BITS, Pilani- Dubai Campus
Knowledge Village

I Year I Semester 2005-06

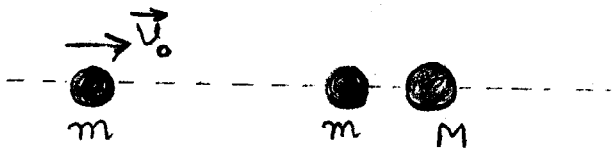
Comprehensive Exam

Course Name:	PHYSICS I	**Course No.:**	PHY UC131
Date:	5th Jan'06	**Weightage:**	40%
Duration:	3 hrs	**Max. Marks:**	40

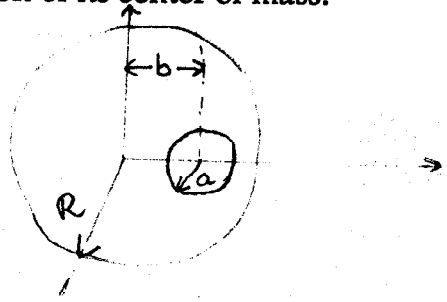
Answer all the questions sequentially.
Start every new question on a fresh page
All questions are compulsory
Data provided is sufficient

SECTION A

Q1. Two spheres on the right are slightly separated and initially at rest; the left sphere is incident with speed v_0. Assuming head on elastic collision (a) if $M \leq m$, show that there are two collisions and find all final velocities (b) if $M > m$, show that there are three collisions and find all final velocities. **[2+1]**



Q2. The uniform solid sphere of radius R shown in figure has a spherical hole of radius a in it. Find the position of its center of mass. **[3]**



Q3. A gyroscope flywheel of radius 2.83cm is accelerated from rest at 14.2 rad/s^2 until its angular speed is 2760 rev/min. **[1+1+1]**

(a) What is the tangential acceleration of a point on the rim of the flywheel?

(b) What is the radial acceleration of this point when the flywheel is spinning at full speed?
(c) Through what distance does a point on the rim move during the acceleration?

Q4. Derive an expression for the moment of inertia of a solid cylinder of mass M, length L and radius R about an axis passing through the center of mass and perpendicular to the axis of the cylinder? **[4]**

SECTION B

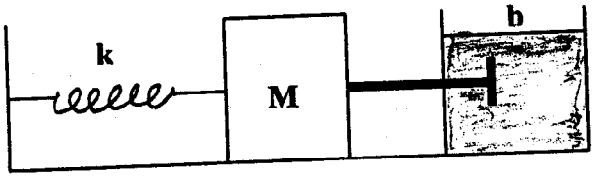
Q5. Calculate the angular momentum about an axis passing through the Earth's center of an 83.5kg person on the equator of the rotating earth. (Given $R_E = 6.37 \times 10^6$ m) **[2]**

Q6. In a 80 person ski lift , a machine raises passengers averaging 650N in weight a height of 145m in 50s at constant speed. Find the power output of the motor, assuming no frictional losses. **[1]**

Q7. A solid sphere of radius 4.5cm rolls without slipping up an inclined plane of inclination angle 32°. At the bottom of the incline, the center of mass of the sphere has a translational speed of 5.15m/s. How far does the sphere travel up the plane? **[3]**

Q8. A 3.5kg block is thrust up a 25°incline with an initial speed v of 4.0m/s. It is found to travel a distance of d = 1.2m up the plane as its speed gradually decreases to zero. How much internal energy does the system of block + plane + earth gain in the process due to friction. **[3]**

Q9. For the system shown in figure, the block has a mass of 1.65kg and the force constant is 8.25N/m. the frictional force is given by –b(dx/dt) where b is 220g/s. suppose that the block is pulled aside a distance of 13.5cm and released
(a) Calculate the time interval required for the amplitude to fall to one third of its initial value.
(b) How many oscillations are made by the block in this time?



