MUCHINGA PROVINCE JETS FAIR,2014

THEME:GOLDEN JUBILLE:RECOGNIZING SCIENTISTS AS A DRIVING FORCE F OR NATIONAL DEVELOPMENT

ANSWER ALL QUESTIONS

QUESTION 1

Fig.1.0. shows an electrical circuit.

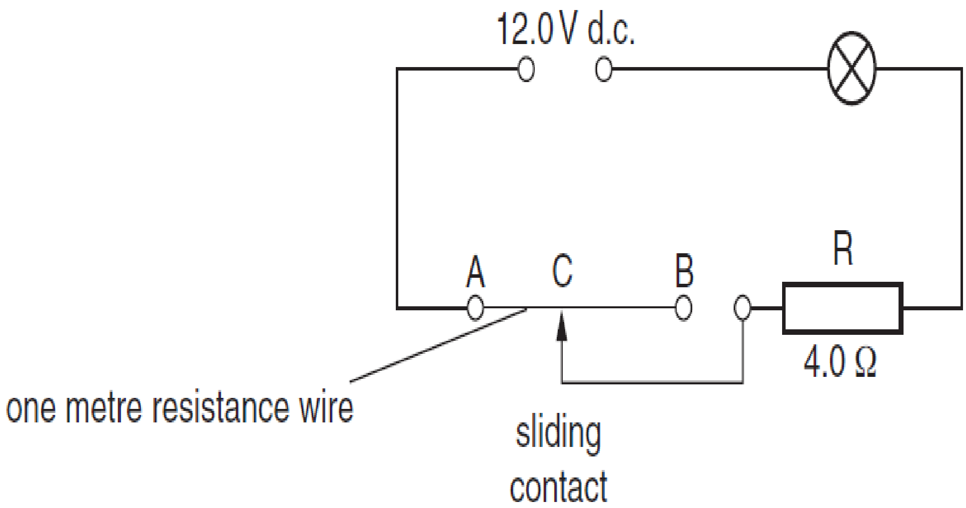


Fig.1.0

The resistance of the lamp is 4.0 ó when it is at its normal brightness.

(a) The lamp is rated at 6.0 V, 9.0 W.

Calculate the current in the lamp when it is at its normal brightness. [2]

(b) The sliding contact C is moved to A. The lamp lights at its normal brightness.

Calculate

(i) the total circuit resistance, [1]

(ii) the potential difference across the 4.0 ó resistor . [1]

(c) The sliding contact C is moved from A to B.

(i) Describe any change that occurs in the brightness of the lamp. [1]

(ii) Explain your answer to **(i)**. [2]

(d) The 1 m wire between A and B, as shown in Fig. 8.1, has a resistance of 2.0 ó.

Calculate the resistance between A and B when

(i) the 1 m length is replaced by a 2 m length of the same wire, [1]

(ii) the 1 m length is replaced by a 1 m length of a wire of the same material but of only half the cross-sectional area. [1]

2. (a) The neutrons and protons in a stable nucleus are held together by nuclear forces and energy is needed to break them apart. What name is given to this energy? **[2]**

(b) Consider the following reaction.

$${}_{92}^{235}U + {}_{0}^{1}n \longrightarrow {}_{57}^{148}La + {}_{35}^{85}Br + 2\,{}_{0}^{1}n + \text{energy.}$$

(i) What type of reaction is shown by the reaction above? Give a reason for your answer **[2]**

(ii) What is the mass defect of this reaction? **[2]**

(iii) What energy in joules is released by the above reaction? Given that:

1u = 931M eV.

1 M eV = 1.9×10^{-19}j.

Mass of La =148.0 u.

Mass of Br = 85.0 u.

