GLASGOW COLLEGE UESTC

Final Exam paper

Physics I (1009)

Date:30th, June, 2021
Time:14:30-16:30

Attempt all PARTS. Total 100 marks

Use one answer sheet for each of the questions in this exam.
Show all work on the answer sheet.
For Multiple Choice Questions, use the dedicated answer sheet provided.

Make sure that your University of Glasgow and UESTC Student Identification Numbers are on all answer sheets.

An electronic calculator may be used provided that it does not allow text storage or display, or graphical display.

All graphs should be clearly labelled and sufficiently large so that all elements are easy to read.

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

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Q1 Multiple choice

Choose the ONE alternative that best completes the statement or answers the question.

1. ( ) A wheel rotates with an angular velocity of 26rad/s at time t=0 s, and it has a constant acceleration of -0.43rad/s^2. In this situation, the time t at which the kinetic energy of the wheel is twice the initial value, is closest to: [3]

(A) 90 s

(B) 110 s

(C) 130 s

(D) 150 s

2. ( ) A solid cylinder of 90 cm radius is positioned on a frictionless incline 30° above horizontal. A force F is exerted by a string wrapped around the spool. When F has a certain critical value the center of mass of the spool does not move. In this case, what is the angular acceleration of the spool? [3]

(A) 5 rad/s^2

(B) 11 rad/s^2

(C) 14 rad/s^2

(D) 22 rad/s^2

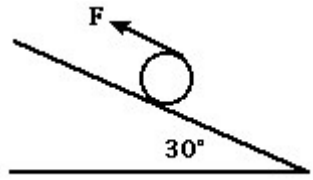

Figure Q1-2.

3. ( ) A 2.0 kg block on a frictionless table is connected to two springs with spring constants k_1 and k_2 whose opposite ends are fixed to walls. What is the oscillation angular frequency if $k_1 = 9.0N/m$ and $k_2 = 5.0N/m$? [3]

(A) 0.42 rad/s

(B) 0.59 rad/s

(C) 2.6 rad/s

(D) 3.7 rad/s

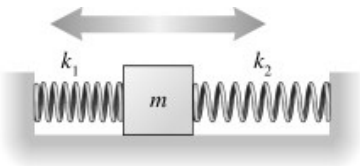

Figure Q1-3.

4. ( ) A 0.25 kg harmonic oscillator has a total oscillation energy of 9.9J. If the oscillation amplitude is 20.0cm, what is the oscillation frequency? [3]

(A) 2.1 Hz

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(B) 3.6 Hz

(C) 5.0 Hz

(D) 7.1 Hz

5. ( ) Which of the following is a FALSE statement? [3]

(A) In a transverse wave the particle motion is perpendicular to the velocity vector of the wave.

(B) Waves transport energy and matter from one region to another.

(C) The speed of a wave is usually different from the speed of the vibrating particles that constitute the wave.

(D) A wave in which particles move back and forth in the same direction as the wave is moving is called a longitudinal wave.

6. ( ) A 2.0 m string is fixed at both ends and tightened until the wave speed is 18 m/s. What is the frequency of the standing wave as shown in figure? [3]

(A) 27 Hz

(B) 54 Hz

(C) 81 Hz

(D) 110 Hz

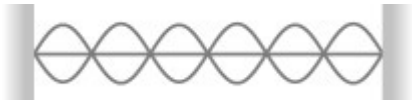

Figure Q1-6.

7. ( ) An optical engineer needs to ensure that the bright fringes from a double-slit are 15.7mm apart on a detector that is 1.70m from the slits. If the slits are illuminated with 633nm light, how far apart should the slits be? [3]

(A) 63.0 μm

(B) 68.5 μm

(C) 74.0 μm

(D) 79.5 μm

8. ( ) Which of the following changes would increase the separation between the bright fringes in the diffraction pattern formed by a diffraction grating? [2]

(A) Increase the wavelength of the light used.

(B) Increase the separation between the slits.

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(C) Immerse the apparatus in water.

(D) None of these.

9. ( ) After a light passes through a polarizer P_1, the intensity is I_0. Then, it passes through another polarizer P_2 and the intensity is I. The maximum of I may be [2]

(A) 0

(B) $I_0/2$

(C) $I_0/\sqrt{2}$

(D) I_0

Q2 Consider a square plane object, with total mass *M* and length *a* for each side. It can rotate about axis perpendicular to the plane.

(a) Calculate the rotational inertia I_1 about the central axis O. [10]

(b) Calculate the rotational inertia I_2 about the axis through point B. [5]

(c) Suppose *M* can rotate on horizontal plane about fixed axis O. A small bullet with mass *m* moves along line AB with speed *v*, hits on *M* and sticks into point A. Find out the angular velocity of system after collision, and calculate the kinetic energy loss in collision. [10]

Hint: Use the parallel axis theorem / perpendicular axis theorem.

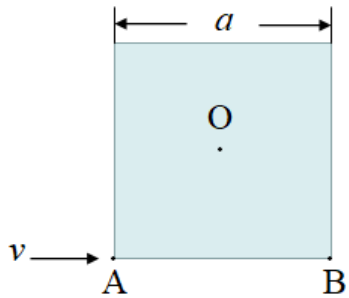

Figure Q2.

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Q3 A plane harmonic transverse wave travels at 50m/s along the +*x* axis.

(a) The motion of particle A in the medium is described as figure (a). Determine its motional equation $y_A(t)$. [9]

(b) If the *x* coordinate of particle A is $x_A = 5\text{m}$, determine the wave function $y_1(x,t)$ for the traveling wave. [8]

(c) If there is another wave y_2 that interferes with y_1 to produce a standing wave, where an antinode appears at point B (*x*=20m). Determine $y_2(x,t)$. [8]

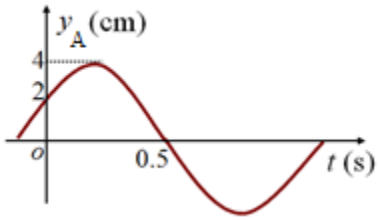

Figure Q3(a).

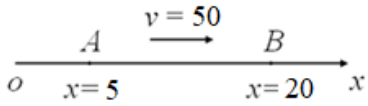

Figure Q3(b)(c)

Q4 Consider an optical grating with 20 slits, the width for each slit is *a*=0.1mm, and the distance between neighboring slits is *d*=0.4mm. Monochromatic light with wavelength 600nm falls on the grating. The optical phenomenon is shown on a screen at a distance *L*=2.0m.

(a) We can use one slit to observe the diffraction. Find out the width *X* of central bright fringe. Suppose the other slits are blocked. [9]

(b) Now open two neighboring slits to observe the interference. What is the distance *X'* between bright fringes? [8]

(c) When all the slits are opened, describe the phenomenon. And what happens when the number of open slits changes from 10 to 20? [8]

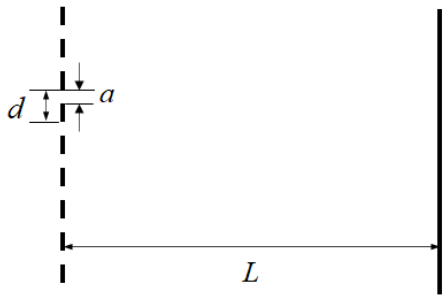

Figure Q4.

End of question paper