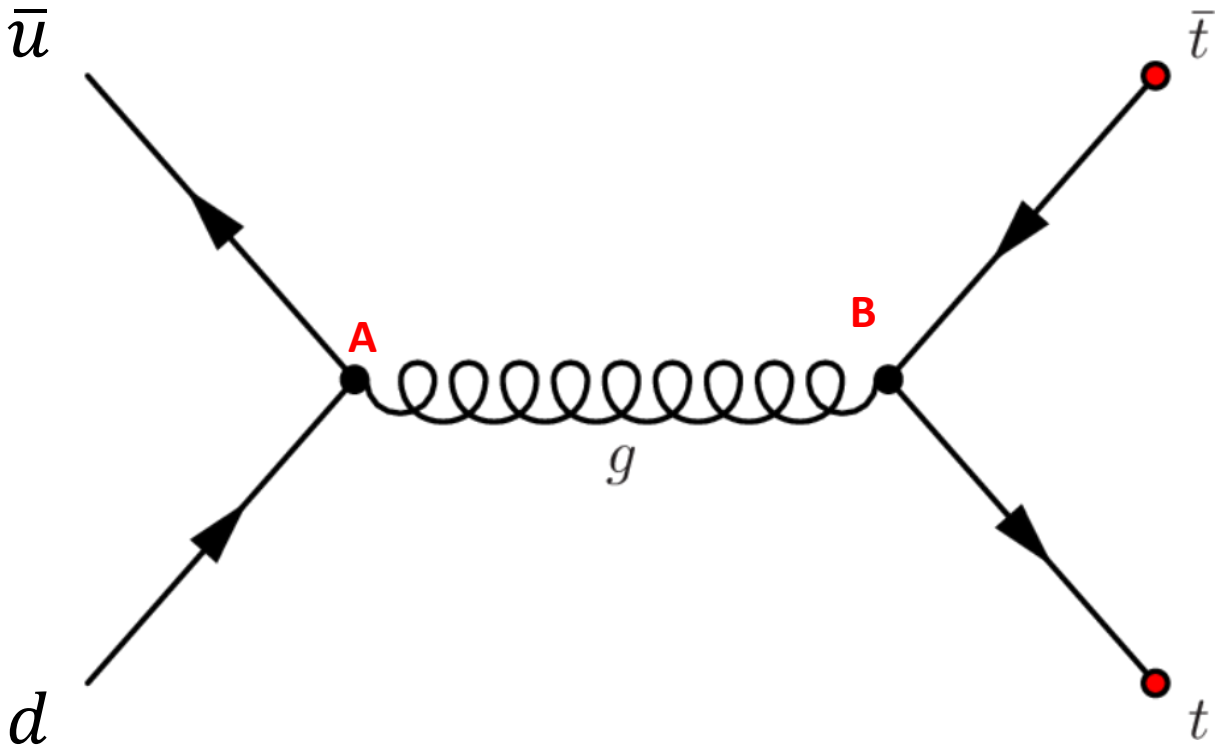
Exercise 1

Example



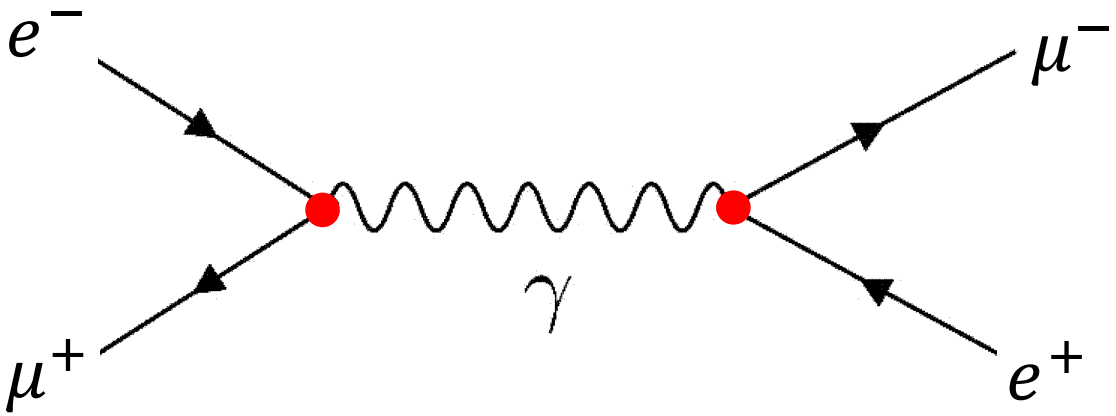
Can this process occur?
Why or why not?

