The University of Zambia
School of Natural Sciences
Department of Physics
2013/2014 Academic Year
Final Examinations
PHY1010: Introductory Physics

Question 1 is compulsory. Attempt only four more questions.
Clearly indicate on the answer script which questions you have attempted.
All questions carry equal marks. The marks are shown in brackets.
Show your working clearly. Omission of essential work will lead to loss of marks.

Time: Three Hours. **Maximum Marks: 100.**

Write only your computer number clearly on the answer book as well as on the answer sheet for Question 1. Tie them together. Do not write your name.

Wherever necessary use:

$G = 6.67 \times 10^{-11}$ N.m^2/kg^2 : $g = 9.8$m/s^2 : $P_A = 1.013 \times 10^5$ N/m^2 : $\rho_{water} = 1000$kg/m^3 :

specific heat capacity of water = 4200J/kg.K : 1 pascal = 1 N/m^2 : 1 cal. = 4.2 J :

$R = 8314$ J/kmol.K :

The University of Zambia
Physics Department
University Examinations 2013/2014
PHY1010 Introductory Physics

Answer sheet for Question 1

Computer Number only .....

Q1. Put a cross (×) or tick mark (√) in the appropriate box.
If it is on the dividing line, it will not be counted.

	a	b	c	d
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				

Do NOT write here.
For official use only:

	Number of parts N	Factor f	Marks f × N
Correct		2	
Wrong		–(0.67)	
	Net Marks:		

Attach this sheet firmly with the main answer book. If you lose this sheet, you will lose the marks for Question 1!!

Question 1: Sample answers: F(a), G(d).... etc. For each correct answer, 2 marks. For each wrong answer, 0.67 will be deducted. No answer, zero mark. Minimum total mark for Question 1 is zero. **It is worth trying!!** [**10 × 2 = 20**]

(A) A body will gain in G.P.E. if it:

(a) moves up

(b) moves down

(c) moves horizontally

(d) does not move.

(B) A shell fired from a cannon explodes in mid-air. Then:

(a) its total momentum increases

(b) its total momentum decreases

(c) its kinetic energy increases

(d) its momentum and kinetic energy remain unchanged.

(C) All rotating objects at sea level that have the same mass and angular velocity also have the same:

(a) moment of inertia

(b) angular momentum

(c) gravitational potential energy

(d) kinetic energy.

(D) The center of gravity of an object:

(a) is sometimes arbitrary

(b) may be outside the object

(c) is always at its geometrical center

(d) is always at the interior of the object.

(E) Good absorbers of heat are also:

(a) poor emitters (b) non-emitters

(c) good emitters (d) highly polished.

(F) Air in a cylinder is suddenly compressed by a piston, which is then maintained at the same position. With the passage of time:

(a) the pressure decreases

(b) the pressure increases

(c) the pressure may remain constant

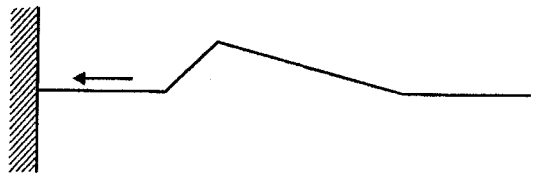
(d) the pressure may increase or decrease, depending on the nature of the gas.

(G) Two waves are given by the equations $y = a \sin(\omega t - kx)$ and $y = a \cos(\omega t - kx)$. The phase difference between the two waves is:

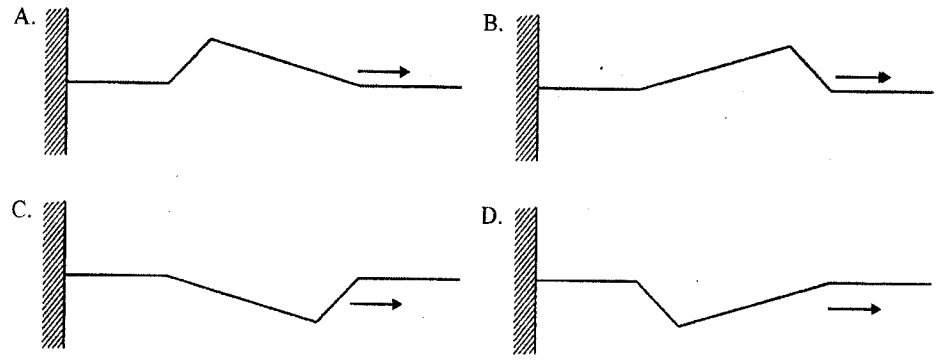
(a) π (b) $\pi/4$

(c) $\pi/2$ (d) zero.

(H) A pulse is sent down a string fixed at one end.



Which **one** of the following diagrams best represents the reflected pulse?



