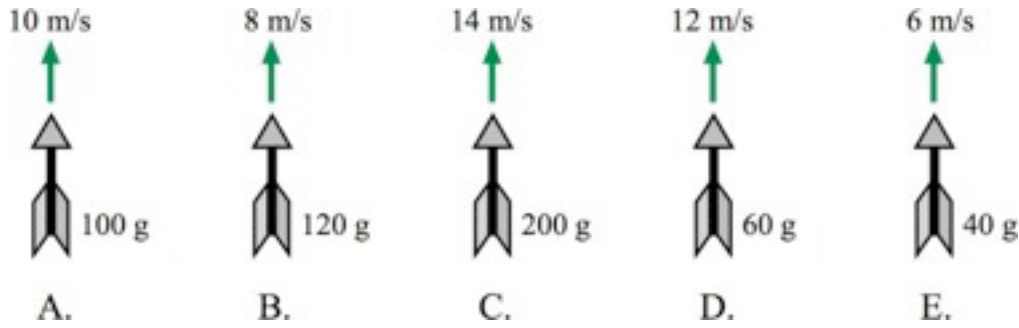


Part A – Ranking and Multiple Choice

A1 The figure below shows five arrows with differing masses that were launched straight up with the noted speeds.

Rank the arrows, from greatest to least, on the basis of the maximum height the arrows reach. Ignore air resistance; the only force acting is gravity. (1 mark)



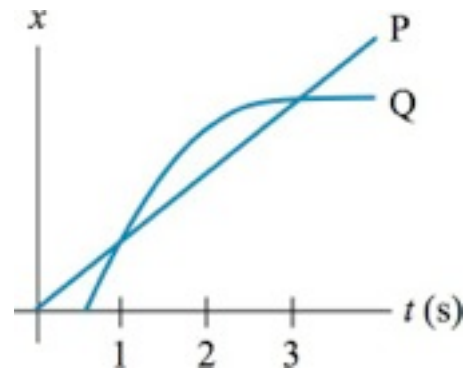
Rank by velocity

$C > D > A > B > E$

any mistake: 0 points

A2. Masses P and Q move with the position graphs shown. Do P and Q ever have the same velocity? If so, at what time or times? Choose one of the answers below. (1 mark)

- A. P and Q have the same velocity at 2 s.
 B. P and Q have the same velocity at 1 s and 3 s.
 C. P and Q have the same velocity at 1 s, 2 s, and 3 s.
 D. P and Q never have the same velocity.



A 1 point
 B,C,D 0 points

Mark:

A3. Mike jumps out of a tree and lands on a trampoline. The trampoline sags 2 feet before launching Mike back into the air. At the very bottom, where the sag is the greatest, Mike's acceleration is:

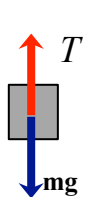
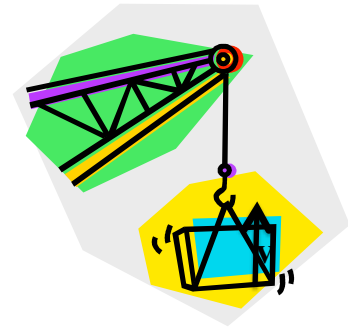
(1 mark)

- A. Upward
- B. Downward
- C. Zero

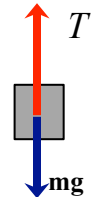


A 1 point
B,C 0 points

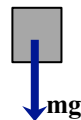
A4. A hoist is lifting up a crate. Which Free-Body Diagram below best represents the forces exerted on the crate while it is moving up and slowing down? (1 mark)



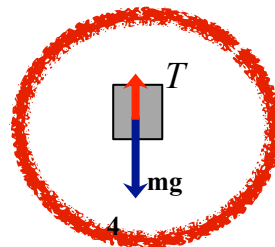
1



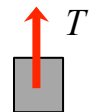
2



3



4



5

4 1 point
1,2,3,5 0 points

Mark:

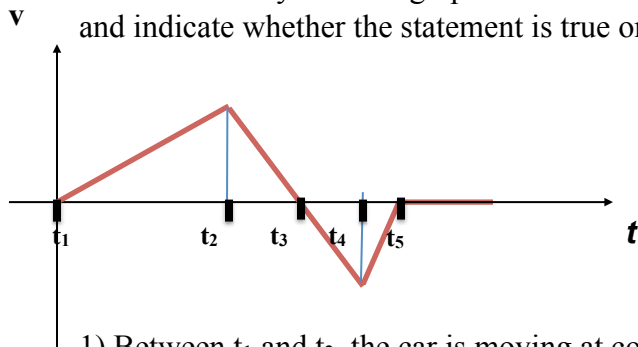
A5. The pick-up truck in front of you is braking in front of a red light. There is a heavy box in the back of the pick-up truck that is not secured by a rope or in contact with any side wall. You observe that the box is not sliding while the truck is braking. Which of the following friction forces acts on the box to hold it in place? (1 mark)



- A. a static friction force in the direction of motion of the truck;
- B. a static friction force opposite to the direction of motion of the truck;
- C. a kinetic friction force in the direction of motion of the truck;
- D. a kinetic friction force opposite to the direction of motion of the truck.
- E. a rolling friction force in the direction of motion of the truck;
- F. a rolling friction force opposite to the direction of motion of the truck.
- G. no friction force because the box is not moving relative to the truck;

True or False?

