PHYS 105 · Chapter 5: Force and Motion — I

Past-Exam Review — questions from PSU past midterm (Major 1 & 2) and final exams

Constant: g = 9.81 m/s^2 · The source of each question is shown in [brackets].

Part 1: Multiple-Choice Questions (50)

Indicate the answer choice that best completes the statement or answers the question.

5.1 Newton's First and Second Laws

Q1. *Which of the following does Newton's first law of motion describe?* **[Midterm 232]**

A *Inertia*
B *Work*
C *Energy*
D *Change in motion*

Q2. *Mass is:* **[Major 2 · 202]**

A *a measure of how hard it is to change the velocity of an object*
B *measured in grams as its SI unit*
C *a vector quantity*
D *All of the above*

Q3. *In the absence of an external force, a moving object with constant velocity will:* **[Major 2 · 202]**

A *stop immediately*
B *slow down and come to a stop*
C *move faster and faster*
D *keep moving with constant velocity*

Q4. *If the net force on a moving object is zero, the object will:* **[Major 2 · 211]**

A *move faster and faster*
B *slow down and finally stop*
C *move with constant speed only*
D *move with constant velocity*

Q5. *If the net force on an object is zero, then the object:* **[Final 211]**

A *must be moving with constant velocity*
B *must be at rest*
C *is at rest or moving with constant velocity*
D *is accelerating*

Q6. *An object moves to the right at a constant velocity. Which statement is true?* **[Major 2 · 201]**

A *Only one force acts on it, to the right*
B *The net force on it is to the right*
C *No forces at all act on it*
D *The net force on it must be zero*

Q7. *Under what condition(s) is an object in equilibrium?* **[Midterm 252]**

A *Only when moving with constant nonzero velocity*
B *When at rest or moving with constant velocity*
C *When moving with constant velocity or constant acceleration*
D *Only when moving with constant acceleration*

Q8. *Which of the following objects is in equilibrium?* **[Midterm 233]**

A *An object moving at constant speed*
B *An object moving at constant velocity*
C *An object moving at constant acceleration*
D *None of the above*

Q9. *If we know an object is moving at constant velocity, we may assume that:* **[Final 232]**

A *the net force acting on it is zero*
B *no forces are acting on it*
C *the object is accelerating*
D *the object is losing mass*

Q10. *A car moves at constant velocity on a straight road. What is the net force on the car?* **[Midterm 243]**

A *It is equal to the car's weight*
B *It is equal to zero*
C *It is greater than zero*
D *None of the above*

Q11. *The direction of an object's acceleration is:* **[Major 2 · 202]**

A *the same as the net force on it*
B *the same as its velocity*
C *opposite to the net force on it*
D *None of the above*

Q12. *If a constant net force acts on an object, the object will move:* **[Final 202]**

A *with constant acceleration*
B *with increasing acceleration*
C *with constant velocity*
D *with decreasing acceleration*

Q13. *Mass and weight:* **[Major 2 · 211]**

A *are always equal*
B *are two different quantities*
C *are both measured in kilograms*
D *are both measured in newtons*

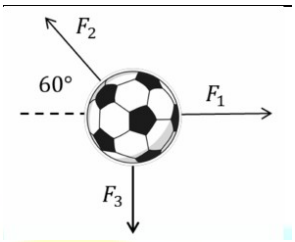
Q14. *Which of the following statements is NOT true?* **[Final 202 · Major 2 · 211]**

A *μ_s is always larger than or equal to μ_k*
B *For every action there is an equal and opposite reaction*
C *Action and reaction act on two different objects*
D *The mass of an object on Earth differs from its mass on the Moon*

Q15. *Two forces $F_1 = (22\hat{x} + 67\hat{y})$ N and $F_2 = (8\hat{x} - 7\hat{y})$ N act on a 5 kg object. What is its acceleration (in m/s^2)?* **[Major 2 · 211]**

A $3\hat{x} + 6\hat{y}$
B $5\hat{x} + 10\hat{y}$
C $6\hat{x} + 12\hat{y}$
D $15\hat{x} + 30\hat{y}$

Q16. *Three forces act on a ball as shown: $F_1 = 8$ N (along +x), $F_2 = 16$ N (60° above the −x axis), $F_3 = 5$ N (along −y). What is the magnitude of the net force?* **[Final 182]**



A *8.86 N*
B *5 N*
C *6.93 N*
D *zero*

Q17. *A sled on frictionless ice is pulled by a force of 130 N directed 30° above the horizontal. The mass of the sled and occupant is 60 kg. What is the sled's acceleration?* **[Major 2 · 201]**

