Mark schemes

1. (a) Gravitational field lines show the direction (and relative magnitude) of force on a mass (placed in the force field) ✓
Or
The direction a stationary/placed mass would (initially) move.

1

(b) (Lines are closer together so) the field is stronger ✓
(Material forming the Earth) at **K** has a high(er) density (than the surrounding material) ✓

*For second mark allow more mass at **K**.*

'Force is stronger' does not gain first mark.

2

(c) The ball will speed up/accelerate (when moving towards **K**) ✓
(because) the potential is lower at **K** ✓
Or
the angled field lines between **J** and **K** have a component towards the right ie towards **K**) ✓

2

(d) A gravitational field should only show attraction to a body / lines of force should only be going to an object / arrow heads (on the left) should point towards **L**. ✓ (owtte)

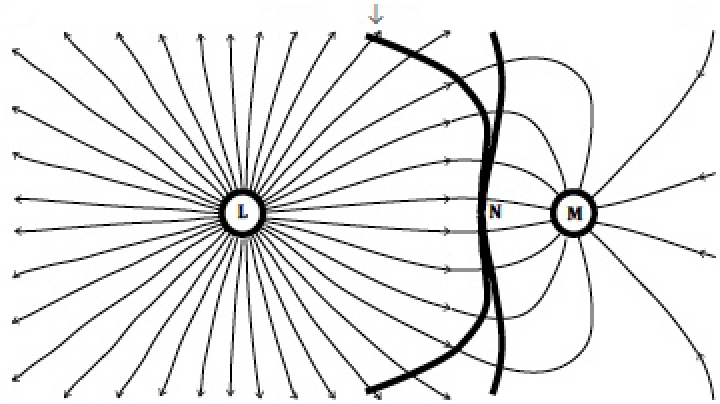
Reference to positive or negative almost always will lose the mark.

1

(e) object = L
object = L ✓

1

(f) The drawn line should approximately cross the field lines at right angles ✓



A mark is given if the line is symmetrical top to bottom and it bends to the left. ✓

First mark:

Only look at the <u>*4 lines*</u> *of force close to N. Essentially the range is from a vertical line to one that curves only slightly in order to cross the 4 field lines close to N at right angles. This mark can also be given if a right angle symbol appears on the diagram at any field crossing of the drawn line.*

Second mark:

There must be some bending of the line to the left (beyond the 4 lines close to N) but no more than that indicated by the arrow above the diagram (For reference the range extends to the position of the second field line that is truncated)

So a very large circle centred on L and leaving the diagram might get 2nd mark but not the 1st.

A vertical line might get the 1st but not the 2nd.

A small circle around M will not score.

If multiple lines are drawn only mark the line that passes through N.

2

[9]

2. **A** **[1]**

3. **A** **[1]**

4. D **[1]**

5. B **[1]**

6. C

[1]

7. **C**

[1]

8. **D**

[1]

9. **D**

[1]

10. (a) $t = \sqrt{\frac{2s}{g}}$ or $4.5 = \frac{1}{2} \times 9.81 \times t^2$ ✓

$t = 0.96$ s✓

2

(b) Field strength = 186000V m^{-1}✓

Acceleration = Eq / m

or $186\,000 \times 1.2 \times 10^{-6}$ ✓

0.22 m s^{-2} ✓

3

(c) 0.10(3)m (allow ecf from (i))✓

1

(d) Force on a particle = *mg* and

acceleration = F / m so always = *g*✓

Time to fall (given distance) depends (only) on the distance and acceleration✓

OR:

$g = GM / r^2$ ✓

Time to fall = $\sqrt{2s / g}$

so no *m* in equations to determine time to fall✓

2

(e) Mass is not constant since particle mass will vary✓

Charge on a particle is not constant✓

Acceleration = Eq / m or (V / d) (q / m) or Vq / dm✓

E or V / d constant but charge and mass are 'random' variables so q / m will vary (or unlikely to be the same)✓

4

[12]

11. **C**

[1]

12. **D**

[1]

13. **D**

[1]

14. **A**

[1]

15. **D**

[1]

16. **D**

[1]

17. **C**

[1]

18. (a) Total Mass of nuclei is more than the mass of the fusion product ✓$_1$

✓$_1$ Alternatively the B/A of the fusion product is greater than B/A of both the starting nuclei.

Binding energy or Binding energy per nucleon increases when a nucleus is formed by fusion ✓$_2$

✓$_2$ In order to release energy, the total binding energy of the two nuclei must be less than the binding energy of the nuclide formed

2

(b) $(\Delta m = \left(\text{mass } {}^{3}_{2}\text{He} + \text{mass } {}^{17}_{8}\text{O}\right) - \text{mass } {}^{20}_{10}\text{Ne})$

✓1 Δm = (3.01603 + 16.99913) – 19.99244) = 0.02272 u (must have at least 3 sig fig)

Δm = 0.02272 (u) ✓1

Energy released = 3.38 to 3.40 × 10^{-12} J ✓2 (allow an ecf for the conversion of units)

✓2 Δm = 0.02272 × 1.661 10^{-27} kg = 0.02272 × 1.661 10^{-27} × (3.00 × $10^8)^2$ J = 3.39 × 10^{-12} J

OR

Δm = 0.02272 × 931.5 MeV

= 21.16 × 1.60 × 10^{-13}J = 3.39 × 10^{-12}J

2

(c) Mark for use of potential energy formula and identifying the 2(e) and the 8(e) ✓1

✓1 condone other numerical errors

$$\left(V = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r} = \frac{2 \times 8 \times \left(1.60 \times 10^{-19}\right)^2}{4\pi \times 8.85 \times 10^{-12} \times 5.1 \times 10^{-15}}\right)$$

V = 7.2(2) × 10^{-13} (J) ✓2 (correct answer only)

✓2 correct final answer gains both marks

2

(d) Making reference to the doubling charge which increases the gain in potential energy or force needed (to bring nuclei together) ✓1 (owtte)

✓1 no computation is expected
Condone increase instead of doubling

(So) the larger charge (of ${}^{34}_{16}\text{S}$) requires greater kinetic energy or pressure for fusion and decreases the rate of fusion ✓2 (owtte)

Making reference to the larger radius/size of the sulphur nucleus compared to the oxygen nucleus

(So) the larger radius (of = ${}^{34}_{16}\text{S}$) (requires smaller kinetic energy or pressure for fusion) and the separation can be larger for fusion to take place so increases the rate of fusion ✓3 (owtte)

✓3 A full calculation is not expected, such as

$$\frac{R_S}{R_O} = \sqrt[3]{\frac{A_S}{A_O}} = \sqrt[3]{\frac{34}{17}} = \sqrt[3]{2}$$

If no marks are awarded accept number of protons for charge in mp1.

3

[9]