B1. The velocity vs. time graph below shows the motion of a car. Read the following statements and indicate whether the statement is true or false (0.5 marks each)



- 1) Between t_1 and t_2 , the car is moving at constant speed. (TRUE/**FALSE**)
- 2) At $t = t_2$, the car is changing direction. (TRUE/**FALSE**)
- 3) At $t = t_3$, the car's velocity is zero. (**TRUE**/FALSE)
- 4) At $t = t_3$, the car's acceleration is zero. (TRUE/**FALSE**)
- 5) At $t = t_5$, the car stops. (**TRUE**/FALSE)
- 6) Between t_1 and t_3 , the car moves in positive direction. (**TRUE**/FALSE)
- 7) Between t_3 and t_4 , the car moves in negative direction. (**TRUE**/FALSE)
- 8) Between t_4 and t_5 , the car moves in positive direction. (TRUE/**FALSE**)

half point for each correct answer

Mark:

Part C – Problem Questions

C1. A motorist traveling at a constant velocity of 50 km/h passes a school zone where the speed limit is 30 km/h. A police officer on his motorcycle stopped at the school starts off in pursuit with a constant acceleration of 3.0 m/s^2 as soon as he sees the car passing by.

a) Roughly estimate or guess a reasonable time (range) it should take the officer to catch up to the motorist. Don't waste any time on this – just write what you spontaneously think (0.5 marks)

anything between 5s and 5min is correct

b) Now calculate: how much time elapses before the officer catches up with the car? (3 marks)

$$\begin{array}{l} \text{distance for police: } s_{\text{police}} = .5 * a * t^2 \\ \text{distance for car: } s_{\text{car}} = v_{\text{car}} * t \end{array}$$

$$\text{the two will equal: } \rightarrow .5 * a * t = v_{\text{car}} \quad \text{or} \quad t = 2 * v_{\text{car}} / a = 9.3\text{s}$$

c) What is the officer's speed at that point? (1 mark)

$$v_{\text{police}} = a * t = a * 2 * v_{\text{car}} / a = 2 * v_{\text{car}} = 100 \text{ km/h} = 27.8 \text{ m/s}$$

d) Check your answers: How does your time estimate compare to your answer in (b)? Is the speed you obtained in (c) reasonable? (0.5 marks)

students will get 0.5 marks if they either spot an unreasonable answer of their own or if they got b) and c) right and it agrees with their prediction.

If their guess is far out and their answer is right and they don't comment accordingly they do not get 0.5marks

e.g. "I guessed right but my answer is wrong" (good)

"I guessed right and my answer is right" (good)

"I guessed right and my answer is wrong but I don't say this is a problem" (bad)

"I guessed wrong and my answer is right but I don't find this disturbing" (bad)

Mark:

C2. You and your little sister are out in the snow on a sled that has a mass of 11 kg. Your sister who weighs 29 kg is sitting on the sled and you want to push her along. You start applying a horizontal force and initially the sled doesn't move but you slowly increase your force until, suddenly, the sled does move. You maintain the same force that you were applying when the sled started moving for the next 5.0 s after which you let go.

(Assume that the kinetic friction coefficient is $\mu_k = 0.02$ and the static friction coefficient is $\mu_s = 0.08$ in this case.)

a) How far do you have to run if you apply the force for 5.0 s? (3 marks)

$$\text{max static friction } F_{\text{stat,max}} = 0.08 * m * g = 31.36 \text{ N} = F_{\text{push}}$$

$$\text{kinetic friction } F_{\text{kin}} = 0.02 * m * g = 7.84 \text{ N}$$

$$F_{\text{net}} = F_{\text{push}} - F_{\text{kin}} = (\mu_s - \mu_k) * m * g = 23.52 \text{ N}$$

$$\text{acceleration } a = F_{\text{net}} / m = .588 \text{ m/s}^2$$

$$\text{distance } s = .5 * a * t^2 = 0.5 * .588 \text{ m/s}^2 * (5\text{s})^2 = 7.35 \text{ m}$$

b) What is your sister's speed at $t = 5.0$ s? (1 mark)

$$v_{\text{sled}} = a * t = 2.94 \text{ m/s} = 10.6 \text{ km/h}$$

c) After letting go, how far does your sister and her sled move until she is stationary again?

(In case you could not solve part b assume that her speed is $v = 2.5$ m/s at $t = 5.0$ s.) (3 marks)

$$F_{\text{net}} = F_{\text{kin}} = -\mu_k * m * g = m * a$$

$$a = -\mu_k * g = -.196 \text{ m/s}^2$$

$$v_f^2 - v_i^2 = 2 * a * d \quad (v_f = 0)$$

$$d = -v_i^2 / (2 * a)$$

$$= 22.05 \text{ m (if correct speed from b)}$$

$$= 15.9 \text{ m (if speed as given in question c)}$$

Mark:
