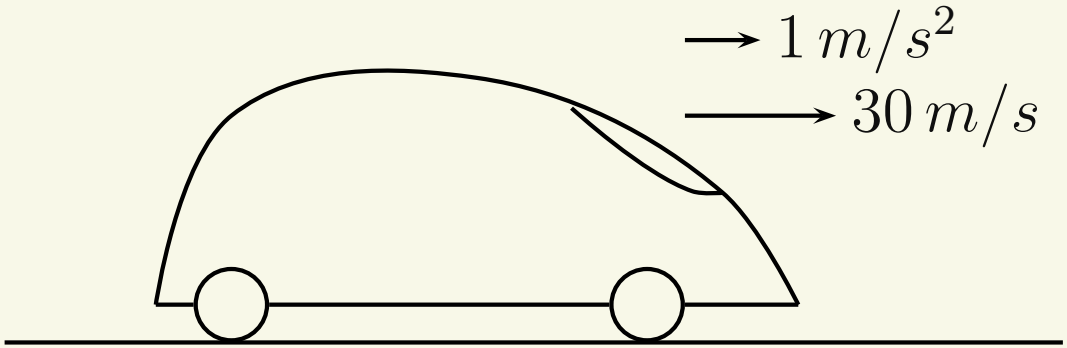




Dynamics Exercise II

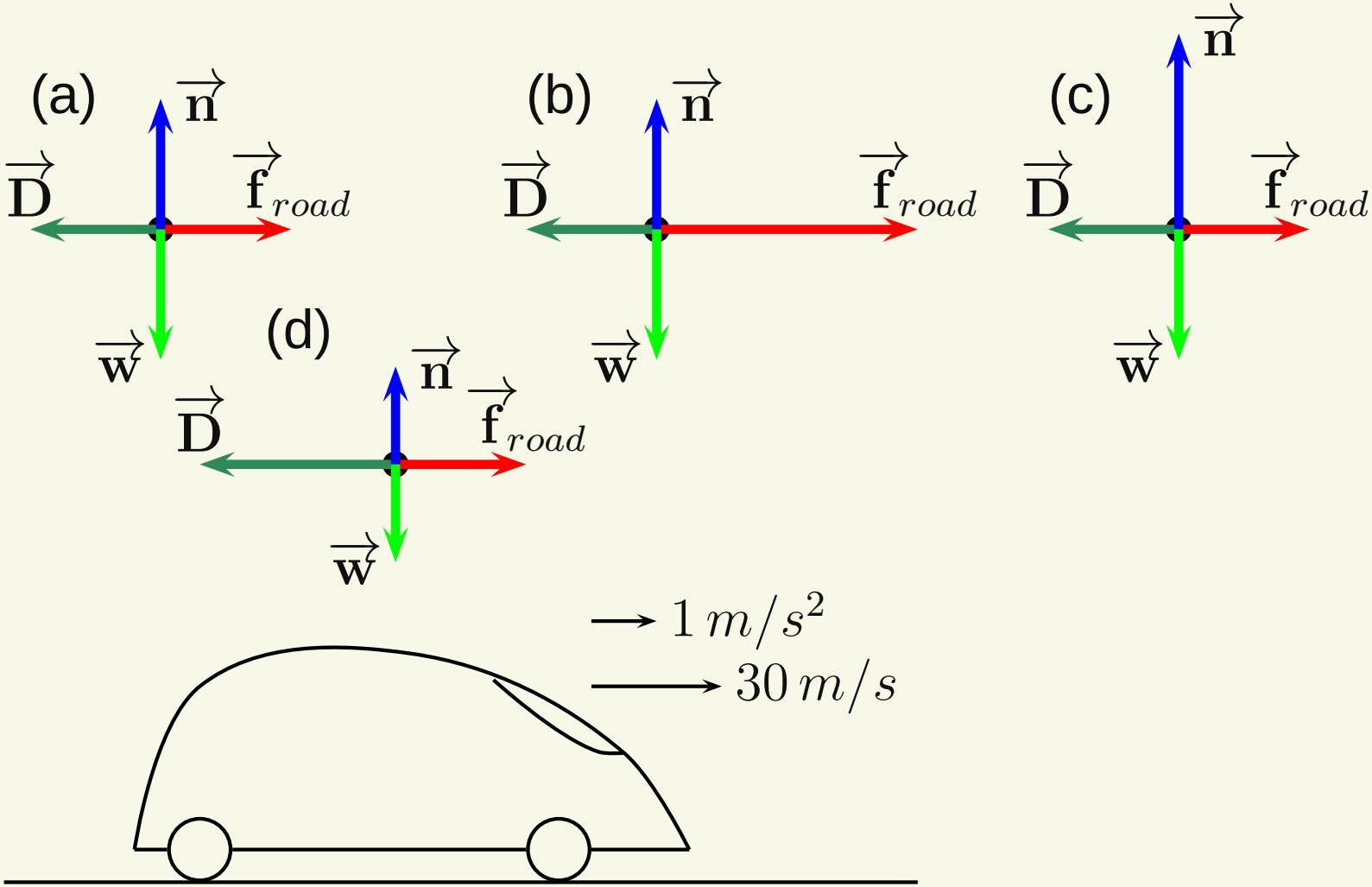
A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?





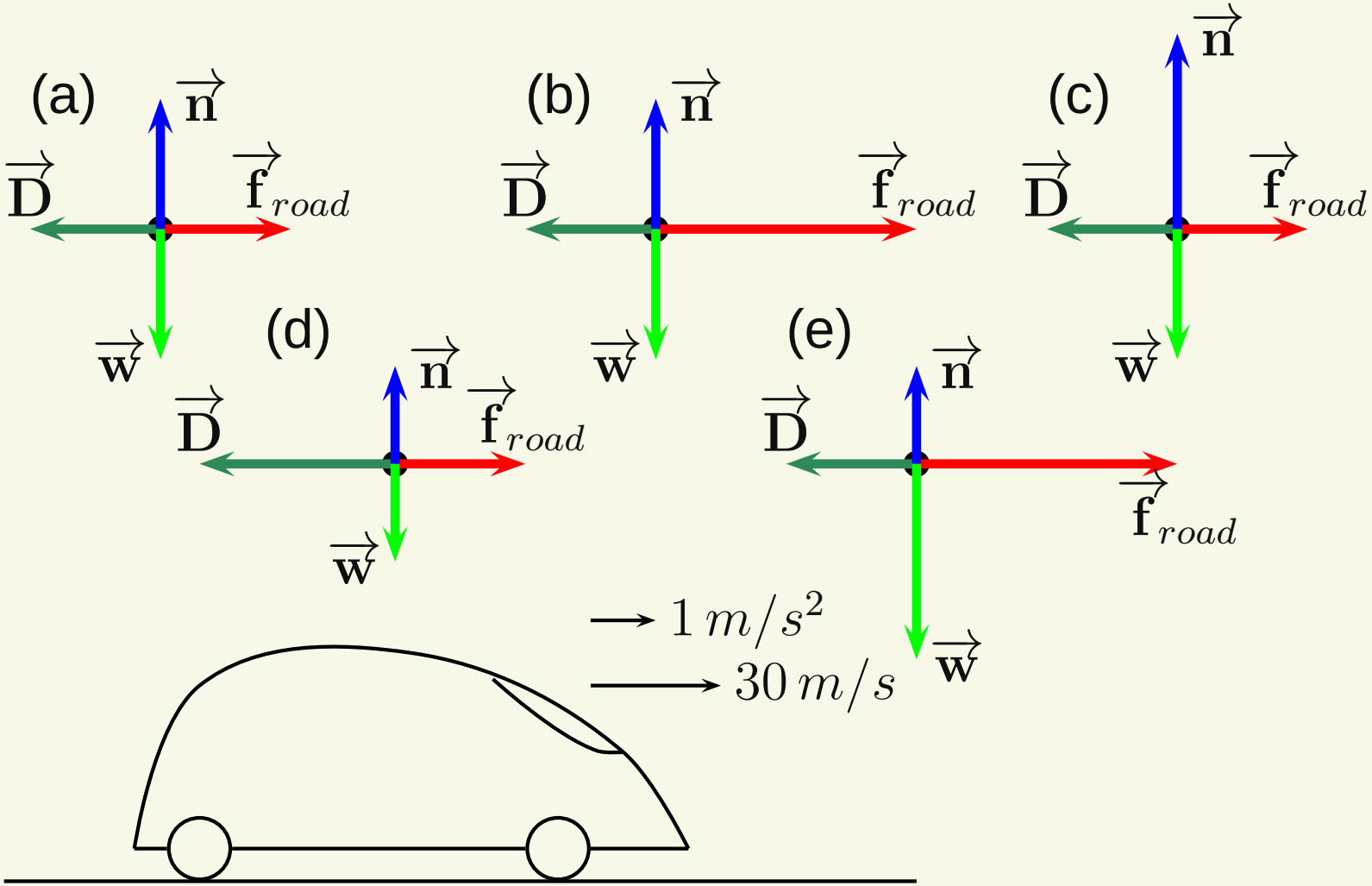
Dynamics Exercise II

A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?



