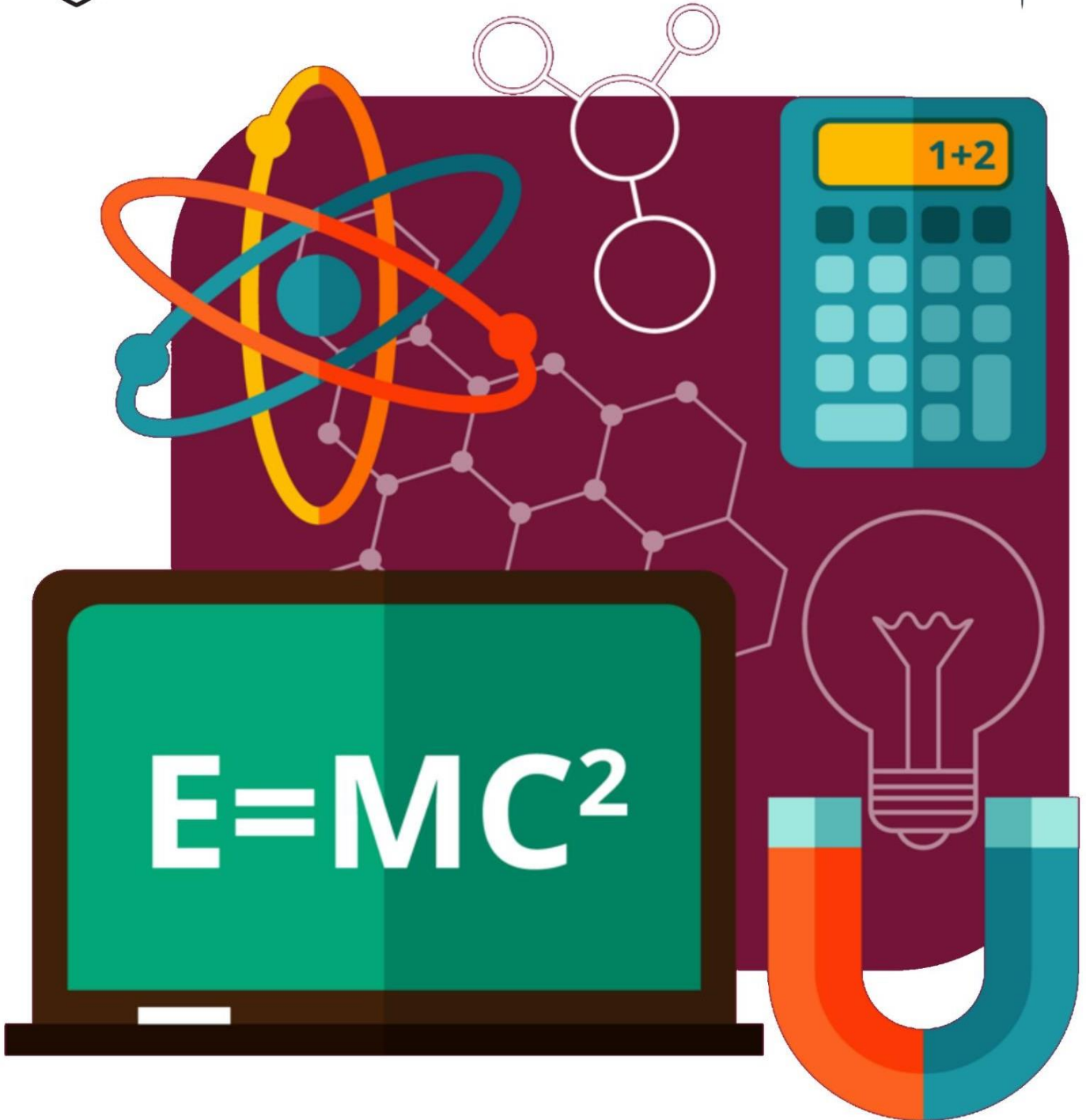




# PAST PAPERS



# PHYSICS

## (CHAPTERS 30/31)

1. A beam of high energy  $\alpha$  particles is incident upon a person and deposits 0.35 J of energy in 0.8 kg of tissue the dose equivalent ( in rem) the person receives is: ( $RBE_{\alpha} = QF_{\alpha} = 20$ )

