NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER II EXAMINATION 2014-2015

PH1011 - Physics

Apr/May 2015 Time Allowed: 2.5 Hours

SEAT NUMBER: | | | | | |

MATRICULATION NUMBER: | | | | | | | | | |

INSTRUCTIONS TO CANDIDATES

1. This question and answer booklet contains **EIGHT (8)** questions and comprises **SEVENTEEN (17)** printed pages.

2. Answer **ALL EIGHT (8)** questions. All workings must be clearly shown.

3. Marks for each question are as indicated.

4. This **IS NOT** an **OPEN BOOK** examination.

5. All your solutions should be written in this booklet within the space provided after each question.

For examiners:

Questions	**1** (15)	**2** (15)	**3** (10)	**4** (10)	**5** (15)	**6** (15)	**7** (10)	**8** (10)	**Total** (100)
Marks									

Q1 (15 marks) /15

(a) As shown in Figure 1(a), a cylinder of mass M and radius r is rolled, without slipping, down a ramp and eventually takes off the ramp at 20 cm above the ground. Calculate the horizontal range at which the cylinder landed on the ground. Take r to be much smaller than 2 m.

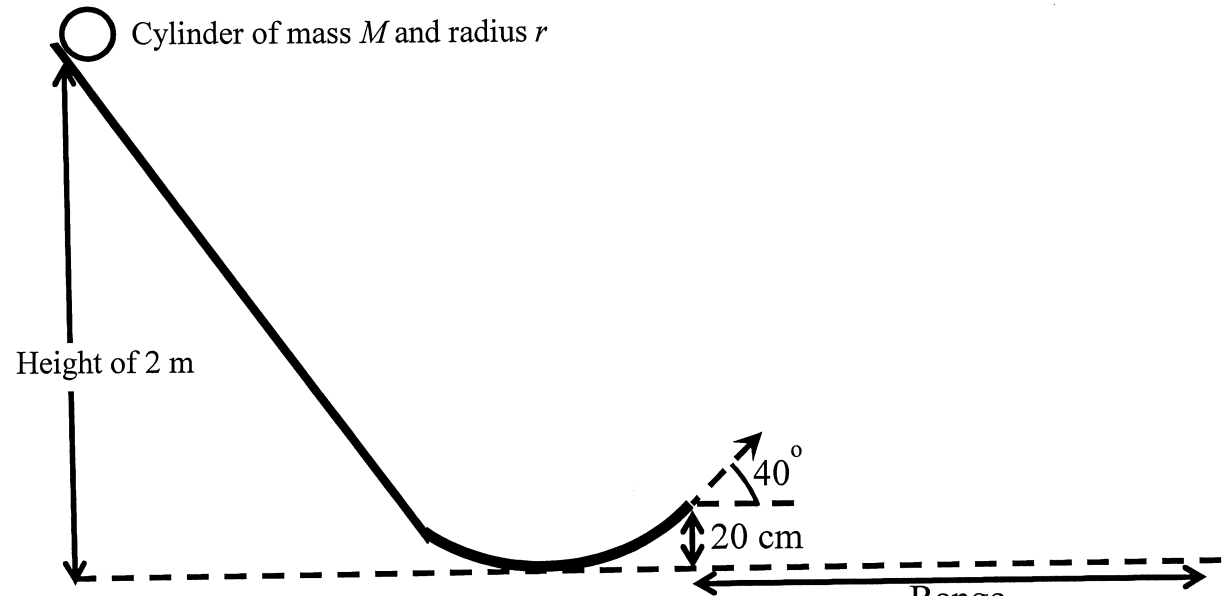
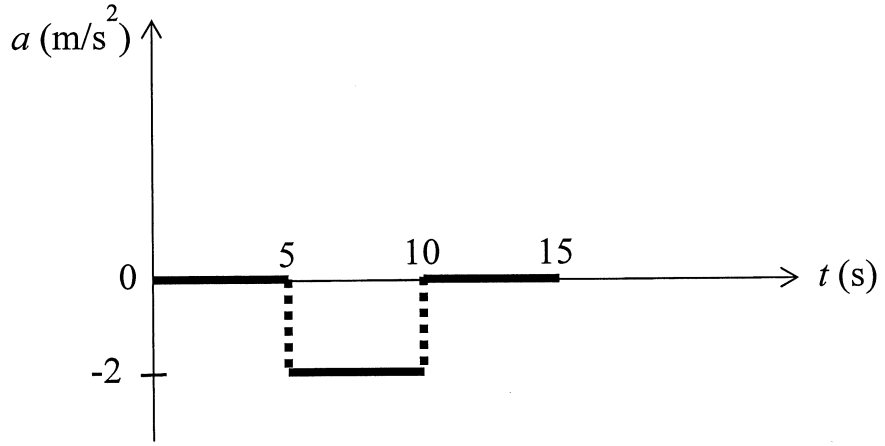