A *1.08 m/s^2*
B *1.88 m/s^2*
C *2.07 m/s^2*
D *1.25 m/s^2*

Q18. *A wagon of weight 20 N is accelerated across a level surface at 0.15 m/s^2. What net force acts on it?* **[Final 232]**

A *0.92 N*
B *0.31 N*
C *3.0 N*
D *4.5 N*

5.2 Some Particular Forces (Weight, Normal Force, Tension)

Q19. *Weight is:* **[Major 2 · 202]**

A *a force*
B *a quantity that depends on the mass and the planet's g*
C *always directed downward*
D *All of the above*

Q20. *The normal force is:* **[Major 2 · 202]**

A *measured in newtons*
B *always directed upward*
C *directed perpendicular to the surface*
D *Both (a) and (c) are correct*

Q21. *Tension force is:* [Final 222]

A *transmitted through a string*
B *applied by a surface*
C *a gravitational force*
D *Any of the above*

Q22. *A 0.5 kg jug filled with 2 kg of liquid rests on a table. What is the normal force exerted by the table on the jug?* [Final 231]

A *2.5 N*
B *20 N*
C *5 N*
D *25 N*

Q23. *A 5 kg box is on a table. A person pushes down on the box with an additional force of 20 N. What is the normal force on the box from the table?* [Midterm 243]

A *49 N*
B *20 N*
C *69 N*
D *29 N*

Q24. *A 3 kg block rests on a horizontal surface. It is pushed with F = 10 N directed 30° below the horizontal. What is the normal force on the block?* [Major 2 · 201]

A *29.4 N*
B *39.4 N*
C *34.4 N*
D *24.4 N*

Q25. *A box weighing 351 N is pushed from above with a force of 101 N at 60.0° below the horizontal across a frictionless floor. Find the normal force between the box and the floor.* [Final 242]

A *160 N*
B *350 N*
C *438 N*
D *263 N*

Q26. *A 4.5 kg bucket is pulled up by a rope with an upward acceleration of 1.2 m/s^2. What is the tension in the rope?* [Major 2 · 201]

A *49.5 N*
B *44.1 N*
C *38.7 N*
D *5.4 N*

Q27. *A 70 kg man stands in an elevator accelerating upward at 2.2 m/s^2. His apparent weight is:* [Midterm 233]

A *840 N*
B *532 N*
C *686 N*
D *950 N*

Q28. *What is the apparent weight of a 60.0 kg person in an elevator accelerating upward at 2.00 m/s^2?* [Midterm 242]

A *509 N*
B *709 N*
C *469 N*
D *60.0 N*

Q29. *Your mass is 55 kg and you stand on a scale in an elevator moving with a downward acceleration of 2.5 m/s^2. What is your apparent weight?* **[Midterm 232]**

A *677 N*
B *55 N*
C *540 N*
D *402 N*

Q30. *What is the apparent weight of a 65 kg man in an elevator with a downward acceleration of 3.8 m/s^2?* **[Final 202]**

A *637 N*
B *390 N*
C *884 N*
D *2420.6 N*

Q31. *A man weighs a fish with a spring scale attached to the ceiling of an elevator. At rest he reads 40.0 N. What does the scale read when the elevator accelerates downward at 2.00 m/s^2?* **[Final 222]**

A *23.5 N*
B *38.2 N*
C *31.8 N*
D *44.1 N*

Q32. *Your mass is 60 kg and you ride an elevator moving with constant speed while standing on a scale. The scale reads:* **[Final 221]**

A *a value depending on the speed*
B *589 N*
C *less than 589 N*
D *more than 589 N*

Q33. *In an accelerating elevator a student's apparent weight is 550 N. At rest it is 600 N. If the student's mass is 61.2 kg, what is the elevator's acceleration?* **[Midterm 251]**

A *18.8 m/s^2*
B *−18.8 m/s^2*
C *−0.82 m/s^2*
D *0.82 m/s^2*

Q34. *A 51 kg person stands on a scale in an elevator accelerating downward. The scale reads 398 N. What is the magnitude of the acceleration?* **[Midterm 243]**

A *2 m/s^2*
B *4 m/s^2*
C *1 m/s^2*
D *9.81 m/s^2*

Q35. *A 47 kg person steps on a scale in an elevator. The scale reads 611 N. What is the elevator doing?* **[Major 2 · 211]**

A *The elevator is at rest*
B *It moves with constant velocity*
C *It accelerates upward at 3.2 m/s^2*
D *It accelerates downward at 3.2 m/s^2*

