Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	MECHANICS AND WAVES
COURSE CODE	:	BWC 10803
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Define Newton's Third Law.

(2 marks)

(b) **Figure Q1(b)** shows a box of weight 5000 N lying on an inclined plane with an angle of 35° above the horizontal plane. The box is connected to a ball of weight 70 N by a light string over a smooth pulley. Given the coefficient of kinetic friction, μ_k for the inclined plane is 0.15.

(i) Draw a free body diagram for the system.

(4 marks)

(ii) Calculate the normal force, N for the box.

(3 marks)

(iii) Calculate the frictional force, f experienced by the box.

(3 marks)

(iv) Calculate the acceleration, a of a ball as the box moves down the inclined plane.

(5 marks)

(v) Calculate the tension, T in the string.

(3 marks)

Q2 (a) **Figure Q2(a)** shows a trolley of weight 60 N passing through point A with a velocity of 6 m s^{-1}. It slides down a rail to point C. From A to C, 250 J of energy is lost due to friction. Calculate

(i) The total energy at point A.

(3 marks)

(ii) The velocity of the trolley at point C.

(4 marks)

(b) Define the following terms.

(i) Work-Energy Theorem.

(2 marks)

(ii) Conservation of Mechanical Energy.

(2 marks)

(c) **Figure Q2(c)** shows a 20 N force drags an 8 kg bag through a horizontal distance of 40 m. The force acts at an angle, $\theta = 30°$ with the horizontal floor. The floor is rough with coefficient of kinetic friction, μ_k of 0.20.

(i) Draw the free body diagram of the bag.

(3 marks)

(ii) Compute the work done by the force.

(2 marks)

(iii) Determine the normal force exerted by the bag.

(2 marks)

(iv) Calculate the work done by frictional force.

(2 marks)

Q3 (a) Define the following terms.

(i) Amplitude, A and Period, T.

(2 marks)

(ii) Angular frequency, ω.

(2 marks)

(b) A spring stretches 0.15 m when a 0.3 kg mass is gently attached to it. The spring is then set up horizontally with 0.3 kg mass resting on a frictionless table. The situation is shown in **Figure Q3(b)**. The mass is pushed so that the spring is compressed 0.1 m from the equilibrium point, it is then released from rest.
Determine:

(i) the spring stiffness constant, k and angular frequency, ω.

(4 marks)

(ii) the amplitude, A of the horizontal oscillation.

(2 marks)

(iii) the magnitude of the maximum velocity, v_{max}.

(2 marks)

(iv) the magnitude of the maximum acceleration, a_{max} of the mass.

(2 marks)

(v) the period, T and the frequency, f.

(2 marks)

(vi) the displacement, x as a function of time.

(2 marks)

(vii) the velocity, v at $t = 0.15$ s.

(2 marks)

Q4 (a) State the differences between electromagnetic waves and mechanical waves.
(2 marks)

(b) The magnetic field of a plane electromagnetic wave is described as follows:

$$\vec{B} = B_0 \sin(kx - \omega t)\hat{j}$$

(i) What is the wavelength, λ of the wave?
(2 marks)

(ii) Write an expression for the electric field $\vec{E}$ associated with this magnetic field.
(4 marks)

(iii) What is the direction and magnitude of Poynting vector associated with this wave? State the appropriate unit.
(3 marks)

(iv) This wave is totally reflected by a thin conducting sheet lying in the *y*-*z* plane at $x = 0$. What is the resulting radiation pressure on the sheet? State the appropriate unit.
(3 marks)

(c) A sinusoidal electromagnetic wave emitted by a cellular phone has a wavelength of 35.4 cm and an electric field amplitude of 5.40×10^{-2} Vm^{-1} at a distance of 250 m from the antenna. Determine the

(i) frequency of the wave.
(2 marks)

(ii) magnetic field amplitude.
(2 marks)

(iii) intensity of the wave.
(2 marks)

Q5 (a) (i) Give definitions for interference and diffraction.
(2 marks)

(ii) State the differences in patterns for double-slit interference and single slit diffraction.
(4 marks)

(b) A Fraunhofer diffraction experiment is performed using light of wavelength $\lambda = 5000$ Å with a slit width of 0.05 mm.

(i) How far away must the detecting screen be?

