BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

FIRST SEMESTER 2017-2018

Mid Semester Exam (Closed Book)

Part I

Course No: PHY F112 Course Title: **General Physics** Date: 10.10.2017

Max. Time: 30 min. Total Marks: 35

Name: _____ ID:_____ Score:____

Notes: Write the answers to this part in the box provided under each question. Your answers will mostly require either one (or few) word(s) or a single number. Do not write long sentences. Take gravitational acceleration g = 10 m/s$^{2.}$

1. A traffic light of weight w hangs from two lightweight cables, one on each side of the light. Each cable hangs at a 45º from the horinzontal. What is the tension in each cable? [2]

2. The normal force is not always equal to the weight. Give two examples. [2]

3. Rank the following in order of their kinetic energies, from least to greatest:
(i) A 2 kg block moving at 5 m/s
(ii) A 1 kg block initially moving at 4 m/s and then had 20 J of work done on it
(iii) A 1 kg block that was initially at rest and then had 30 J of work done on it
(iv) A 2 kg block that was initially moving at 10 m/s and later worked on another body a work equal to 80 J [2]

4. You drive north on a straight two-lane road with a constant speed 88 km/h. A truck in the other lane approaches you at a constant speed 104 km/h.
(a) What is the truck's velocity relative to you?
(b) What is your velocity relative to the truck?
(c) How do these two velocities change after you and the truck pass each other? [3]

5. If a rocket in a gravity-free outer space has the same thrust at all times, is its acceleration constant, increasing, or decreasing? [2]

6. A paratrooper whose chute fails to open lands in snow. He gets hurt slightly. Had he landed on bare ground, the stopping time would have been 10 times shorter and the collision lethal. Does the presence of snow increase, decrease, or leave unchanged the values of
(a) the paratrooper's change in momentum
(b) the impulse stopping the paratrooper
(c) the force stopping the paratropper [2]

7. The figure shows three paths connecting points a and b. A single force **F** does the indicated work on a particle moving along each path in the indicated direction. On the basis of this information, is force **F** conservative? [2]

8. Which angular quantity is not always a vector? Why? [2]

9. A bug rides the rim of a rotating merry-go-round. If the angular speed of the system is constant, does the bug have (a) radial acceleration, (b) tangential acceleration, (c) or both? [2]

10. A block of mass m is moving with a constant acceleration a on a rough horizontal floor. If the coefficient of friction between the block and the ground is μ, what is the power delivered by the external force **F** in total time t? [2]

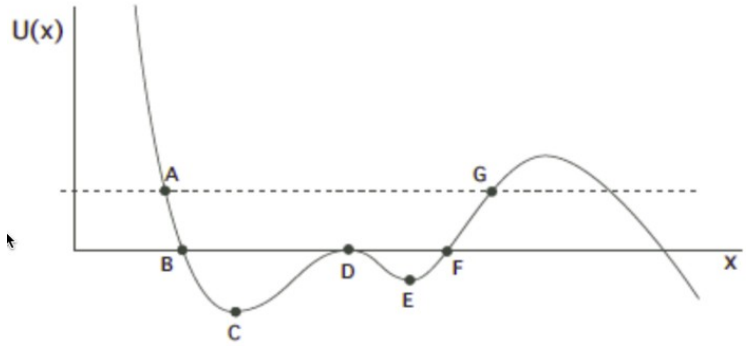
11. A billiard ball moving with a speed of 5 m/s collides with an identical ball, originally at rest. If the first ball stops dead after the collision, with what speed will the second ball move forward? [2]

12. You are driving a Honda City car on a track at a speed of 150 km/h, and your friend is driving a Volkswagen at 80 km/h. For which of the two cars is the net force greater? [2]

13. A particle moves along an x-axis from x=0 to x_1 while a conservative force, directed along the x-axis acts on the particle. The figure shows three situations. Rank the situations according to the change in the potential energy during the motion, greatest first. [3]

14. Suppose a uniform rope of mass M and length L hangs from the limb of a tree. Will the tension at each point on the rope as we go from top to bottom, increase, decrease, or remain constant? [2]

15. Identify the turning points in the following diagram. [2]



16. If there are 3 frieght cars of mass M pulled with a force F by a locomotive as shown in the figure, assuming friction is negligible, what are the forces on each car? [3]

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Part II

Course No: PHY F112 Course Title: **General Physics** Date: 10.10.2017

Max. Time: 60 min. Total Marks: 70

1. Elevators A and B are connected by a short cable as shown in Figure 1 and can be pulled upward or downward by the cable above cab A. The masses of cab A and cab B are, 1800 kg and 1200 kg, respectively. A 10 kg box lies on the floor of cab A. The tension in the cable connecting the two cabs is 1.9×10^4 N. (a) What is the magnitude of the normal force on the box from the floor? (b) If the 10 kg box lies instead on the floor of the cab A, what would be the magnitude of the normal force on the box from the floor? [15]

2. Two blocks A and B are connected by a rope of negligible mass via a frictionless pulley as shown in Figure 2. The weights of A and B are 100 N and 30 N, respectively. The coefficient of friction between A and in the incline are $\mu_s = 0.50$ and $\mu_k = 0.25$. The angle is 40°. What is the acceleration of A, if initially A is (a) at rest, (b) moving up the incline, and (c) moving down the incline? [15]

3. As shown in Figure 3, puck 1, of mass 0.25 kg is sent sliding across a frictionless lab bench, to undergo a one-dimensional elastic collision with stationary puck 2. Puck 2 then slides off the bench and lands a distance d from the base of the bench. Puck 1 rebounds from the collision and slides off the opposite edge of the bench, landing a distance 2d from the base of the bench. What is the mass of puck 2? [15]

4. As shown in Figure 4, wheel A of radius 15 cm is coupled by belt B to wheel C of radius 30 cm. The angular speed of wheel A is increased from rest at a constant rate of$1.6\ \text{rad/s}^2$. Find the time needed for wheel C to reach an angular speed of 100 rev/min, assuming the belt does not slip. [10]

5. A sand spraying locomotive sprays sand horizontally into a frieght car as shown in Figure 5. The locomotive and the frieght car are not attached. The engineer in the locomotive maintains his speed so that the distance to the frieght car is constant. The sand is transferred at a rate 10 kg/s with a velocity of 5 m/s relative to the locomotive. The car starts from rest with an initial mass of 2000 kg/. Find its speed after 100 s. [15]