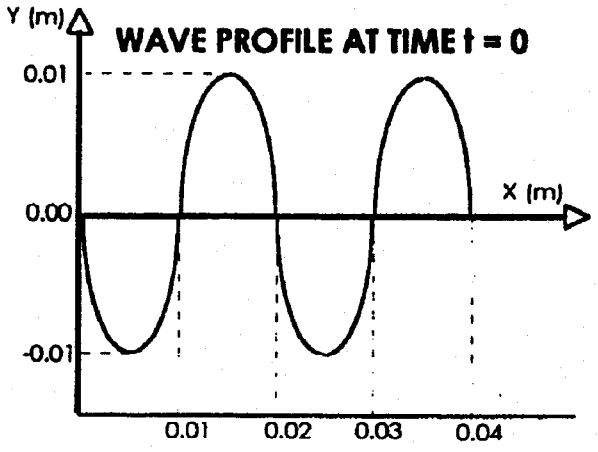
[4]

SECTION C

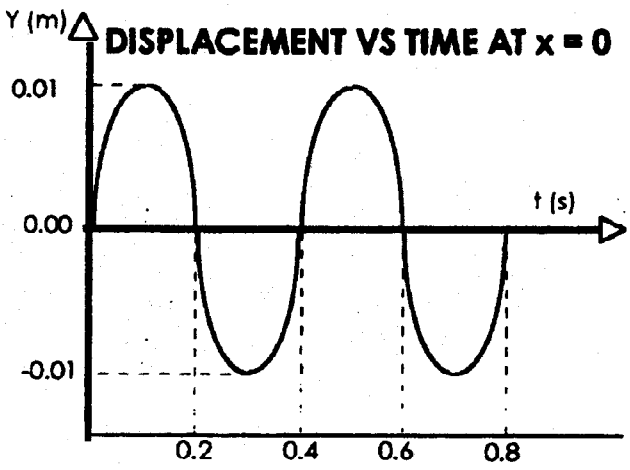
Q10. The two graphs below both represent a transverse harmonic wave moving in the positive x-direction. One shows the wave profile at the specific time $t = 0$, and the other the displacement of the medium at the point $x = 0$.

(a) Use the information provided by the two graphs to write down a mathematical expression for the wave. **[3]**

(b) Given that this wave is on a string of mass per unit length of 10^{-2} kg.m^{-1}, determine the tension in the string. **[1]**



(A)



(B)

Q11. A soap bubble is illuminated by a combination of red light (λ = 680 nm) and blue light (λ = 510 nm). What is the minimum thickness of the soap bubble film to the nearest nm if the red light is strongly reflected and the blue light is not reflected? ($n_{air} = 1$; $n_{soap} = 1.33$) **[3]**

Q12. In a double-slit diffraction experiment using coherent light with a wavelength of λ = 500 nm is sent through two parallel slits, each having a width $a = 0.700$ μm. The distance between the centers of the slits is $d = 2.80$ μm.

(a) Find the direction of all the possible interference maxima on the screen. Express your answers in terms of the angle away from the bisector of the line joining the slits. **[2]**

(b) How many bright fringes appear on the screen? **[1]**

(c) What is the intensity of the second maxima from the centre? **[1]**

Q13. Three discreet spectral lines occur at angles of 10.09°, 13.71°, and 14.77° in the first-order spectrum of a grating spectrometer. **[3]**

(a) If the grating has 3660 slits/cm, what are the wavelengths of the light?

(b) What is the dispersion and total angular width of the second light wavelength obtained?

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I Year I Semester 2005-06

Comprehensive Exam (REPEATERS)

COURSENAME : PHYSICS I; COURSE No. PHY UC131

Duration: 3 hrs Max. Marks: 40

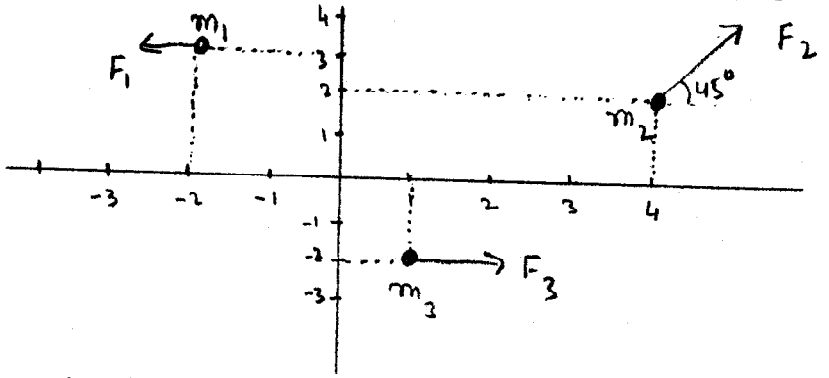
Date: 27/12/2005

Answer all the questions sequentially.
Start every new question on a fresh page
All questions are compulsory
Data provided is sufficient