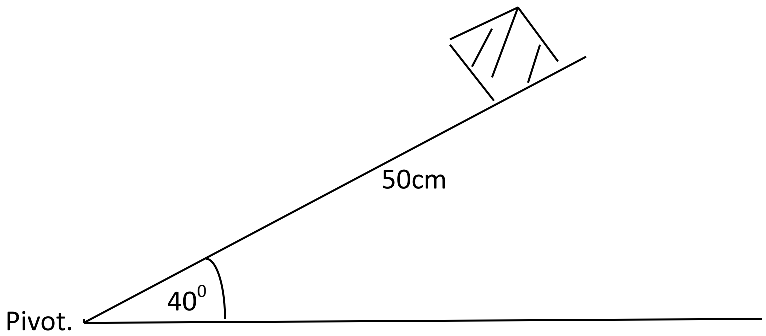
Mass of U = 235.1 u.

Mass of 1 neutron = 1.009 u.

(c) Calculate the binding energy in MeV of a helium nucleus if the mass of the proton and netron have masses of 1.0073 u and 1.0087 respectively. [Mass of helium nucleus = 4.0015 u, 1u = 193MeV] **[3]**

(d) Define chain reaction.

3. A student was investigating kinetic and static friction of a surface using a wooden block. They placed the block at one end which is slowly turned until the block just started sliding. This happened at the angle of 40^0 as illustrated by the diagram below.



(a)(i) Distinguish between static and kinetic friction.

(ii) How can you demonstrate that static friction is greater than kinetic friction?

(b) Calculate the static friction of the experiment.

(c)(i) State the force which works to slide the block.

(ii) Calculate the work done by the force in c (i) above.

(d) If the static friction is 10% greater than the kinetic friction, determine the final velocity of the block.

4. 4. The radioactive isotope $_{55}^{137}Cs$ emits a beta particle to become the isotope $_{b}^{a}Ba$.

a. i. What is meant by the term isotope? [1]

ii. Explain the meaning of the term superscript 137 and subscripts 55. **[2]**

iii. State the value of a and b. **[2]**

b. State the nature of each of the following radiations.

i. Gamma radiation **[1]**

ii. Beta radiation **[1]**

iii. Alpha radiation **[1]**

c. When radiation passes through matter, it may cause ionization.

i. Explain briefly what is meant by ionization. **[1]**

ii. Which of the radiations in (b) will produce the greatest amount of ionization per centimeter of path length? **[2]**

d. Polonium $_{84}^{210}Po$ decays to lead $_{82}^{206}Pb$ by the reaction

$$_{84}^{210}PO \longrightarrow {}_{82}^{206}Pb + {}_{2}^{4}He$$

The atomic masses are:

Polonium 3.485×10^{-25} kg
Lead 3.418×10^{-25} kg
Helium 0.066×10^{-25} kg

The speed of light c in vacuum is 3×10^{8} m/s. estimate the energy released when an atom of Polonium -210 decays. **[4]**

5. a. A block of metal of mass 0.5kg initially at a temperature of 100^{o}c is gently lowered into an insulated copper containers of mass 0.05kg containing 0.9kg of water at 20 ^{o}c. if the final temperature of the mixture is 25^{o}c. calculate the specific heat capacity C of the metal block. (assume no loss of heat and no water is vapourized)

b. A double walled flask containing water is heated with a 16W heater and it is found that it takes 30 minutes for the temperature to rise from 20^{o}c to 100^{o}c.

I. estimate an upper limit for the value of specific heat capacity of the inner flask and its contents.

II. Calculate the mass of water that could be vaporized after 30 minutes of steady heating when power is supplied at a rate of 60 W. take the specific latent heat of vaporization of water to be 2.26×10^{6} Jkg^{-1}.

Specific heat capacity of i) water 4200J
ii) copper/container -385J

6. (a) in relation to projectile motion define the following terms:

