KABARAK   **UNIVERSITY**

EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHYS 111

COURSE TITLE: MECHANICS

STREAM: SESSION I

DAY: TUESDAY

TIME: 9.00 – 11.00 A.M.

**DATE:**   25/11/2008

INSTRUCTIONS:

1. Answer **_Question ONE_** and **_any other TWO_** questions.
2. Question ONE carries **40 marks**, all other questions carry **15 marks** each.
3. Assume $\pi = 3.14$, Gravitational Constant $= 6.67 \times 10^{-11} \ N \ m^2 \ kg^{-2}$ and $g = 9.8 \ m/s^2$

PLEASE TURN OVER

Question 1 (40 Marks)

a) What are the SI units of the following parameters;
   - i. mass
   - ii. length

2 marks

b) The ceiling of a rectangular room whose sides measure 20m by 30m is about to fall. A steel beam needs to be fixed diagonally across the room to support the ceiling. How long must the beam be?

3 marks

c) In uniform motion, if x refers to displacement, u and v refer to initial and final velocities, a refers to acceleration and t refers to time, which of the following equations is dimensionally correct?
   - i. $x = ut + at^3$
   - ii. $v^2 = u^2 + 2at$
   - iii. $x = at + vt^2$
   - iv. $v^2 = u^2 + 2ax$

2 marks

d) A rally car can accelerate in a straight line from zero to 80km/hr in 3.5s. Calculate the magnitude of the average acceleration of the car.

3 marks

e) Which of these statements correctly finishes this statement?
   An object dropped from rest to fall freely…
   - i. falls 9.8 m each second
   - ii. falls 1 m every 9.8 seconds
   - iii. has its velocity increase by 9.8 m/s every second
   - iv. has its acceleration increase by 9.8 m/s every second

2 marks

f) Suppose a golf ball is hit with an initial velocity of 30 m/s at an angle of 35° to the horizontal. Calculate
   - i. the maximum height reached by the ball
   - ii. the horizontal distance travelled by the ball before hitting the ground. *Assume the ground is flat.*

6 marks

g) A 40 kg crate is at rest on a level concrete surface. If the coefficient of static friction between the crate and the concrete surface is 0.69, what horizontal force is required to get the crate moving?

3 marks

h) State the law of conservation of energy

2 marks

i) A 60-kg woman runs up the staircase below in 15 seconds. If the staircase is made up of 10 steps, each being 0.25m high, how much power does she expend vertically?

4 m
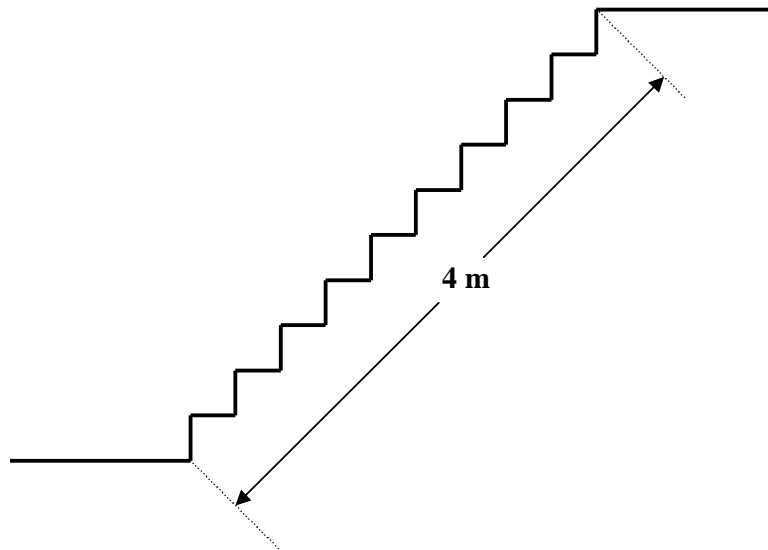
4 marks

j) Two spherical masses are connected using a bar of negligible mass. If the distance between the centres of the two spheres is 1.2 m, find the location of the centre of mass of the system if;