SECTION A

1. In a game of pool, the cue ball strikes another ball initially at rest. After the collision, the cue ball moves at 3.5 m/s along a line joining at an angle of 65^0 with its original direction of motion. The second ball acquires a speed of 6.75 m/s. Find the
   (a) The angle between the direction of motion of the second ball and the original direction of motion of the cue ball
   (b) The original speed of the cue ball **[1+2]**

2. Below figure shows a system of three initially resting particles of masses m_1=4.1Kg, m_2= 8.2Kg, and m_3=4.1Kg. the particles are each acted on by different net external forces, which have magnitudes F_1=6N, F_2=12N, and F_3=14N. the direction of forces are shown in the figure. (a) Where is the center of mass of this system. (b) what is the acceleration of the centre of mass **[1+2]**



3. Starting from rest at t=0, a wheel undergoes a constant angular acceleration. When t=2.33s, the angular velocity of the wheel is 4.96 rad/s The acceleration continues until t=23s, when it

abruptly ceases. Through what angle does the wheel rotate in the interval t=0 to t=46s? [2+1]

4. A uniform disc of radius R and mass M is spinning with angular speed of w_o. It is placed on a flat horizontal surface. If μ_k is the coefficient of kinetic friction between disc and surface. (a) Find the frictional torque on the disc.(b) How long will it take for the disc to come to the rest [2+2]

SECTION B

5. A car of mass 1400kg moves on a circular race track of radius 40m with a speed of 40m/s. What is the angular momentum relative to the center of the track. [2]

6. To push a 30kg crate up a 25°incline, a worker exerts a force of 130N parallel to incline. As the crate slides 3.5 m how much work is done on the crate a) by the worker, b) force of gravity. [2]

7. An elevator cab of mass m = 900kg moves from street level to the top of the multi-storied building of height h = 405m above ground .What is the change in gravitational potential energy of the cab-earth system. [2]

8. During a rockslide a 550kg rock slides from rest down a hill slope that is 450m long and 295m high. The speed of the rock as it reaches the bottom of the hill is 65m/s. How much mechanical energy does the rock lose in the slide due to friction? [3]

9. A circular hoop of radius 70.2cm and mass 2.45kg is suspended on a horizontal nail. a) find its frequency of oscillation for small displacements from equilibrium b)what is the length of the equivalent simple pendulum. [3 + 1]

SECTION C

10. Two wires are anchored at both ends. Wire 1 has a mass of 85 gm and a length of 12.8 m. Wire 2 has a mass of 50 grams, a length of 20 m, and a tension of 106 N. What must be the tension in Wire 1 if frequency of its third harmonic is to equal that of the second harmonic of Wire 2? If the tension on Wire 1 above is 400 N what is its fundamental frequency? [3]

11. A thin film of alcohol (n=1.2) lies on a flat glass plate (n=1.51). When monochromatic light, whose wavelength can be changed, is incident normally, the reflected light is a minimum for = 512 nm and a maximum for = 640 nm. What is the thickness of the film nm and the order of the interference. [4]

12. In the double-slit Fraunhofer interference-diffraction experiment, if the slits of width 0.010 mm are separated by a distance 0.20 mm, and the incident light is monochromatic with a wavelength λ = 600 nm . How many bright fringes are there in the central diffraction maximum? What is the linear position of the 15th maxima of the interference fringe? D = ২·০ M [3]

13. Light of wavelength 500 nm is incident normally on a diffraction grating. If the third-order maximum of diffraction pattern is observed at 32.0°, (a) what is the number of rulings per centimeter for the grating? (b) What is the Dispersion of at this order and the angular width of the maxima at this point? [4]

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I-Year I-Semester 2005-06
TEST-2 (Open Book)

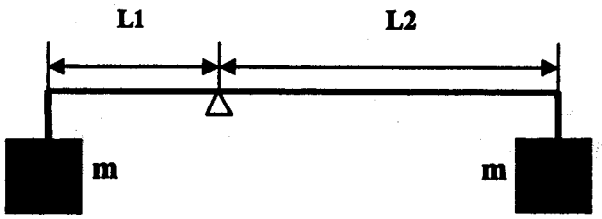
Course Name:	Physics I;	**Course No.:**	PHY UC131;
Date:	20th Nov. 2005;	**Weightage:**	20%;
Test No.:	TEST 2;	**Max Marks:**	30

