BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT: SCIENCE AND MATHEMATICS

PROGRAMME: DIPLOMA IN SCIENCE EDUCATION MATHEMATICS (DIPSCED)

COURSE CODE DMT004: MECHANICS

DURATION: 3HOURS TOTAL MARKS:100

INSTRUCTIONS TO CANDIDATES

i. Answer all questions in Section A

ii. Choose Three questions in Section B

SECTION A: [40 Marks]

Answer all questions in this section

A1. (a) Distinguish between a vector and a scalar quantity in Theoretical Mechanics? [2 Marks]

(b) Determine whether the vectors: $\mathbf{x} = i + 2j + 3k$, $\mathbf{y} = i + j + k$ and $\mathbf{z} = i + 2j + k$ are coplanar? [3 Marks]

(c) If $x = \{1,1,1\}$, $y = \{1,3,1\}$ and $z = \{2,2,2\}$ are three vectors, prove that they are coplanar? [5 Marks]

A2. Two forces F_1 and F_2, act on an object in a plane. F_1 has a magnitude of 30N and is directed 30° above the horizontal. F_2 has a magnitude of 40 N and is directed 60° below the horizontal. Calculate the resultant force acting on the object. [10 Marks]

A3. (a) Define uniform motion. [2 Marks]

(b) An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 ms^{-2}. The takeoff speed for this plane will be 65 ms^{-1}. Assuming this minimum acceleration, what is the minimum allowed length for the runway? [3 Marks]

(c) (i) A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 ms^{-2}. Determine the time for the feather to fall to the surface of the moon. [3 Marks]

(ii) A car traveling at 22.4 ms^{-1} skids to a stop in 2.55 s. Determine the skidding distance of the car (assume uniform acceleration). [2 Marks]

A4. **(a)** Define a state of equilibrium? [2Marks]

(b) An object is in equilibrium under the action of three concurrent forces. Force $\mathbf{F_1}$ has a magnitude of 25 N and acts at an angle of **30°** above the horizontal. Force $\mathbf{F_2}$ has a magnitude of 30 N and acts at an angle of 60° below the horizontal. Force $\mathbf{F_3}$ has a magnitude of 40 N and acts vertically downward. Determine the angle at which the resultant force acts

SECTION B: [60 MARKS]

Choose **Three** questions in this section.

B1. (a) A force F of magnitude 30 N acts at angle of 45° above the horizontal. Find the magnitude of the resultant force of its horizontal and vertical components? [10 Marks]

(b) An object is on an inclined plane with an angle of inclination of 30°. The weight of the object is 200 N. Determine the components of the weight parallel and perpendicular to the slope? [10 Marks]

B2. (a) A ball is kicked with an initial velocity of 20 ms^{-1} at an angle of 30° above the horizontal Calculate the maximum height reached by the ball. [10 Marks]

(b) A projectile is launched from the ground with an initial velocity of 40 ms^{-1} at an angle of 60° with respect to the horizontal. Determine the time of flight and the horizontal range? [10 Marks]

B3. (a) A car of mass 800 kg accelerates from rest to a speed of 25 ms^{-1} in 10 seconds along a straight road. Calculate the work done by the engine? [10 Marks]

(b) A spring with a spring constant of 200 Nm^{-1} is compressed by 0.1 metres. Calculate the potential energy stored in the spring. [10 Marks]

B4. An object is in equilibrium under the action of three concurrent forces. Force F_1 = 25N and acts at an angle of 30° above the horizontal? Force F_2 = 30N and acts at an angle of 60° below the horizontal. Force F_3= 40N and acts vertically downward. Determine the resultant force and angle at which the resultant force acts with respect to the horizontal? [20 Marks]

END OF PAPER