- A) 34.8      B) 87.5      C) 438      D) 875      E) 219

2. A person ingests 0.63  $\mu$  Ci of a radioactive source. The emitter alpha particles deposit all their energy in the lungs. Given energy of each alpha particles is 4.0 MeV. Assume all the emitter alphas are absorbed within a 0.5 kg mass of tissue. The absorbed dose (in rad) for one year is :

- A) 1900      B) 47      C) 955      D) 94      E) 150

3. The isotope,  ${}^3\text{He}$ , has a half Life of 12.3 years. Assume we have 10.0 kg of the substance. The mass (in kg ) of  ${}^3\text{He}$  that will be left after 30 years is closest to:

- A) 0.5      B) 0.2      C) 1.8      D) 4.2      E) 1.3

4. A radioactive sample with decay rate R and decay energy Q has a power output of:

- A)  $Q/R$       B)  $Q^2/R$       C) R      D) QR

5. A certain nucleus containing 8 protons and 7 neutrons a radius R. Which of the following value would be to the expected value of the radius of a nucleus having 51 protons and 69 neutrons?

- A) 1.85R
- B) 2.00R
- C) 2.14R
- D) 6.38R
- E) 8.00R

6. At  $t=0$  container holds equal number of atoms of phosphorus 30 with a half life of 2.5 minutes, and of nitrogen 13 with a half life of 10 minutes. After 20 minutes the ration of the number of nitrogen atoms remaining to the number of phosphorus atoms remaining (N/P) is:

- A) 64      B) 1/64      C) 1/256      D) 8      E) 256

7. At  $t=0$ , A living piece of wood contains  $6.5 \times 10^{10}$  atoms of Carbon (A=14) per gram. A 44 g of a dead piece of wood is found in a forest. The dead peace shows a Carbon (A=14) activity of 100 decays/minutes. How long (in years) has this piece been dead?

The half-Life Carbon (A=14) of is 5730 years

- A) 12300
- B) 8500
- C) 15600
- D) 4700
- E) 2400

8. The isotopes Ra (  $A=266$ ) undergoes  $\alpha$  decay with a half-Life of 1620 years. The activity ( in Ci ) of 1.00 g of Ra ( $A=266$ ), is:

(1 Ci= $3.7 \times 10^7$  Bq ,  $N_A=6.02 \times 10^{23}$ )