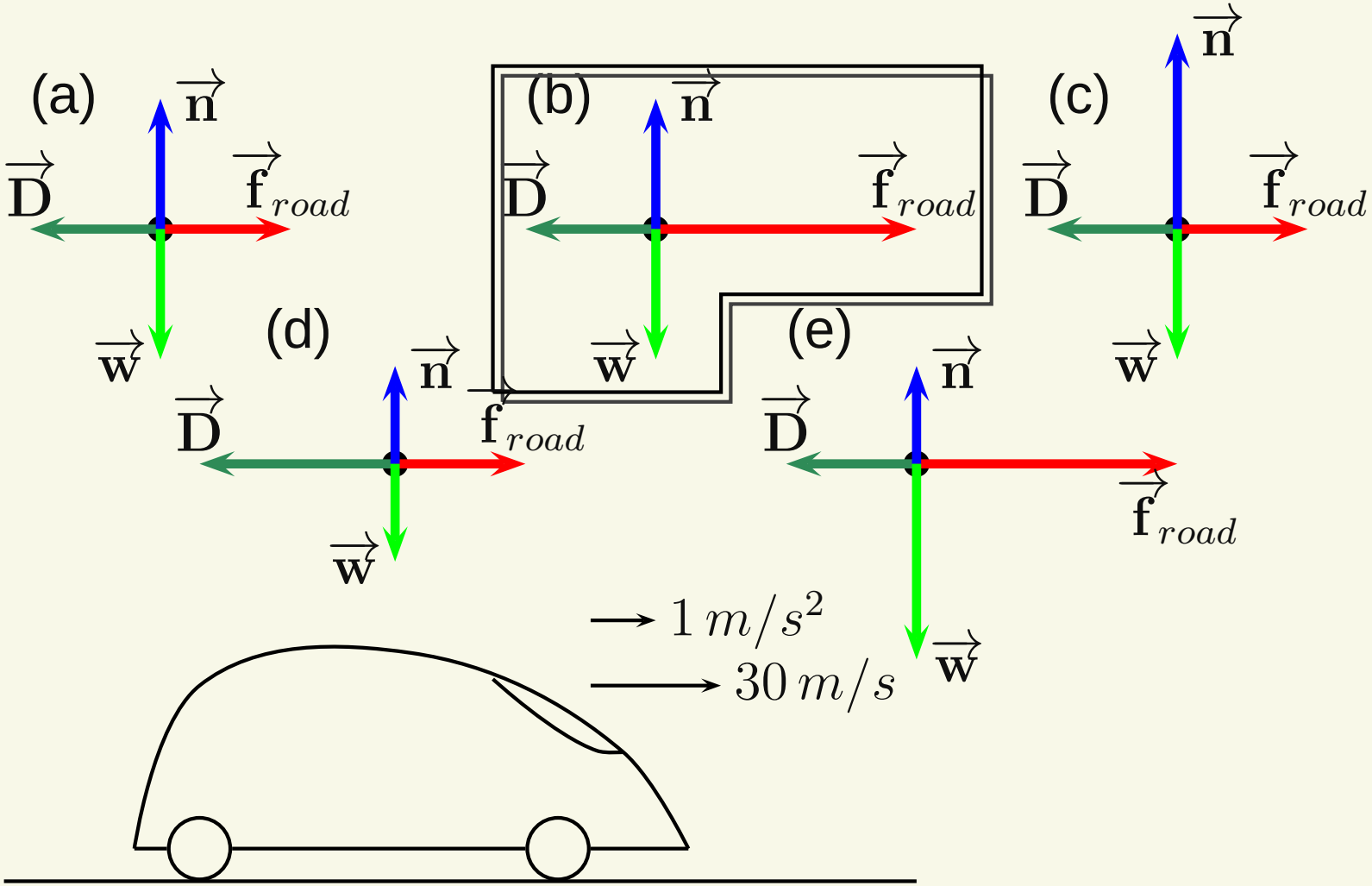
Dynamics Exercise II

A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?



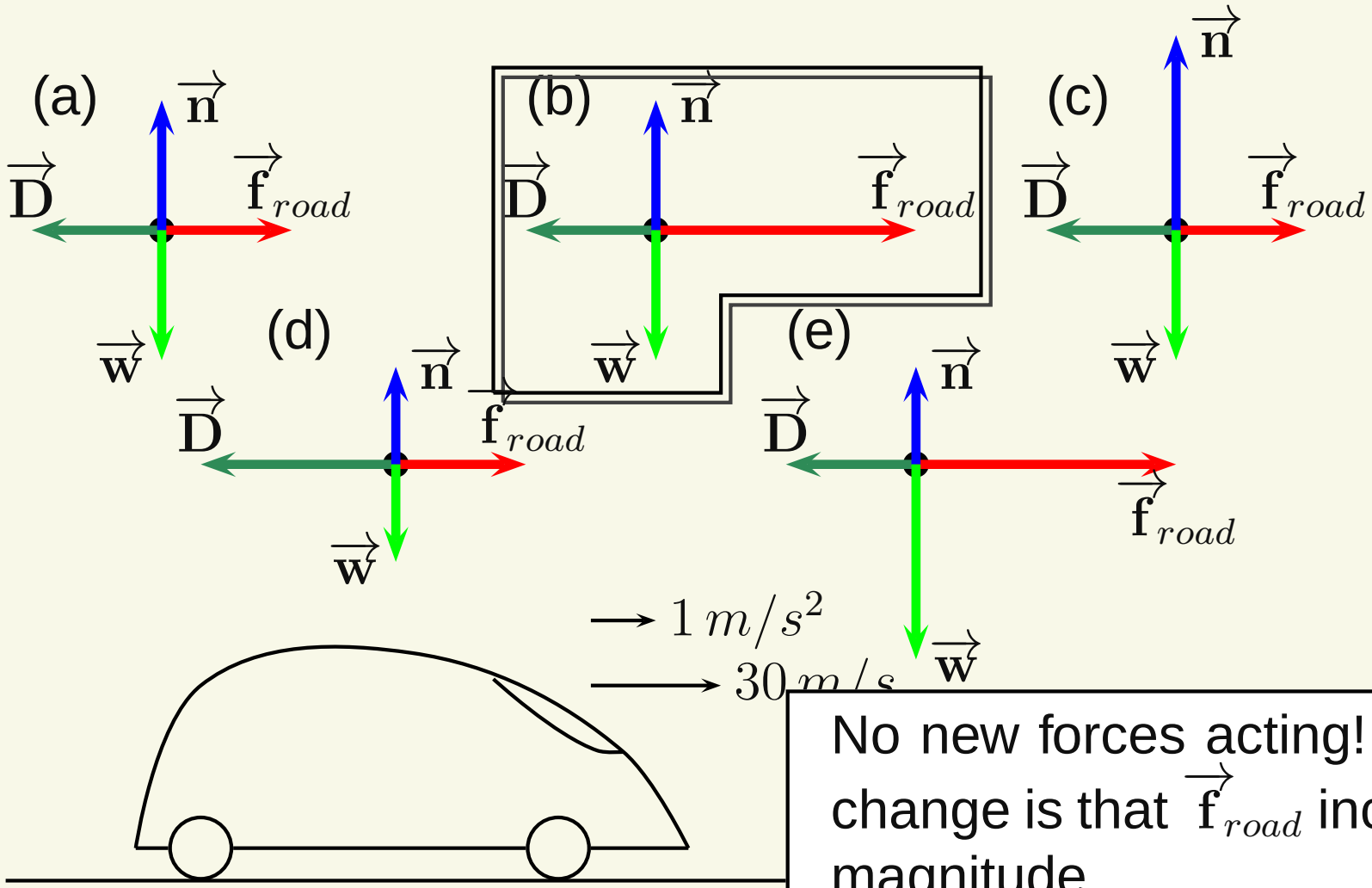
Dynamics Exercise II

A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?



Dynamics Exercise II

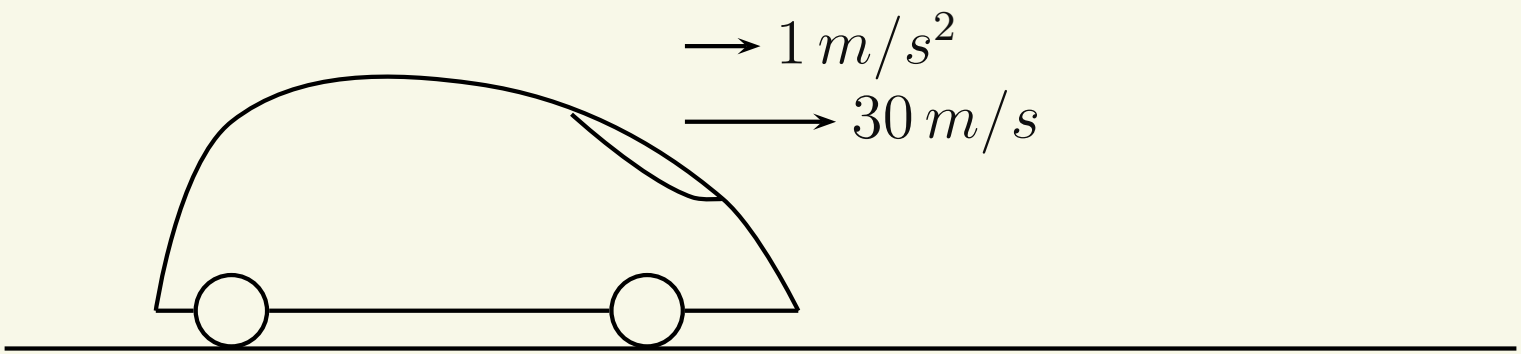
A minivan is traveling with speed of $30\,m/s$ and accelerating at $1\,m/s^2$. Which of the following is the correct free-body diagram for the minivan?



