End-Semester Test (AY21/22 S1)

EP0605 – Advanced Physics **Time Allowed: 1½ hour**

Instructions to Candidates **Max Marks**: 100

1. All the Singapore Polytechnic examination rules must be strictly adhered to.
2. This paper consists of **6** questions. You are allowed the handwritten A4 cheat sheet.
3. Answer all the questions in this question booklet. All working must be shown.
4. This paper consists of **8** pages (inclusive of the cover page).
5. Fill in your personal particulars below.

Name :			
Admission No :		S/No	
Class :	EL/EP0605/FT/01	Date :	

Question	**Marks**
1	
2	
3	
4	
5	
6	
Total	

1. An electric potential difference of 1000 V is applied to a pair of parallel plates that is separated by 1.00 cm. A particle of positive charge 9.60×10^{-19} C, initially at rest, is released from the positive plate. You can ignore the weight of the particle.

    a) What is the magnitude of the uniform electric field between the plates?
    b) If the mass of the particle is 2.16×10^{-15} kg, what is the kinetic energy of the particle as it reaches the other plate?
    c) What is the speed of the particle as it reaches the other plate?

(17 marks)

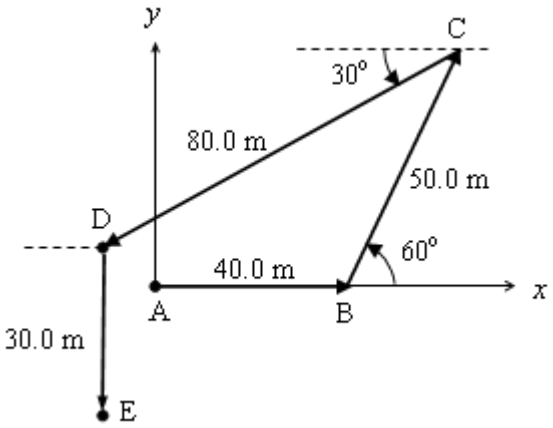
2. A particle with charge -2.00×10^{-9} C is moving in a uniform magnetic field $\boldsymbol{B} = (-1.50\ \text{T})\ \mathbf{k}$. The magnetic force acting on the particle is found to be $\boldsymbol{F} = -(4.50 \times 10^{-7}\ \text{N})\ \mathbf{i} + (6.00 \times 10^{-7}\ \text{N})\ \mathbf{j}$.

   a) Calculate the *x*- and *y*- components of the particle's velocity.
   b) Explain why the *z*- component of the particle's velocity cannot be determined.
   c) If the *x*-*y* plane motion is circular, what is the radius of the circle? The mass of the particle is 1.00×10^{-12} kg.

(17 marks)

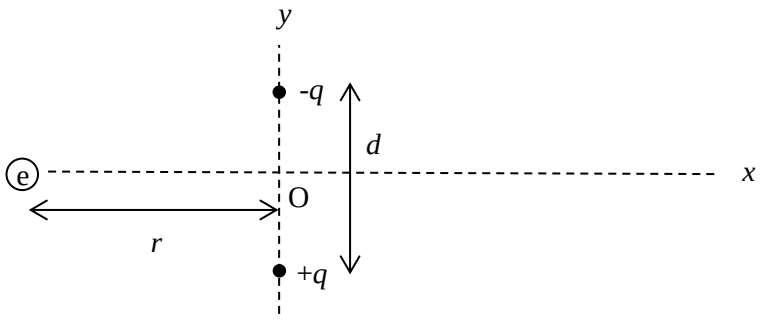
3. A person runs from point A to point E (via B, C and D) in 1.00 minute as shown in the figure.

   a) Write each of the 4 displacement vectors in terms of unit vectors **i** and **j**.
   b) What is the person's final displacement relative to A?
   c) What is the person's average speed?
   d) What is the magnitude and direction of the person's average velocity?



(17 marks)

4. The diagram shows a positive and a negative charge, each of magnitude $q = 1.0 \times 10^{-6}$ C. They are separated by a distance, $d = 0.20$ m along the y-axis. An electron, e, is initially at a distance $r = 1.0$ m from the origin O. The charge on an electron is -1.6×10^{-19} C while the Coulomb's constant is 8.99×10^{9} N m^2/C^2.



a) What is the electric field due to the two charges at the location of the electron? State its magnitude and direction.

b) What is the electric potential due to the two charges at the location of the electron? Explain your answer.

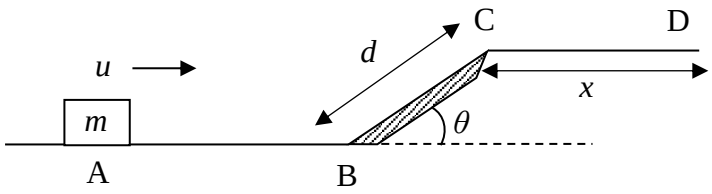
(17 marks)

5. A particle of mass 4.00 kg is subjected to a net force $F = (\alpha + \beta x^2)$ N that acts along the x-axis. The numerical value of α is −7.00 while that of β is 0.600. The particle is initially at the origin, and moves at 4.00 m/s away from the origin along the negative x-axis.

   (a) What are the SI units of α and β?
   (b) What is the speed of the particle when it reaches x = 8.00 m?
   (c) Is the force F conservative? Explain your answer with suitable calculations.

(17 marks)

6. In the figure below, an object of mass m moves with a speed u on a flat frictionless surface AB. It then encounters an incline BC. The incline is rough where the coefficient of kinetic friction is μ_k. After the object reaches the top of the incline, it continues to move on a second flat frictionless surface CD. The length of BC is d and that of CD is x, the angle of inclination is θ and the acceleration due to gravity is g. The answers should be in terms of the variables given.



a) Draw the free body diagram of the object when it is on the incline.
b) What is the work done by the force of friction?
c) What is the speed of the object at point D?

(15 marks)

Answers:

1(a)	1.00×10^5 V/m
1(b)	9.60×10^{-16} J
1(c)	0.943 m/s
2(a)	$v_x = -200$ m/s, $v_y = -150$ m/s
2(b)	v_z is not affected by the field, so it is not determined from force measurements.
2(c)	0.083 m
3(a)	$\overrightarrow{AB} = 40.0\,\hat{\imath}$, $\overrightarrow{BC} = 25.0\,\hat{\imath} + 43.3\,\hat{\jmath}$, $\overrightarrow{CD} = -69.3\,\hat{\imath} - 40.0\,\hat{\jmath}$, $\overrightarrow{DE} = -30.0\,\hat{\jmath}$
3(b)	$(-4.30\,\hat{\imath} - 40.0\,\hat{\jmath})$ m
3(c)	3.33 m/s
3(d)	0.450 m/s, 80.9° south of west
4(a)	1800 N/C, along positive *y*-axis
4(b)	0 V
5(a)	α: N; β: N/m^2
5(b)	6.26 m/s
5(c)	Yes
6(b)	$-\mu_k mgd\cos\theta$
6(c)	$\sqrt{u^2 - 2gd(\sin\theta + \mu_k\cos\theta)}$