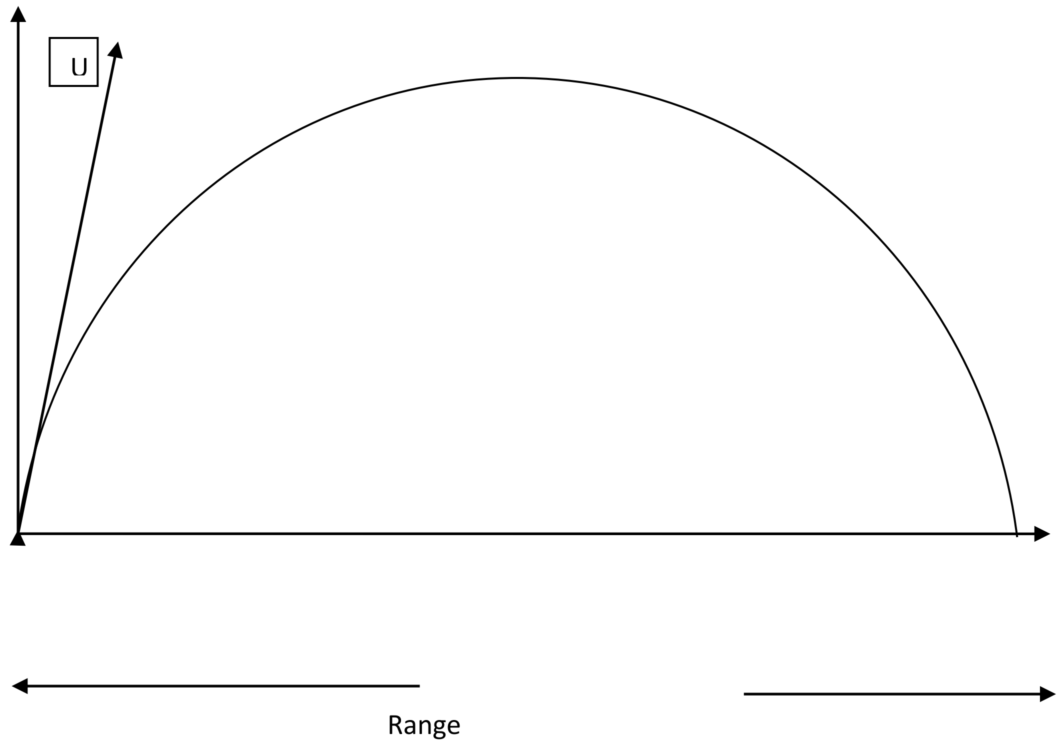
(i) Range [1 MARK]

(ii) Time of flight [1 MARK]

(iii) Projectile [1 MARK]

(iv) Maximum height [1 MARK]

(b) A ball is hit with a velocity of 5m/s at an angle of 60^0 to the horizontal. Consider the t figure shown below.



Use the figure above to calculate the following: take $g=10m/s^2$

i) The time of the flight. [3 MARKS]

ii) The maximum height [3 MARKS]

iii) The range [3 MARKS]

c) Another ball is projected so as to attain a maximum range. Find the maximum height attained if the initial velocity is 12m/s. take g to be $10m/s^2$. [3 MARKS]

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Marking schemes for question 1

(a) I = W/V or 9/6

I = 1.5 A

(b) (i) 8 ohm

(ii) 6 V

(c) (i) brightness decreases/dimmer B1

(ii) resistance of circuit greater

current through lamp falls

(d) (i) 4 ohm A1

(ii) 4 ohm

[2]

MARKING SCHEME FOR QUESTION 2

(a) The energy is called binding energy. [2]

(b) (i)Fission reaction. Because the nucleus is being split into smaller nuclei.

(ii)mass defect = mass of reactants – mass of products.

=235.1 u – (148u+85u+1.009u+1.009u)

= 235.1u – 235.018u

=0.982u

(iii)energy = loss in mass

Energy = 0.982 u [1]

Since 1u = 931eV

0.982u = x

X = 0.982u x 931 eV

X =914.242 eV [1]

Energy in J = 914.242 eV x 1.9 x 10^{-19} J

Energy = [2]

C. Binding energy = mass of nucleons – mass of nucleus

= 4.032u – 4. 0015u

= 0.0305u

Therefore: energy = 0.0305u x 931 mev

Energy = 28.395 mev

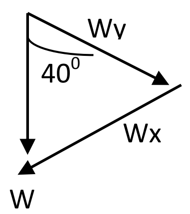
Energy = 28.4 mev [3]

D.A chain reaction is a self perpetuating rapid reaction that occurs during nuclear fission. [2]