No new forces acting! The only change is that $\vec{\mathbf{f}}_{road}$ increased in magnitude.

Dynamics Exercise III

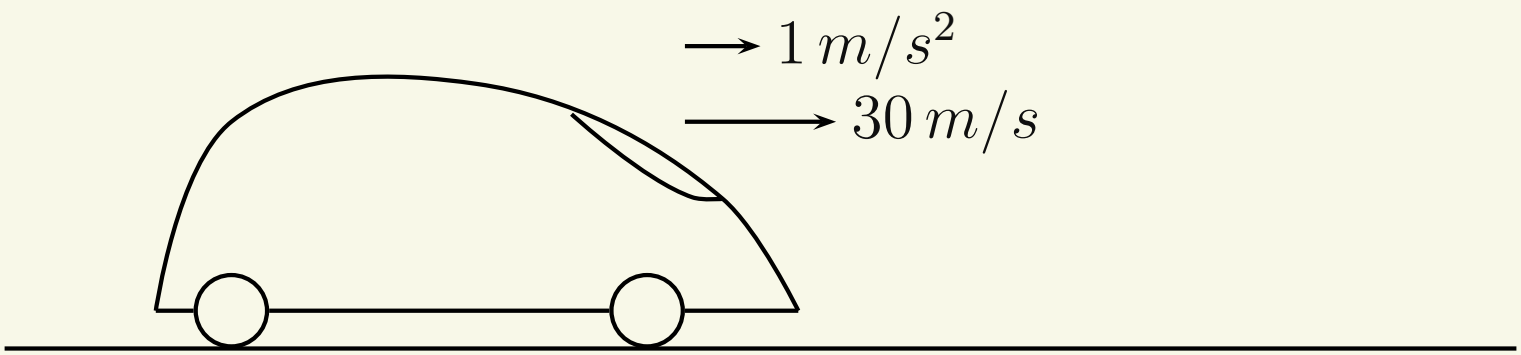
A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?



Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

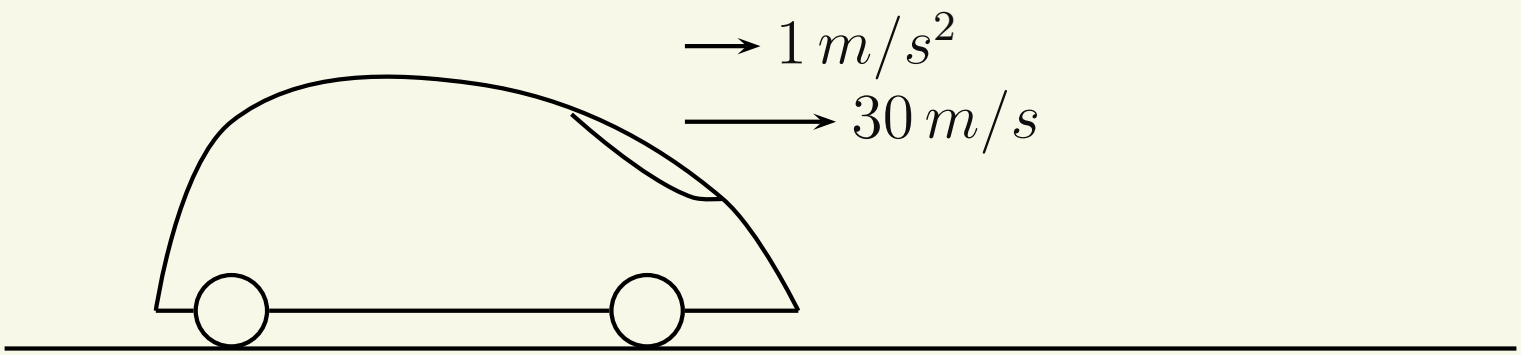
(a) $700\,N$



Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

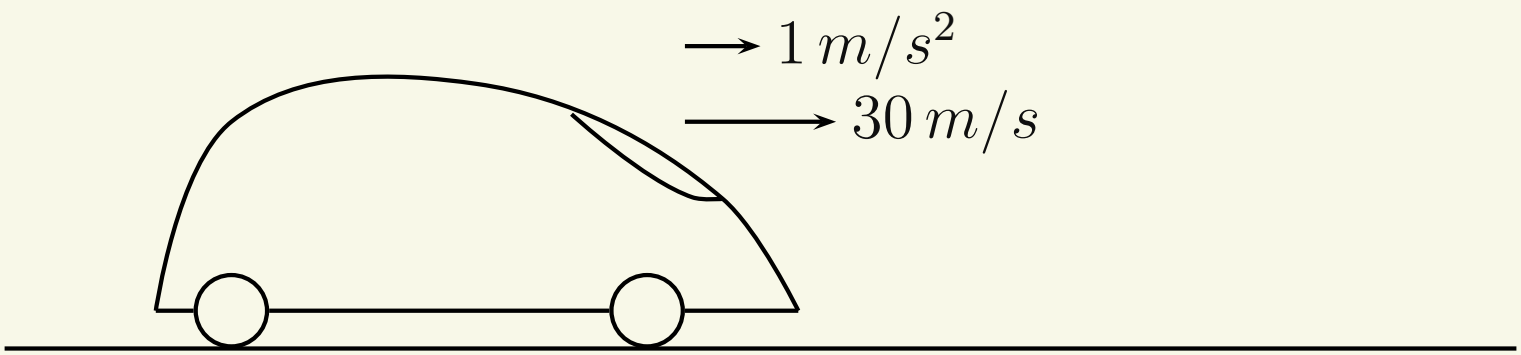
(a) $700\,N$ (b) $300\,N$



Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

(a) $700\,N$ (b) $300\,N$ (c) $1000\,N$

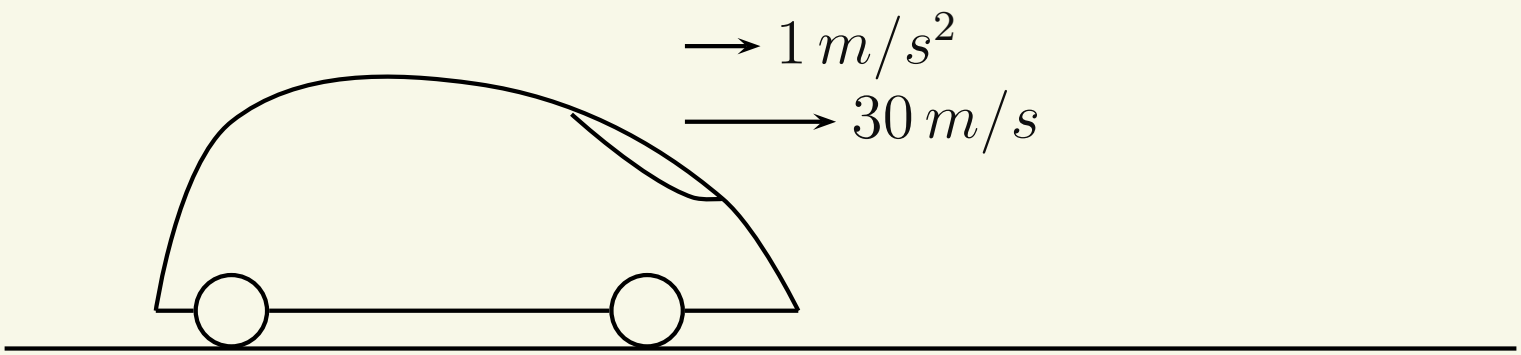


Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

(a) $700\,N$ (b) $300\,N$ (c) $1000\,N$

(d) $400\,N$

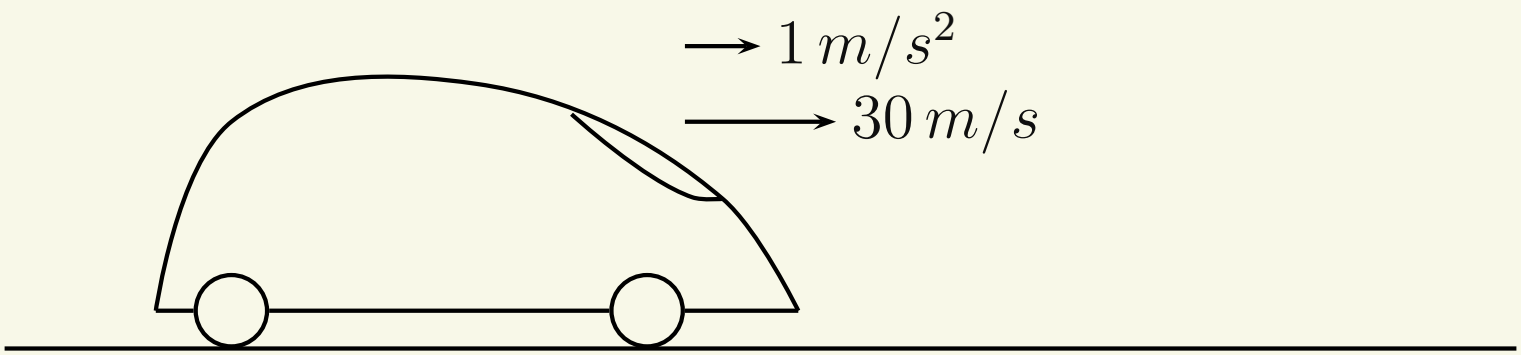


Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

(a) $700\,N$ (b) $300\,N$ (c) $1000\,N$

(d) $400\,N$ (e) $20700\,N$

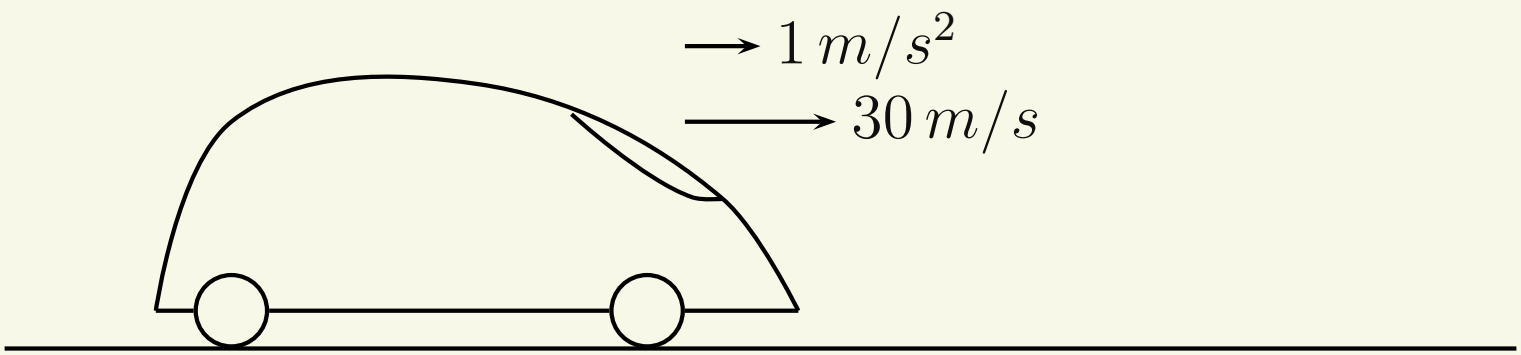


Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

(a) $700\,N$ (b) $300\,N$ **(c) $1000\,N$**

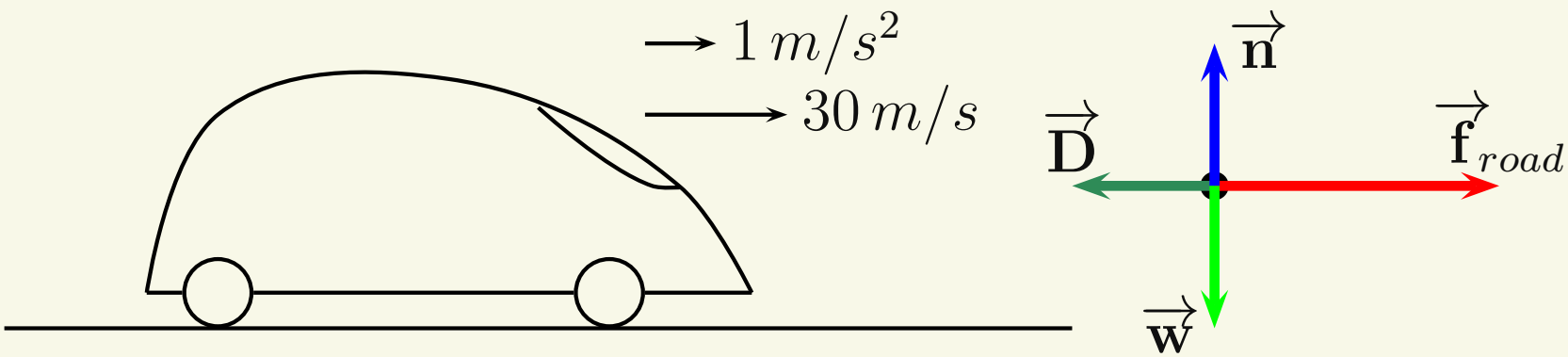
(d) $400\,N$ (e) $20700\,N$



Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

(c) $1000\,N$

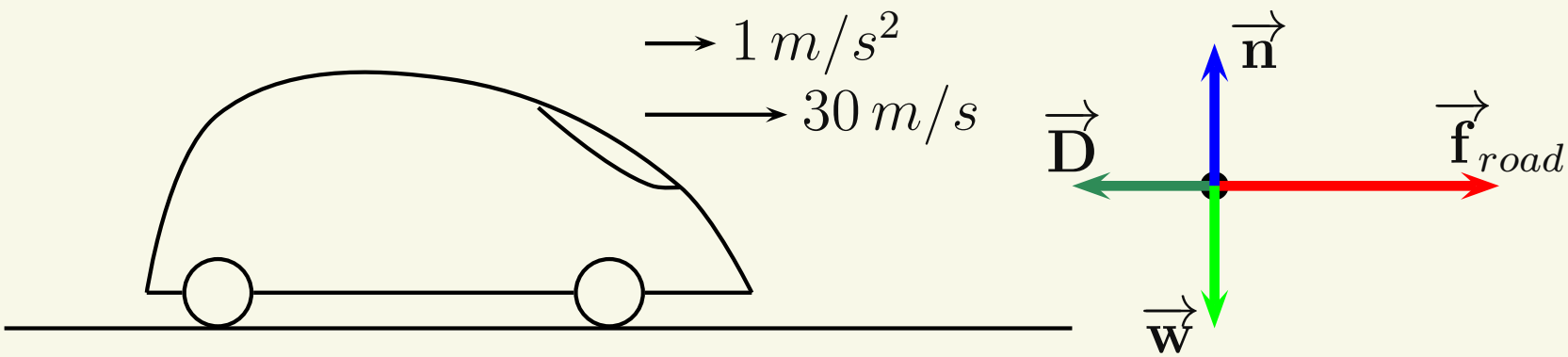


Dynamics Exercise III

A 700-kg minivan is traveling at $30\,m/s$ and accelerating at $1\,m/s^2$. If there is a 300-N drag acting against the car, what force is the road exerting on the minivan?

$$\sum F_x = ma_x \Rightarrow$$
$$f_{road,x} + n_x + D_x + w_x = ma_x \Rightarrow$$
$$f_{road} - D = ma_x$$
$$f_{road} - 300\,N = (700\,kg)(1\,m/s^2)$$

(c) $1000\,N$



Apparent Weight

Scales do not measure weight, they measure normal force.

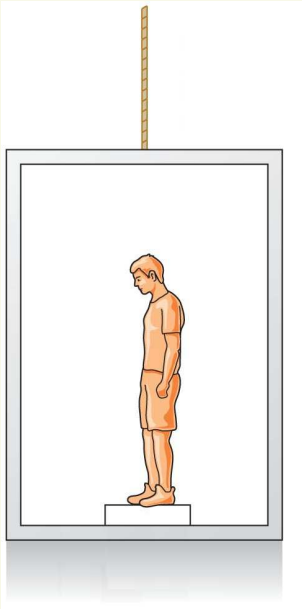
Apparent Weight

Scales do not measure weight, they measure normal force.

Example: An $80\,kg$ man steps on a bathroom scale. In his bathroom, what does the scale read?

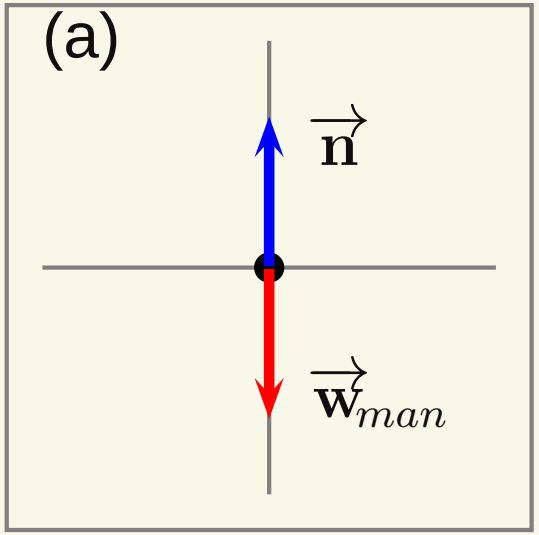
Apparent-Weight Exercise I

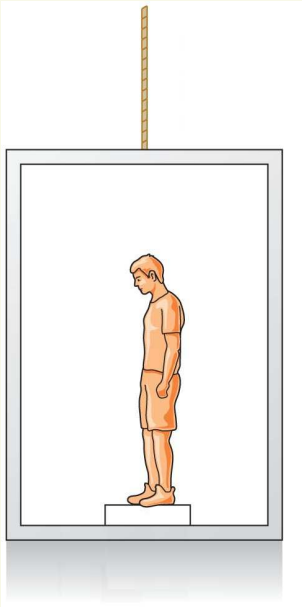
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?



