# The University of Zambia
## Physics Department
## Term Test-II March 2015
## PHY 1010: Introductory Physics- I

**All questions carry equal marks. The marks are shown in brackets. Question 1 is compulsory. Attempt three more questions. Clearly indicate on the answer script cover page which questions you have attempted.**

**Time: Two hours.** **Maximum marks = 100.**

**Write clearly your name, computer number, and tutorial group number on the answer book.**

---

**Wherever necessary use:**

$g$ = 9.8 m/s$^2$ : $\rho_{water}$ = 1000 kg/m$^3$ : 1 hp = 746 watts : 1 ton = 1000 kg

**Some equations you may find useful:**

$x = v_{avg}t$ : $v_f = v_0 + at$ : $v_f^2 = v_0^2 + 2ax$ : $x = v_0 t + \frac{1}{2}at^2$ : $W = mg$ : **p** = m**v**

$f = \mu F_N$ : $Ft = \Delta p = m(v_f - v_0)$ : work = $Fs\cos\theta$ : K.E. = (½)$mv^2$ : $F = ma$

G.P.E. = $mgh$ : power = work/time = $Fv$ : $\Delta PE + \Delta KE + \Delta TE = 0$

$R = \frac{2u^2 \sin\theta\cos\theta}{g} = \frac{u^2 \sin 2\theta}{g}$ : $y = x\tan\theta - \frac{g}{2v_0^2\cos^2\theta}x^2$ : $t = \frac{2u\sin\theta}{g}$ : $v_{avg} = \frac{v_f + v_0}{2}$

$v_T = \omega r$ : $\omega_f = \omega_0 + \alpha t$ : $\omega_f^2 = \omega_0^2 + 2\alpha\theta$ : $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ : $F_C = (mv^2/r)$ : $I = mk^2$ : $a_T = \alpha r$ :

$L = I\omega$ : $\tau = I\alpha = Fr$ : $v_T = (2\pi r)/T$ : $\tan\theta = v^2/rg$ : $I = \sum mr^2$ : $KE_{total} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$ :

$1rev = 360^0 = 2\pi\, rad$ : $F = G\frac{m_1 m_2}{r^2}$ : volume of a sphere = $\frac{4}{3}\pi r^3$

**For Question 1, you must use the blank answer sheet provided.**

**For other questions, clearly indicate which one you are attempting:**

**Example:**

**Question 2(b)**

**DO NOT write the question number in the top left corner of the page, and then staple over it!! We have to see it.**

**Question 1:** Sample answers: F (a), G (d).... etc. For each correct answer, 2.5 marks. For each wrong answer, (0.83) will be deducted. No answer, zero mark. No deduction of marks for not attempting. Minimum total mark for Question 1 is zero. **So don't be afraid to attempt!!** **[10 × 2.5 = 25]**

(A) In any collision between two objects there need not be the conservation of

(a) linear momentum
(b) total energy
(c) kinetic energy
(d) angular momentum

(B) An object in equilibrium may not have

(a) any torques acting on it
(b) any force acting on it
(c) acceleration
(d) velocity

(C) Momentum is most closely related to

(a) potential energy
(b) kinetic energy
(c) power
(d) impulse

(D) Object *A* strikes object *B*, which is initially at rest. The maximum transfer of energy from *A* to *B* occurs when $m_A$ is

(a) greater than $m_B$
(b) less than $m_B$
(c) equal to $m_B$
(d) any of the above, depending on the speed of *A*

(E) The gravitational acceleration of an object

(a) varies somewhat over the surface of the Earth
(b) has the same value everywhere on the surface of the Earth
(c) has the same value everywhere in space
(d) is greater on the moon because of its smaller diameter

(F) The rotational equivalent of force in linear motion is

(a) angular momentum
(b) moment of inertia
(c) weight
(d) torque

(G) A ballet dancer spins faster when she folds her arms due to

(a) increase in energy and increase in angular momentum
(b) constant angular momentum and increase in kinetic energy
(c) decrease in friction
(d) increase in energy and decrease in angular momentum

(H) In what direction does the force exerted by the lower hinge of a door act?