(I) Which of the following statements is false?

(a) change in air temperature has no effect on the speed of sound,

(b) change in air pressure has no effect on the speed of sound,

(c) speed of sound in water is higher than that in air

(d) two persons on moon cannot hear the sound of each other.

(J) Doppler's effect is applicable for:

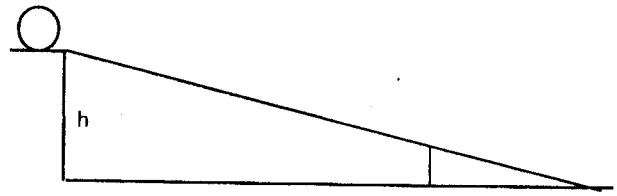
(a) light waves only
(b) sound waves only
(c) both light and sound waves
(d) neither light nor sound waves.

Attempt any four questions only from below. If you attempt more than that, we may choose the first four attempted.

Q2(a). A vector **A** of magnitude 6N has a direction 30^0 anti-clockwise from the $+y$-direction. Another vector **B** magnitude 15 N has a direction 180^0 clockwise from the $+x$-direction. A third vector **C** magnitude 9 N has a direction 45^0 anti-clockwise from the $+x$-direction. They all start out from the origin of the axes. Find **A** - **B** + **C**. **[7]**

(b) A police siren appears to change pitch from 850 Hz to 770 Hz as it rushes past a person standing by the road side. How fast is the police car moving past the person?
The speed of sound in air is 343 ms^{-1}. **[7]**

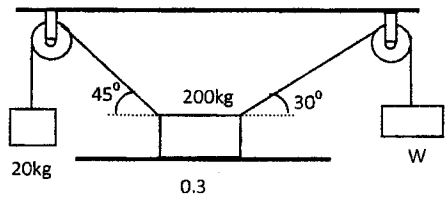
(c) A uniform disk and a uniform sphere of the same mass and radius roll down an inclined plane from the same point. Find the ratio of the disk's speed to that of the sphere at the bottom of the incline. [For the sphere, $I = (2/5)\ MR^2$ and for the disk $I = (1/2)\ MR^2$] **[6]**



Q3(a). If a freely falling body travels half its total path in the last second, calculate the time and height of its fall. **[8]**

(b) An iron bar 400 cm long is clamped 100 cm from one end. Find the lowest resonance frequency for longitudinal waves in the bar. Draw the figure.
(Given, velocity of the wave in the bar = 4000 m/s) **[5]**

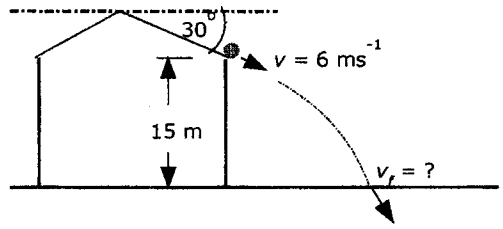
(c) Two weights are hung over two frictionless pulleys as shown in the figure below. What weight W will cause the 200kg block to just start moving to the right. Given, coefficient of static friction between the table and the block is 0.3 **[7]**



Q4(a). A sloping roof of a building makes an angle of 30^0 with respect to the horizontal and the edge of the roof is 15 m above the ground. A ball rolling from the top of the roof attains a velocity of 6 ms^{-1} as it leaves the edge of the roof. See figure below.

i) How long does it take for the ball to hit the ground?
ii) How far horizontally from the bottom of the building does the ball strike the ground?

[7]



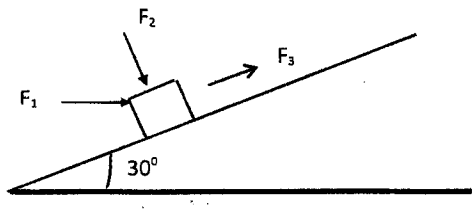
(b) A glass rod and a steel rod are of equal length at 0^0C. At 100^0C they differ in length by exactly 0.001m. What were the lengths at 0^0C? **[7]**

Given α_{glass} = 0.000008/^{0}C and α_{steel} = 0.000012/^{0}C.

(c) Find the maximum load in kg which may be hung from a steel wire of diameter 1mm if the permitted strain may not exceed 1/1000. Young's modulus for steel is 2.00 $\times 10^{11}$ N/m^2.