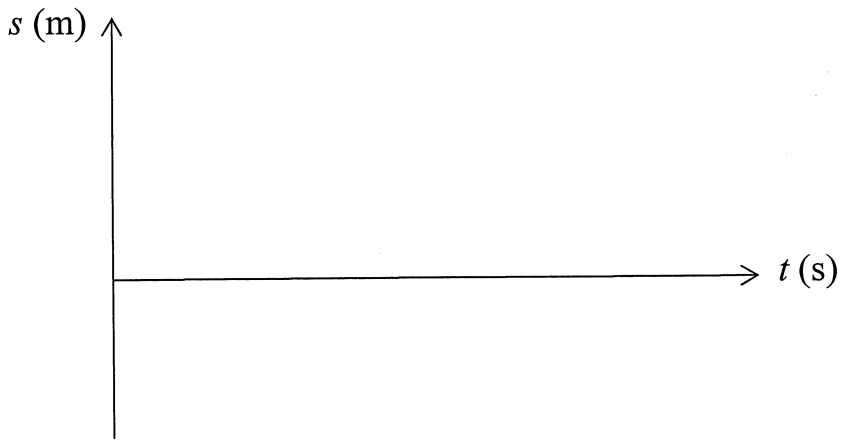
Figure 1(a)

Note: Question 1 continues on page 3

ANS: _____

(b) For the acceleration-time graph shown, sketch the corresponding displacement-time graph on the given axes. At $t = 0$, $s = 0$ and $v = 10$ m/s. You are required to label the displacements at $t = 5$, 10 and 15 seconds.





Q2 (15 marks) /15

(a) An object at rest on a flat, horizontal surface explodes into two fragments, one piece has seven times the mass of the other piece. The fragment with larger mass slides 8.2 m before stopping. Calculate the distance that the smaller mass slides before stopping. Assume that both fragments have the same coefficient of kinetic friction whose value is not needed. (Hint: Start with conservation of linear momentum and realize that it is a 1D problem.)

Note: Question 2 continues on page 5

ANS: _____

(b) A 200 kg wood crate sits in the back of a truck. The coefficients of friction between the crate and the truck are $\mu_s = 0.9$ and $\mu_k = 0.5$. The truck starts off up a 20^o slope. What is the maximum acceleration the truck can have without the crate slipping out the back? (Hint: Friction points up the slope.)

ANS: _____

Q3 (10 marks) /10

As shown in Figure 3, there are 4 masses of mass $M = 1.5$ kg each on one side of an inclined plane. The coefficient of kinetic friction between the inclined plane and the block is $\mu_k = 0.2$. 3 strings made of the same material are attached to the 4 masses as shown in Figure 3. An increasing tensional force is applied to block D to drag all 4 masses up the slope. The breaking tension is 40 N for each of the 3 strings.

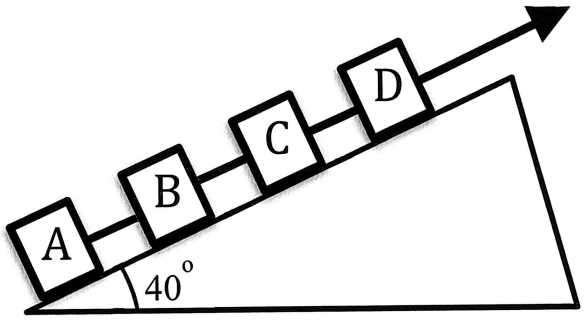


Figure 3

(a) Draw a free body diagram for block C and label all the forces drawn.

