Mark scheme for Support Worksheet – Option J, Worksheet 1

1 Baryons consist of three quarks. [1]

2 Each quark has spin $\frac{1}{2}$ (in units of $\hbar$); and so three quarks can have their spins all up for a total of $\frac{3}{2}$; or two up and one down for a total of $\frac{1}{2}$. [3]

3 A meson consists of one quark and one antiquark. [1]

4 Each quark and antiquark has spin $\frac{1}{2}$ (in units of $\hbar$); and so a quark and an antiquark can have their spins both up for a total of 1; or one up and one down for a total of 0. [3]

5 The photon is one but there are many others. [1]

6 The antiparticle must have opposite quantum numbers to those of the particle; hence for $Q = -Q$ implies $Q = 0$ [2]

7 A particle may emit a **virtual** exchange particle thereby changing its energy and momentum; the emitted exchange particle is absorbed by another particle which therefore also changes its energy and momentum; this exchange is interpreted as an interaction between the two particles. [3]

8 The photon. [1]

9 The $W^{\pm}$; and Z^0 bosons. [2]

10 The gluons. [1]

11 **a** The proton consists of uud. [1]

b The neutron consists of ddu. [1]

12 It would violate baryon number conservation; $1 \rightarrow 0 + 0$ [2]

13 It would violate baryon number conservation; $1 + (-1) \rightarrow 1 + 0 + 0$ [2]

14 **a** Gluons do not change the flavour of the quark and so q is still u. [1]

b Red antiblue. [1]

15 $S = -3$; $Q = 3 \times \frac{-1}{3} = -1$ [2]

16 $S = +1$; $Q = \frac{2}{3} + \frac{1}{3} = +1$ [2]