Question number	Answer	Notes	Marks
3	any three from: MP1. reaction time of driver (including comment on drink / drugs / driver paying attention / driver distracted / driver tired); MP2. condition of car's brakes / force applied to brakes; MP3. condition of car's tyres; MP4. condition of road surface (including ice / water / mud / friction ideas); MP5. visibility factor (e.g. fog / dirty windscreen); MP6. speed of car; MP7. mass of car; MP8. kinetic energy of car; MP9. momentum of car;	allow 'thinking distance' allow 'braking distance' in the absence of MP2, MP3 and MP4	3

Total for question = 3 marks

Question number	Answer	Notes	Marks
4	MP1. find volume (of bolt); MP2. using displacement method; MP3. further detail of displacement method; MP4. correct use of density equation to find mass; MP5. further example of good practical technique;	MP2 MP3 MP5 can be awarded if seen on diagram e.g. • ensure bolt is fully submerged • measure volume of water before and after then find difference • (if using Archimedes can) ensure all displaced water is collected allow use of standard symbols e.g. • take repeats and average • use of appropriately sized measuring cylinder • make sure no water splashes out • read volume of water from bottom of meniscus • read at eye level to reduce parallax error	5

Total for question 4 = 5 marks

Question number	Answer	Notes	Marks
12	any three from: MP1. pollen grain changes direction; MP2. (due to) collisions; MP3. by {smaller / tiny / water / invisible} particles; MP4. (this is) Brownian motion;	allow random motion	3

Total for question 12 = 3 marks

<table>
<tr><th colspan="2">Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>13</td><td>a</td><td>Geiger(-Muller) tube/detector;

clock / counter / stopwatch;</td><td>‘Geiger counter’ on its own gets 1 mark only</td><td>2</td></tr>
<tr><td></td><td>b (i)</td><td>source 1 line correct;
source 2 line correct;
source 3 line correct;;

<table><tr><th></th><th>Alpha</th><th>Beta</th><th>Gamma</th></tr><tr><td>Source 1</td><td></td><td></td><td>✓</td></tr><tr><td>Source 2</td><td></td><td>✓</td><td></td></tr><tr><td>Source 3</td><td>✓</td><td>✓</td><td></td></tr></table></td><td>one mark for each correct tick for source 3
-1 if all three types ticked</td><td>4</td></tr>
<tr><td></td><td>(ii)</td><td>(due to) background radiation;</td><td></td><td>1</td></tr>
<tr><td></td><td>c (i)</td><td>time taken;

and either of
• for (radio)activity to halve;

• for half of (radioactive) nuclei / atoms / isotope to decay;</td><td>allow
how long it takes
reject ‘half the time’

allow count rate for activity
reject:
• particles
• molecules
• substance
• ‘break down’
• ‘reactivity’
• a nucleus / an atom
• halve in mass
• to completely/fully decay</td><td>2</td></tr>
<tr><td></td><td>(ii)</td><td>count after one half-life found;
idea of it taking 3 half-lives;
correct evaluation of time;

e.g.
after 1 half-life, count = 390
after 3 half-lives, count = 97.5
(time = 3 x 6 =) 18 (days)</td><td>award full marks for answer of 17.78… days</td><td>3</td></tr>
</table>

Total for question 13 = 12 marks