No, this process cannot occur because

At vertex A:

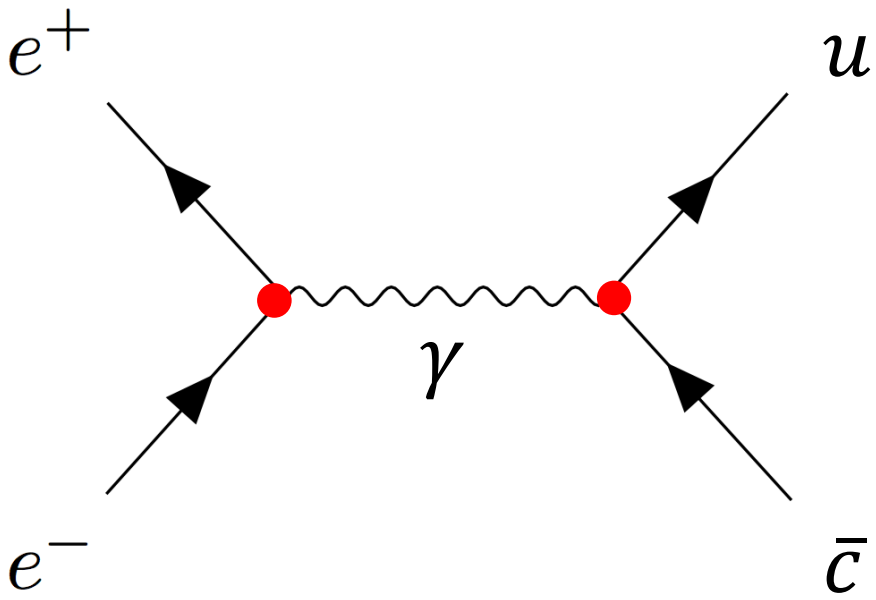
1) Electric charge is not conserved! Must have the charge of the $q_{\bar{u}}$ and q_d equal to the gluon's electric charge, which is zero. But, $q_{\bar{u}} + q_d = -\frac{2}{3} - \frac{1}{3} = -1$.
2) Flavor of the initial state quarks is different! The quark and antiquark must be the same flavor, such as $\bar{u}u, \bar{d}d, etc$.

Question 1



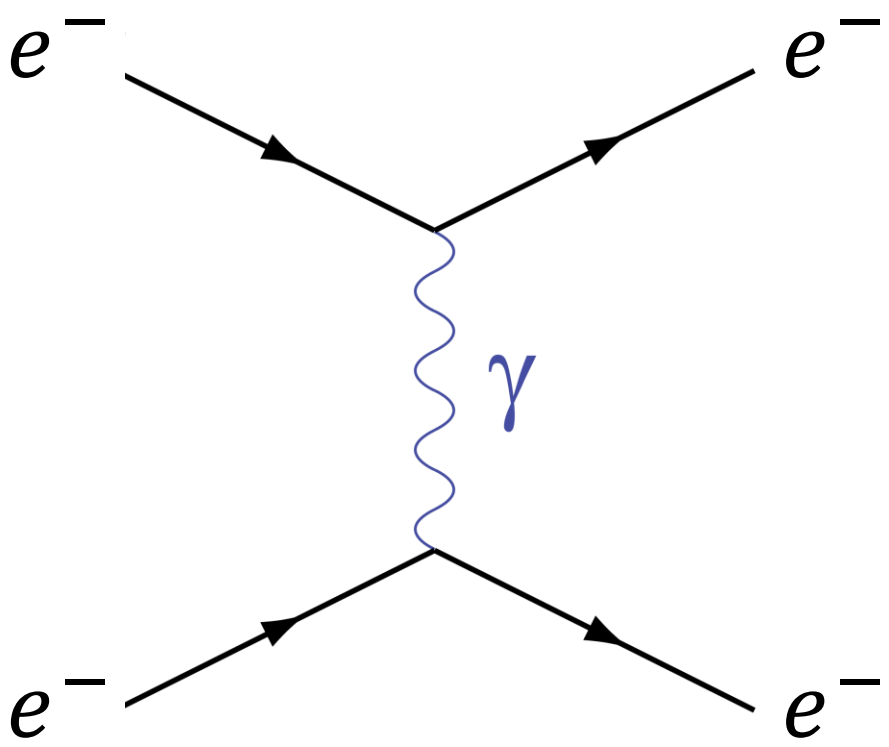
Can this process occur?
Why or why not?

