UNIVERSITY OF JOHANNESBURG

PHYG01A/PHY1GA1 - Exam 2019

Total possible marks: 100 **Time:** 120 minutes

Examiner: Ms. CS van Niekerk **Moderator:** Dr. E Carleschi

INSTRUCTIONS:
1) Insert units in the calculations and answer all questions (please do not write in pencil!).
2) Cell phones must be switched off in the test venue.
3) Remember that in derivations, figures and explanations carry marks.

Question 1 [14 marks]

1.1 Alice the alien is visiting planet Earth to acquire a cow specimen for her terrestrial research. She has landed her ship in a pasture. The ship's sensors are giving the coordinates of the surrounding cows in meters (detailed below). The ship is located at the origin of the coordinate system. Cow A is at point (6,8), Cow B is at point (-4,9) and Cow C is at point (7,7). If Alice wants to acquire the cow that is closest to her ship, which cow should she take? **[6]**

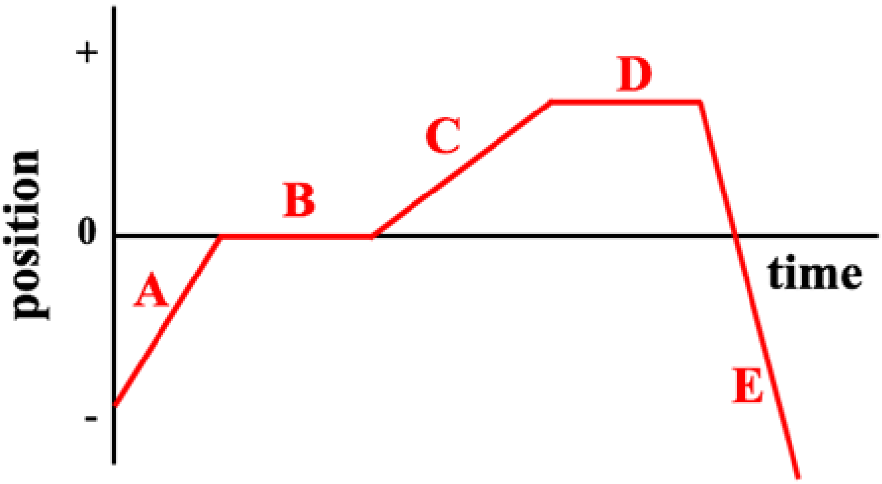
1.2 A plane is heading 34° west of south. After 2400 yards, the plane changes direction to 78° north of west. He travels a further 4800 yards in this direction.
a) Find the distance (in meters) and direction the pilot has moved. Given: 1 yard = 0.9144 meters. [**5**]

b) Explain how the above problem could be solved graphically. [**3**]

Question 2 [12 marks]

2.1 Explain the difference between distance and displacement. [**2**]

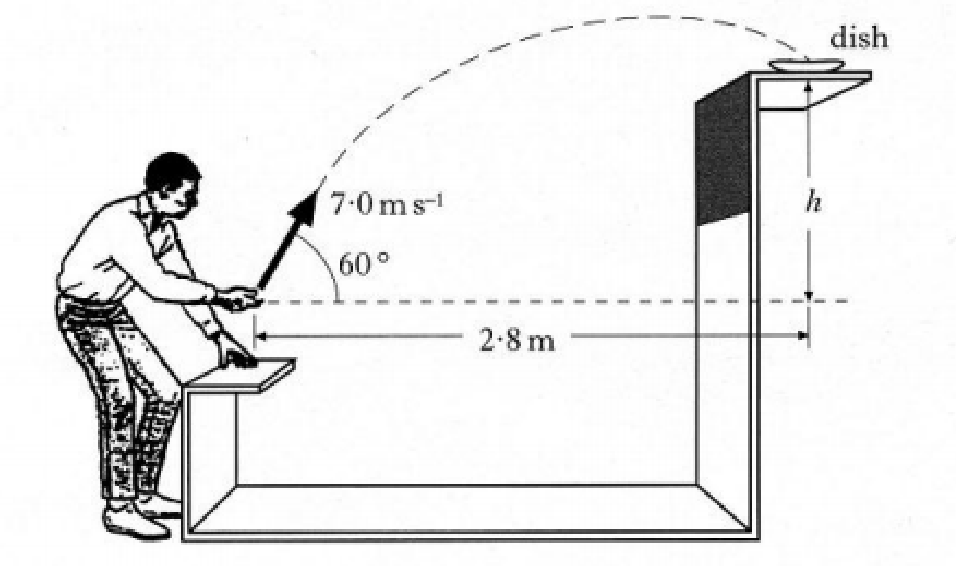
2.2 Five stages - labeled A, B, C, D, and E - of an object's motion are represented by the position-time graph below. Describe the velocity and acceleration of the object during each stage. [**10**]



Question 2.2 continued...

