KABARAK UNIVERSITY

EXAMINATIONS

2008/2009 ACADEMIC YEAR

PRE-UNIVERSITY CERTIFICATE COURSE IN PHYSICS

COURSE CODE: **PPHYS 021**

COURSE TITLE: **BASIC MECHANICS AND WAVES**

STREAM: **PRE-UNIVERSITY**

DAY: **TUESDAY**

TIME: **2.00 – 4.00 P.M.**

DATE: **09/12/2008**

INSTRUCTIONS:

1. **Answer question 1 and any other two questions**
2. **Question 1 carries 30 marks and is compulsory**
3. **All other questions carry 20 marks each.**
4. **The following constants may be necessary; g = 9.8ms^{-2}, C = 3 x 10^{8}ms^{-1} and speed of sound in air v = 344ms^{-1}.**

PLEASE TURN OVER

QUESTION 1 (30 marks)

a.) State Newton's third law of motion. **(1 mark)**

b.) An electric motor rotates at 3700 revolutions per minute and has a radius of 4cm. What is the velocity (v) at the tip of the transformer? **(3 marks)**

c.) Show that the work done in stretching a spring through an extension of X_M and whose spring constant is k is given as;

$$Work = \tfrac{1}{2} kX_m^2$$ **(3 marks)**

d.) Give one example of a vector quantity and one of a scalar quantity. **(2 marks)**

e.) What is the angle between vectors $\mathbf{a} = 4\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$ and $\mathbf{b} = 2\mathbf{i} - \mathbf{j} + 3\mathbf{k}$. **(3 marks)**

f.) A particle's position on the x-axis is given by $x = t^3 - 6x + 4$ with x in meters and t in seconds.

i.) Find the particle's velocity function V (t) and acceleration function a (t). (2 marks)

ii.) At what time is V = 0? **(3 marks)**

g.) Sketch a graph of position verses time showing uniform acceleration. **(2 marks)**

h.) Give two differences between standing waves and progressive waves. **(2 marks)**

i.) The equation of a certain wave, transverse is given by the equation

$$y = 2 \sin 2\pi \left(\frac{t}{0.01} - \frac{x}{30} \right)$$

Where x and y are in centimeters and t in seconds. What are?

i.) Wavelength

ii.) Frequency

iii.) Speed of propagation of the wave? **(6 marks)**

j.) Define Doppler Effect. **(1 mark)**

k.) State the principle of superposition of waves. **(1 mark)**

l.) Define a wave. **(1 mark)**

QUESTION 2 (20 MARKS)

a.) Show that the wave equation $y = A \sin \omega t$ can also be written as $y = A \sin (\omega t - kx)$ **(6 marks)**

b.) The equation of a transverse traveling wave on a string is given as

$$y = 2 \cos (\pi (0.5x - 200t))$$

Where x and y are in cm and t in seconds. Find;

i.) Wavelength

ii.) Frequency and

iii.) Speed of propagation of the wave. **(6 marks)**

c.) Name two conservation laws that exist in nature. **(2 marks)**

d.) Show that the center of gravity $X_{c.o.g}$ is equal to center of mass X_{com} if the gravity is the same for all elements of a body. **(6 marks)**

QUESTION 3 (20 MARKS)

a.) Draw a labeled diagram of a block and tackle pulley system which has two pulley wheels in each block showing forces in each string. **(2 marks)**

i.) How would you measure the effort necessary to lift a load of 45N using this system? **(1 mark)**

ii.) Explain how far the effort would move if the load rises vertically by 20cm **(2 marks)**

iii.) Calculate the efficiency of the system if an effort of 15N is required. **(3 marks)**

iv.) Why is the efficiency likely to be different for a much smaller load? **(1 mark)**

b.) State Newton's second law of motion. **(1 mark)**

c.) Fig 1 shows a cord holding stationary block of mass 10kg on a frictionless plane that is inclined at an angle $\theta = 30^0$.

i.) What are the magnitudes of the force T on the block from the cord and the normal force N on the block from the plane? **(3 marks)**

ii.) We now cut the cord. As the block then slides down the inclined plane, does it accelerate? If so, what is its acceleration? **(3 marks)**

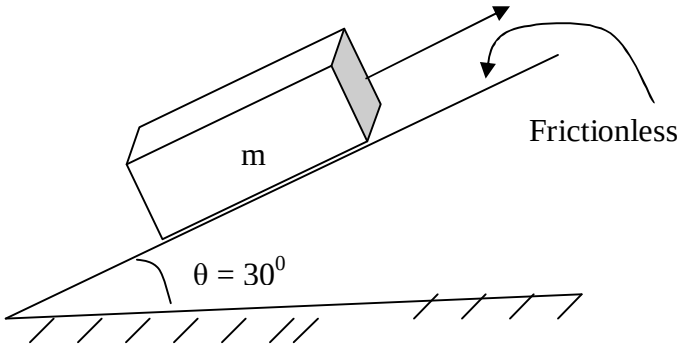

Fig 1

d.) Give the difference between static frictional force and kinetic frictional force. **(2 marks)**

e.) State the law of conservation of momentum. **(2 marks)**

QUESTION 4 (20 MARKS)

a.) Two ice hockey players suitably padded collide directly with each other and immediately become entangled. One has a mass of 110kg and is traveling at $4ms^{-1}$ while the other has a mass of 80 kg and is traveling at $6ms^{-1}$ towards the first player. In which direction and at what speed do they travel after they entangle?

b.) A motor car of mass 1100kg starts from rest and accelerates steadily until it is traveling at $36kmh^{-1}$.

i.) If it takes 11 s to attain this speed, what is its acceleration?

ii.) Calculate the force exerted between the tires and the road to produce this acceleration.

iii.) How far does the car travel during these 11s? **(6 marks)**

c.) State Newton's second law of linear motion. **(1 mark)**

d.) Fig 2 shows constant forces $\mathbf{F_1}$ and $\mathbf{F_2}$ acting on a box as the box slides rightward across a frictionless floor. Force $\mathbf{F_1}$ is horizontal with magnitude 2.0N; force $\mathbf{F_2}$ is angled upward by 60^0 to the floor and has magnitude 4.0N. The speed V of the box at a certain instant is $3.0ms^{-1}$.

i.) What is the power due to each force acting on the box at that instant and what is the net power?

ii.) If the magnitude of F_2 is instead 6N what now is the net power and is it changing? **(4 marks)**

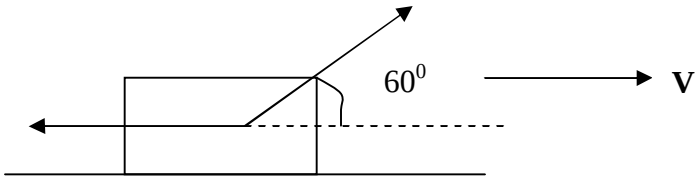

Fig 2