End-Semester Test (AY20/21 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.
3. Answer all the questions in this question booklet. All working must be shown.
4. This paper consists of **9** 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. A 4.00 kg particle moves along the positive x axis. Its position vector (expressed in terms of unit vectors) varies with time (measured in seconds) as $\boldsymbol{r}(t) = (t + 2.00t^3)\,\mathbf{i}$ m.

   a) Find the kinetic energy at any time t.

   b) Find the acceleration of the particle at any time t.

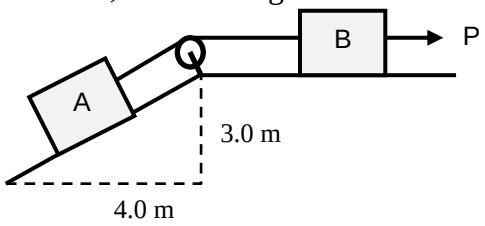
   c) Find the force acting on it at time t.

   d) Find the power delivered to the particle at time t.

   e) Calculate the work done on the particle from $t = 0$ to $t = 2.00$ s.

(17 marks)

2. Two blocks rest on smooth surfaces. They are joined together by an inextensible massless string that passes over a frictionless pulley. The mass of block A is 5.0 kg and the mass of block B is 6.0 kg. A force P is acting on block B as shown in the below figure. If block B accelerates to the right at 2.0 m/s^2, find the magnitude of P.



a) Draw the free body diagram for each block.

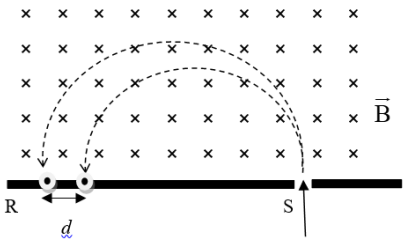
b) What is the magnitude of force P?

c) What is the magnitude of the tension in the string?

(17 marks)

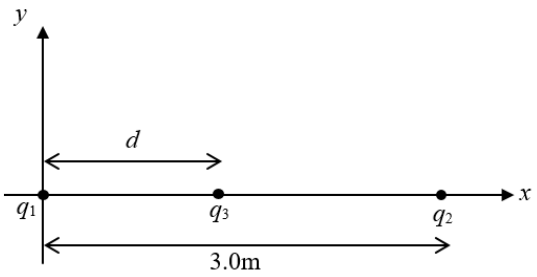
3. (a) A proton of charge $q = 1.6 \times 10^{-19}$ C moves through a uniform magnetic field (in Tesla) $\mathbf{B} = B_x \mathbf{i} + 3.0\, B_x \mathbf{j}$. The proton has a velocity $\mathbf{v} = 2\,\mathbf{i} + 4\,\mathbf{j}$ m/s and the force acting on it is $6.4 \times 10^{-19}\,\mathbf{k}$ N, find B_x.

(b) In the below figure, two singly ionized atoms pass through slit S each with a speed of 7.00×10^5 m/s. They then enter a uniform magnetic field of magnitude 0.070 T pointing into the page. They move in circular paths and strike a photographic plate RS each leaving a dot on the plate. One atom has a mass of 1.67×10^{-27} kg, while the other has a mass of 8.35×10^{-27} kg. Find the distance d between the dots.



(17 marks)

4. As shown in the figure, three point charges lie on the x-axis such that $q_1 = +4.0\ \mu C$ is at the origin and $q_2 = +16\ \mu C$ is at $x = 3.0$ m. Note that $1\ \mu C = 10^{-6}$ C.



a) What is the magnitude of the electric force on q_1 due to q_2?

b) If charge q_3 is located such that the net force on it is zero, find the distance d from the origin where q_3 is located somewhere between q_1 and q_2.

(17 marks)

5. (a) An object of mass *m*, moving in the positive *x*-axis is under the influence of a conservative force which is described by the below potential energy function

$$U(x) = \left(\frac{\alpha}{x^2} \right)$$

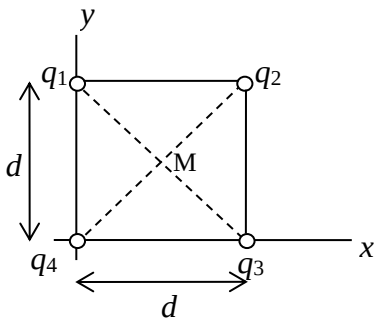
where *x* is in metres and α is a positive constant.

(i) What is the SI unit of α?
(ii) What is the acceleration of the object in terms of *m*, *x* and α?

(b) An object of mass 65 kg is uniformly accelerated from rest to 6.00 m/s in 3 s. What is the average power supplied by the force? Assume that there is no friction.

(17 marks)

6. The figure below shows four particles on the edges of a square of edge length d = 0.050 m and having charges q_1 = +10.0 nC, q_2 = −20.0 nC, q_3 = +20.0 nC and q_4 = −10.0 nC. Note that 1 nC = 10^{-9} C. The centre of the square is M.



a) Calculate the magnitude of the electric field due to each charge at M.

b) What is the total electric field at M in terms of unit vectors?

c) What is the force acting on a +5.00 nC charged particle if it placed at M?

d) What is the electric potential at M?

(15 marks)

Answers:

1(a)	$2.00(1 + 12.0t^2 + 36.0t^4)$ J
1(b)	$12.0t\ \hat{\imath}$ m/s^2
1(c)	$48.0t\ \hat{\imath}$ N
1(d)	$48.0t + 288t^3$ W
1(e)	1250 J
2(b)	51.4 N
2(c)	39.4 N
3(a)	2.0 T
3(b)	0.835 m
4(a)	0.064 N
4(b)	1 m
5(a)(i)	J m^2
5(a)(ii)	$\frac{2\alpha}{mx^3}$
5(b)	390 W
6(a)	$E_1 = E_4 = 7.20 \times 10^4$ N/C, $E_2 = E_3 = 1.44 \times 10^4$ N/C
6(b)	$1.02 \times 10^5\ \hat{\jmath}$ N/C
6(c)	5.05×10^{-4} N
6(d)	0 V