Q I. A diatomic oxygen molecule O_2 rotating in XY plane about the Z axis passes through its center, perpendicular to its length. The mass of each oxygen atom is 2.75×10^{-26} kg and at room temperature, the average separation between two oxygen atom is $d = 1.30 \times 10^{-10}$ m.

a) Calculate the moment of inertia of the molecule about the Z axis. [2.5]

b) A typical angular speed of a molecule is 4.6×10^{12} rad/s. If the oxygen molecule is rotating with this angular speed about the Z axis, what is its rotational kinetic energy? [2.5]

QII Figure below shows two blocks of mass m suspended from the ends of a rigid weightless rod of length L1 + L2, with L1=30 cm and L2=70 cm. The rod is held in the horizontal position shown in the figure and then released. Calculate the linear acceleration of the two blocks as they start to move. [5]



QIII A) A marble of mass 'm' is moving on a frictionless floor with velocity 'v' along +X direction. What is the angular momentum of the marble with respect to (a) the origin, O, (b) the position (0,2,0). The positions are in meters. [2]

B) Consider a person standing on a platform that can rotate. The person is holding a wheel that is spinning such that its angular momentum is pointing upwards as shown in Fig 1:

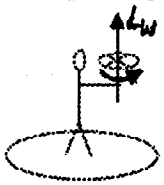


Fig: 1

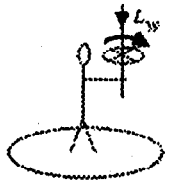
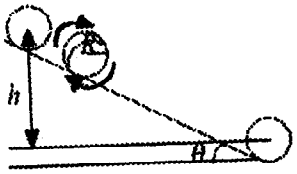


Fig: 2

The person then turns the wheel over so that the angular momentum of the wheel is pointing down, Fig. 2. (a) What happens to the motion of the man? (b) Why? (c) What is his angular momentum compared to the original angular momentum of the wheel before it was turned upside down? [3]

QIV A) Consider a disk rolling down a ramp without slipping:



Assuming the disk is initially at rest:

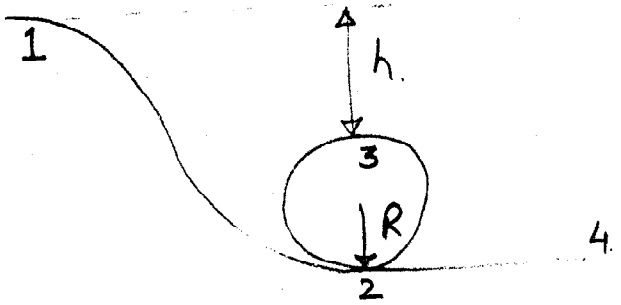
(a) What makes the disk start rolling? (b) What is the translational speed of its center of mass when it reaches the bottom of the ramp? (c) What is its angular velocity when it reaches the bottom of the ramp? [3]

B) Calculate the velocity of the centre of mass for (a) a sphere, (b) a hollow cylinder, at the bottom of the inclined plane. Both have mass 'm' and radius 'r'. [2]

QV A toy car starts from rest at position 1 (shown in the figure) and rolls without friction along the loop1234 whose radius is R.

(a) Find the smallest height h at which the car can start such that it just completes the loop at 3 without falling off the track.

(b) What speed does the car have at position 4? [2+3]



Q VI A particle of mass 50 Kg slides down a slope of length 60 meter which makes an angle 30^0 with horizontal. The speed of the particle when it reaches the bottom of the slope is 5 m/s. How much mechanical energy does the particle lose in the slide due to friction ($g=9.8 m/s^2$). [5]

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I-Year I-Semester 2005-06
QUIZ-1 (Closed Book)

Course Name:	Physics I;	**Course No.:**	PHY UC131;
Date:	8th Nov. 2005;	**Weightage:**	10%;
Test No.:	QUIZ 1;	**Max Marks:**	12

NOTE: All questions carry **one mark each**. Please ***enclose the final answer in a box.***
Use the attached blank sheet for rough work.

