

Name of the Student: _____

Max. Marks : 23 Marks

Time : 23 Minutes

Mark Schemes

Q1.

- (a) horizontal velocity =
- $20 \cos 40^\circ = 15.3 \checkmark$
- (m s
- ⁻¹
-)

*Needs minimum 3 sf**For MP1 it must be clear that the horizontal velocity has been determined.*horizontal velocity (is constant) / minimum when vertical velocity = 0 $\checkmark$

2

- (b) (vertical velocity)
- $v = 20 \sin 40^\circ (= 12.9) \checkmark$
- (m s
- ⁻¹
-)

$$s = ut + \frac{1}{2} at^2$$

$$-3 = -12.9t + \frac{1}{2} \times 9.81t^2 \text{ or } 3 = 12.9t - \frac{1}{2} \times 9.81t^2 \checkmark$$

$$(4.91t^2 - 12.9t + 3.00 = 0)$$

*For second mark both suvat equation and substitution must be shown.
Equation may be rearranged before substitution*

2

- (c) Use of quadratic formulae with +, - or
- $\pm \checkmark$

$$\text{eg } t = \frac{12.9 \pm \sqrt{(-12.9)^2 - 4 \times 4.91 \times 3.00}}{2 \times 4.91}$$

0.258 s and 2.37 s $\checkmark$ *Two correct answers alone scores first 2 marks.*Time to reach 3 m once on the way up and once on the way down (OWTTE) $\checkmark$ Larger value $\checkmark$ *ecf available for last 2 marks*

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- (d)
- $s = vt = 20 \cos 40^\circ \times 2.37 = 36.3 \text{ m so no } \checkmark$

*ecf from (c)**Calculation must be seen*

1

- (e) Gradient is the acceleration
- AND**

area under graph = vertical distance travelled ✓₁

Without air resistance:

comment about gradient ✓₂

comment about area ✓₃

With air resistance

comment about gradient ✓₄

comment about area ✓₅

For each comment on the graph a reason must be given not just a description.

e.g for ✓₂

• *constant gradient = g or 9.81 m s⁻¹*

e.g. for ✓₄

• *initially steeper gradient since air resistance in same direction as weight (so a > g)*

• *when line crosses time axis, gradient = g / 9.81 / gradient without air resistance as air resistance = 0 when v = 0 /*

• *After crossing time axis, gradient decreases as air resistance increases with speed*

E.g. for ✓₃ or ✓₅

• *total area under graph = 0 since ball starts and finishes on ground*

• *area between graph and axis is max height/vertical distance*

• *without air resistance reaches a higher height as area greater*

statement referring to area under both graphs gains ✓₃ and ✓₅

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Q2.

- (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) $(\Delta m = (\text{mass } {}^3_2\text{He} + \text{mass } {}^{17}_8\text{O}) - \text{mass } {}^{20}_{10}\text{Ne})$

✓₁ $\Delta m = (3.01603 + 16.99913) - 19.99244 = 0.02272 \text{ u}$ (must have at least 3 sig fig)

$$\Delta m = 0.02272 \text{ (u)} \quad \checkmark_1$$

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

$$\checkmark_2 \Delta m = 0.02272 \times 1.661 \times 10^{-27} \text{ kg} = 0.02272 \times 1.661 \times 10^{-27} \times (3.00 \times 10^8)^2$$

$$\text{J} = 3.39 \times 10^{-12} \text{ J}$$

OR

$$\Delta m = 0.02272 \times 931.5 \text{ MeV}$$

$$= 21.16 \times 1.60 \times 10^{-13} \text{ J} = 3.39 \times 10^{-12} \text{ J}$$

2

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

✓₁ condone other numerical errors

$$\left(V = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r} = \frac{2 \times 8 \times (1.60 \times 10^{-19})^2}{4\pi \times 8.85 \times 10^{-12} \times 5.1 \times 10^{-15}} \right)$$

$$V = 7.2(2) \times 10^{-13} \text{ (J)} \quad \checkmark_2 \text{ (correct answer only)}$$

✓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.

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