Note: Question 3 continues on page 7

(b) Calculate the acceleration of block C when the string between C and D breaks. (Hint: You need equations for blocks A and B as well.)

ANS: _____

Q4 (10 marks) /10

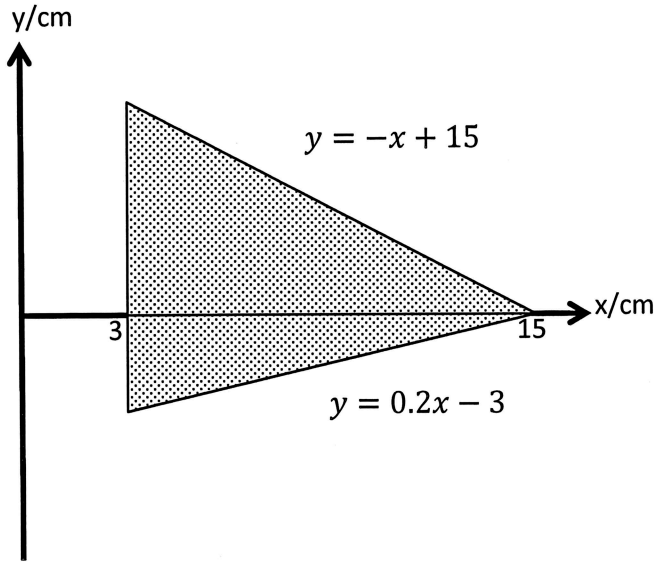
(a) 3 people, one of mass 90 kg, another of mass 70 kg and another of mass 50 kg, sit respectively in the back, centre and front of a uniform rowboat of mass 60kg and of length 4 m. With the rowboat initially at rest, the 3 persons now crowd at the front end of the rowboat. Calculate how far and in what direction will the rowboat move.

ANS: _____

ANS: _____

Note: Question 4 continues on page 9

(b) Calculate the moment of inertia of this uniform triangular plate rotating about $y-$ axis. The mass density is $\mu = 2$ g/cm^2.



ANS: _____

Q5 (15 marks) /15

2 moles of diatomic ideal gas goes through a cyclic process shown in Figure 5. From A to B, the process is nonstandard; from B to C, it is adiabatic; from C to A, the process is isothermal. (Recall that 1 atm = 1.01 x 10^5 Pa)

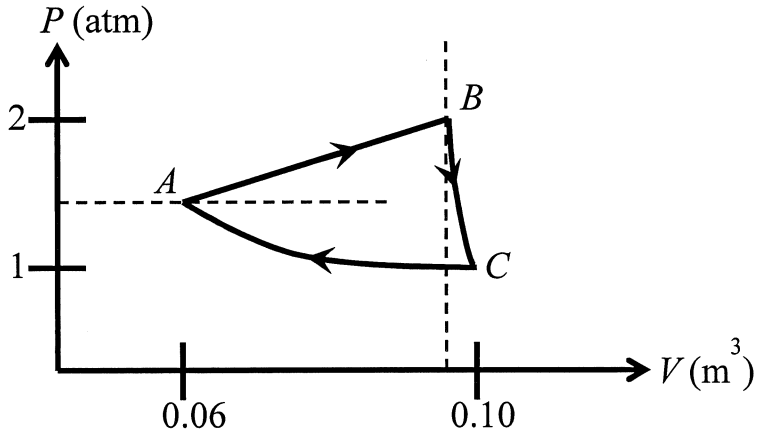


Figure 5 (Not drawn to scale)

(i) Calculate the temperature of the isotherm AC.

ANS: _____

(ii) Calculate the work done by the gas in process AB.
(You are given that $P_A = \frac{5}{3}$ atm.)

Note: Question 5 continues on page 11

ANS: _____

(iii) Calculate the temperature of the gas at B.

ANS: _____

(iv) Calculate the change in internal energy for process AB.

ANS: _____

(v) Calculate the efficiency of this cycle.

ANS: _____

Q6 (15 marks) /15

In Figure 6(a) is a circuit with $V_1 = 15$ V, $V_2 = 10$ V, $R_1 = 5\ \Omega$, $R_2 = 2\ \Omega$ and $R_3 = 6\ \Omega$. Calculate all the currents in the circuit.