Q36. *A rocket accelerates straight up from rest. The apparent weight (normal force) of a 57 kg astronaut during takeoff is 3000 N. What is the rocket's acceleration?* **[Major 2 · 201]**

A $52.6\ m/s^2$
B $62.4\ m/s^2$
C $42.8\ m/s^2$
D $55.7\ m/s^2$

5.3 Newton's Third Law and Applying Newton's Laws

Q37. *Jan hits a nail with a hammer. During the interaction there is a force:* **[Midterm 232]**

A *on the hammer but not on the nail*
B *on the nail but not on the hammer*
C *on the nail and also on the hammer*
D *neither on the nail nor on the hammer*

Q38. *A book rests on a table. Which statement is true?* **[Midterm 233]**

A *The book's force on the table is greater*
B *The book's force on the table is smaller*
C *The two forces are equal in magnitude*
D *There are no forces between them*

Q39. *If you push on a wall, the wall pushes on you:* **[Major 2 · 202]**

A *with the same magnitude and direction*
B *with the same magnitude, opposite direction*
C *in the same direction, different magnitude*
D *Not enough information*

Q40. *When a bullet is fired from a gun, the force the bullet exerts on the gun is:* **[Final 211]**

A *smaller than the force of the gun on the bullet*
B *larger than the force of the gun on the bullet*
C *the same as the force of the gun on the bullet*
D *in the same direction as the gun's force*

Q41. *A 4 kg block and a 2 kg block are on a horizontal frictionless surface. A +12 N force pushes the 4 kg block against the 2 kg block. What force does the 2 kg block exert on the 4 kg block?* **[Midterm 251]**

A $4\ N$
B $12\ N$
C $-12\ N$
D $-4\ N$

Q42. *Block A (35 kg) is next to block B (15 kg) on a smooth table. When A is pushed with a horizontal force, both accelerate at 3.0 m/s². What force does A exert on B?* **[Midterm 241]**

A *150 N*
B *75 N*
C *45 N*
D *105 N*

Q43. *Block A (35 kg) is next to block B (15 kg) on a smooth table. When B is pushed with a horizontal force, both accelerate at 3.0 m/s². What force does B exert on A?* **[Midterm 242]**

A *200 N*
B *75.0 N*
C *105 N*
D *125 N*

Q44. *Two blocks m_1 = 5 kg and m_2 = 3 kg are in contact on a frictionless surface. A horizontal force F = 16 N acts on m_1 and the system accelerates at 2 m/s². What is the contact force between the blocks?* **[Final 202]**

A *16 N*
B *6 N*
C *2 N*
D *4 N*

Q45. *Crates of 4.00 kg and 6.00 kg on a frictionless surface are connected by a light rope. A force F on the 6.00 kg crate makes both accelerate at 2.50 m/s². What is the tension in the rope?* **[Midterm 252]**

A *5.00 N*
B *10.0 N*
C *15.0 N*
D *20.0 N*

Q46. *A 3 kg box slides on a frictionless surface inclined at $\theta = 30°$. What is the net force on the box?* **[Midterm 243]**

A *25.5 N*
B *3 N*
C *29.4 N*
D *14.7 N*

Q47. *A car of mass m is on an icy (frictionless) driveway inclined at 20.0°. What is its acceleration?* **[Final 222]**

A *2.69 m/s²*
B *9.22 m/s²*
C *3.36 m/s²*
D *4.98 m/s²*

Q48. *A 2 kg block is tied to a wall on a frictionless incline of 31°. Find the tension in the string that ties it to the wall.* **[Final 222]**

A *20 N*
B *17 N*
C *30 N*
D *10 N*

Q49. *A sled weighing 77.0 N is tied to a tree on a frictionless hill inclined at 30.0°. If it remains at rest, what force does the rope exert on the sled?* **[Final 242]**

A *23.4 N*
B *38.5 N*
C *66.7 N*
D *77.0 N*

Q50. *An object hangs in equilibrium from two ropes. One rope (21.0 N) makes 60.0° with the horizontal; the other (13.1 N) makes 36.7° with the horizontal. What is the weight of the object?* **[Final 241]**

A *26 N*
B *13 N*
C *34 N*
D *8 N*

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Part 2: Problems (15)

Solve the following problems and show your work in detail.