Question 2



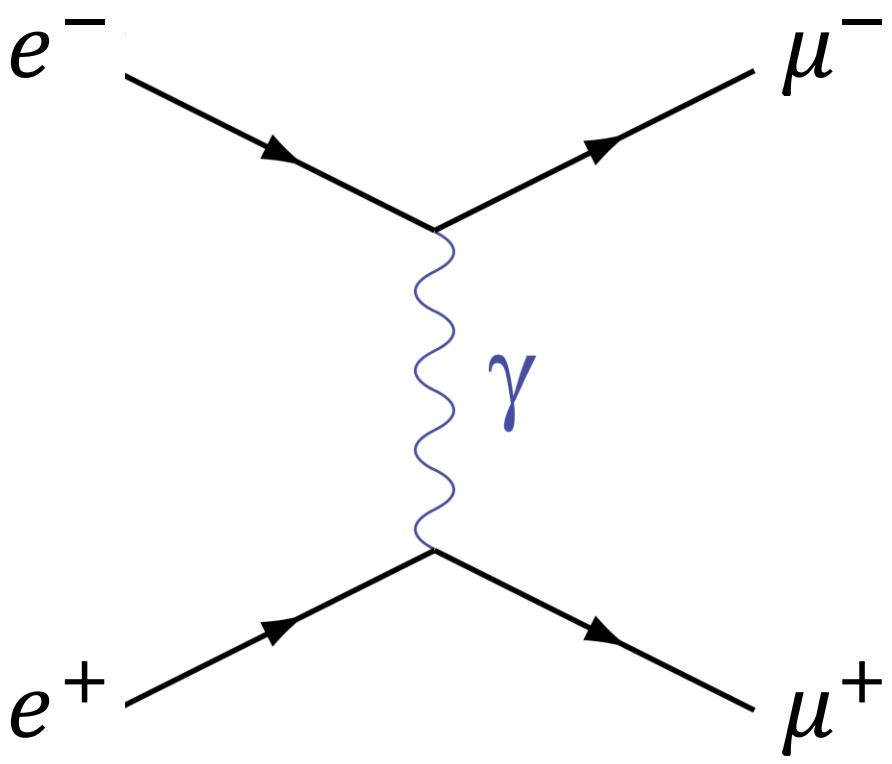
Can this process occur?
Why or why not?