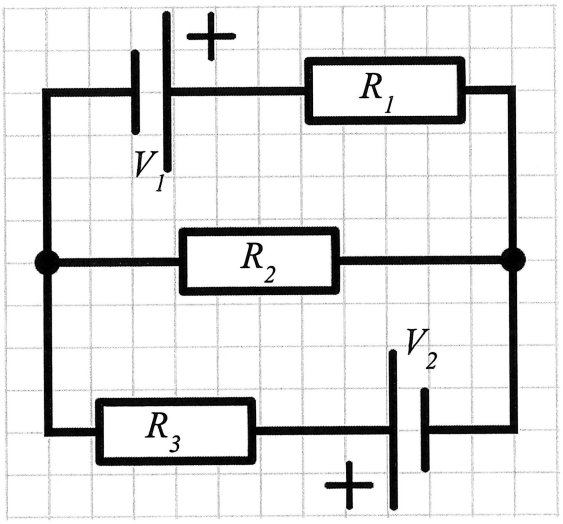


Figure 6(a)

current through resistor R_1: _____

current through resistor R_2: _____

current through resistor R_3: _____

Note: Question 6 continues on page 13

(b) Consider a RC circuit with $V_1 = 20$ V, $R_1 = 50\ \Omega$ and $R_2 = 10\ \Omega$. The capacitors are $C_1 = 12\ \mu$F, $C_2 = 18\ \mu$F and $C_3 = 24\ \mu$F.

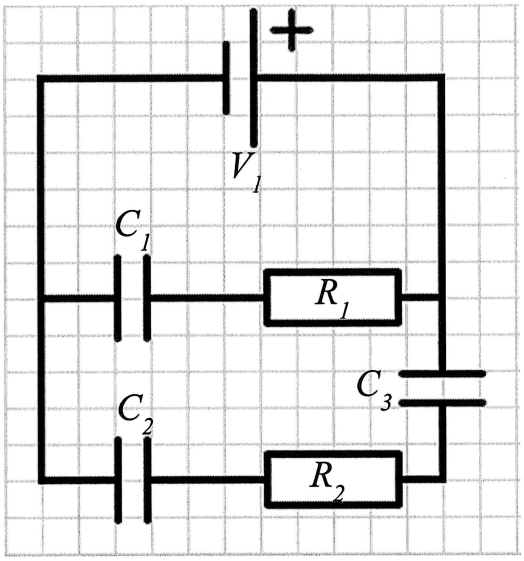


Figure 6(b)

(i) Calculate the combined capacitance of C_2 and C_3.

ANS: _____

(ii) After a long time, the 3 capacitors are fully charged. Calculate the charge in each capacitor.

ANS: _____

ANS: _____

ANS: _____

Q7 (10 marks) /10

(a) Calculate the electric potential at point P which is a distance L from the centre of a charged ring of total charge Q and radius r. See Figure 7(a). Hint: treat each "piece" of the ring like a small point charge.

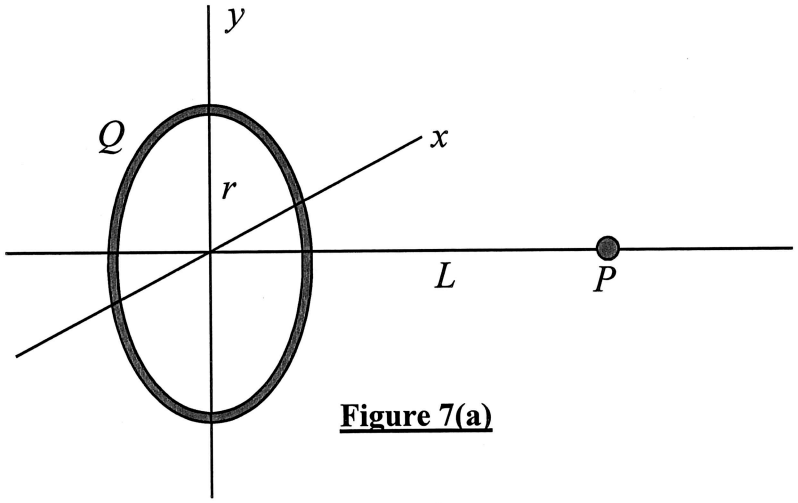


Figure 7(a)

ANS: _____

Note: Question 7 continues on page 15

(b) A solid insulating sphere of radius a is uniformly charged with $Q = 3.00\ \mu C$. A conducting shell of inner radius b and outer radius c is concentric with the sphere.

