End-Semester Test (AY21/22 S2)

EP0605 – Advanced Physics **Time Allowed: 1 hour 40 minutes**

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 one handwritten A4 cheat sheet.
3. Answer all the questions in this question booklet. All workings must be shown.
4. This paper consists of **7** pages (inclusive of the cover page).
5. Fill in your personal particulars below.

Name :			
Admission No :		S/No	
Class :	EL/EP0605/FT/01, EL/EP0605/FT/02	Date :	

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

1. A particle moves such that its position vector is $\boldsymbol{r} = 2.0 \cos(3.0t)\,\mathbf{i} + 2.0 \sin(3.0t)\,\mathbf{j}$ where all the quantities are in SI units.

   (a) Determine the velocity and acceleration vectors as a function of time.
   (b) Determine the speed and magnitude of acceleration.
   (c) Show that the acceleration vector points opposite to the position vector.

   (15 marks)

2. An object of mass 46.0 kg is placed on a horizontal smooth floor. The object moves from rest due to a constant horizontal force of magnitude 225 N for 11.0 m. After that, the object encounters a rough surface and it continues to move under the effect of the 225 N force for 10.0 m. The coefficient of kinetic friction is 0.20.

   When the block has travelled 21.0 m, calculate

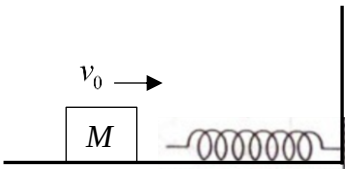
   (a) the work done by the 225 N force,
   (b) the work done by the frictional force, and
   (c) the final speed of the object.

(17 marks)

3. Block *M* of mass 0.500 kg slides along a rough surface where $\mu_k = 0.300$ as shown below. The block has a speed $v_0 = 1.00$ m/s at the instant when it collides with a massless spring. The spring constant of the spring is 20 N/m.

(a) Find the frictional force acting on the block during the motion.
(b) Find the maximum compression of the spring, x_f .
(c) What is the minimum value of the μ_s required to keep the block from springing back to the left when it stops?

(17 marks)

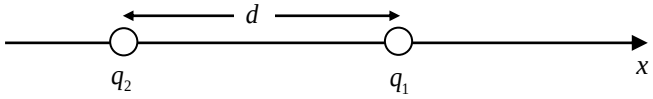


4. (a) Two equal and opposite charges are separated by 0.160 m. At the midpoint, the magnitude of the net electric field due to the two charges is 586 N/C. What is the magnitude of each charge? Given: Coulomb's constant $k = 8.99 \times 10^9$ N m^2/C^2.

   (b) An electron is in an electric field of magnitude 696 N/C. What is the magnitude of the acceleration of the electron? What is the direction of the acceleration with respect to the electric field? The mass of an electron is 9.11×10^{-31} kg while the charge of an electron is -1.60×10^{-19} C.

(17 marks)

5. Charge $q_1 = 3.4\,\mu\text{C}$ is located at the origin and charge $q_2 = -2.0\,\mu\text{C}$ is located at x = 5 cm as shown below. The Coulomb's constant is 8.99×10^9 N m^2/C^2.



(a) At what points along the x-axis, is the net electric field zero?
(b) At what point between the two charges is the electric potential zero?
(c) Is there other point along the x-axis at which the electric potential zero? Explain.

(17 marks)

6. A wire of length 2.0 m is in a uniform magnetic field and carries a current of 8.2 A. When this wire lies along the +x-axis, the force acting on the wire is $\boldsymbol{F}$ = (−2.5 **j)** N. When it lies along the +y-axis, the force acting on the wire is $\boldsymbol{F}$ = (2.5 **i** −5.0 **k**) N. Find the magnetic field in terms of the unit vectors.

(17 marks)

Answers:

1(a)	$\vec{v} = (-6.0)\sin(3.0t)\,\hat{\imath} + (6.0)\cos(3.0t)\,\hat{\jmath}$ m/s $\vec{a} = (-18)\cos(3.0t)\,\hat{\imath} + (-18)\sin(3.0t)\,\hat{\jmath}$ m/s^2
1(b)	$v = 6.0$ m/s, $a = 18$ m/s^2
2(a)	4730 J
2(b)	-902 J
2(c)	13 m/s
3(a)	1.47 N
3(b)	0.101 m
3(c)	0.412
4(a)	2.09×10^{-10} C
4(b)	1.22×10^{14} m/s^2, direction: opposite of the electric field
5(a)	-16 cm
5(b)	1.85 cm
5(c)	Yes. The other point is at the left side of q_2 as this point is closer to the negative charge than the positive charge
6	$\vec{B} = \left(0.30\hat{\imath} + 0.15\hat{k}\right)$ T