VERSION A

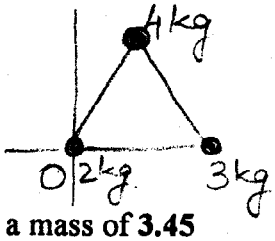
1. A glider of mass of mass $\mathbf{m_1}$ = **1.35kg** moves with a velocity of **3.75m/s** on a frictionless level air track and collides with a second glider of mass $\mathbf{m_2}$ = **2.5kg** that is initially at rest. After the collision, the first glider is found to be moving at **1.09m/s** in a direction opposite to that of its initial motion. What is the velocity of $\mathbf{m_2}$ after the collision?

Ans:

2. After a totally inelastic collision, two objects of the same mass and initial speed are found to move away together at half their initial speed. Find the angle between the initial velocities of the objects.

Ans:

3. Locate the centre of mass of three particles of 2 kg, 3 kg and 4 kg placed at the three corners of an equilateral triangle of 1 meter side?



Ans:

4. A rocket at rest in space where there is virtually no gravity has a mass of **3.45 x 10 ^{5} kg** of which **2.05 x 10^5 kg** is fuel. The engine consumes fuel at the rate of **495 kg/s** and the exhaust speed is **3.45 km/s**. The engine is fired for **325 s**. Find the thrust of the rocket .

Ans

5. A rigid object is rotating with an angular speed $\omega < 0$. The angular velocity vector ω and angular acceleration α are antiparallel. The angular speed of the object is _____(clockwise/anticlockwise) and _____(increasing/decreasing)

6. A bicycle wheel with a radius of 0.4 m, initially at rest, undergoes a constant angular acceleration of 2 rad/s^2. Find a) instantaneous angular velocity, linear velocity and angular displacement of the wheel after 3 seconds.

Ans:

7. A section of hollow pipe and a solid cylinder have the same radius, mass and length. They both rotate about their long central axes with the same ω. Which object has the higher rotational kinetic energy?

Ans:

8. A turntable is connected to a motor and is rotating with and angular speed ω. When the motor is switched off the turntable takes a time interval Δt to come to stop. You replace this turntable with another turntable of same mass but twice the radius. You rotate this turntable at the same angular speed as the previous and then switch off the motor. If the frictional torque remains the same as that for the previous situation, what is the time interval to stop this turntable compared to Δt for the previous one?

Ans:

9. A boy stands on a freely rotating platform. With his arm extended, his rotation speed is 0.25 rev/s. But when he draws them in, his speed is 0.80 rev/s. Find the ratio of his moment of inertia in the first case to that in the second.

Ans:

10. The velocity of a particle of mass m is $v = 5i + 4j + 6k$ when $r = -2i + 4j + 6k$. Find the angular momentum of the particle about the origin.

Ans:

11. A block of mass 3.63 kg slides on a horizontal frictionless table with a speed of 1.22m/s. It is brought to rest in compressing a spring (spring constant = 135N/m) in its path. By how much is the spring compressed?

Ans:

12. Compute the power output of a machine that lifts a 500 Kg crate through a height of 20m in a time of 60 s?

Ans:

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I-Year I-Semester 2005-06
QUIZ-1 (Closed Book)

Course Name:	Physics I;	**Course No.:**	PHY UC131;
Date:	8th Nov. 2005;	**Weightage:**	10%;
Test No.:	QUIZ 1;	**Max Marks:**	12

NOTE: All questions carry **one mark each**. Please ***enclose the final answer in a box.***
Use the attached blank sheet for rough work.

VERSION B

1. The velocity of a particle of mass m is v= 5i+ 4j+ 6k when r = -2i+ 4j+ 6k. Find the angular momentum of the particle about the origin.

Ans:

2. Compute the power output of a machine that lifts a 500 Kg crate through a height of 20m in a time of 60 s?

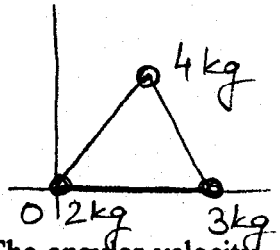
Ans:

3. A section of hollow pipe and a solid cylinder have the same radius, mass and length. They both rotate about their long central axes with the same ω. Which object has the higher rotational kinetic energy?