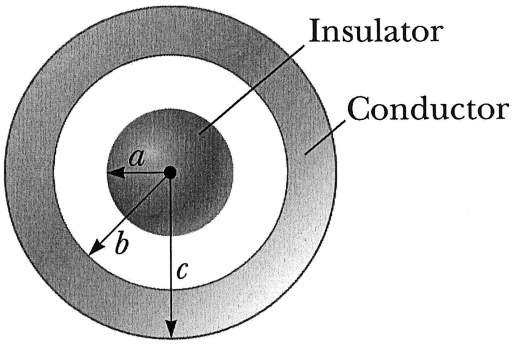
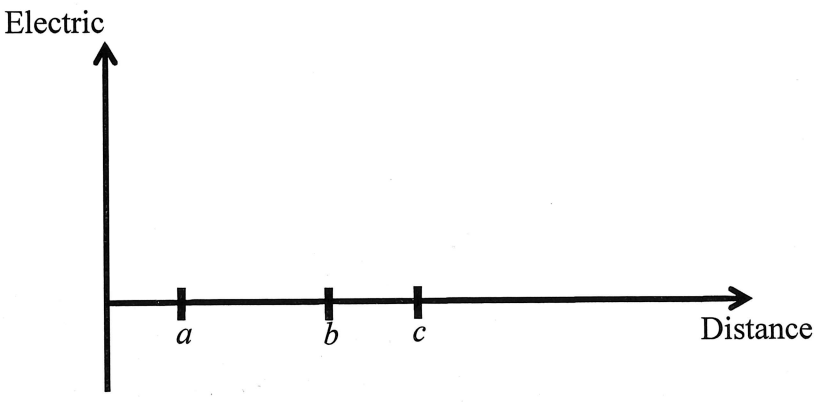


Figure 7(b)

(i) Using Gauss Law or otherwise, determine the charge on the inner surface of the conducting shell.

ANS: _____

(ii) Sketch the electric field from a to c and beyond. You do not need to sketch the electric field for distance less than a.



Q8 (10 marks) /10

(a) A long cylindrical conductor of radius R carries a current I as shown in Figure 8(a). The current density (current per cross sectional area) is not uniform. The current density increases outwards as br where b is a constant. Using Ampere's law or otherwise, derive an expression for the magnitude of the magnetic field at r_1.

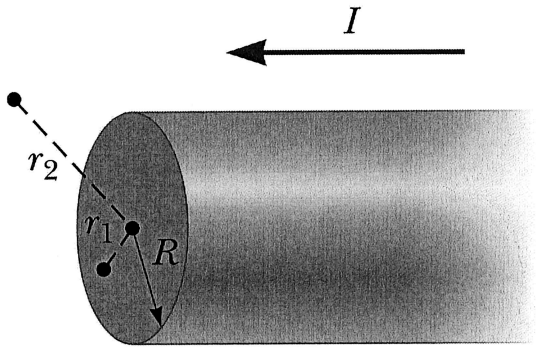


Figure 8(a)

ANS: _____

Note: Question 8 continues on page 17

(b) A conducting rod of length l moves with velocity $\vec{v}$ parallel to a long wire carrying current I. The axis of the rod is maintained perpendicular to the wire with the near end a distance r away, see Figure 8(b). Derive an expression for the magnitude of the emf induced in the rod.

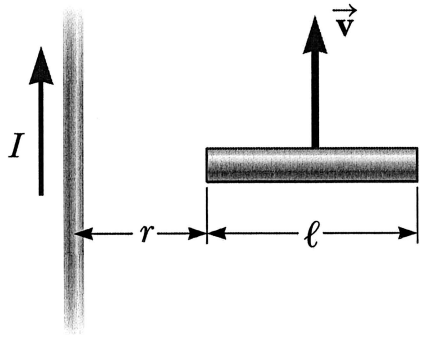


Figure 8(b)

ANS: _____

-End of Paper-

PH1011 PHYSICS

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.