     i. the two masses are 5 kg each
    ii. $m_1 = 3$ kg and $m_2 = 8$ kg

6 marks

k) In how many earth years does the planet Uranus orbit the sun if its orbital radius is 19.18 times larger than that of the earth?
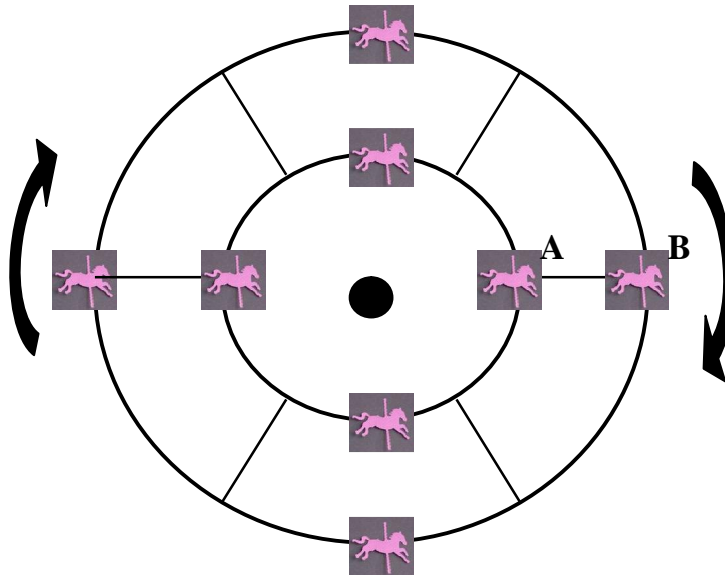
4 marks

l) The angle subtended by a distant ship on a sailor's eye is $2°$. If the sailor knows the distant ship to be 180 m long, approximately how far is the ship from the sailor?

3 marks

Question TWO (15 marks)

a) The amusement park merry-go-round below makes one complete revolution in 45 seconds in the direction shown by the arrows. Two children are riding on the merry-go-round, one of them sitting on the inside horse (horse **A**) and the other one is sitting on one of the outside horse (horse **B**). If horse **A** is 3m from the centre and horse **B** is 6m from the centre, calculate;
      i.   the angular velocity of each child.
   ii.   the tangential velocity of each child.

8 marks

b) The driver of a car travelling at 72 km/hr along a straight, level road sees a group of animals crossing the road approximately 100 m away. He brakes and manages to bring the car uniformly to a stop in a distance of 60 m. If the car weighs 8.8×10^3 N, calculate the braking force of the car.

5 marks

c) State the principle of moments.

2 marks

Question THREE (15 marks)

a) A ditch 2.5 m wide crosses the path of a rider on a motorbike (see figure below). An upward incline of 15° has been built at the edge of the ditch on the side the rider is coming from. The top of this incline is level with the top of the other side of the ditch. With what minimum velocity must the motorbike be moving for it to clear the ditch and land safely on the other side? *The motorbike is 1.4 m long.*

15° **2.5 m**
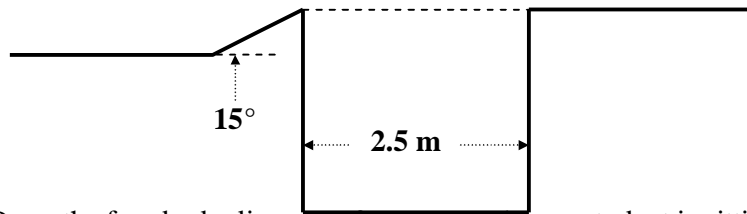
6 marks

b) Draw the free-body diagram of a system where a student is sitting on a chair while holding a laptop on her laps. Name all the forces present.

6 marks

c) Name the three main types of equilibrium that objects can assume.
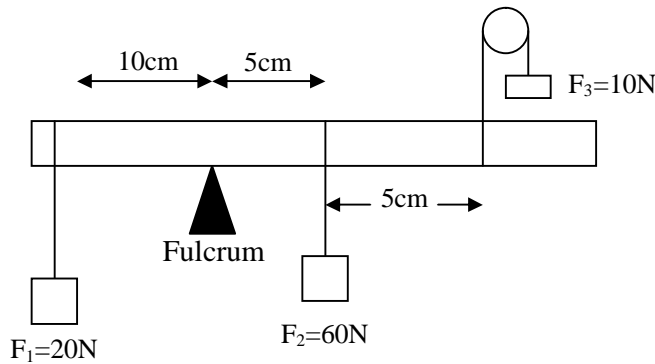
3 marks

Question FOUR (15 marks)

a) Two stars of mass 2×10^{22} kg and 1.6×10^{24} are 0.2 light years apart. Calculate the approximate force of attraction between the two stars. *Assume one year is 365 days.*

6 marks

b) A person's reaction time can be measured by having another person drop a ruler from above and through the thumb and forefinger. The first person drops the ruler (without warning) and the second person grasps the falling ruler as quickly as possible, and the length of the ruler below the top of the finger is noted. If on the average the ruler descends 18 cm before it is caught, what is the person's average reaction time?

4 marks

c) Calculate the resultant moment of the system below.

10cm   5cm   F₃=10N

5cm

Fulcrum

F₁=20N   F₂=60N

5 marks