Question 3



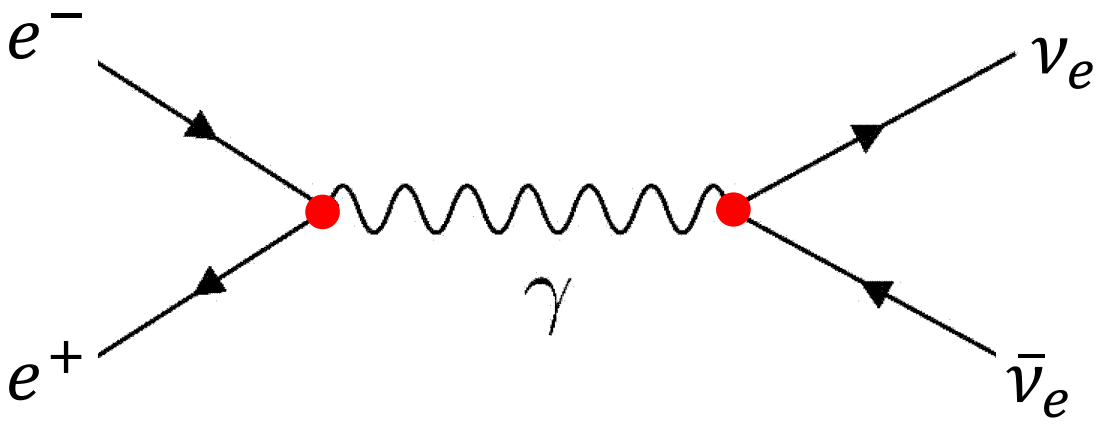
Can this process occur?
Why or why not?

Question 4



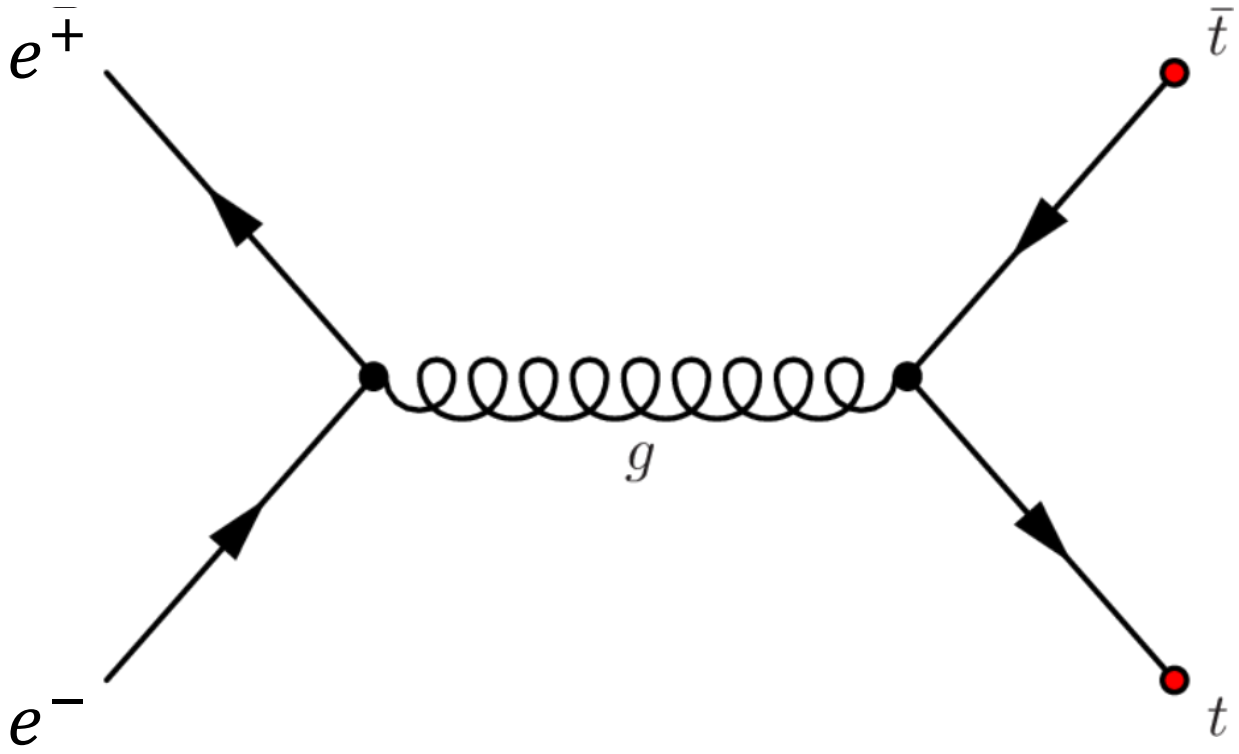
Can this process occur?
Why or why not?

