**Q7** A positively charged particle is initially moving from left to right in the plane of the page, and enters a region in which a magnetic field $B$ is applied in the same direction, as shown in Figure 3. Which *one* item from the key for Q7 correctly describes the motion of the particle immediately after entering the region of the field? Pencil across *one* cell in row 7.


**Figure 3**

KEY for Q7

A The particle continues to move with the velocity it had before entering the field.

B The particle continues to move in its original direction, but its speed *increases*.

C The particle continues to move in its original direction, but its speed *decreases*.

D The particle continues to move in the plane of the page, but it is deflected towards the *top* of the page.

E The particle continues to move in the plane of the page, but it is deflected towards the *bottom* of the page.

**Q8** A particle of rest mass $m$ has relativistic energy $2mc^2$, where $c$ is the speed of light in a vacuum. What is the magnitude of the particle's relativistic momentum? Select the answer from the key for Q8, and pencil across *one* cell in row 8.

KEY for Q8

A $\sqrt{3}\,mc$

B $2mc$

C $\sqrt{5}\,mc$

D $3mc$

E $4mc$

**Q9** Light of frequency $4.0 \times 10^{15}$ Hz falls onto a clean metal surface and liberates electrons by the photoelectric effect. Outside the metal surface, the emitted electrons are found to have a maximum kinetic energy of $1.9 \times 10^{-18}$ J. Estimate the work function of the metal and select the correct option from the key for Q9. Pencil across *one* cell in row 9.

KEY for Q9

A $1.3 \times 10^{-19}$ J

B $7.5 \times 10^{-19}$ J

C $9.8 \times 10^{-19}$ J

D $2.7 \times 10^{-18}$ J

E $4.5 \times 10^{-18}$ J

**Q10** A particle is described by the wavefunction

$$\psi(x) = A \sin(x/D)$$

where $A$ and $D$ are constants. Let $P_1$ be the probability of finding the particle in a small region centred on $x = D/2$, and let $P_2$ be the probability for finding the particle in a similar region, of the same width, centred on $x = D/4$. What is the ratio $P_2/P_1$? Choose from the key for Q10 the value nearest to your answer, and pencil across *one* cell in row 10.

KEY for Q10

A 0.27

B 0.52

C 0.72

D 1.39

E 1.94

F 3.76

**Q11** The key for Q11 contains five facts that rely on quantum mechanics. Which one of these is most closely related to the fact that a composite particle formed from a pair of fermions behaves like a boson? Pencil across *one* cell in row 11.

KEY for Q11

A Rotating neutron stars emit beams of electromagnetic radiation which are detected on Earth as regular pulses.

B Human vision is very acute, in spite of the presence of thermal radiation.

C The Sun is able to emit a considerable amount of energy through a process initiated by the fusion of two protons.

D At very low temperatures, liquid $^3$He is able to flow easily through very narrow tubes.

E Lasers rely on the process of stimulated emission of radiation.