

BACHELOR OF SCIENCE IN MARINE RESOURCE MANAGEMENT

APS 4109: FUNDAMENTALS OF PHYSICS

MAIN EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

When necessary take:

Acceleration due to gravity, $g=9.8\text{ms}^{-2}$

Permittivity of free space, $\epsilon_0= 8.854\times 10^{-12}$

Charge on electron, $e=-1.602\times 10^{-19}$

Mass of an electron, $m_e=9.1\times 10^{-31}\text{kg}$

Question one (compulsory)

- a) (i) State two advantages of dimensional analysis. (2marks)
- b) (ii) The Newton's law of universal gravitation is given by $F = G \frac{Mm}{r^2}$
where the values have their usual meaning. Use dimensional analysis to deduce the units of G. (3marks)
- c) i) Define frictional force (1marks)
- ii) State two factors that affect the force of friction. (2marks)

iii) A 3.1×10^5 kg train traveling up a plane inclined at an angle of 30° . If the coefficient of dynamic friction is $\mu_k = 0.25$, calculate the force that the train engine should apply to maintain the motion at a constant velocity. (5marks)

d) Show that the expression for charging a capacitor through a resistor is given by $Q = Q_0(1 - e^{-\frac{t}{RT}})$ where the symbols have their usual meanings. (5marks)

e) Consider a wave represented by the equation $y = 10 \sin(200\pi t - \frac{\pi}{0.17} x)$

Find; i) the period of the wave. (3marks)

ii) the speed of the wave. (3marks)

f) A body of mass 1200kg is making a turn on a circular road of radius 40m at a speed of 25m/s. Find the centripetal force required to make the turn. (3mark).

QUESTION TWO

a) i). A body moving with a constant acceleration \mathbf{a} m/s² changes its velocity from \mathbf{u} m/s to \mathbf{v} m/s in time, t seconds. If the displacement during the time interval is s meters, show that

I) $\mathbf{v} = \mathbf{u} + \mathbf{at}$ (2marks)

II) $\mathbf{s} = \mathbf{ut} + \frac{1}{2}\mathbf{at}^2$ (2marks)

III) $\mathbf{v}^2 = \mathbf{u}^2 + 2\mathbf{as}$ (2marks)

ii) A ball is thrown vertically at 10m/s from a bridge which is 15m above the river.

- I) What is the speed of the ball as it hits the river? (3marks)
- II) With what speed would it hit the river if it was thrown downwards at 10m/s. (Take $g=10\text{m/s}^2$) (2marks)

b)A $10\mu\text{F}$ capacitor is charged to a 80v supply and then connected across an uncharged capacitor of $20\mu\text{F}$. Calculate:

- i) the final p.d across each capacitor. (3marks)
- ii)the final charge on each capacitor. (3marks)
- iii)the initial and final energy stored by each capacitor. (3marks)

QUESTION THREE

a)i).A body moving in a circular path with a constant speed is said to be accelerating. Explain (2marks)

ii)Write an expression for the centripetal acceleration, \mathbf{a} for a body moving in a circular path of radius, \mathbf{r} and speed \mathbf{v} . (2marks)

iii)The moon revolves around the earth in a nearly circular path of radius 382,400km from the center of the once in 27.3 days. Calculate the speed of the moon in m/s. (4marks)

iv)How fast is the moon accelerating towards the center of the earth. (2marks)

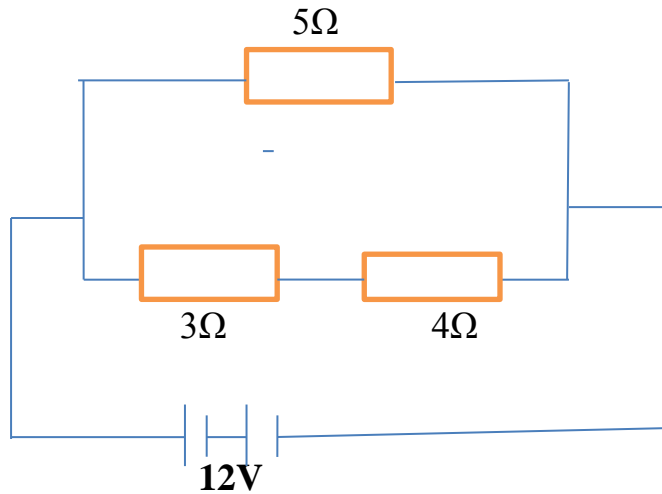
b)A student gave an expression for the time of oscillation for a small drop of liquid of radius, \mathbf{r} and liquid density as ρ under surface tension, \mathbf{S} as follows