[6]

Q5(a). A block moves up a 30° incline under the action of certain forces, three of which are shown in the figure. F_1 is a horizontal force of magnitude 40N. F_2 is normal to the plane having a magnitude of 20N, while F_3 is parallel to the plane of magnitude 30N. Determine the work done by each force as the block moves 80cm up the incline. **[6]**



(b) A swimmer has 0.820 liter of dry air in his lungs when he dives into a lake. Assuming the pressure of the dry air inside his lungs is 95% of the external pressure at all times, what is the volume of the dry air in his lungs at a depth of 10.0 m?
Assume that atmospheric pressure at the surface is 1.013×10^5 Pa. **[7]**

(c) Two guitar strings are tuned to the same frequency of 294 Hz. The tension in one string is then decreased by 2%. What will be the beat frequency when the two strings are played together? **[7]**

Q6(a). A billiard ball moving at 4 m/s strikes another identical billiard ball at rest and moves off at 3.46 m/s in a direction 30^0 from the original direction. Find the velocity of the target ball. **[7]**

(b) A small balloon partly filled with helium has a radius of 18.0cm (spherical shape). Internal pressure is 1.05 atm at 20^0C. Find the number of moles of helium in the balloon, and the mass of the helium. (M =4 for He_2) **[7]**

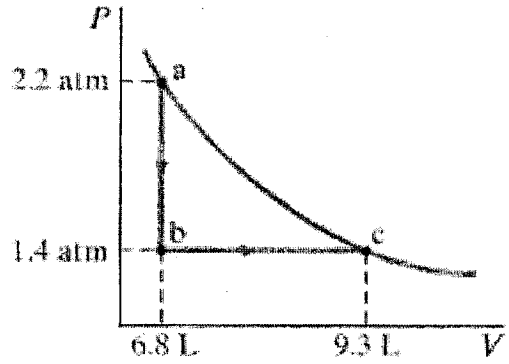
(c) As shown in the figure below, consider the following two-step process. Heat is allowed to flow out of an ideal gas at constant volume so that its pressure drops from 2.2 atm to 1.4 atm. Then the gas expands at constant pressure, from a volume of 6.8 litres to 9.3 litres, where the temperature reaches its original value.

Calculate

(i) the total work done by the gas in the process,

(ii) the change in internal energy of the gas in the process, and

(iii) the total flow of heat into or out of the gas. **[6]**

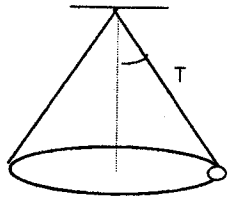


Q7(a). As shown in the figure below,

(i) calculate the force necessary to keep a mass of 0.8kg revolving in a horizontal circle of radius 0.7m with a period of 0.5s,

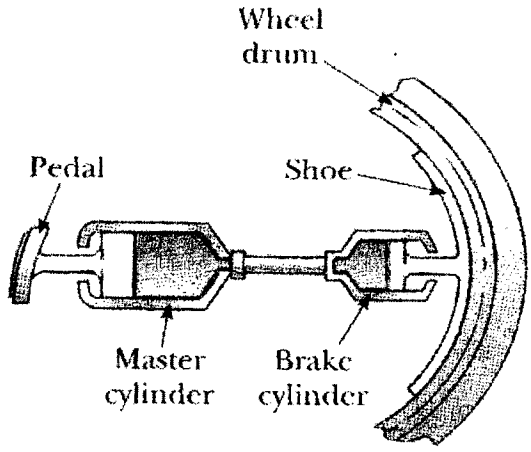
(ii) calculate the direction of this force,

(iii) calculate also the tension in the string. **[7]**



(b) Figure below shows the essential parts of a hydraulic brake system. The area of the piston in the master cylinder is 6.4cm^2, and that of the piston in the brake cylinder is 1.8 cm^2. The incompressible brake fluid is pumped from the Master cylinder to the Brake cylinder when the brake is applied. The coefficient of friction between shoe and wheel drum is 0.5.

If the wheel has a radius of 34cm, determine the frictional torque about the axle when a force of 44N is exerted on the brake pedal. **[6]**



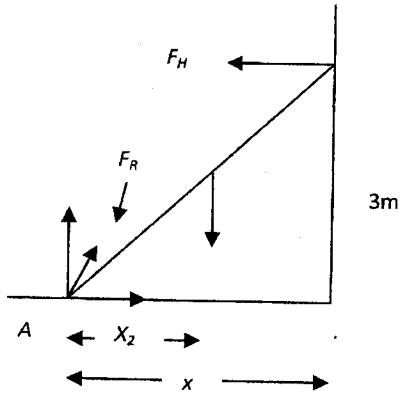
(c) The efficiency of a reversible engine working between two temperatures is 0.5. If on increasing the temperature of the cold reservoir by 100 ^{0}C, the efficiency becomes 0.333, find the temperatures of the source and the cold reservoir. **[7]**

Q8(a). A glass contains 0.25 kg of water initially at 25^0C. How much ice, initially at -20^0C, must you add to obtain a final temperature of 0^0C with all the ice melted?

Neglect the heat capacity of the glass.

