Name: _____ **Date: _____**

Science SPH4U Physics
– Forces and Motion, version 1.03

Please **READ ALL** the following instructions carefully before you start the exam.

- This is not an open book test; other than a standard calculator and scrap paper, other aids are not allowed.
- You are responsible to bring your own calculator. Sharing a calculator with someone else is **strictly prohibited**.
- Formula sheet will not be provided for this test.
- Good luck!

Section A: _____

Section B: _____

Section C: _____

Section D: _____

Total: _____

Note: When the test is returned to you, please check your mark.

Section A: Multiple-Choice (Knowledge): There is only one correct answer for each question. Each question is worth one mark. Please record your answer at the designated area only (10 marks).

1. When a projectile reaches its maximum height, …
   a) it experiences a constant acceleration.
   b) it has zero acceleration.
   c) its horizontal speed became zero.
   d) the sum of forces acting on it is zero.

2. A book is at rest on a desk. Which one of the following statements is correct?
   a) The desk exerts no force on the book.
   b) The forces acting on the book are balanced.
   c) The book exerts no force on the desk.
   d) The desk exerts a larger force on the book.

3. An object is in uniform circular motion on a frictionless table. The object is tied to a string 20cm long and is spinning at 30rpm clockwise.
   a) The speed of the object is approximately 2.51m/s.
   b) When the object's velocity is pointing towards the east, it accelerates north.
   c) The magnitude of the acceleration is a constant.
   d) The period of this object is roughly 0.5 seconds.

4. A 5000kg helicopter accelerates upward at $0.550 m/s^2$ while lifting a 1500kg car.
   a) The tension connecting the car to the helicopter is 825N.
   b) The helicopter produces a force of lift 2750N.
   c) The net force acting on the car is 1925N.
   d) None of the above is correct.

5. A ball rolling off the cliff at 6.0m/s 30 degree below horizontal.
   a) The vertical final speed will be 3.0m/s.
   b) The horizontal initial speed will be 3.0m/s.
   c) The acceleration of the ball remains the same.
   d) The ball at its highest point will have a velocity of 0 m/s.

6. A 20kg block is resting on a 30-degree incline.
   a) The minimum coefficient of static friction is approximately 0.577
   b) The normal force is about 170N.
   c) The force of friction has a magnitude of 98.1N.
   d) All of the above statements are correct.

7. If an object is in uniform circular motion, which one of the following is true?
   a) The net force acting on the object must be zero.
   b) The object has zero acceleration.
   c) There is no force acting on the object.
   d) The object has a constant speed.

8. In a tug-of-war, side A is pulling with 150N and side B is pulling with 200N.
   a) The tension of the rope will be 50N.
   b) The tension of the rope will be 150N.
   c) The tension of the rope will be 200N.
   d) The tension of the rope will be 350N.
   e) None of the above

9. An airplane pilot coming out of a vertical loop from the bottom of the circle experiences a normal force equals to 2mg from his seat, where m is his mass.
   a) The airplane is accelerating g upward.
   b) The airplane is accelerating 2g upward.
   c) The airplane is accelerating 3g upward.
   d) The airplane is accelerating 4g upward.

10. A 500g mass is attached to a string 60cm long capable of withholding 5.0N of tension. The object is traveling at constant speed in a vertical circle. Assume the object is spinning at its maximum speed, when the object is at the bottom of the circle, which of the following is a false statement?
   a) The acceleration of the object is 0.19 m/s^2 [Up].
   b) The minimum tension occurs at the top of the vertical circle.
   c) The tension at that moment is 5.0N.
   d) The frequency of the object is about 25.3rpm.

Section B: Short Answer (Communication): Answer each of the following questions. Clarity of the explanation will be rewarded (6 marks).

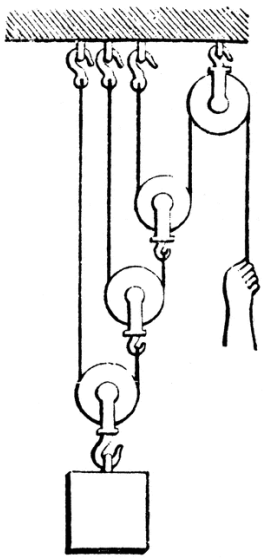
1. Two objects of identical mass are attached to the ends of two strings. One string is three times longer than the other. Both strings are made of the same material. Thus, the maximum tension of each string will be identical. Both objects will be placed in uniform circular motion on a frictionless table. Compare the maximum speed of both objects (3 marks). Numerical justifications must be provided.

2. Derive the formula for the maximum speed of a vehicle on a frictionless banked curve in uniform circular motion with radius of curvature r. You must show the procedure of the derivation (3 marks).

Section C: Problem Solving (Application): Solve the following questions. Marks will be deducted for incomplete or improper procedures (9 marks).

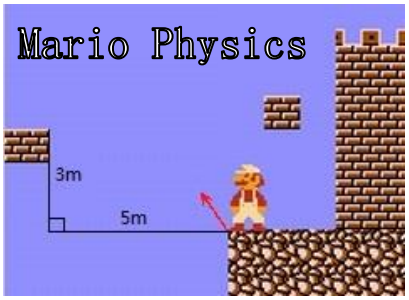
1. A coin is placed 18.0cm from the axis of a rotating turntable of variable speed. When the speed of the turntable slowly increases, the coin stationary until 61rpm is reached, at which point the coin slides off. What is the coefficient of static friction between the coin and the turntable (3 marks)? If the coin is to be placed 9.0cm away from the center, what will be the maximum angular velocity in rpm such that coin be remain stationary (2 mark)?

2. According to the diagram shown on the right, given the man is pulling downward with a force of 98.1N, determine the mass of the weight in kilogram such that the system is in static equilibrium (1 mark). Show full procedure with explanations (3 marks).



Section D: Comprehensive Application (Thinking & Inquiry): Marks will be deducted for incomplete or improper procedures (4 marks).

Mario is trying to jump to the next platform. Given the displacement for x and y are 5 meters and 3 meters respectively, and Mario is jumping at 45° above the horizontal, what is the minimum speed such that he may safely land on the indicated platform (2 marks)? Full procedure must be shown.



If Mario were to change his jumping angle from 45° above the horizontal to 60° above the horizontal, do you think the minimum speed required will be a) higher, b) lower, c) identical, or d) not able to determine (1 mark)? Provide a justification (1 mark).