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First Semester Examinations 2011/2012

First Year Examinations for the Degree of Bachelor of Science in Mechanical Engineering

SPH 2173: PHYSICS FOR ENGINEERS I

Supplementary/Special

Date	Time
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Please, answer the first question and any two other questions

1. (a) State in words and mathematically formulate three Newton’s laws of motion **(6 marks)**
- (b) Define and differentiate kinetic energy and work. Mathematically prove the relationship between them. Prove that their dimensions are the same **(6 marks)**
- (c) State in words and mathematically formulate the principle of conservation of linear momentum for an isolated system of particles **(6 marks)**
- (d) State in words and mathematically formulate the three Newton’s laws of rotational motion **(6 marks)**
- (e) Define the term “simple harmonic motion, SHM”. Deduce Newton’s law of motion of SHM. Prove the law of conservation of total mechanical energy for SHM **(6 marks)**

2. (a) An auto’s velocity increases uniformly from $6.0 \frac{m}{s}$ to $20 \frac{m}{s}$ while covering $70m$. Find the acceleration and the time taken **(6 marks)**
- (b) A horizontal cable pulls a $200 - kg$ cart along a horizontal track. The tension in the cable is $500N$. Starting from rest
 - (i) How long it will take the cart to reach a speed of $8 \frac{m}{s}$?
 - (ii) How long far will it have gone? **(7 marks)**
- (c) A $6.0 - kg$ block rests on horizontal surface. Its coefficient of kinetic friction is 0.22 . The block is connected by a string passing over a pulley to a $3.0 - kg$ mass as in Fig.1.
 - (i) What is the acceleration a ? (ii) What is the tension T in the string? **(7 marks)**

3. (a) A block falls from a table $0.6m$ high. It lands on an ideal, massless, vertical spring with a force constant of $2.4k \frac{N}{m}$. The spring is initially $25cm$, but it is compressed to a minimum height of $10cm$ before the block stops. Find the mass of the block **(6 marks)**
- (b) What power must a man spend on a $100 - kg$ log that he is dragging down a hillside at a speed of $0.50 \frac{m}{s}$? The hillside makes an angle of 20° with the horizontal and the coefficient of friction is 0.9 **(7 marks)**
- (c) A $500 - g$ wheel has a moment of inertia of $0.015kg.m^2$ is initially turning at $30 \frac{rev}{s}$. It coasts to rest after $163rev$. How large is the torque that slowed it? **(7 marks)**
4. (a) A block of mass $2kg$ hangs from a spring of force constant $k = 800 \frac{N}{m}$. The block is pulled $20cm$ from equilibrium and released
- (i) What are the amplitude, angular frequency, and period of the motion?
- (ii) What are the velocity and acceleration of the block when it is $12cm$ from equilibrium? **(8 marks)**
- (b) A $0.2kg$ mass suspended from a spring describes a simple harmonic motion with a period T of $3s$ and amplitude R of $10cm$. At $t = 0$ the mass passes upward through the equilibrium position.
- (i) Find the force constant k of the spring.
- (ii) Find the displacement, velocity, and acceleration of the mass when $t = 1s$ **(8 marks)**
- (c) An electric heater supplies $1.8kW$ of power in the form of heat to a tank of water. How long will take to heat $200kg$ of water in the tank from 10 to $70^\circ C$? Assume heat losses to the surroundings to be negligible **(4 marks)**
5. (a) For the wave $y = 5 \sin 30f \left[t - \left(\frac{x}{240} \right) \right]$, where x and y are in centimetres and t in seconds, find the (i) displacement when $t = 0$ and $x = 2cm$; (ii) wavelength; (iii) velocity of the wave and (iv) frequency of the wave **(6marks)**
- (b) A body falls from rest. Find (i) its acceleration, (ii) the distance it falls in $3s$ (iii) its speed after falling $70m$ (iv) the time required to reach a speed of $25 \frac{m}{s}$ (v) the time taken to fall $300m$. **(8 marks)**
- (c) A projectile is fired with initial velocity $v_0 = 95 \frac{m}{s}$ at an angle $\theta = 50^\circ$. After $5s$, it strikes the top of a hill. What is the elevation of the hill above the point of firing? At what horizontal distance from the gun does the projectile land? **(6 marks)**
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