Question 5



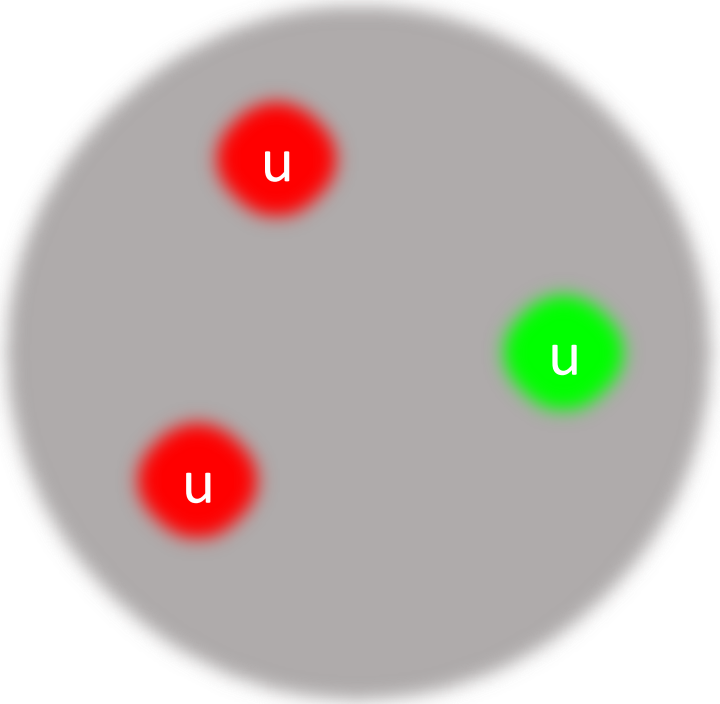
Can this process occur?
Why or why not?

Question 6



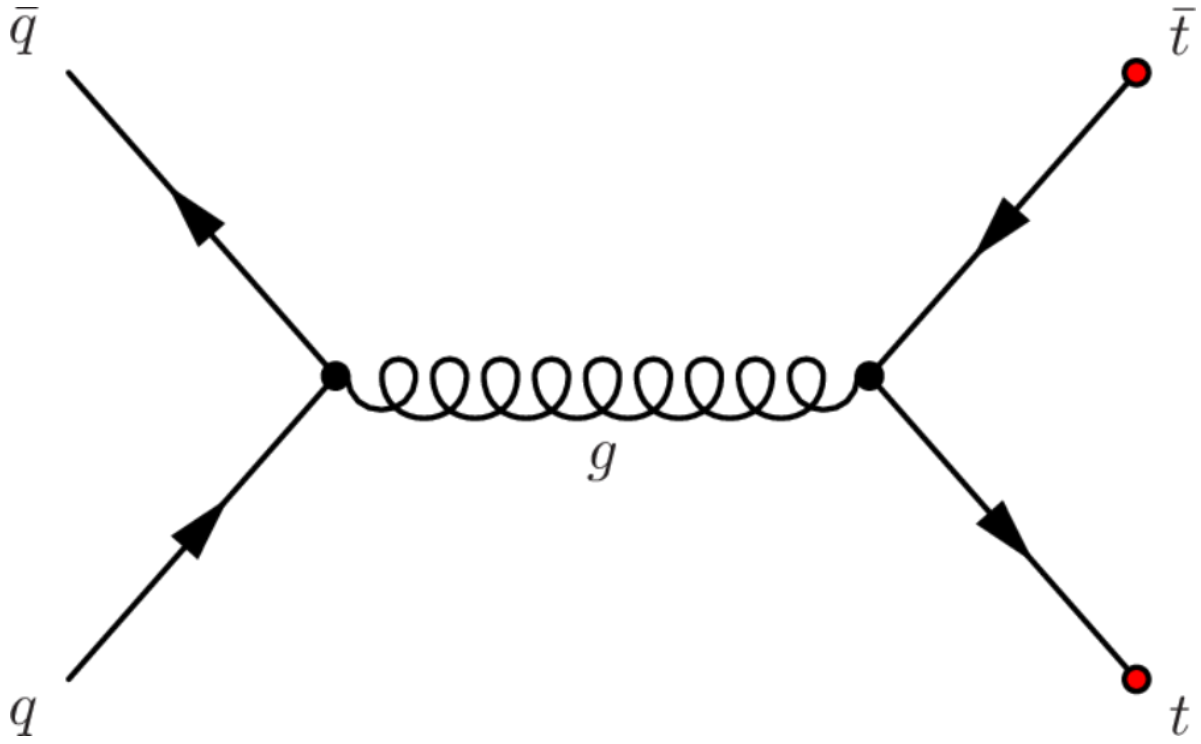
Can this process occur?
Why or why not?