Problem 1. *An 11.0 kg marble block on a frictionless floor is pulled horizontally by A with F_1 = 12.0 N and pushed by B with F_2 = 40.0 N at 35.0° above the horizontal (both toward the same side).* **[Midterm 252]**

a) *Draw the free-body diagram.*

b) *Find the horizontal acceleration.*

c) *Find the normal force.*

Problem 2. *A 5.00 kg block is pulled along a horizontal frictionless surface by a 12.0 N force at 25.0° above the horizontal.* **[Midterm 251]**

a) *Draw the free-body diagram.*

b) *Find the normal force.*

c) *Find the horizontal acceleration.*

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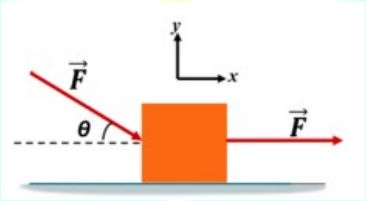
Problem 3. *A 14 kg box on a smooth floor is pushed with $F_1 = 40$ N directed 60° below the horizontal and pulled with a horizontal force $F_2 = 15$ N in the same horizontal direction.* **[Midterm 241]**

a) *Draw the free-body diagram.*

b) *Find the acceleration.*

c) *Find the normal force.*

Problem 4. *A 10 kg block on a frictionless floor is acted on by two 30 N forces: one horizontal to the right, the other pushing at $\theta = 30°$ below the horizontal (see figure).* **[Midterm 242]**



a) *Draw the free-body diagram.*

b) *Find the normal force.*

c) *Find the horizontal acceleration.*

Problem 5. *A 12 kg box on a smooth floor is pulled to the left by a 30 N force at 25° above the horizontal.* **[Midterm 243]**

a) *Draw the free-body diagram.*

b) *Find the acceleration.*

c) *Find the normal force.*

Problem 6. *A 5 kg box on a frictionless floor is pushed by F_1 = 80 N directed 60° below the horizontal (toward +x) and F_2 = 50 N directed along −x.* **[Midterm 233]**

a) *Draw the free-body diagram.*

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b) *Find the acceleration.*

c) *Find the normal force.*

Problem 7. *A person pushes an 8 kg cupboard on a frictionless floor with a force of 15 N along the negative x-axis.* **[Midterm 232]**

a) *Draw the free-body diagram.*

b) *Find the normal force.*

c) *Find the acceleration.*

Problem 8. *A horizontal force of 50 N acts on a box at rest on a smooth horizontal surface, giving it an acceleration of 1.5 m/s^2.* **[Major 2 · 202]**

a) *Draw the free-body diagram.*

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b) *Find the mass of the box.*

c) *Find its weight.*

d) *Find its speed after 10 s.*

Problem 9. *A force F at 30° above the horizontal acts on a 4.0 kg block on a smooth horizontal surface, giving it an acceleration of 1.25 m/s^2.* **[Major 2 · 202]**

a) *Draw the free-body diagram.*

b) *Find F.*

c) *Find the normal force.*

Problem 10. *A traffic light hangs in equilibrium from two cables at $\theta_1 = 37°$ and $\theta_2 = 53°$ with the horizontal, and a vertical cable T_3. The tension in the second cable is $T_2 = 102.2$ N.* **[Major 2 · 201]**

a) *Draw the free-body diagram for each body.*

b) *Find T_1.*

c) *Find T_3 and the weight of the light.*

Problem 11. *Two masses $m_1 = 5$ kg and $m_2 = 3$ kg hang on either side of an ideal pulley (Atwood machine). Neglect friction.* **[Final 182]**

a) *Draw the free-body diagram for each body.*

b) *Find the acceleration.*

c) *Find the tension.*

Problem 12. *A 4.00 kg block A on a frictionless table is attached by a string over a pulley to a hanging 7.00 kg block B. They are released from rest.* **[Final 242]**

a) *Draw the free-body diagram for each body.*

b) *Find the acceleration.*

c) *Find the tension.*

d) *Find the normal force on A.*

Problem 13. *A 5 kg block on a smooth 40° incline is connected by a string over a pulley to a hanging 10 kg block.* **[Major 2 · 201]**

a) *Draw the free-body diagram for each body.*

b) *Find the acceleration.*

c) *Find the tension.*

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Problem 14. *A 50 kg body m_1 on a horizontal table and a 10 kg body m_2 on a smooth 37° incline are connected by a rope over a pulley. A force F on m_1 keeps the system moving at constant velocity (assume no friction on the table).* **[Final 231]**

a) *Draw the free-body diagram for each body.*

b) *Find the tension.*

c) *Find the force F.*

Problem 15. *A boy on a toboggan slides down a frictionless snowy slope at 30°. The boy and toboggan together have a mass of 60 kg.* **[Final 232]**

a) *Draw the free-body diagram.*

b) *Find the acceleration.*

c) *Find the normal force.*

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