

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1. Newton's second law gives the net force acting on the crate as

$$F_{net} = 95.0 \text{ N} - f_k = 60.0 \text{ kg} \cdot 1.20 \text{ m/s}^2 = 72.0 \text{ N}$$

This gives the kinetic friction force as $f_k = 23.0 \text{ N}$, so choice (a) is correct.

2. Since the pedestal is in equilibrium, the normal force pressing upward on its base supports the total weight of the man and pedestal. Therefore,
or

$$n = F_{g_{man}} + F_{g_{pedestal}} = m_{man} + m_{pedestal} g = 97.0 \text{ kg} \cdot 9.80 \text{ m/s}^2 = 951 \text{ N}$$

showing that (e) is the correct choice.

3. The tension, F_{upper} , in the vine at the point above the upper monkey must support the weight of both monkeys $\left(\text{i.e., } F_{upper} = 2 F_{g_{single monkey}} \right)$. However, the tension in the vine between the two monkeys supports only the weight of the lower monkey $\left(F_{lower} = F_{g_{single monkey}} \right)$, meaning that $F_{upper}/F_{lower} = 2$ and choice (d) is correct.

4. Because the block has zero vertical acceleration, Newton's second law says that

$$\Sigma F_y = F \sin -30.0^\circ - mg + n = 0$$

or

$$n = -70.0 \text{ N} \sin -30.0^\circ + 8.00 \text{ kg} \cdot 9.80 \text{ m/s}^2 = +35.0 \text{ N} + 78.4 \text{ N} = 113 \text{ N}$$

and we see that (c) is correct.

5. From Newton's law of universal gravitation, the force Earth exerts on an object on its surface is

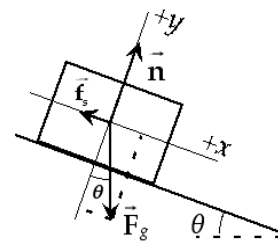
$F_g = GM_E m / R_E^2 = mg$, or the acceleration of gravity at Earth's surface is $g = GM_E / R_E^2$. If both the mass and radius of the Earth should double, so $M'_E = 2M_E$ and $R'_E = 2R_E$, the acceleration of gravity at the surface would then be

$$g' = G \frac{M'_E}{R'^2_E} = G \left(\frac{2M_E}{4R_E^2} \right) = \frac{1}{2} \left(G \frac{M_E}{R_E^2} \right) = \frac{g}{2} = \frac{9.80 \text{ m/s}^2}{2} = 4.90 \text{ m/s}^2$$

meaning that (b) is the correct answer.

6. When the crate is held in equilibrium on the incline as shown in the sketch, Newton's second law requires that $\Sigma F_x = \Sigma F_y = 0$. From

$\Sigma F_x = +|\vec{F}_g|_x - |\vec{f}_s| = 0$, the magnitude of the friction force equals the component of gravitational force acting down the incline, or choice (e) is correct. Note that $|\vec{f}_s| = |\vec{f}_s|_{\max} = \mu_s n$ only when the crate is on the verge of starting to slide.



7. According to Newton's third law, the force of reaction (in this case, the force exerted on the rock by the glass) is always equal in magnitude to the force of action (in this case, the force the rock exerts on the glass). Thus, (b) is the correct choice.
8. The box will accelerate in the direction of the resultant force acting on it. The only horizontal forces present are the force exerted by the manager and the friction force. Since the acceleration is given to be in the direction of the force applied by the manager, the magnitude of this force must exceed that of the opposing friction force, however the friction force is not necessarily zero. Thus, choice (b) is correct.
9. Choose a coordinate system with the positive x -direction being east and the positive y -direction being north. Then the components of the four given forces are:

$$\begin{array}{ll} A_x = +40 \text{ N}, A_y = 0 & B_x = 0, B_y = +50 \text{ N} \\ C_x = -70 \text{ N}, C_y = 0 & D_x = 0, D_y = -90 \text{ N} \end{array}$$

The components of the resultant (or net) force are $R_x = A_x + B_x + C_x + D_x = -30 \text{ N}$ and

$R_y = A_y + B_y + C_y + D_y = -40 \text{ N}$. Therefore, the magnitude of the net force acting on the object is

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(-30 \text{ N})^2 + (-40 \text{ N})^2} = 50 \text{ N},$$

or choice (a) is correct.

10. Constant velocity means zero acceleration. From Newton's second law, $\Sigma \vec{F} = m\vec{a}$, so the total (or resultant) force acting on the object must be zero if it moves at constant velocity. This means that (d) is the correct choice.
11. An object in equilibrium has zero acceleration $\vec{a} = 0$, so both the magnitude and direction of the object's velocity must be constant. Also, Newton's second law states that the net force acting on an object in equilibrium is zero. The only *untrue statement* among the given choices is (d), untrue because the value of the velocity's constant magnitude need not be zero.

12. As the trailer leaks sand at a constant rate, the total mass of the vehicle (truck, trailer and remaining sand) decreases at a steady rate. Then, with a constant net force present, Newton's second law states that the magnitude of the vehicle's acceleration $a = F_{net}/m$ will *steadily increase*. Choice (b) is the correct answer.
13. When the truck accelerates forward, its natural tendency is to slip from beneath the crate, leaving the crate behind. However, friction between the crate and the bed of the truck acts in such a manner as to oppose this relative motion between truck and crate. Thus, the friction force acting on the crate will be in the forward horizontal direction and tend to accelerate the crate forward. The crate will slide only when the coefficient of static friction is inadequate to prevent slipping. The correct response to this question is (c).
14. The mass of an object is the same at all locations in space (e.g., on Earth, the Moon, or space station). However, the gravitational force the object experiences weight, $w = mg$ does vary, depending on the acceleration of gravity g at the object's current location in space. It is the gravitation attraction of the Earth that holds the space station (and all its contents, including astronauts) in orbit around Earth. The only correct choice listed is (b).
15. Assuming that the cord connecting m_1 and m_2 has constant length, the two masses are a fixed distance (measured along the cord) apart. Thus, their speeds must always be the same, which means that their accelerations must have equal magnitudes. The magnitude of the downward acceleration of m_2 is given by Newton's second law as

$$a_2 = \frac{\Sigma F_y}{m_2} = \frac{m_2 g - T}{m_2} = g - \left(\frac{T}{m_2} \right) < g$$

where T is the tension in the cord, and downward has been chosen as the positive direction. Therefore, the only correct statement among the listed choices is (a).

16. Only forces which act **on** the object should be included in the free-body diagram of the object. In this case, these forces are (1) the gravitational force (acting vertically downward), (2) the normal force (perpendicular to the incline) exerted on the object by the incline, and (3) the friction force exerted on the object by the incline, and acting *up* the incline to oppose the motion of the object down the incline). Choices (d) and (f) are forces exerted on the incline by the object. Choice (b) is the resultant of forces (1), (2), and (3) listed above, and its inclusion in the free-body diagram would duplicate information already present. Thus, correct answers to this question are (b), (d), and (f).