- A) 1.96
- B) 0.98
- C) 10.0
- D) 0.49
- E) 5.00

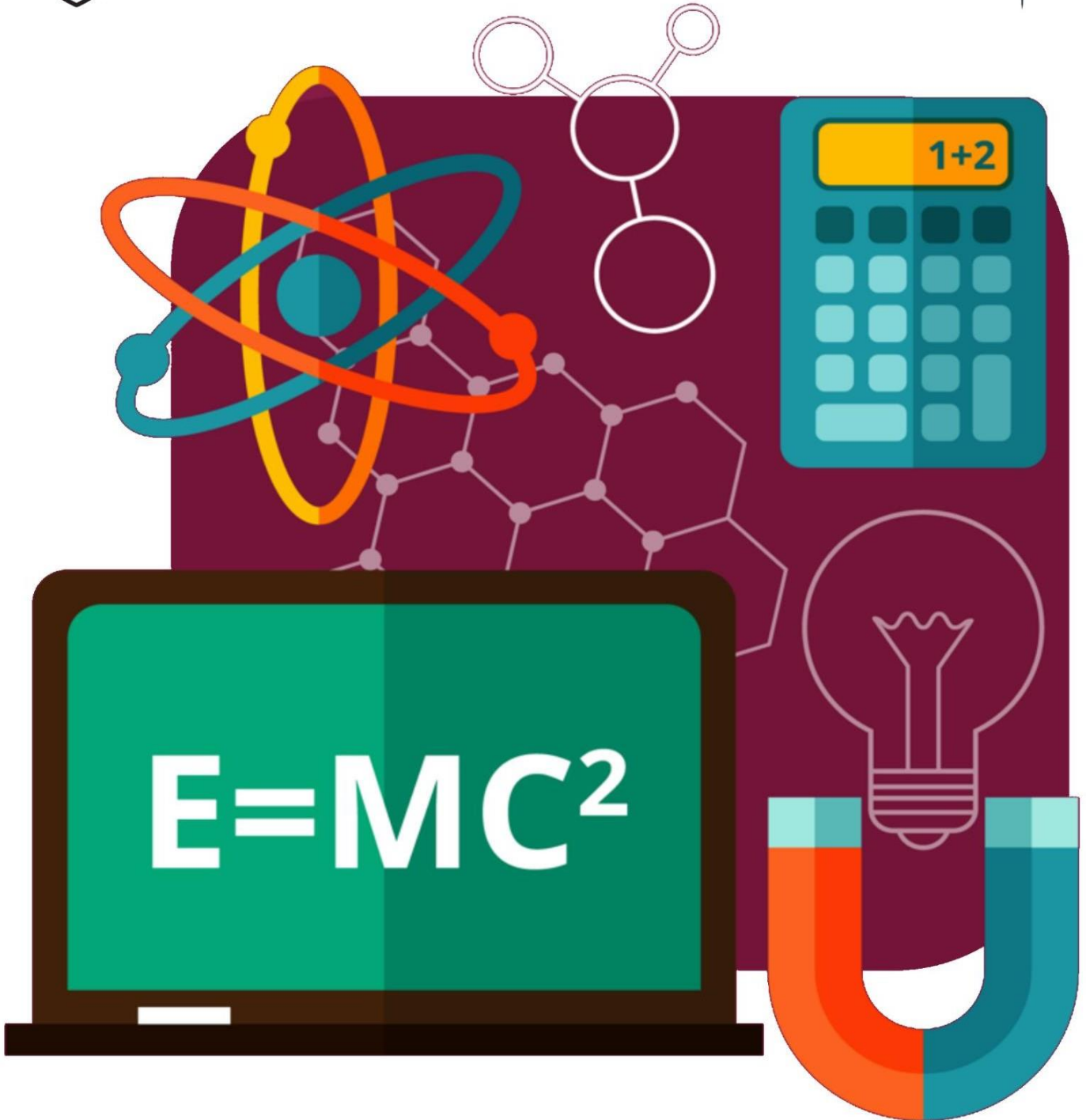
9. A 67.0-kg person mistakenly ingests 0.35-ci of  $^3\text{He}$  which emits electrons each with 5.0 keV. Assume that all of the electrons emitted from  $^3\text{He}$  are absorbed uniformly throughout the body. The absorbed dose (in rad) for one week is: (1 Ci =  $3.7 \times 10^{10}$  Bq)

- A) 9.35
- B) 2.76
- C) 27.6
- D) 935
- E) 7.46

**There is no substitute for hard work.**



# PAST PAPERS



# PHYSICS

$$AD = \frac{J}{kg}$$

$$4 \times 10^6 \times 1.602 \times 10^{-19} \frac{J}{decay} \times 0.63 \times 10^{-6} \times 3.7 \times 10^{10} \frac{decay}{s}$$

