

## Part I

1. A coin is tossed vertically up in the air. It first rises and then falls. As the coin passes through its highest point the net force on it
  - (a) becomes zero.
  - (b) acts downwards and reaches a maximum value.
  - (c) acts downwards and reaches a minimum value.
  - (d) acts downwards and remains constant.

Answer (d): The force due to gravity acts downwards and is constant.

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. 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.

4. A constant force is exerted for a short time interval on a cart that is initially at rest on frictionless track. This force gives the cart a certain final speed. The same force is exerted for the same length of time on another cart, also initially at rest, that has twice the mass of the first one. The final speed of the heavier cart is
  - (a) one-fourth that of the lighter cart
  - (b) half that of the lighter cart
  - (c) the same as that of the lighter cart
  - (d) double that of the lighter cart

Answer (b): If the force is the same but the mass is half then the acceleration is half. So if the time interval is kept the same than the change in velocity is half.

5. A rocket of mass 10000 kg is accelerates upward at a rate of  $4 \text{ m/s}^2$ . The force provided by the rocket engines must be

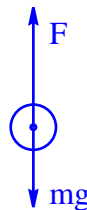
(a) 40000 N      (b) 100000 N      (c) 140000 N      (d) 160000 N

Answer (c): Call the upward force  $T$  for thrust.  $F_{\text{net}} = T - W = ma \Rightarrow T = W + ma = mg + ma \approx 140000 \text{ N}$ .

## Part II

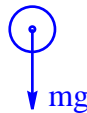
1. A basketball player is jumping vertically upward in order to land a shot. Her legs are flexed and pushing on the floor so that her body is accelerated upward.

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



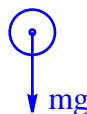
$F$  is the reaction force of the ground pushing up on her feet and  $mg$  is her weight acting down

- (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.

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

- (a) When the child applies a force of 0.50N 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.

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