$$T = K \sqrt{\frac{\rho r^3}{S}} \quad \text{Where k is a dimensional less constant.}$$

Prove that this expression is dimensional correct. (3marks)

c)i)Show that for two resistors, R_1 and R_2 connected in parallel, the effective resistance R is given by $R = \frac{R_1 R_2}{R_1 + R_2}$ (3marks)

ii)The figure below shows a circuit diagram of resistors connected to a 12v battery of negligible resistance.



Determine the potential difference across the 4Ω resistor. (4marks)

QUESTION FOUR

a).A block m_2 on an inclined plane is joined to mass m_1 by a cord over a pulley as shown in the figure below. The block slides on a frictionless surface and the effects of the pulley are negligible. Show that the acceleration is given by

$$a = \left(\frac{m_1 - m_2 \sin \theta}{m_1 + m_2} \right) g$$

Where, θ is the angle of inclination and g is the acceleration due to gravity. (10marks).

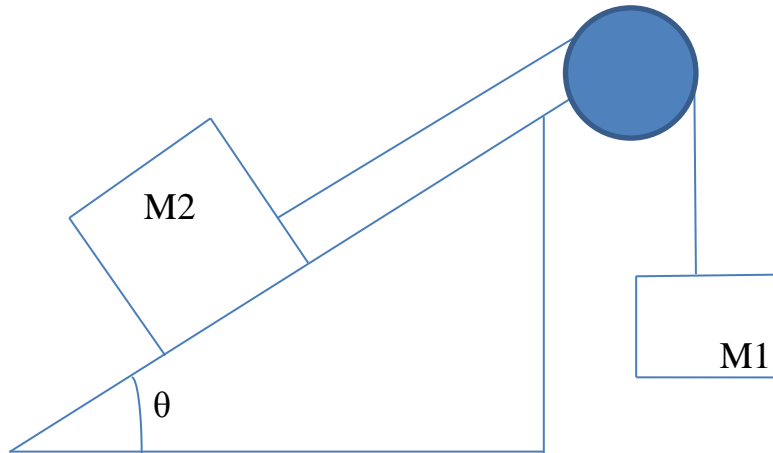


Figure 2

b). Two point charges $q_1=+25\text{nC}$ and $q_2=75\text{nC}$ are separated by a distance of 3.0cm. Find the magnitude and the direction of an electric force that q_1 exert on q_2 .
(5marks)

c)At what temperature would the resistance of a copper conductor be double its resistance at 0°C if the temperature coefficient of resistivity of copper $\alpha=0.0039$.
(5marks)

QUESTION FIVE

a)i)Differentiate between elastic and inelastic collisions. (2marks)

ii).Two ball A and B are involved in a collision. If B is initially at rest while A was moving to the right when it collides with B then both stick and move off with a velocity of 2m/s to the right. Calculate the initial speed of A if its mass is half that of B. (6marks)

b) A body of mass 5kg is attached to a hook of a spring balance hanging from the roof of a lift. What is the reading of the spring balance when the lift is :

i) Ascending at an acceleration of 0.6m/s^2 (2marks)

ii) Descending at an acceleration of 0.5m/s^2 (2marks)

iii) Ascending at a constant velocity. (2marks)

c) i) Define electromotive force. (1marks)

ii) State two factors that affect the resistance of a wire (2marks)

d) A glass rod rubbed with wool is found to have a negative charge of $5.0 \times 10^{-7}\text{C}$.

i) What is the charge acquired by the wool. (1marks)

ii) Estimate the number of electrons transferred (2marks)