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, $g=9.8ms^{-2}$

Permittivity of free space, $\varepsilon_o = 8.854\times10^{-12}$

Charge on electron, $e=-1.602\times10^{-19}$

Mass of an electron, $Me=9.1\times10^{-31}kg$

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 pane inclined at an angle of 30^0.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

$$y = 10sin(200\pi t - \frac{\pi}{0.17}x)$$

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 **a** m/s^2 changes its velocity from **u** m/s to **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) $\mathbf{s} = \mathbf{ut} + \frac{1}{2}\boldsymbol{at^2}$ (2marks)

III)$\mathbf{v^2} = \mathbf{u^2} - \mathbf{2as}$ (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 $g=10m/s^2$) (2marks)

b)A 10µF capacitor is charged to a 80v supply and then connected across an uncharged capacitor of 20 µF. 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, **a** for a body moving in a circular path of radius, **r** and speed **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)

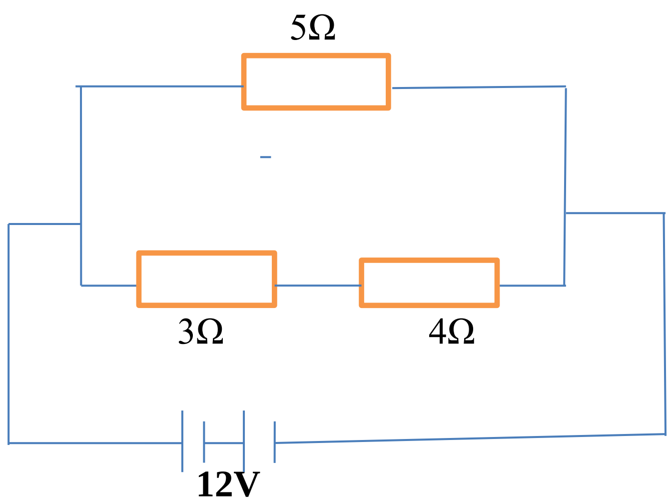
iv)How fast is the moon accelerating towards the center of the earth. (2marks)

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

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

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

c)i)Show that for two resistors, R1and R2 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 bock m_2 on an inclined pane is joined to mass m_1 by a cord over a pulley as shown in the figure bellow. The bock sides on a frictional less 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).

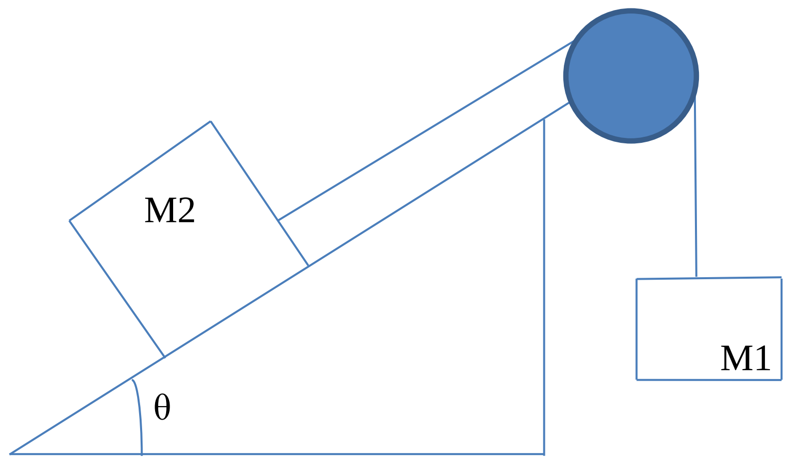


Figure 2

b). Two point charges q_1=+25nC and q_2=75nC 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 0^0C if the temperature coefficient of resistivity of copper α=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 affects the resistance of a wire (2marks)

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

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

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