Exercise on Feynman Diagrams

Particles:

Symbol - particle	Charge (units of e)	Baryon Number	Lepton Number
u – up quark	+2/3	1/3	0
d – down quark	-1/3	1/3	0
e – electron	-1	0	1
ν_e - neutrino	0	0	1

Force Carriers (Bosons):

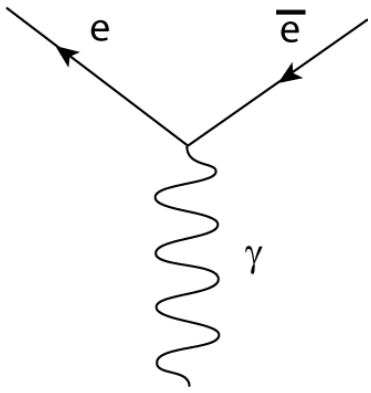
Symbol - particle	Charge (units of e)	Force Carried	Mass
γ - photon	0	Electromagnetic	0
g - gluon	0	Strong	0
W+	1	Weak	large
W–	-1	Weak	large
Z	0	Weak	large

Question 1: What is meant by $\bar{e}$?

a) anti-electron with a charge of +1
b) anti-electron with a charge of -1
c) proton
d) neutron
e) pion
f) none of these is correct

Note: We use time as vertical in our diagrams

Question 2: What process is described by the following Feynman Diagram?



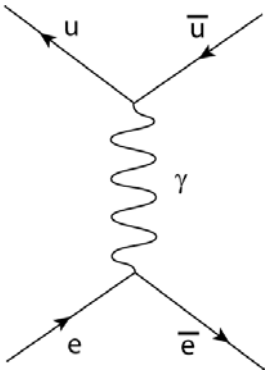
A) Creation of an electron and anti-electron by a photon
B) Scattering of an electron by an anti-electron
C) Scattering of two electrons by the EM force
D) Creation of a quark by the strong force
E) None of these is correct

Question 3: Is it possible for a down quark and an anti-down quark to interact to produce two electrons and an anti-electron.

Hint: Check that the charge, lepton number, and baryon number are conserved

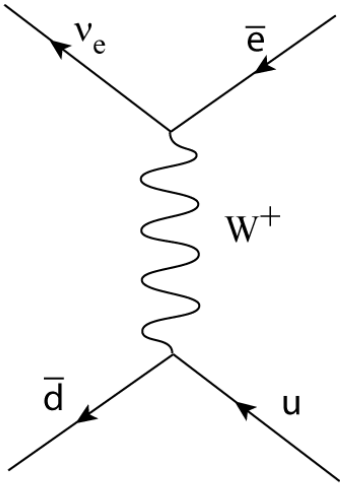
A) Yes
B) No

Question 4: What does the following diagram show?



A). Electrons interacting by the weak force
B). Electrons and quarks interacting by the strong force
C). **An electron and anti-electron annihilating, leading to the creation of a quark and anti-quark.**
D). An electromagnetic interaction of electrons and quarks
E). A gluon creating a photon and anti-photon.

Extra Credit: A Positive Pion (charge +e) is a particle made up of a up and an anti-down quark. Pions decay by the weak force, that is the two quarks can interact by the weak force. Is the follow diagram a possible representation of that process?



pion ($u\bar{d}$)

A). **YES** B) NO
Check that the charge, lepton number, and baryon number are the same before and after