(2 marks)

(ii) If a two-slit system is used, what is the ratio of intensities of the first side-maximum to the central maximum if the distance between the centres of the (identical) slits is 0.1 mm?

(4 marks)

(c) A pair of narrow, parallel slits separated by 0.25 mm is illuminated by green light with wavelength of 546.1 nm. The interference pattern is observed on a screen 1.20 m away from the plane of the parallel slits.

(i) Calculate the distance from the central maximum to the first bright region on either side of the central maximum.

(4 marks)

(ii) Calculate the distance between the first and second dark bands in the interference pattern.

(4 marks)

– **END OF QUESTIONS** –

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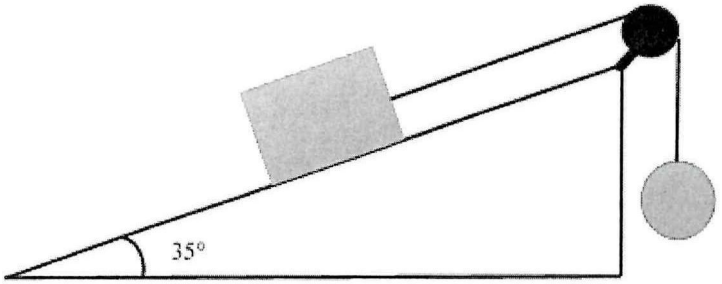

Figure Q1(b)

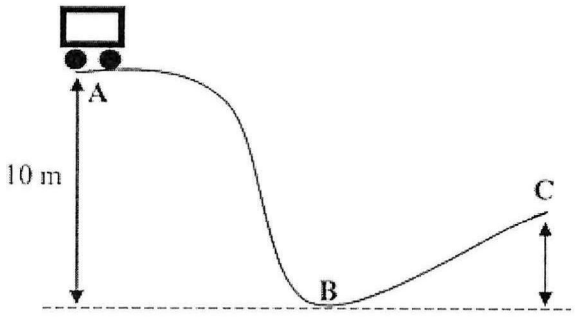

Figure Q2(a)

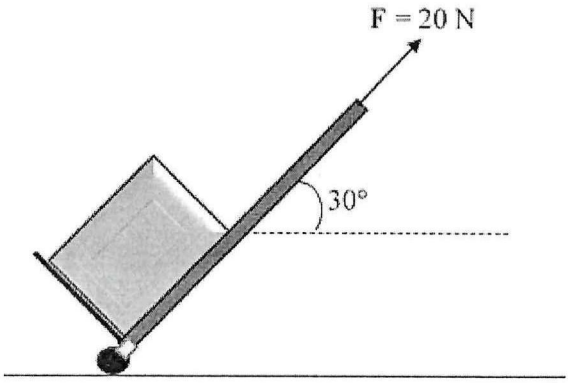

Figure Q2(c)

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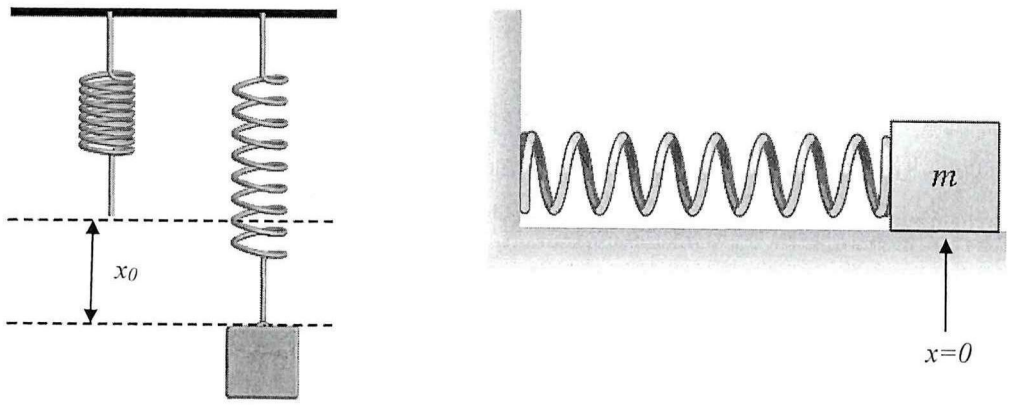

Figure Q3(b)