(a) straight up
(b) straight down
(c) horizontally outward toward the door
(d) horizontally inward toward the door support

(I) The product of torque and the angular displacement through which the torque acts is called

(a) rotational inertia
(b) work
(c) moment of inertia
(d) radius of gyration

(J) The centre of gravity of an object

(a) is always at the geometrical centre
(b) is sometimes arbitrary
(c) is always in the interior of the object
(d) maybe outside the object

**Attempt any three questions from the following:**

**Q 2 (a)** A 600 g pool ball moving at 2.0 m/s hits a second pool ball of the same mass at rest. The first ball moves off at 1.5 m/s at an angle of 30° from the original direction. Assume the surface of the pool table to be frictionless. Find:

i) the angle at which the second ball moves off, and
ii) the speed of the second ball after impact. **[13]**

**(b)** A 5 kg cat walks out on a hinged beam held in the horizontal position by a support wire in order to try and reach a basket containing frozen 2.0 kg fish hanging at the end of the beam as shown in figure 1. The beam is uniform and weighs 20 N, and is 3 m long.

i) Draw a free-body diagram for the arrangement, and
ii) find the tension in the support wire and the components of the reaction force at the hinge when the cat is 1 m away from the hinge. **[12]**

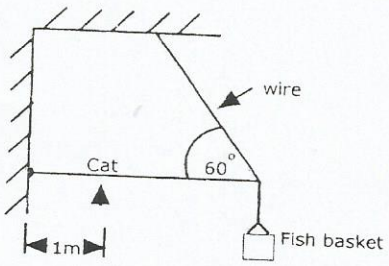
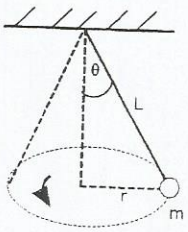



Figure 1

**Q 3 (a)** Consider the conical pendulum shown below in which a bob of mass *m* tied to a string of length *L* moves in a circular path of radius *r*. Sketch the forces acting on it in a free-body diagram and obtain the expression for the final velocity *v*.

**[9]**




**(b)** An electric fan is turned off and its angular velocity decreases from 500 rev/min to 200 rev/min in 4 s. Find:

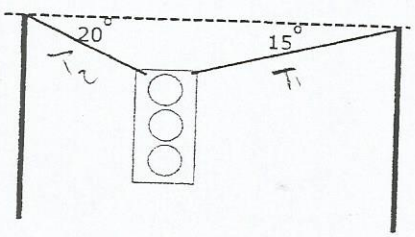
i) the angular acceleration in rad/s$^2$;
ii) the angular displacement in radians after 4 s; and
iii) how long it takes the fan to come to rest?

**[9]**

**(c)** A 950 N traffic signal unit is suspended from a cables attached to posts on either side of the road. The cable on the right makes an angle of 15° with respect to the horizontal. The cable on the left makes an angle of 20° with respect to the horizontal.

i) Calculate the ratio of the tensions in the two cables, $T_1/T_2$. (The tension in the cable on the right is $T_1$).
ii) Calculate the tension $T_2$ in the cable on the left

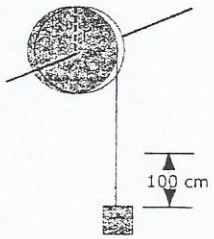
**[7]**



**Q 4 (a)** A wheel of radius 6 cm is mounted so as to rotate about a horizontal axis through its centre. A string of negligible mass wrapped round its circumference carries a mass of 200 g attached to its free end. When allowed to fall, the descends through 100cm in 5 seconds. Calculate:

i) its moment of inertia; and

ii) the tension in the cord. **[12]**



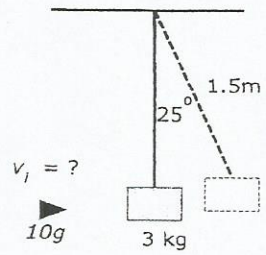

**(b)** A sphere of mass $M$ and radius $R$ starts from rest at a height $h$ and rolls down a 25° slope which is 3.55 m long. What is the linear velocity of the sphere as it leaves the slope? [$I_{sphere} = \frac{2}{5} MR^2$] **[10]**

**(c)** A 3 kg metal ball is moving with a velocity of 5 m/s. How large is the force needed to stop the metal ball in a time interval of $6.0 \times 10^{-4}$ seconds? **[3]**

**Q 5 (a)** A train has to negotiate a curve of radius 300 m; in order to minimize wear on the outer wheels the outer rail has to be raised by a height $h$ in relation to the inner rail. The speed limit of this section is 40 kph and the rails are 1 m apart. Calculate the height $h$. **[7]**

**(b)** When 100 J of work is done on a heavy wheel, its angular speed increases from 60 rev/min. to 180 rev/min. What is its moment of inertia? **[8]**

**(c)** A 10 g bullet is fired horizontally into a 3 kg block of wood suspended from a string 1.5 m long. The bullet gets lodged into the block. The block swings up because of the impact deflecting the string to a position 25° from the vertical. Find the initial speed of the bullet. **[10]**




**-END OF TEST 2-**