## (CHAPTERS 30/31)

$$\times 365 \times 24 \times 3600 \rightarrow 0.47 J$$

$$AD = \frac{0.47}{0.5} = 0.94 \text{ Gy} \times 100 = 94 \text{ rad}$$

1. A beam of high energy  $\alpha$  particles is incident upon a person and deposits  $0.35 \text{ J}$  of energy in  $0.8 \text{ kg}$  of tissue the dose equivalent (in rem) the person receives is: ( $RBE_{\alpha} = QF_{\alpha} = 20$ )

$$ED = AD * RBE$$

- A) 34.8      B) 87.5      C) 438      **D) 875**      E) 219

$$\frac{0.35}{0.8} * 20 = 8.75 \text{ Sv} \times 100 = 875 \text{ rem}$$

2. A person ingests  $0.63 \mu\text{Ci}$  of a radioactive source. The emitter alpha particles deposit all their energy in the lungs. Given energy of each alpha particles is  $4.0 \text{ MeV}$ . Assume all the emitter alphas are absorbed within a  $0.5 \text{ kg}$  mass of tissue. The absorbed dose (in rad) for one year is:

- A) 1900      B) 47      C) 955      **D) 94**      E) 150

3. The isotope,  ${}^3\text{He}$ , has a half Life of  $12.3 \text{ years}$ . Assume we have  $10.0 \text{ kg}$  of the substance. The mass (in kg) of  ${}^3\text{He}$  that will be left after  $30 \text{ years}$  is closest to:

- A) 0.5      B) 0.2      **C) 1.8**      D) 4.2      E) 1.3

$$M = M_0 e^{-\lambda t}$$

$$M = 10 e^{-\frac{\ln(2)}{12.3} * 30} = 1.84$$

القانون  
 $N = N_0 e^{-\lambda t}$   
 ليس بها أي طالب  
 بالكتلة فضيها  
 بدالة م

4. A radioactive sample with decay rate R and decay energy Q has a power output of:

- A)  $Q/R$       B)  $Q^2/R$       C) R      **D) QR**

$$P = \frac{J}{s} \Rightarrow \frac{J}{\cancel{decay}} * \frac{\cancel{decay}}{s} \rightarrow \frac{J}{s}$$

$$\downarrow Q * R$$

5. A certain nucleus containing 8 protons and 7 neutrons a radius R. Which of the following value would be to the expected value of the radius of a nucleus having 51 protons and 69 neutrons?

A) 1.85R

B) 2.00R

C) 2.14R

D) 6.38R

E) 8.00R

$$R = R_0 (A)^{\frac{1}{3}}$$

Mass num  
↓  
Constant

$$\frac{R_1}{R_2} = \frac{R_0 (8+7)^{\frac{1}{3}}}{R_0 (51+69)^{\frac{1}{3}}}$$

$$(8+7)^{\frac{1}{3}} R_2 = (51+69)^{\frac{1}{3}} R_1 \quad \text{No} = \text{No} \quad \rightarrow \quad R_2 = \frac{(51+69)^{\frac{1}{3}}}{(8+7)^{\frac{1}{3}}} R_1 = 2 R_1$$

6. At  $t=0$  container holds equal number of atoms of phosphorus 30 with a half life of 2.5 minutes, and of nitrogen 13 with a half life of 10 minutes. After 20 minutes the ration of the number of nitrogen atoms remaining to the number of phosphorus atoms remaining (N/P) is:

A) 64

B) 1/64

C) 1/256

D) 8

E) 256

$$\frac{N_1}{N_2} \Rightarrow \frac{N_1}{N_2} = \frac{N_0 e^{-\lambda_1 t}}{N_0 e^{-\lambda_2 t}} = \frac{3 e^{-\frac{\ln(2)}{10} \times 20}}{e^{-\frac{\ln(2)}{2.5} \times 20}} = 64$$

other way  $\lambda = \frac{\ln(2)}{T_{1/2}}$   
 $\frac{(\frac{1}{2})^{\frac{20}{10}}}{(\frac{1}{2})^{\frac{20}{2.5}}} = \frac{(\frac{1}{2})^2}{(\frac{1}{2})^8} = 64$

7. At  $t=0$ , A living piece of wood contains  $6.5 \times 10^{10}$  atoms of Carbon ( $A=14$ ) per gram. A 44 g of a dead piece of wood is found in a forest. The dead peace shows a Carbon ( $A=14$ ) activity of 100 decays/minutes. How long (in years) has this piece been dead?

