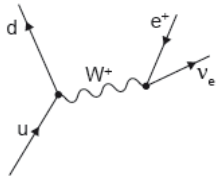
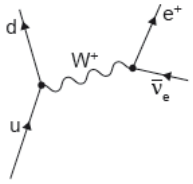
Ch7.2 *[26 marks]*

1. Which Feynman diagram shows beta-plus (β^+) decay? *[1 mark]*

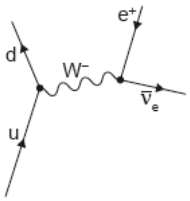
A.



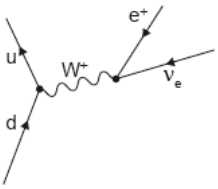
B.



C.



D.



Markscheme

A

2. The average binding energy per nucleon of the $^{15}_{8}\mathrm{O}$ nucleus is 7.5 MeV. What is the total energy required to separate the nucleons of one nucleus of $^{15}_{8}\mathrm{O}$? *[1 mark]*

A. 53 MeV

B. 60 MeV

C. 113 MeV

D. 173 MeV

Markscheme

C

3. Two pure samples of radioactive nuclides X and Y have the same initial number of atoms. The half-life of X is $T_{\frac{1}{2}}$. *[1 mark]*

After a time equal to 4 half-lives of X the ratio $\frac{\text{number of atoms of X}}{\text{number of atoms of Y}}$ is $\frac{1}{8}$.

What is the half-life of Y?

A.
$0.25T_{\frac{1}{2}}$

B.
$0.5T_{\frac{1}{2}}$

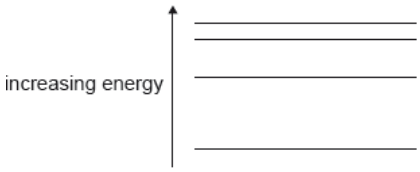
C.
$3T_{\frac{1}{2}}$

D.
$4T_{\frac{1}{2}}$

Markscheme

D

4. The energy-level diagram for an atom that has four energy states is shown. *[1 mark]*



What is the number of different wavelengths in the emission spectrum of this atom?

A. 1

B. 3

C. 6

D. 7

Markscheme

C

5. A detector, placed close to a radioactive source, detects an activity of 260 Bq. The average background activity at this location is 20 Bq. The radioactive nuclide has a half-life of 9 hours. *[1 mark]*

What activity is detected after 36 hours?

A. 15 Bq

B. 16 Bq

C. 20 Bq

D. 35 Bq

Markscheme

D

6. Element X decays through a series of alpha (α) and beta minus (β^-) emissions. Which series of emissions results in an isotope of X? *[1 mark]*

A. 1 α and 2 β^-

B. 1 α and 4 β^-

C. 2 α and 2 β^-

D. 2 α and 3 β^-

Markscheme

A

7. A graph of the variation of average binding energy per nucleon with nucleon number has a maximum. What is indicated by the region around the maximum? *[1 mark]*

A. The position below which radioactive decay cannot occur

B. The region in which fission is most likely to occur

C. The position where the most stable nuclides are found

D. The region in which fusion is most likely to occur

Markscheme

C

8. Three of the fundamental forces between particles are *[1 mark]*

I. strong nuclear

II. weak nuclear

III. electromagnetic.

What forces are experienced by an electron?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

C

9. What is correct about the Higgs Boson? *[1 mark]*

A. It was predicted before it was observed.

B. It was difficult to detect because it is charged.

C. It is not part of the Standard Model.

D. It was difficult to detect because it has no mass.

Markscheme

A

10. Identify the conservation law violated in the proposed reaction. *[1 mark]*

$$p^+ + p^+ \rightarrow p^+ + n^0 + \mu^+$$

A. Strangeness

B. Lepton number

C. Charge

D. Baryon number

Markscheme

B

11. Which statement about atomic spectra is **not** true? *[1 mark]*

A. They provide evidence for discrete energy levels in atoms.

B. Emission and absorption lines of equal frequency correspond to transitions between the same two energy levels.

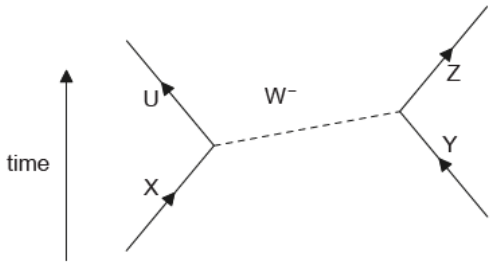
C. Absorption lines arise when electrons gain energy.

D. Emission lines always correspond to the visible part of the electromagnetic spectrum.

Markscheme

D

12. The Feynman diagram shows a particle interaction involving a W^- boson. *[1 mark]*



Which particles are interacting?

A. U and Y

B. W^- boson and Y

C. X and Y

D. U and X

Markscheme

C

13. A nucleus of phosphorus (P) decays to a nucleus of silicon (Si) with the emission of particle X and particle Y. *[1 mark]*

$$^{30}_{15}\mathrm{P} \rightarrow {}^{30}_{14}\mathrm{Si} + \mathrm{X} + \mathrm{Y}$$

What are X and Y?