Apparent-Weight Exercise I

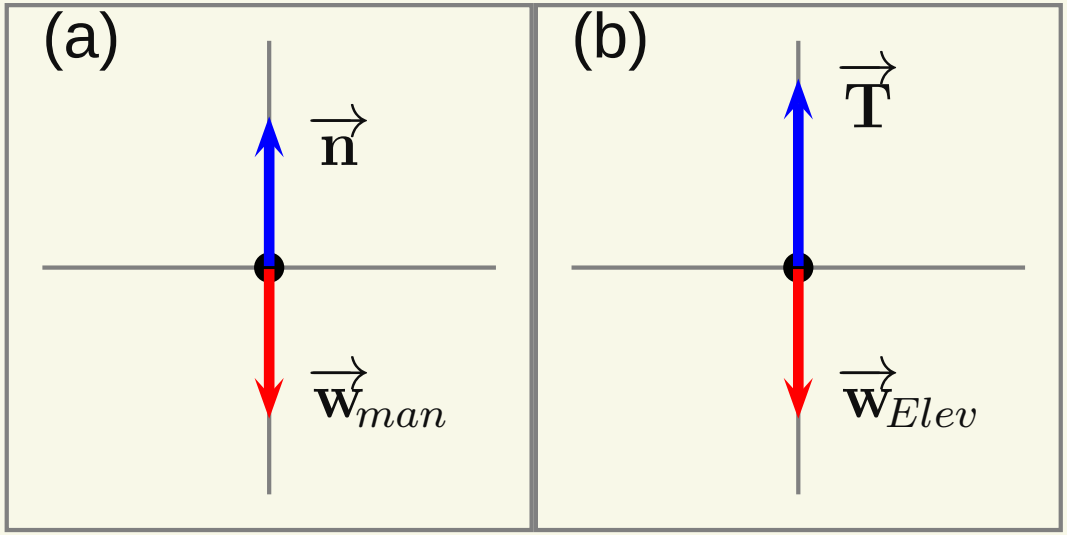
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

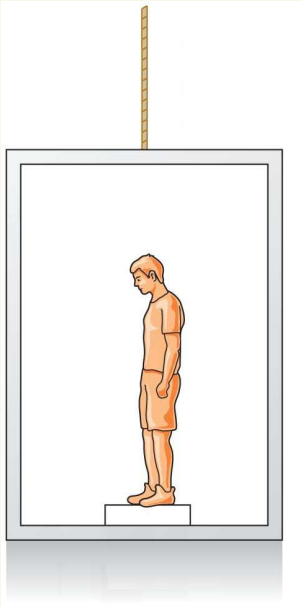




Apparent-Weight Exercise I

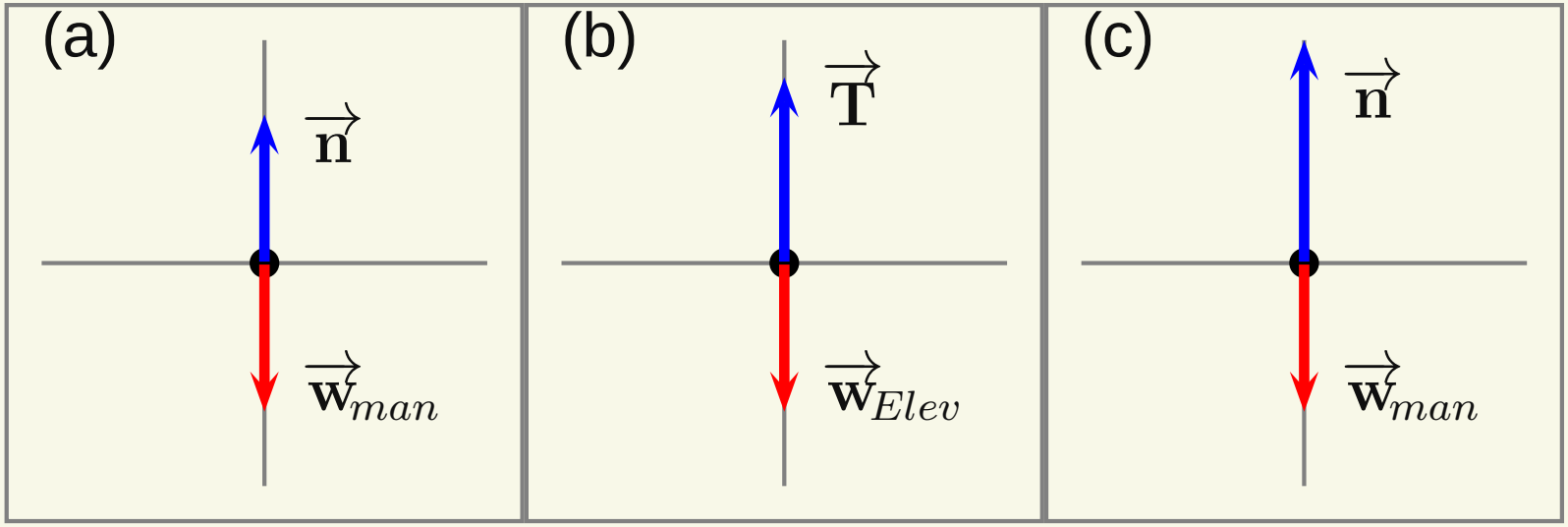
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

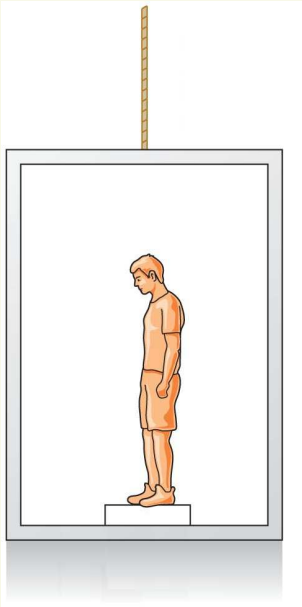




Apparent-Weight Exercise I

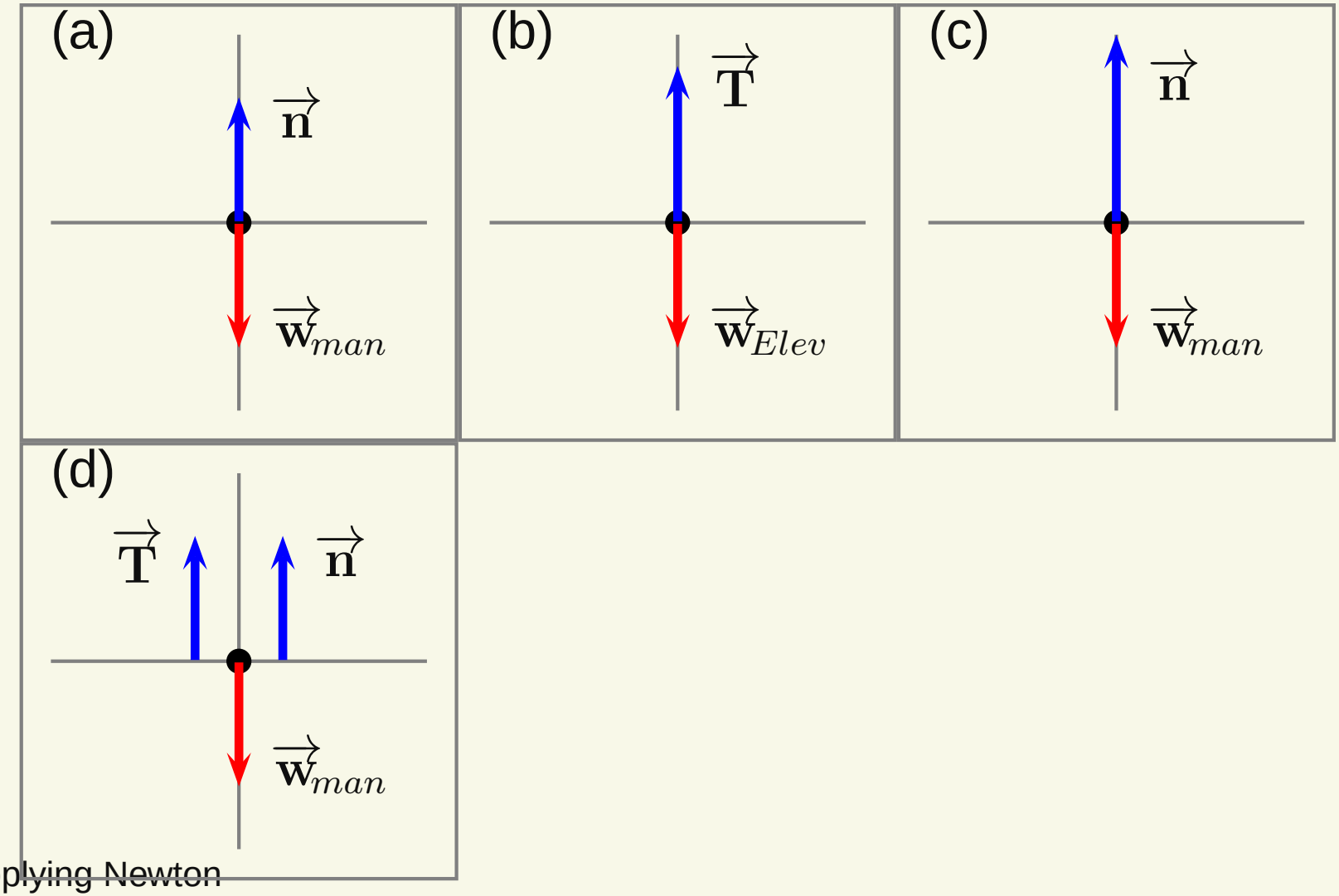
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