Ans:

4. Locate the centre of mass of three particles of 2 kg, 3 kg and 4 kg placed at the three corners of an equilateral triangle of 1 meter side?

Ans:



5. A rigid object is rotating with an angular speed ω < 0. The angular velocity vector ω and angular acceleration α are antiparallel. The angular speed of the object is _____(clockwise/anticlockwise) and _____(increasing/decreasing)

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Ans:

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Ans:

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Ans:

9. A turntable is connected to a motor and is rotating with and angular speed ω. When the motor is switched off the turntable takes a time interval Δt to come to stop. You replace this turntable with another turntable of same mass but twice the radius. You rotate this turntable at the same angular speed as the previous and then switch off the motor. If the frictional torque remains the same as that for the previous situation, what is the time interval to stop this turntable compared to Δt for the previous one?

Ans:

10. A boy stands on a freely rotating platform. With his arm extended, his rotation speed is 0.25 rev/s. But when he draws them in, his speed is 0.80 rev/s. Find the ratio of his moment of inertia in the first case to that in the second.

Ans:

11. After a totally inelastic collision, two objects of the same mass and initial speed are found to move away together at half their initial speed. Find the angle between the initial velocities of the objects.

Ans:

12. A rocket at rest in space where there is virtually no gravity has a mass of **3.45 x 10 ^{5} kg** of which **2.05 x 10^5 kg** is fuel. The engine consumes fuel at the rate of **495 kg/s** and the exhaust speed is **3.45 km/s**. The engine is fired for **325 s**. Find the thrust of the rocket .

Ans:

BITS, PILANI – DUBAI CAMPUS
KNOWLEDGE VILLAGE, DUBAI

I-Year I-Semester 2005-06
TEST-1 (Closed Book)

Course Name:	Physics I;	**Course No.:**	PHY UC131;
Date:	2nd Oct. 2005;	**Weightage:**	20%;
Test No.:	TEST 1;	**Max Marks:**	30

Q I. A) A skater is standing still on a frictionless ice rink. Her friend throws a Frisbee straight at her. In which of the following cases is the largest momentum transferred to the skater? (a) The skater catches the Frisbee and holds onto it? (b) The skater catches the Frisbee momentarily, but then drops it vertically downward. (c) The skater catches the Frisbee, holds it momentarily, and throws it back to the friend. **[1]**

B) A trolley of mass 1500 kg collides with a wall. The initial velocity of the trolley is 15 m/s and it rebounds with a velocity of 2.6 m/s. If the collision lasts for 0.15 s, find the impulse caused by the collision and the average force exerted on the car. **[3]**

C) A proton collides elastically with another proton that is initially at rest (close interaction). The incoming proton has an incoming speed of 3.50×10^5 m/s. After the collision, one proton moves off at an angle of 37.0° to the original direction of motion, and the second deflects at an angle of Φ to the same axis. Find the final speeds of the two protons and the angle Φ. If the whole system is observed by a neutron moving by with the speed 1.0×10^5 m/s along the initial direction of the proton, what are the various velocities as observed by this neutron? **[6]**

QII A) A straight rod of length L has one of its ends at the origin and the other at x=L. If the mass per unit length of the rod is given by Ax where A is a constant, calculate its center of mass? **[4]**

B) A rocket at rest in space, where there is virtually no gravity, has a mass of 2.55×10^5 kg, of which 1.81×10^5 kg is fuel. The engine consumes fuel at the rate of 480 kg/s, and the exhaust speed is 3.27 km/s. Te engine is fired for 250 s.

(a) Find the thrust of the rocket engine

(b) What is the mass of the rocket after the engine burn?

(c) What is the final speed attained? **[2+2+2]**

QIII A) The angle turned through by a wheel of a generator during a time interval of ' t ' is given by

$$\emptyset = at + bt^4 - ct^6$$

Where a, b, c are constants. What is the expression for its (a) angular velocity (b) angular acceleration? **[2+2]**

B) The flywheel of an engine is rotating at 33.5 rad/s. When the engine is turned off, the flywheel decelerates at a constant rate and comes to rest after 23s. Calculate the (a) angular acceleration (in rad/s^2), (b) the angle (in rad) through which the flywheel rotates in coming to rest, and (c) the number of revolutions made by the flywheel in coming to rest. **[2+2+2]**