3. MARKING KEY FOR QUESTION 3

a. **i. static friction operates between the surfaces of an object at rest; kinetic friction operates in an object in motion.**
   Ii. When an object just starts moving , the operating force can be reduced to maintain a constant speed.

b. **force diagram, if static friction is U_s**
   U_s = Wx, Wx is the weight component that just covered U_s



Wx = W sin 30^0

U_s = W sin 30^0 ; W = m x g

= 2kg x 10N /kg

=20N

U_s = 20N x Sin 30^0
= 20N x 0.5
= 10N

c. **i. the pull of gravity on the block**
   ii W = F x S ; F = Wx; S = 0.5m
   Wx = Wsin30^0

   = 20N x 0.5
   = 10N
   W = 10N x 0.5m
   = 5J

d. **let kinetic friction be U_k; then U_k = 0.9 U_s = (1 – 0.1) U_s**
   the resultant F, F = Wx – U_k = m x a
   U_s = 10N; U_k = 0.9 x 10N = 9N
   F = Wx - U_k
   = 10N – 9N
   = 1N
   Therefore, 1N = 2kg x a
   A= 0.5m/s^2
   But $V^2 = U^2 + 2as$
   U = 0;
   A= 0.5m/s^2
   S = 0.5m
   $V^2 = 0^2$ + 2 x 0.5 x 0.5
   V^2 = 0.50m^2/s^4
   V = 0.71m/s

ANSWER FOR QUESTION 4

4. i. atoms of the same element with the same proton number but different nucleon number of neutrons. [1 mark]

ii.137 is the sum of protons and neutrons in one atom of the isotope. 55 is the number protons in one atom of the element. [2 marks]

iii.a = 137 b = 56.

b. i. Gamma radiation is electromagnetic radiation.

ii. Beta radiation consists of electrons. [3 marks]

iii.Alpha radiation consists of helium nuclei.

c. i. the loss or gain of electrons by an atom to become an ion.

ii. Alpha radiation [3 marks]

d.Total mass of fragments = $3.418 \times 10^{-25} + 0.066 \times 10^{-25} = 3.484 \times 10^{-25}$ [1 mark]

mass defect = $3.485 \times 10^{-25} – 3.484 \times 10^{-25} = 1 \times 10^{-28}$ [1 mark]

$E = mc^2$ [1 mark]

$E = 1 \times 10^{-28} \times (3 \times 10^8)^2 = 9 \times 10^{12}$ J [1]

ANSWERS FOR QUESTION 5

a. ΔH = Mc ΔT / Q = Mc ΔT
= 0.5 x c x (100 -25)
= 0.5 x c x 75
= 37.5c heat lost by the block. [2 marks]

Heat gained by water and container
ΔH = Mc ΔT + Mc ΔT
0.9 x 4200 x (25-20) + 0.05 X 385 X (25-20)
(0.9 X 420 X 5) + (0.05 X 385 X 5)
18900 + 96.25
18996. 25J [3 marks]

Therefore: $\frac{37.5c}{37.5} = \frac{18996}{37.5}$

$C = \frac{18996}{37.5}$

C = 506.6 J/kg/k or 506.6 $Jkg^{-1}K^{-1}$ [2 marks]

b. i. E = Pt

= 16 x 30 x 60

= 28.800J [1 mark]

Assuming not heat is lost the upper limit for the specific heat capacity of the inner flask and contents would be:

$$C = \frac{Pt}{\Delta T}$$

$$C = \frac{28800}{100 - 20}$$

$$C = \frac{28800}{80}$$

C = 360 J/Kg/K or 360 J $Kg^{-1}K^{-1}$ [2 marks]

ii.E = Pt

= 60 x 30 x 60

= 108000 J [1 mark]

$\Delta H = P_2 t_2 - P_1 t_1$

108000 J – 28800 J

79200 J [1 mark] Energy available to vaporize the water.

Therefore:

$$Mw = \frac{79200}{2.26 \times 10^6}$$

$= 3.5 \times 10^{-2}$ Kg

= 3.5g [2 marks]

Total [15 marks]