Question 7

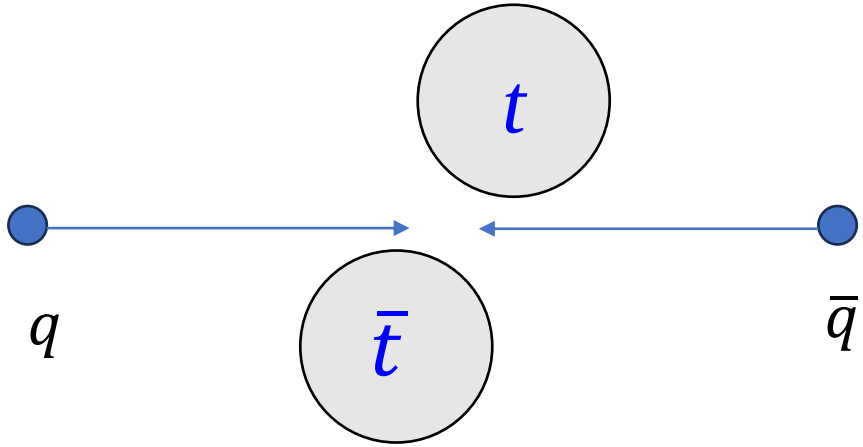


Does this particle exist?
Why or why not?

Question 8



Where does one get the antiquarks if you wanted to try to make this process happen?



Assuming the quark and antiquark collide “head on”, what is the minimum energy the quark and antiquark must have?

Exercises

Using the Table on the next page:

- Draw a Feynman diagram for the strong decay $\phi \rightarrow K^+K^-$.
- Draw a Feynman diagram for the strong decay $\Upsilon \rightarrow B^0\bar{B}^0$.
- Draw a Feynman diagram for the EM decay $\mathrm{J}/\psi \rightarrow \mu^+\mu^-$.
- Draw a Feynman diagram for the strong decay $\Delta^{++} \rightarrow p\pi^+$.

Some Mesons

Particle	Quarks
π^+	$(u\bar{d})$
π^-	$(\bar{u}d)$
π^0	$(u\bar{u}), or\ (d\bar{d})$
K^+	$(u\bar{s})$
K^-	$(\bar{u}s)$
K_S^0	$(s\bar{d})$ or $(\bar{s}d)$
D^+	$(c\bar{d})$
D^-	$(\bar{c}d)$
D^0	$(c\bar{u})$
$\bar{D}^0$	$(\bar{c}u)$
D_s^+	$(c\bar{s})$
D_s^-	$(\bar{c}s)$

Particle	Quarks
B^+	$(\bar{b}u)$
B^-	$(b\bar{u})$
B^0	$(\bar{b}d)$
$\bar{B}^0$	$(b\bar{d})$
B_s^0	$(\bar{b}s)$
$\bar{B}_s^0$	$(b\bar{s})$
ϕ	$(s\bar{s})$
J/ψ	$(c\bar{c})$
Υ	$(b\bar{b})$

Some Baryons

Particle	Quarks
p	uud
n	udd
Δ^-	ddd
Δ^0	udd
Δ^+	uud
Δ^{++}	uuu
Λ	sud
Λ_c^+	cud
Λ_b^0	bud

Quarks

Particle	Charge
d	$-1/3$
u	$+2/3$
s	$-1/3$
c	$+2/3$
b	$-1/3$
t	$+2/3$

Antiquarks have opposite charge to the quarks