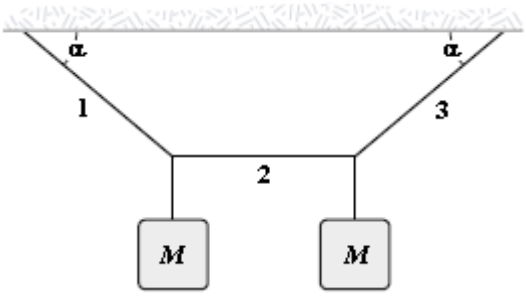
Part 1$_a$ – Multiple Choice (answer on this questionnaire)

1) The initial speed of a cannon ball is 0.20 km/s. If the ball is to strike a target that is at a horizontal distance of 3.0 km away from the cannon, what is the **minimum** time of flight for the ball?
Note: the range of a projectile is given by $R = v_i^2 \sin 2\theta_i / g$.

a. 16 s b. 21 s c. 24 s d. 14 s e. 19 s

2) If $\alpha = 40°$ and the tension in string 2 is 30 N, determine M, the mass of either of the two blocks as shown in the figure.



a. 3.4 kg b. 3.6 kg c. 2.6 kg d. 4.9 kg

e. 7.5 kg

3) A 1.5 kg mass has an acceleration of $(4.0\hat{\mathbf{i}} - 3.0\hat{\mathbf{j}})$ m/s^2. Only two forces act on the mass. If one of the forces is $(2.0\hat{\mathbf{i}} - 1.4\hat{\mathbf{j}})$ N, what is the magnitude of the other force?

a. 4.1 N b. 6.1 N c. 5.1 N d. 7.1 N e. 2.4 N

4) A 2.0 kg mass swings at the end of a light string (length = 3.0 m) like a simple pendulum. Its speed at the lowest point on its circular path is 6.0 m/s. What is its kinetic energy at an instant when the string makes an angle of 50° with the vertical?

a. 21 J b. 15 J c. 28 J d. 36 J e. 23 J

5) The position of a particle moving along the x axis is given by $x = (21 + 22t - 6.0t^s)$ m where t is in seconds. What is the average velocity during the time interval $t = 1.0$ s to $t = 3.0$ s?

a. -6.0 m/s b. -4.0 m/s c. -2.0 m/s d. -8.0 m/s e. $+8.0$ m/s

6) A block (mass = 4.0 kg) sliding on a horizontal frictionless surface is attached to one end of a horizontal spring (k = 100 N/m) which has its other end fixed. If the maximum distance the block slides from the equilibrium position is equal to 20 cm, what is the speed of the block at an instant when it is a distance of 16 cm from the equilibrium position? Hint: the velocity at maximum stretch will be zero.

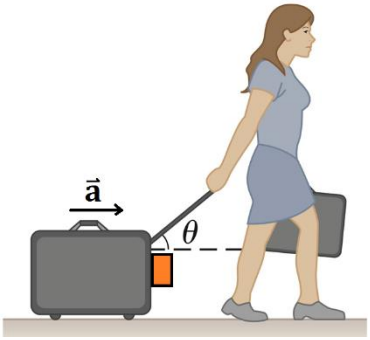
a. 71 cm/s b. 60 cm/s c. 80 cm/s d. 87 cm/s e. 57 cm/s

7) A force acting on an object moving along the x axis is given by $F_x = (14x - 3.0x^2)$ N where x is in meters. How much work is done by this force as the object moves from $x = -1$ m to $x = +2$ m?

a. $+12$ J b. $+28$ J c. $+40$ J d. $+42$ J e. -28 J

Part 2 – Long Answer (answer in your exam booklet)

1) A woman at an airport is towing her 20 kg suitcase by pulling on a strap at an angle $\theta = 40°$ above the horizontal. A 2.0 kg block is placed against the front of her suitcase as shown in the figure.



(a) What value of acceleration must the suitcase have so that the block does not fall? The coefficient of static friction between the block and the suitcase is $\mu_s = 0.62$. **(3 pts)**
(b) What force must the woman apply to accelerate the suitcase at this rate? Assume the suitcase moves without friction. **(3 pts)**
(c) If the suitcase and block initially was at rest at time $t = 0$, what would be their combined kinetic energy at time $t = 5$ s? **(2 pts)**

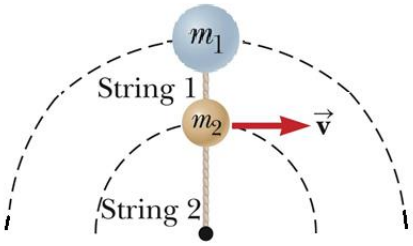
2) The speed of a bullet as it travels down the barrel of a rifle toward the opening is given by:

$$v = (-5.50 \times 10^7)t^2 + (3.25 \times 10^5)t$$

where v is in m/s and t is in seconds. The acceleration of the bullet just as it leaves the barrel is zero. Note. The equation for speed is only valid while the bullet is in the barrel of the rifle.

(a) What is the acceleration of the bullet as a function of time while it is in the barrel? (**2 pts**)
(b) How much time does the bullet spend in the barrel being accelerated? **(2 pts)**
(c) What is the bullet's speed as it leaves the barrel? **(2 pts)**
(d) If the rifle is aimed at an angle of 60° above the horizontal, how long will it take for the bullet to reach its maximum height? **(2 pts)**

3) A sphere of mass $m_1 = 6.0$ kg is tied to a sphere of mass $m_2 = 2.0$ kg with String 1 of length 0.75 m. The combination is swung in a vertical circular path on a second string, String 2, of length 1.25 m. During the motion, the two strings are collinear at all times as shown in the figure. At the top of its motion, m_2 is traveling at $v_2 = 8.00$ m/s.



(a) At the top of its motion, what is the speed of m_1? **(3 pts)**
(a) What is the tension in String 1 at this instance? **(3 pts)**
(b) What is the tension in String 2 at this instance? **(2 pts)**

4) A 200 g hockey puck on a frozen pond is given an initial speed of 20.0 m/s. Assume the puck is always in contact with the ice.

(a) If the puck slides 120 m before coming to a rest, determine the coefficient of kinetic friction between the puck and the ice. **(4 pts)**
(b) What is the acceleration of the puck? **(2 pts)**
(b) How much work does the force of friction do on the puck? **(2 pts)**