Given, $c_w = 4190\,\text{J/kg.K}$, $c_i = 2100\,\text{J/kg.K}$, $L_f = 3.34\times10^5\,\text{J/kg}$ **[10]**

(b) As shown in the figure below, a uniform ladder 5m long is leaning against a frictionless wall with its upper end 3m above the ground level. If the ladder weighs 150N, what forces does it exert on the wall (F_H) and on the ground (F_R)? **[10]**



==End of PHY1010 Final Exam 2014==

Some Equations

Uniformly accelerated motion:

$x = \bar{v}t \qquad \bar{v} = \frac{1}{2}(v_f + v_i) \qquad v_f = v_i + at \qquad v_f^2 = v_i^2 + 2ax \qquad x = v_i t + \frac{1}{2}at^2$

Projectile motion:

$v_x = v_i \cos\theta_i = \text{constant} \qquad v_y = v_i \sin\theta_i - gt \qquad y = (v_i \sin\theta_i)t - \frac{1}{2}gt^2$

$y = (\tan\theta_i)x - \left[\frac{g}{2v_i^2(\cos^2\theta_i)}\right]x^2 \qquad R = \frac{v_i^2}{g}\sin 2\theta \qquad t = \frac{2v_i \sin\theta}{g}$

Force and motion:

$F = ma \qquad w = mg \qquad F_{AB} = -F_{BA} \qquad F_f = \mu F_N$

Energy:

$PE = wh = mgh \qquad KE = \frac{1}{2}mv^2 \qquad W = Fx\cos\theta \qquad P = \frac{W}{t} = Fv\cos\theta$

Linear momentum:

$p = mv \qquad F\Delta t = \Delta mv$

Circular motion and gravitation:

$T = \frac{2\pi r}{v} \qquad a_c = \frac{v^2}{r} \qquad F_c = \frac{mv^2}{r} \qquad F_{grav} = G\frac{m_A m_B}{r^2} \qquad 1rev = 360^0 = 2\pi\, rad$

Rotational motion and angular momentum:

$\theta = \frac{s}{r} = \left(\frac{\omega_i + \omega_f}{2}\right)t \qquad \omega = \frac{\theta}{t} \qquad \theta = \omega_i t + \frac{1}{2}\alpha t^2 \qquad \omega_f = \omega_i + \alpha t$

$v = \omega r \qquad \omega_f^2 = \omega_i^2 + 2\alpha\theta \qquad \alpha = \frac{\Delta\omega}{\Delta t} = \frac{a_T}{r} \qquad I = \sum mr^2 \qquad I = mk^2$

$KE_{rot} = \frac{1}{2}I\omega^2 \qquad \tau = FL = I\alpha \qquad W = \tau\theta \qquad P = \tau\omega \qquad L = I\omega$

Properties of matter:

$\rho = \frac{m}{V} \qquad F = -kx \qquad \frac{\Delta L}{L_i} = \frac{1}{Y}\frac{F}{A} \qquad \phi = \frac{s}{d} = \frac{1}{s}\frac{F}{A} \qquad B = \frac{\Delta P}{\Delta V / V_0} \qquad W_{app} = W\left(1 - \frac{\rho_{fluid}}{\rho}\right)$

Thermal Properties of matter:

$PV = nRT$: $\Delta Q = mc\Delta T = nC\Delta T$: $\Delta L = \alpha L \Delta T$: $L_t = L_0(1+\alpha t)$: $\Delta V = \gamma V \Delta T$: $\Delta W = P\Delta V$

$(\Delta Q/\Delta t) = (kA\Delta T)/\Delta L$ $\quad \Delta Q = \Delta U + \Delta W$ $\quad$ volume of a sphere $= (4/3)\pi r^3$

Thermodynamics:

$\Delta Q = \Delta U + \Delta W$: $P_1V_1^{\gamma} = P_2V_2^{\gamma}$ $\quad PV = nRT$ $\quad W = p.\Delta V$ $\quad COP = \frac{Q_C}{W}$ $\quad COP = \frac{Q_H}{W}$

$e = 1 - \frac{T_c}{T_h}$

Waves and Sound:

$f = \frac{1}{\tau}$ $\quad v = \pm\sqrt{\frac{k}{m}(x_0^2 - x^2)}$ $\quad f' = f\frac{v \pm v_L}{v \mp v_S}$ $\quad (\text{dB}) = 10.\log\frac{I}{I_0}$ $\quad v = \sqrt{\frac{T}{m/L}}$

$\tau = \frac{1}{f} = 2\pi\sqrt{\frac{m}{k}}$ $\quad a = -\left(\frac{k}{m}\right)x$ $\quad v = \sqrt{\frac{Y}{\rho}}$ $\quad v = \sqrt{\frac{B}{\rho}}$