UNIVERSITY OF EMBU

2017/2018 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE,

SCI 101: ELEMENTS OF PHYSICS I

DATE: APRIL 5, 2018 **TIME: 2:00-4:00PM**

INSTRUCTIONS:

Answer Question ONE and ANY other two Questions

Important information

Take acceleration due to gravity g = 9.8 N/Kg

$1eV = 1.6 \times 10^{-19}$ J

Planks Constant = 6.63×10^{-34} Js

Young's modulus of steel = 2×10^{11} Pa

Speed of light in vacuum c = 3.0×10^{8} m/s

QUESTION ONE (30 MARKS)

a) State what you understand by each of the following terms in relation to motion of bodies

i) Displacement (1 mark)

ii) Linear momentum (1 mark)

iii) Angular momentum (1 mark)

b) Differentiate between stress and strain in reference to elasticity of materials (2 marks)

c) In converting electrical energy to light energy, a sixty watt light bulb operates at 2.1 % efficiency. Assuming that all the light is green light (wavelength=555nm), determine the number of photons per second given off by the bulb. (3 marks)

d) What is the area under a sine curve from $x=0$ to $x=\pi/2$? (3 marks)

e) Distinguish between refraction and diffraction of light (2 marks)

f) A body moving with a uniform acceleration of $10m/s^2$ covers a distance of $320m$. If its initial velocity was $60m/s$, find its final velocity. (3 marks)

g) The work function for a silver surface is $W_0 = 4.73\ eV$. Find the minimum frequency that light must have to eject electrons from this surface. (4 marks)

h) A football of mass 5×10^{-2} kg is hit by a footballer, causing it to leave her foot at +60m/s. Find the magnitude of the impulse due to the hit. (2 marks)

i) What is an electromagnetic wave? (1 mark)

j) A vertical steel beam in a building supports a load of $6 \times 10^4\ N$. If the length of the beam is 4 m and its cross sectional area is $8\times10^{-3}m^2$, find the distance the beam is compressed along its length. (3 marks)

k) If velocity is given by $v=4t^3+t^2+2$, how far does a body travel between $t=0$ and $t=2$? (4 marks)

QUESTION TWO (20 MARKS)

a) Find the range in wavelengths (in vacuum) for visible light in the frequency range between 4×10^{14} Hz (red light) and 7.9×10^{14} (violet light). (5 marks)

b) Derive the 3 equations of motions of a body moving in a straight line under constant acceleration. (9 marks)

c) A bus of total mass $7200\ Kg$ is moving along a horizontal road at $12\ m/s$. The bus is brought to rest in $10\ seconds$. Calculate the momentum of the bus at initial velocity and find the kinetic energy lost by the bus once it comes to rest. (6 marks)

QUESTION THREE (20 MARKS)

a) A laser beam is aimed 15.95° above the horizontal (x-axis) at a mirror 11,648 m away. It glances off the mirror and continues for an additional 8600 m at 12° above the horizontal until it hits its target. Draw a vector diagram to illustrate this scenario and hence calculate the resultant displacement of the beam to the target (6 marks)

b) Red light (λ= 664 nm in vacuum) is used in Young's experiment with the slits separated by a distance d = 1.20×10^{-4} m. The screen is located at a distance from the slits given by L = 2.75 m as shown in figure 3.1 below. Find the distance y on the screen between the central bright fringe and the third-order bright fringe. (4 marks)

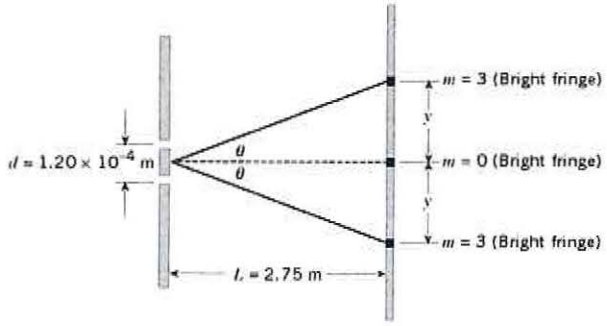

Fig 3.1

c) In a perfectly inelastic collision, a pickup truck with mass *2.4 x 10^3 kg* is travelling eastwards at *+15m/s* while a compact car with mass *9 x 10^2 kg* is travelling westwards at *-20 m/s*. The vehicles collide head on and become entangled after collision. Find the **common speed** of the entangled vehicles after collision and the **change in Kinetic energy** for *each* of the vehicles. (10 marks)

QUESTION FOUR (20 MARKS)

a) Suppose a force that is applied to a car is a function of the car's position. How much work must be done to move the car from *x=2* to *x=4* if the force function *F (x) = 300x* (Newtons)

(5 marks)

b) A block of mass m_1*=1.6* kg moves towards the right with a velocity *+4 m/s* on a frictionless horizontal track. It collides with a mass less spring attached to a second block of mass m_2*=2.1 kg* moving to the left with a velocity *-2.5 m/s* as shown in part (a) below. The spring has a spring constant *6 x10^2 N/M.*

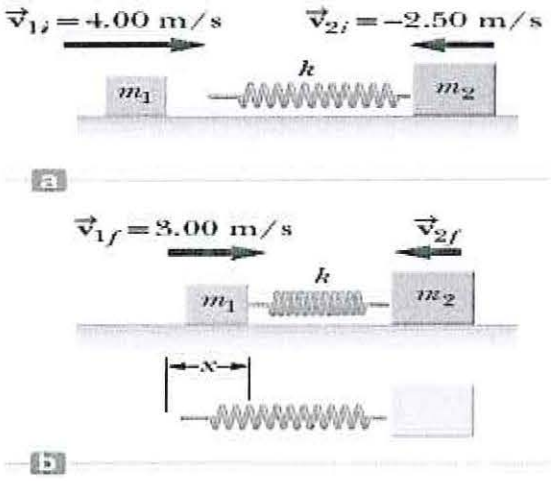

Fig 4.1

i) Determine the velocity of block 2 when block 1 is moving to the right with a velocity *3 m/s* as shown in part (b) above. (5 marks)

ii) Find the compression (x) of the spring (5 marks)

c) The height of a water fall is *33.2 m*. When the water reaches the bottom of the fall, its speed is *25.8 m/s*. Neglecting air resistance, what is the speed of the water at the top of the falls? (5 marks)

QUESTION FIVE (20 MARKS)

a) A high speed train is travelling at a speed of *44.7 m/s* when the engineer sounds the *415Hz* warning horn. The speed of sound is *343 m/s*. Calculate the **frequency** and **wavelength** of the sound as perceived by a person standing at a crossing, when the train is **approaching** and when its **leaving** the crossing (10 marks)

b) i) Write the expression of the equation of continuity and explain what all the symbols in the equation stand for. (3 marks)

ii) A hose pipe has an unobstructed opening with a cross-sectional area of $2.85x10^{-4}\ m^2$ from which water fills a bucket of volume $8x10^{-3}m^3$ in *30s*. Find the speed of water that leaves the hose through (a) the unobstructed opening and (b) through an obstructed opening of area $1.5x10^{-4}m^2$? (7 marks)

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