	X	Y
A.	antineutrino	positron
B.	antineutrino	electron
C.	neutrino	electron
D.	neutrino	positron

Markscheme

D

14. What is the definition of the unified atomic mass unit? *[1 mark]*

A. $\frac{1}{12}$ the mass of a neutral atom of carbon-12

B. The mass of a neutral atom of hydrogen-1

C. $\frac{1}{12}$ the mass of a nucleus of carbon-12

D. The mass of a nucleus of hydrogen-1

Markscheme

A

15. In nuclear fission, a nucleus of element X absorbs a neutron (n) to give a nucleus of element Y and a nucleus of element Z. *[1 mark]*

$X + n \rightarrow Y + Z + 2n$

What is $\frac{\text{magnitude of the binding energy per nucleon of Y}}{\text{magnitude of the binding energy per nucleon of X}}$ and $\frac{\text{total binding energy of Y and Z}}{\text{total binding energy of X}}$?

	$\frac{\text{Magnitude of the binding energy per nucleon of Y}}{\text{Magnitude of the binding energy per nucleon of X}}$	$\frac{\text{Total binding energy of Y and Z}}{\text{Total binding energy of X}}$
A.	greater than 1	greater than 1
B.	less than 1	greater than 1
C.	greater than 1	less than 1
D.	less than1	less than 1

Markscheme

A

16. What is the energy equivalent to the mass of one proton? *[1 mark]*

A. $9.38 \times (3 \times 10^8)^2 \times 10^6$ J

B. $9.38 \times (3 \times 10^8)^2 \times 1.6 \times 10^{-19}$ J

C. $\frac{9.38 \times 10^8}{1.6 \times 10^{-19}}$ J

D. $9.38 \times 10^8 \times 1.6 \times 10^{-19}$ J

Markscheme

D

17. Atomic spectra are caused when a certain particle makes transitions between energy levels. *[1 mark]*
What is this particle?

A. Electron

B. Proton

C. Neutron

D. Alpha particle

Markscheme

A

18. The half-life of a radioactive element is 5.0 days. A freshly-prepared sample contains 128 g of this element. After how many days will there be 16 g of this element left behind in the sample? *[1 mark]*

A. 5.0 days

B. 10 days

C. 15 days

D. 20 days

Markscheme

C

19. The binding energy per nucleon of $^{11}_{4}Be$ is 6 MeV. What is the energy required to separate the nucleons of this nucleus? *[1 mark]*

A. 24 MeV

B. 42 MeV

C. 66 MeV

D. 90 MeV

Markscheme

C

20. The reaction $p^+ + n^0 \rightarrow p^+ + \pi^0$ does not occur because it violates the conservation law of *[1 mark]*

A. electric charge.

B. baryon number.

C. lepton number.

D. strangeness.

Markscheme

B

21. A pure sample of nuclide A and a pure sample of nuclide B have the same activity at time $t = 0$. Nuclide A has a half-life of T, nuclide B has a half-life of $2T$. *[1 mark]*

What is $\frac{\text{activity of A}}{\text{activity of B}}$ when $t = 4T$?

A. 4

B. 2

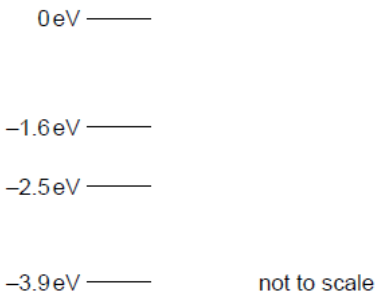
C. $\frac{1}{2}$

D. $\frac{1}{4}$

Markscheme

D

22. Photons of energy 2.3eV are incident on a low-pressure vapour. The energy levels of the atoms in the vapour are shown *[1 mark]*



What energy transition will occur when a photon is absorbed by the vapour?

A. –3.9eV to –1.6eV

B. –1.6eV to 0eV

C. –1.6eV to –3.9eV

D. 0eV to –1.6eV

Markscheme

A

23. When an alpha particle collides with a nucleus of nitrogen-14 $\left(^{14}_{7}\mathrm{N}\right)$, a nucleus X can be produced together with a proton. What is X? *[1 mark]*

A. $^{18}_{8}\mathrm{X}$

B. $^{17}_{8}\mathrm{X}$

C. $^{18}_{9}\mathrm{X}$

D. $^{17}_{9}\mathrm{X}$

Markscheme

B

24. The mass defect for deuterium is 4×10^{-30} kg. What is the binding energy of deuterium? *[1 mark]*

A. 4×10^{-7} eV

B. 8×10^{-2} eV

C. 2×10^{6} eV

D. 2×10^{12} eV

Markscheme

C

25. As quarks separate from each other within a hadron, the interaction between them becomes larger. What is the nature of this interaction? *[1 mark]*

A. Electrostatic
B. Gravitational
C. Strong nuclear
D. Weak nuclear

Markscheme

C

26. Which of the following lists the particles emitted during radioactive decay in order of increasing ionizing power? *[1 mark]*

A. γ, β, α
B. β, α, γ
C. α, γ, β
D. α, β, γ

Markscheme

A