Part I

1. A child throws a ball into the air. After the ball leaves the child's hands it move vertically upward for a while, reaches a maximum height and then falls back toward the ground. Ignoring air resistance, the forces acting on the ball acting on the ball at this time are
   (a) The constant downward force of gravity alone.
   (b) The constant force of gravity and a steadily decreasing upward force of inertia.
   (c) A decreasing upward force as the ball reaches its maximum height and an increasing downward force of gravity after.
   (d) No forces act on the ball. It returns to the ground naturally.

   Answer (a)

2. A helicopter flies horizontally with constant velocity. The net force acting on it is
   (a) parallel to the velocity.
   (b) vertically upward.
   (c) vertically downward.
   (d) zero.

   Answer (d): Velocity is constant so the net force is zero by Newton's 1st Law

3. Imagine that you push a car gently but constantly forward with your index finger. Imagine that the car's wheels are completely frictionless. How will the car respond to your push?
   (a) It will not move unless the push is strong enough to overcome its inertia.
   (b) It will move with steadily increasing speed.
   (c) It will move at a very small constant speed.
   (d) Its speed increase until it reaches a certain value.

   Answer (b): There is a constant force so there is constant acceleration.

4. When a horse pulls a wagon, the force that causes the horse to move forward is
   (a) the force he exerts on the ground.
   (b) the force he exerts on the wagon.
   (c) the force the ground exerts on him.
   (d) the force the wagon exerts on him.

   Answer (c):This is the only force acting on him in the forward direction.

5. A big ship crashes into a small canoe. During the collision the force that the ship exerts on the canoe is

   (a) greater than the force the canoe exerts on the ship.

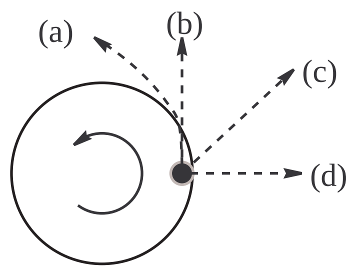
   (b) equal to the force the canoe exerts on the ship.

   (c) less than the force the canoe exerts on the ship.

   (d) is related to the force on the canoe in a way that depends on the nature of the collision.

   Answer (b): By the Newton'w 3rd law. Note the acceleration will be much larger for the canoe since its mass is smaller

6. Imagine that we set a penny near the edge of horizontal turntable. Then imagine that we spin the turntable faster and faster until the penny flies off. What path does the penny follow after if it leaves the turntable in the indicated position?



   Answer (b): After the penny leaves the table there is no horizontal force acting on it so it move in a straight line in its direction of motion.

7. A stationary block sits on a table. Newton's third law is often stated as "To every *action* there is an equal and opposite *reaction*". The reaction to the weight of the book is the force that the

   (a) earth exerts on the book.

   (b) book exerts on the table.

   (c) table exerts on the book.

   (d) book exerts on the earth.

8. A constant force is exerted on a cart that is initially at rest on a track. Friction between the cart and the track is negligible. The force acts for a short time interval and gives the cart a certain final speed. To reach the same final speed with a force that is only half as big, the force must be exerted on the cart for a time interval

   (a) four times as long as for the stronger force

   (b) twice as long as for the stronger force

   (c) half as long as for the stronger force

   (d) a quarter as long as for the stronger force

   Answer (b): If the force is half as big but the mass is the same then the acceleration is half as big so it takes twice as long to reach the same velocity.

Part II

1. A toy is dragged along a rough floor by a child.

   (a) When the child applies a force of 0.50 N horizontally the velocity is constant at 1.0 m/s. What is the force of friction on the toy?

   Since velocity is constant $F_{\text{net}} = 0$ so $f_k = 0.5N$.

   (b) When the child pulls harder so that the applied force is 1.00 N the velocity of the toy increases uniformly to 2.0 m/s in 5.0 seconds. Calculate the acceleration of the block.

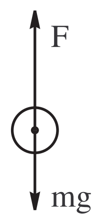
   $$a = \frac{\Delta v}{\Delta t} = \frac{2-1}{5} = 0.2 \text{ m/s}^2$$

   (c) Find the mass of the toy.

   $$m = \frac{F_{\text{net}}}{a} = \frac{1.0 - 0.5}{0.2} = 2.5 \text{ kg}$$

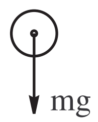
2. A basketball player is jumping vertically upward in order to make a shot at the basket. Initially her knees are bent and then she pushes against the floor with a constant force so that her body is accelerated upward.

   (a) Draw a free-body diagram of the player as she accelerates upwards. Show the relative magnitudes of the various forces and describe each in words.



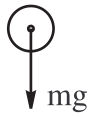
   F is the reaction force of the ground pushing up on her feet and mg is her weight acting down

   (b) Repeat this exercise for the situation immediately after the player's body breaks contact with the floor.



   The only force acting on her is her weight.

   (c) Finally, consider, in the same manner, the situation at the top of the jump.



The only force acting on her is her weight.

(d) The the player has a mass of 70 kg. Suppose she accelerates upward at a rate of 11.2 m/s^2 while she is pushing off the ground and this phase of the jump takes 0.5 seconds.

(i) With what force does she push off the ground?
The force with which she pushes off the ground is equal to the Normal force and since $F_{\text{net}} = N - W$ and Newton's second law states that $F_{\text{net}} = ma$ it follows that $N - W = ma \;\Rightarrow\; N = W + ma = mg + ma = 70(9.8) + 70(11.2) = 1470$ N

(ii) What is her velocity when her feet first leave the ground?
For uniformly accelerated motion $\Delta v = at = 11.2 \times 0.5 = 5.6$ m/s. So this is her speed as she leaves the ground