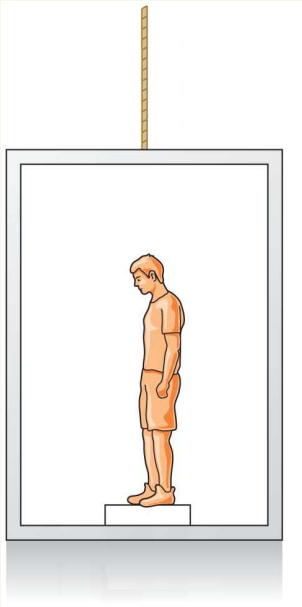




Apparent-Weight Exercise I

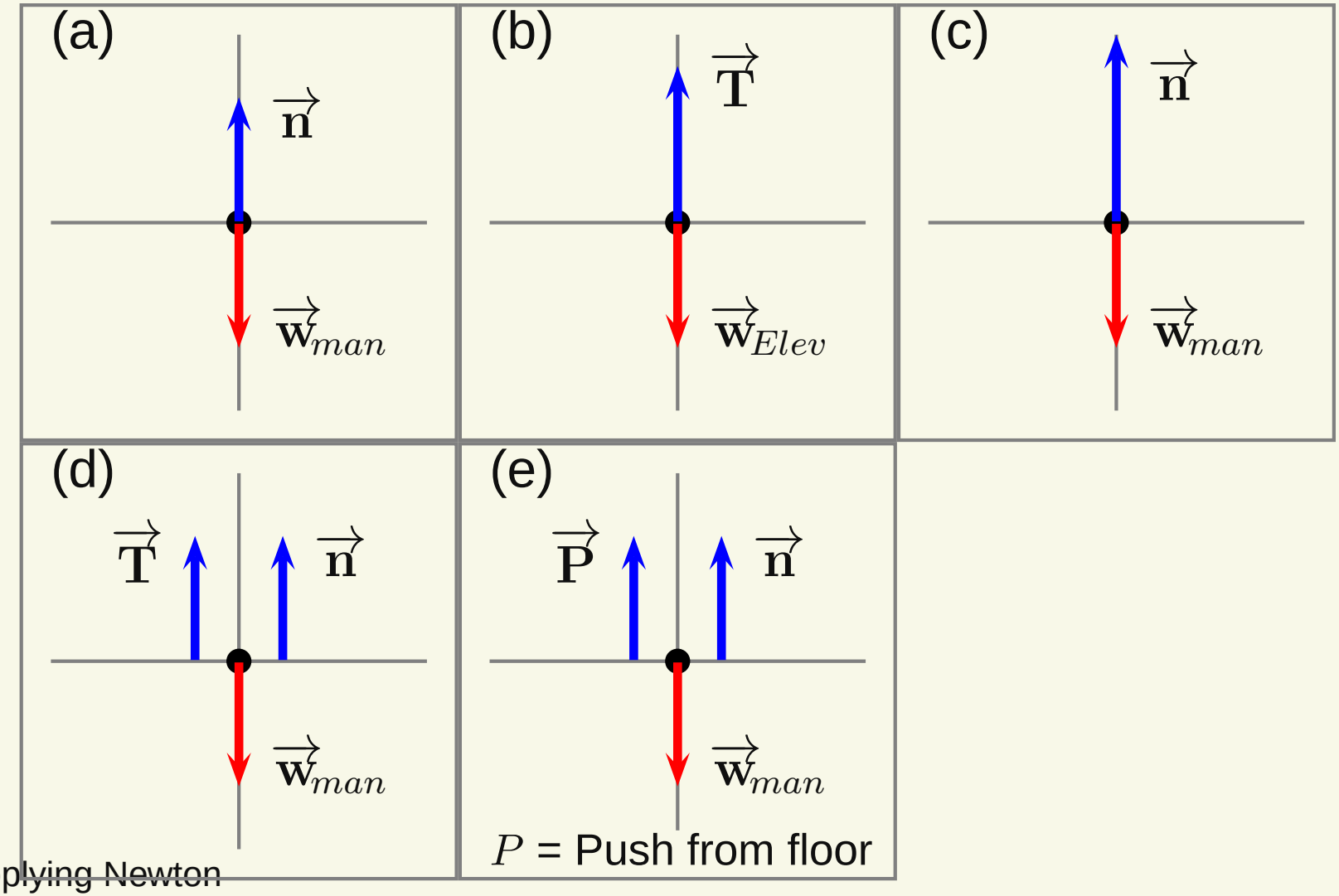
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

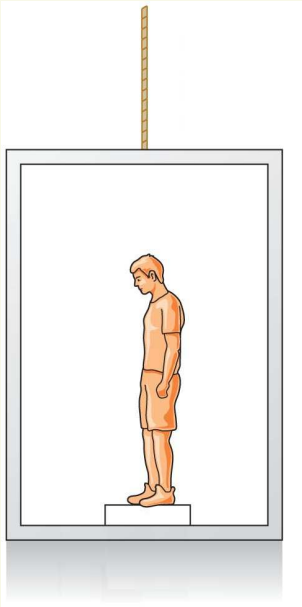




Apparent-Weight Exercise I

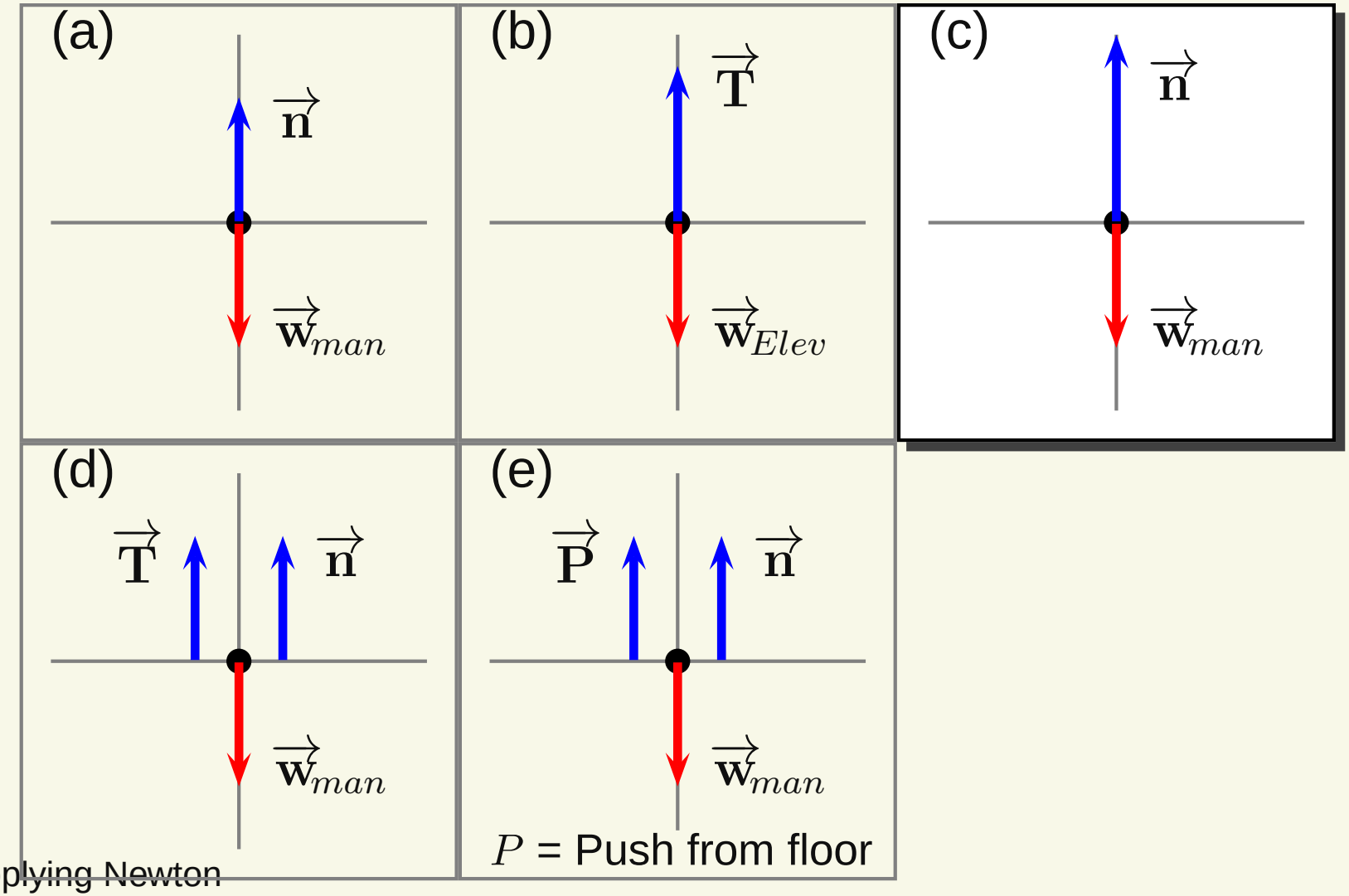
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