Question 3 [20 marks]

3.1 At a funfair, a prize is awarded if a coin is tossed into a small dish. The dish is mounted on a shelf above the ground as shown in the figure. A contestant projects a coin at a speed of 7 m/s at an angle of 60° to the horizontal. When the coin leaves the hand, the horizontal distance between the hand and the dish is 2.8 m.



a) The coin lands in the dish. Find the height, h of the shelf with respect to the person's hand. **[7]**

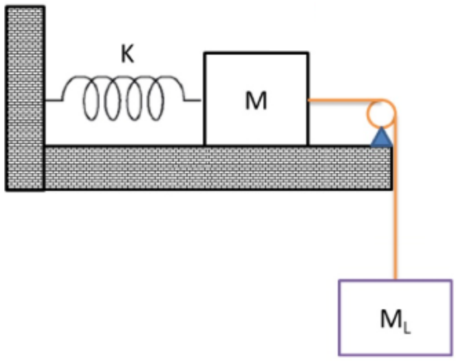
Questions 3.1 (a) continued...

b) How does the value of the kinetic energy of the coin when it enters the dish compare to the kinetic energy of the coin just as it leaves the contestants hand? **[3]**

Question 4 [14 marks]

4.1 State Newton's third law in full. **[2]**

4.2 A system is configured as shown in the figure below i.e. mass M = 10 kg and mass M_L are connected to each other by a frictionless pulley and rope. Mass M is connected to a spring with constant K = 1000 N/m. Assume the coefficients of static and kinetic friction between the surface and mass M are 0.25 and 0.13 respectively.



a) When the spring is stretched 0.2 m, the system is at rest. Calculate the mass of M_L. **[6]**

b) Calculate the the speed of mass M_L when the spring goes through its equilibrium position again. **[6]**

4.3 A child slides down a water slide at an amusement park from an initial height h. The slide can be considered frictionless because of the water flowing down it.
a) Can the equation for conservation of mechanical energy be used on the child? Explain. **[2]**

b) Is the mass of the child a factor in determining her speed at the bottom of the slide? Explain. **[2]**

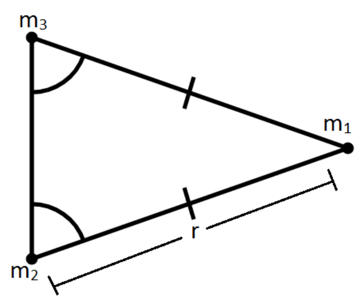
c) The child drops straight down rather than following the curved ramp of the slide. In which case will she be traveling faster at ground level? Explain. **[2]**

d) If friction is present, how would the conservation-of-energy equation be modified? **[2]**

e) Find the maximum speed of the child when the slide is frictionless if the initial height of the slide is 12.0 m. **[2]**

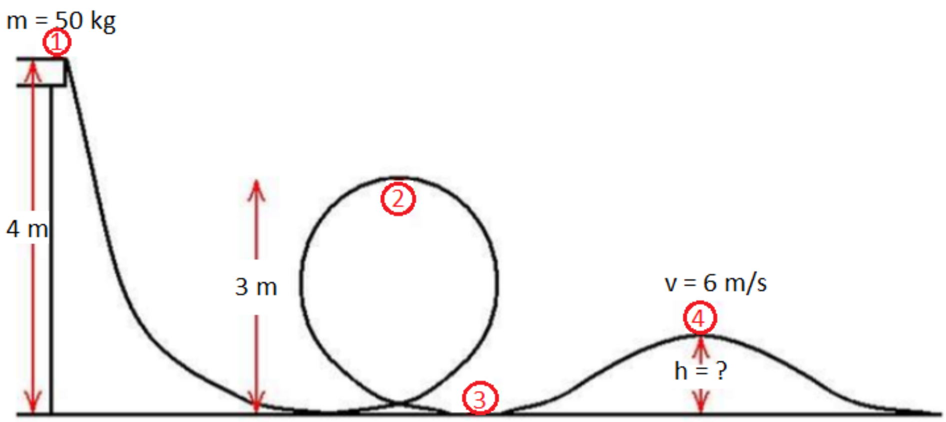
Question 5 [16 marks]

5.1 Three masses are placed at the vertex of an isosceles triganle. Write an expression for the force on mass three due to the other two masses in terms of m_1, m_2, g and r. **[5]**



5.2 A 0.150 kg projectile is fired with a velocity of 715 m/s at a 2.00 kg wooden block that rests on a frictionless table. The velocity of the block, immediately after the projectile passes through it, is 40.0 m/s. Find the velocity with which the projectile exits from the block. **[5]**

5.3 In the figure below, points 1 - 4 are indicated. For each point calculate: **[6]**
(i) the potential energy,
(ii) the kinetic energy and,
(iii) the velocity of the mass at each point.



Question 5.3 continued...

Question 6 [11 marks]

6.1 State the difference between stress and strain on a material. [**2**]

6.2 Explain what happens to an anelastic material when a stress is applied for a time and then removed. Make use of a diagram in your explanation. [**3**]

6.3 Explain the difference between brittle and ductile deformation in rheology. [**2**]

6.4 Assume a 2 kg picture hangs from a nail hammered into a wall. If the weight of the picture causes the nail to bend 1.80 m and the nail has a diameter of 1.50 mm, find the constant of proportionality between the stress and the strain on the nail. **[4]**

Question 7 [9 marks]

7.1 A steel cable holds a 120 kg shark tank 3 m below the surface of saltwater. If the volume of water displaced by the shark tank is 0.1 m^3, what is the tension in the cable? Assume the density of saltwater is 1025 kg/m^3. **[3]**

7.2 A standard basketball (mass = 624 grams; 24.3 cm in diameter) is held fully under water. Calculate the buoyant force and weight. When released, does the ball sink to the bottom or float to the surface? If it floats, what percentage of it is sticking out of the water? If it sinks, what is the normal force, with which it sits on the bottom of the pool? **[6]**

Question 8 [5 marks]

8.1 Jupiter has four moons. They also obey Keplers laws in their orbits around Jupiter. The distance of the moon called Io from Jupiters centre is 4.2 units, and its period is 1.8 Earth-days. Another moon is called Ganymede; it is 10.7 units from Jupiters center. What is the period of Ganymede? **[3]**

8.2 A huge body comes out of sun and moves in space. Calculate the escape velocity of sun if its mass is 1.989×10^{30} kg and radius is 696,300 km. **[2]**

END of QUESTION PAPER