The half-Life Carbon ( $A=14$ ) of is 5730 years

A) 12300

B) 8500

C) 15600

D) 4700

E) 2400

Next page  $\rightarrow$

Q7)  $N_0 = 6.5 \times 10^{10} \text{ atom/g}$   
 $R = 100 \text{ decay/min}$   
 $t = ??$   
 $T_{1/2} = 5730 \text{ year}$

$$N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

$$N_0 = 6.5 \times 10^{10} \frac{\text{atom}}{\text{g}} \times 44 \text{ g} = 2.86 \times 10^{12} \text{ atom}$$

$$100 \frac{\text{decay}}{\text{min}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 1.66 \text{ decay/sec}$$

$$T_{1/2} = 5730 \times 365 \times 24 \times 60 \times 60$$

$$T_{1/2} = 1.8 \times 10^{11} \text{ s}$$

$$R = \lambda \underline{N} = \frac{\ln(2)}{T_{1/2}} N$$



$$1.66 = \frac{\ln(2)}{1.8 \times 10^{11}} \times N$$

$$N = 4.31 \times 10^{11}$$

$$\ln\left(\frac{N}{N_0}\right) = \ln\left(\frac{1}{2}\right) \frac{t}{T_{1/2}}$$

Σ

$$\ln \frac{N}{N_0} = \frac{t}{T_{1/2}} \ln\left(\frac{1}{2}\right)$$

$$\ln\left(\frac{4.5 \times 10^{11}}{2.86 \times 10^{12}}\right) = \frac{t}{5730} \ln\left(\frac{1}{2}\right) \Rightarrow 15608.01 \text{ years}$$



8. The isotopes Ra (A=266) undergoes  $\alpha$  decay with a half-Life of 1620 years. The activity (in Ci) of 1.00 g of Ra (A=266), is:

$T_{1/2}$   
 $1620 \text{ year} \times 365 \times 24 \times 3600$   
 $5.108 \times 10^{10}$

(1 Ci =  $3.7 \times 10^{10}$  Bq,  $N_A = 6.02 \times 10^{23}$ )

A) 1.96

$3.7 \times 10^{10} \text{ Bq}$

$$1 \text{ g} \times \frac{1 \text{ mol}}{266 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 2.26 \times 10^{21}$$

B) 0.98

C) 10.0

D) 0.49

E) 5.00

$$R = \lambda N$$

$$R = \frac{\ln(2)}{5.108 \times 10^{10}} \times 2.26 \times 10^{21} = 3.0667 \text{ Bq}$$

$$\lambda = \frac{\ln(2)}{T_{1/2}}$$

0.828

9. A 67.0-kg person mistakenly ingests 0.35-ci of  $^3\text{He}$  which emits electrons each with 5.0 keV. Assume that all of the electrons emitted from  $^3\text{He}$  are absorbed uniformly throughout the body. The absorbed dose (in rad) for one week is: (1 Ci =  $3.7 \times 10^{10}$  Bq)

A) 9.35

$t = 7 \text{ day} \times 24 \times 3600$

$$AD = \frac{\text{Energy}}{\text{mass}} = \frac{626}{67} = 0.0935$$

$\times 100 = 9.35 \text{ rad}$

B) 2.76

C) 27.6

D) 935

$$5 \times 10^3 \times 1.6 \times 10^{-19} \frac{\text{energy}}{\text{decay}} \times 0.35 \times 3.7 \times 10^{10} \frac{\text{decay}}{\text{sec}} \times 7 \times 24 \times 3600 \text{ sec}$$

E) 7.46

**There is no substitute for hard work.**