APA 1161

Laboratory 5 - Newton's Laws and Applied Biomechanics

CORRECTOR

TOTAL PART: 43 Marks

Part A: Newton's Laws of Motion

1 mark per question for Part A, except for Station 6, question 2 (no mark for answering whether or not they caught the penny)

TOTAL PART A: 24 Marks

Station 1

Perform a long jump with and without a 10-pound weight belt around your waist and measure how far you jump. Try to jump with the same amount of force both times.

Which law(s) of motion was (were) explored with this activity? ***Newton's second law***

In which situation did you jump farther? ***Condition without weight***

Explain your findings using the appropriate law(s) of motion. ***Mass and acceleration are inversely proportional so the greater the mass (when wearing weight belt), the less you accelerate and the shorter the distance travelled.***

Station 2

Throw a tennis ball using only your wrist and measure how far the ball travels. Repeat using your wrist and elbow. Repeat again using your wrist, elbow and shoulder.

Which law(s) of motion was (were) explored with this activity? ***Newton's second law***

In which situation did you throw the ball the farthest? ***Condition where wrist, elbow and shoulder were used.***

Explain your findings using the appropriate law(s) of motion. ***Force and acceleration are directly proportional so the greater the force applied (which takes place due to the greater range of motion of the arm), the greater the acceleration imparted to the ball and the further it will travel.***

Station 3

Slide a puck across different surfaces (artificial ice and wood) and try to get it to stop the same distance on each surface. Pay attention to how hard you have to release the puck in each case.

Which law(s) of motion was (were) explored with this activity? ***Newton's first law***

Which surface required the most amount of force to reach the desired distance and why? ***The surface that required the most amount of force to reach a desired distance was the wood. This is because there was a greater amount of friction between this surface and the puck.***

What type of external force do the different surfaces represent? ***Friction (an external unbalanced force)***

Station 4

Standing beside a wall, execute several vertical jumps using different degrees of knee flexion (30°, 45°, 60°, 75° and 90°) and measure the height of each jump by sticking a piece of tape to the wall at the maximum height of each jump. Measure knee angles using a goniometer. Do not dip below the measured angle when jumping. ***Remove tape from wall when finished.***

Which law(s) of motion was (were) explored with this activity? ***Newton's second and third laws***

What is the relationship between the degree of knee flexion and the height of the jump? ***The greater the flexion (ROM), the greater the force generated in the legs, the higher the jump.***

Explain your findings using the appropriate law(s) of motion. ***Since force and acceleration are directly proportional, the greater the force at takeoff, the greater the acceleration which allows for a higher jump.***
Also, for every action, there is an equal and opposite reaction, so the greater the force generated in the legs, the greater the force imparted to the floor. The floor imparts a force of equal magnitude but in the opposite direction which causes the jumper to jump up.

Station 5

Do a standing long jump without swinging your arms and measure how far you jumped. Do another standing long jump but this time swing your arms and measure how far you jumped.

Which law(s) of motion was (were) explored with this activity? ***Newton's second and third laws***

Which jump was longer? ***Jump with arms***

Explain your findings using the appropriate law(s) of motion. ***As you swing your arms, your body is forced downward in reaction, increasing the force with which you push off the ground. The greater the force, the greater the acceleration, therefore the further you travel.***
Also, for every action, there is an equal and opposite reaction, so the greater the downward force generated, the greater the force imparted to the floor. The floor imparts a force of equal magnitude but in the opposite direction which causes the jumper to jump further.

Station 6

Hold your right hand next to your right ear, with your palm facing up. Place a penny on your elbow then quickly straighten your arm and try to catch the penny.

Which law(s) of motion was (were) explored with this activity? ***Newton's first law***

Did you catch the penny? ***Answer doesn't matter, but they should be able to catch it…:)***

Explain this activity using the appropriate law(s) of motion. ***The penny will remain at rest (held onto the elbow by gravity) unless acted upon by an external unbalanced force. In this case, when the elbow is quickly removed from beneath the penny, gravity will pull the penny towards the ground. The effect of pulling the penny toward the ground is much slower than the speed at which you extended your arm so you are able to catch the penny.***

*Give another example of this phenomenon****. Pulling a tablecloth out from under dishes on a table.***

Station 7

Place a bean bag in the bucket and, holding the handle of the bucket, spin the bucket around in a circle.

Which law(s) of motion was (were) explored with this activity? ***Newton's first***

Did the bean bag fall out? ***No***

Explain this activity using the appropriate law(s) of motion. ***When you spin around in a circle while holding a bucket, a centripetal force must always be present to keep the bucket moving along the curved path. The inertia of the bean bag wants to keep it travelling in a straight line (not a curved path). The bean bags reluctance to move (i.e. its inertia) interacts with the lateral forces created by the walls of the bucket, pushing the bean bag towards the bottom of the bucket. The bean bag does not fall out because it is moving tangentially to the circular path faster than it is moving downward due to gravity.***
****It appears as though a centrifugal force is pulling the bean bag into the bottom of the bucket, but this is a pseudo-force that does not actually exist.***
If the students simply talk about the inertia of the bean bag being what holds it in place, give them full marks.

Station 8

Stand with each of your feet on a separate sheet of paper. Carefully, start to run. Observe the paper. Do this activity in the hallway.

Which law(s) of motion was (were) explored with this activity? ***Newton's first and second laws***

What happened to the pieces of paper when you started to run? ***They slid on the floor, causing the runner to slip OR they flew out from under the runner's feet.***

Explain your findings using the appropriate law of motion.
The papers slid out from under the runner's feet due to there being greater friction between the runner's shoes and the paper than between the paper and the floor. Friction is an external unbalanced force (Newton's first law).
The papers moved proportional to the amount of force applied to them (i.e. the one that was touching my right foot went further backwards than the one touching my left foot because I pushed off with a greater force with my right foot). (Newton's second law)

Part B: Applied Biomechanics

TOTAL PART B: 19 Marks

1 mark per correct critical feature (up to 5 marks)
1 mark per correct teaching cue/intervention (up to 5 marks)
1 mark for circling proper principles (1 mark total no matter how many principles apply)
1 mark for biomechanical principles that are strengths for the volunteer
1 mark for biomechanical principles that are weaknesses for the volunteer
1 mark for biomechanical principles that are strengths for the skilled performer
1 mark for biomechanical principles that are weaknesses for the skilled performer
2 marks for recommended interventions that make sense
2 marks for prescribed exercises that makes sense

*Since all groups will select different skills, the answers for Part B will vary. TAs should refer to the assigned readings from **Fundamentals of Biomechanics, 2nd Edition** by Duane V Knudson (this is an e-book available for FREE through the uOttawa Library website) for solutions to various examples given. **NOTE: Students are NOT allowed to choose an activity already analyzed in the readings. If they do, they get zero marks for this part of the lab.**