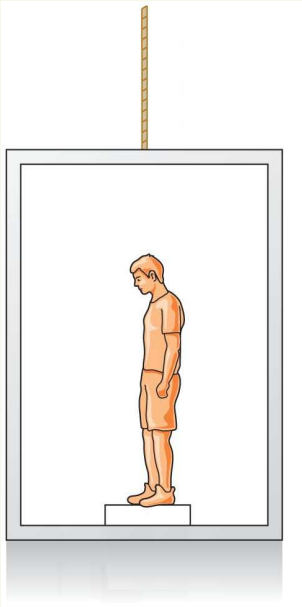




Apparent-Weight Exercise I

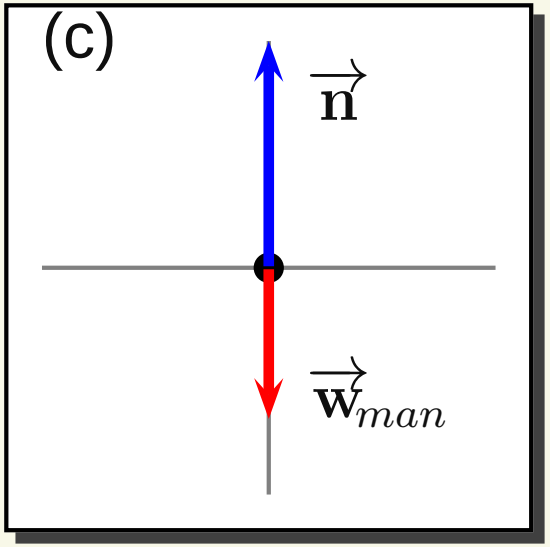
A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?



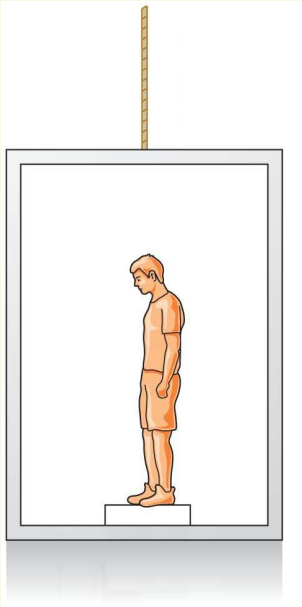


Apparent-Weight Exercise I

A man steps on a bathroom scale which is in an elevator that is accelerating upwards. Which of the following is the correct free-body diagram for the *MAN*?

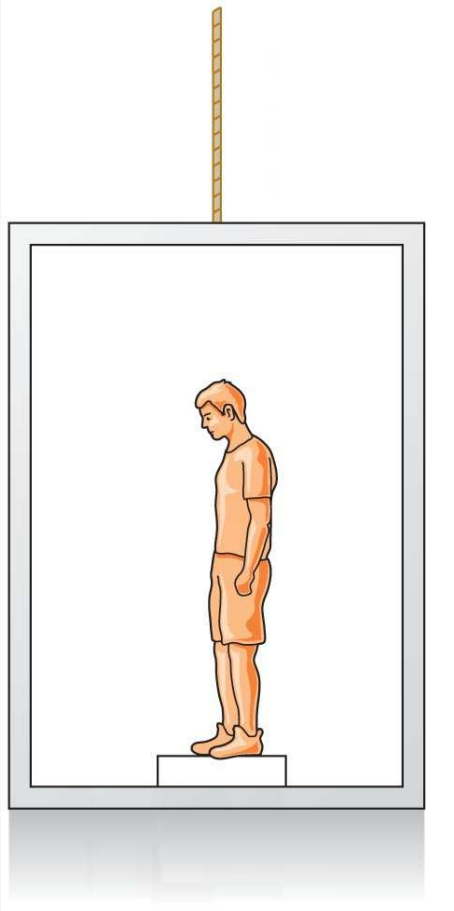


The normal force, $\vec{\mathbf{n}}$ *IS*, the upward push from the floor. In order for the man to accelerate upwards, it must get larger than his weight. No new forces are in this problem.



Apparent-Weight Exercise II

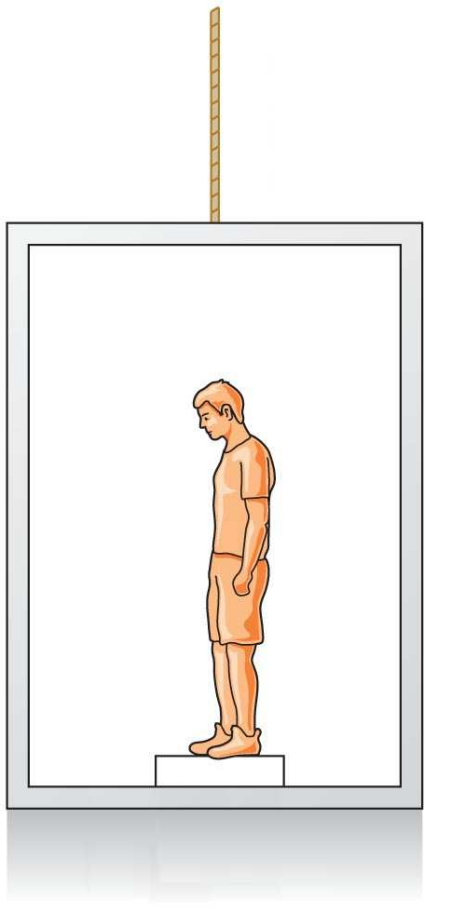
An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?



Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

(a) $0\,N$

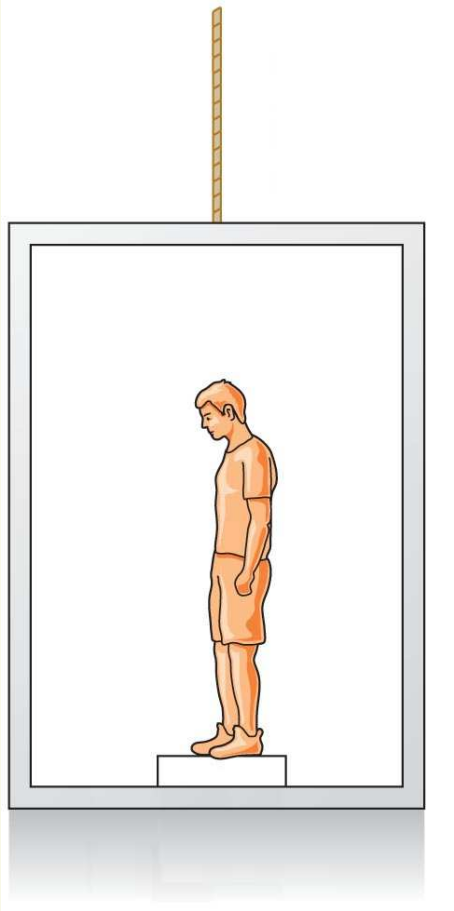


Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

(a) $0\,N$

(b) $(80\,kg)(9.8\,m/s^2 - 2.5\,m/s^2) = 584\,N$



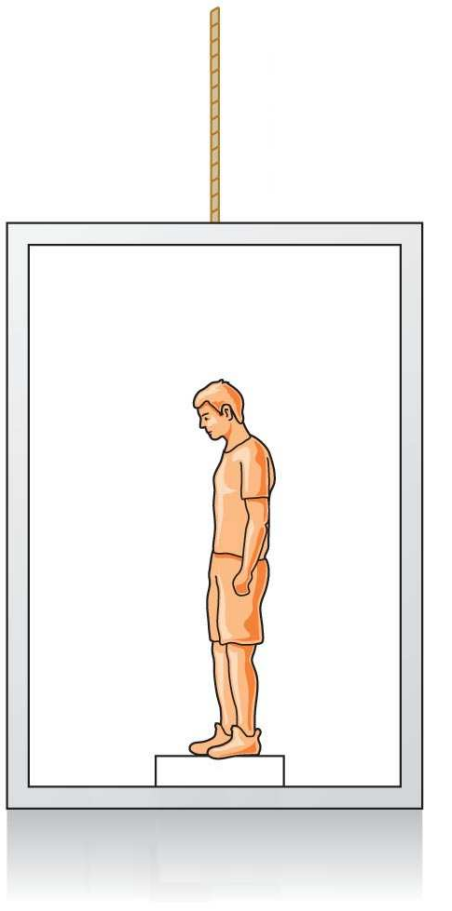
Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

(a) $0\,N$

(b) $(80\,kg)(9.8\,m/s^2 - 2.5\,m/s^2) = 584\,N$

(c) $(80\,kg)(9.8\,m/s^2) = 784\,N$



Apparent-Weight Exercise II

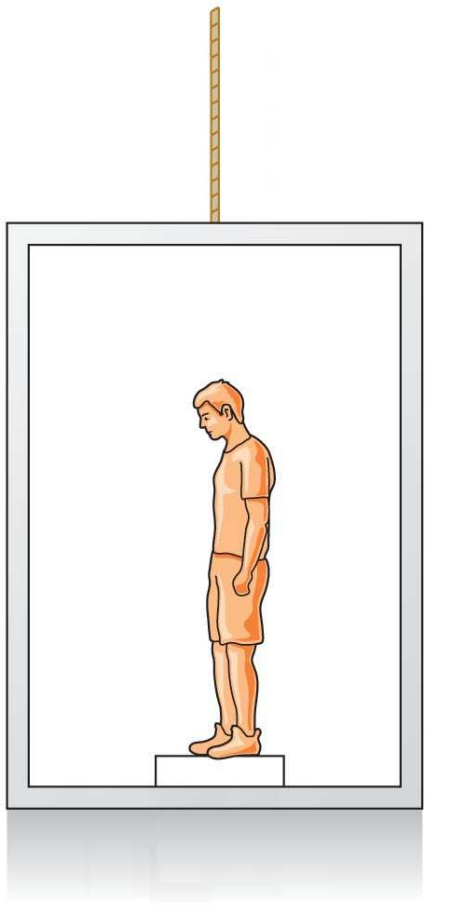
An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

(a) $0\,N$

(b) $(80\,kg)(9.8\,m/s^2 - 2.5\,m/s^2) = 584\,N$

(c) $(80\,kg)(9.8\,m/s^2) = 784\,N$

(d) $(80\,kg)(9.8\,m/s^2 + 2.5\,m/s^2) = 984\,N$



Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

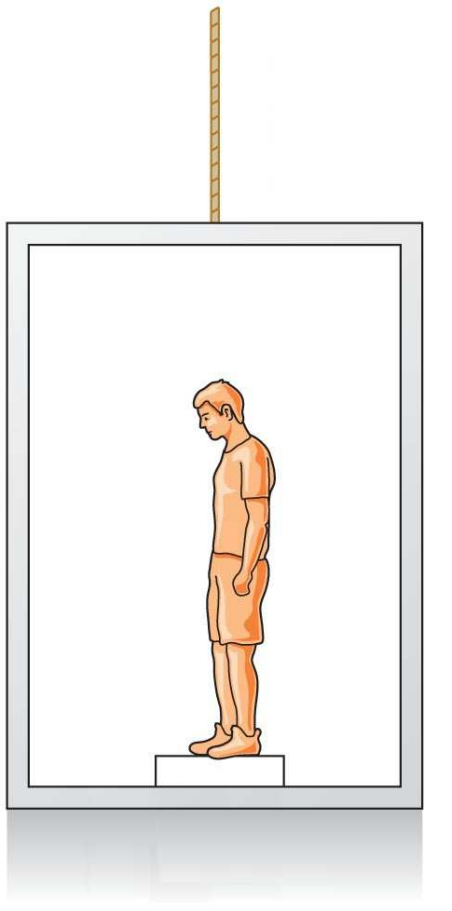
(a) $0\,N$

(b) $(80\,kg)(9.8\,m/s^2 - 2.5\,m/s^2) = 584\,N$

(c) $(80\,kg)(9.8\,m/s^2) = 784\,N$

(d) $(80\,kg)(9.8\,m/s^2 + 2.5\,m/s^2) = 984\,N$

(e) Not enough information to determine



Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

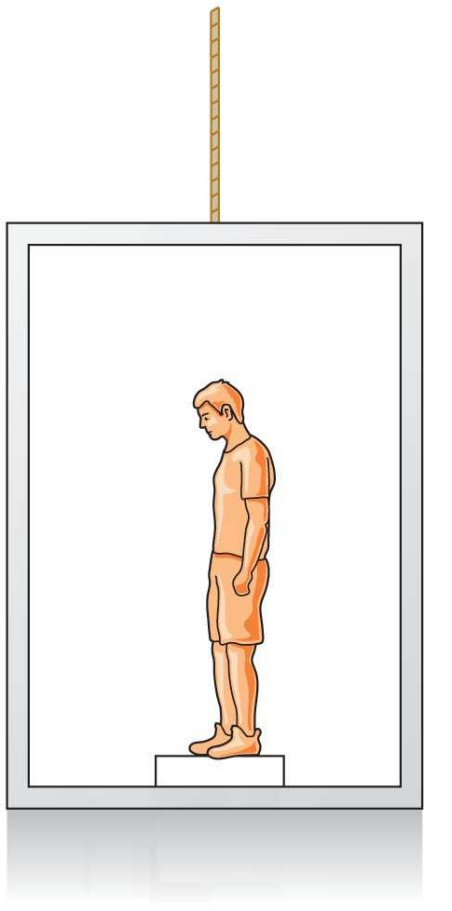
(a) $0\,N$

(b) $(80\,kg)(9.8\,m/s^2 - 2.5\,m/s^2) = 584\,N$

(c) $(80\,kg)(9.8\,m/s^2) = 784\,N$

(d) $(80\,kg)(9.8\,m/s^2 + 2.5\,m/s^2) = 984\,N$

(e) Not enough information to determine

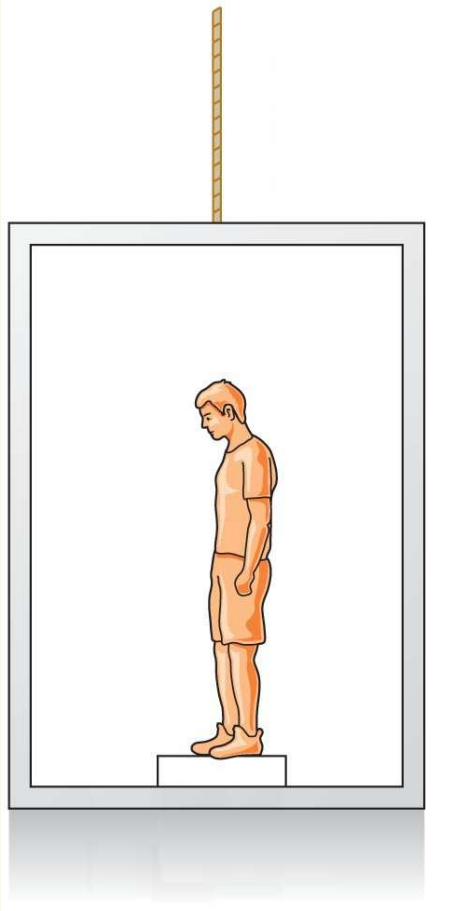


Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

$$\sum F_y = Ma_y \Rightarrow$$
$$n_y + w_y = ma_y \Rightarrow$$
$$n - w = ma_y$$
$$n - mg = ma_y \Rightarrow n = m(g + a_y)$$

(d) $(80\,kg)(9.8\,m/s^2 + 2.5\,m/s^2) = 984\,N$

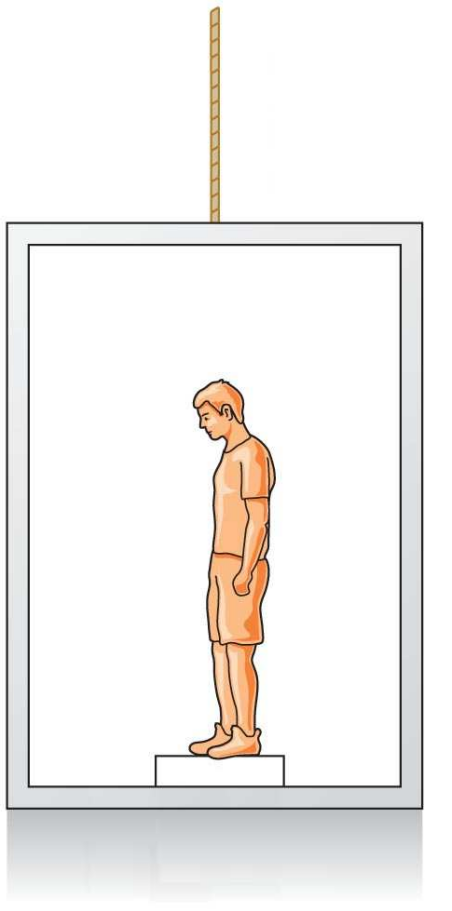


Apparent-Weight Exercise II

An 80-kg man steps on a bathroom scale which is in an elevator that is accelerating upwards at $2.5\,m/s^2$. What does the scale read?

$$\sum F_y = Ma_y \Rightarrow$$
$$n_y + w_y = ma_y \Rightarrow$$
$$n - w = ma_y$$
$$n - mg = ma_y \Rightarrow n = m(g + a_y)$$

(d) $(80\,kg)(9.8\,m/s^2 + 2.5\,m/s^2) = 984\,N$



Scale's reading = n = apparent weight