Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) Use of $E_k = ½ mv^2$ ✔

(Kinetic energy =) 9.2×10^9 (J) ✔

Condone POT error on 1st MP

Allow use where v where has been converted from 5.5 km h^{-1}

An answer to 2 significant figures (with some working) ✔

Significant figure mark requires evidence of some relevant working.

3

(b) **Why force on the gas:**
The gas's momentum is changing ✔
This require a force according to **Newton's 2nd law** ✔

Or

The gas is being accelerated ✔
This require a force according to **Newton's 2nd law** ✔

Max 3** for **why there is a force on the gas** and **why there is a resistive force on the system

*Must have **why the system decelerates** to obtain all **4 marks**.*

The reason why the resultant force causes the deceleration rather than the acceleration.

Why (resistive) force on system:

The gas exerts a force on the parachute (with an equal magnitude and opposite direction force) / there is air resistance (on the system) / there is drag (on the system) / there is a resistive force (on the system) ✔

(because) the Parachute exerts a force on the gas according to **Newton's 3rd law** ✔

Allow statement that is equivalent to N1 / N2 / N3.

Allow: air resistance (or drag) increases.

Allow: there is an upward force

*must have a clear action-reaction pair for this **N3** mark.*

Why system decelerates:
The resistive force is <u>greater than the weight</u> so there is a resultant force
Or
The **resultant** force is acting in the opposite direction (to its motion). ✔

acceleration in same direction as resultant force according to **Newton's 2nd law** ✔

*allow the **resultant** force is vertically upwards*

Or

***Links** to violation for conditions of Newton's 1st law and therefore cannot continue at constant velocity.*

4

(c) Attempt at determining difference = 3.3 (× 10^5) − 2.2 (× 10^5) or difference = 1.1 (× 10^5) ✔

1st mark: Credit an application of conservation of energy (allow written statement, or equation without substitution)

Ignore signs on difference and answer.

MP2 allow their energy in a substitution that is, otherwise correct.

Condone an answer = 18.4 (m s^{-2}) is worth 2 marks.

Use of $E_p = mgh$ ✔

(g =) 3.7 (m s^{-2}) ✔

Condone mgh = ½ mv^2 where rearranged to make g subject.

*Condone 610 x g x 49 = **their energy***

Alternative:

- *Attempt to use appropriate equations of motion to determine acceleration*

$v^2=u^2$ +2as rearranged to make a the subject (condone use of their values for v and u and / or g = a)

- *Attempt to use W=Fs to determine the air resistance F_D (or F_D= 6734(.7) (N) seen)*
- *Attempt to determine g from the deceleration of the system*

$$g = \frac{F_D - ma}{m}$$

3

(d) More mass to **displace** / more particles to **collide with** / more gas / dust to displace ✔

Must have some interaction with parachute-spacecraft.

N/E to say there are more particles / gas / dust /mass

(at any given speed)
Greater (rate of) change of momentum / More work done (per unit distance) / Greater (resistive) force / more kinetic energy transferred (per unit distance) ✔

Greater **resultant** force **on** the system (therefore greater deceleration) / greater loss of velocity per second (therefore greater deceleration) ✔

3rd MP for greater resultant force: allow the idea that the difference between the drag and weight has increased

3rd MP

Allow clear statement that links:

- *rate of change of momentum of gas / dust to rate of change of momentum of system*
- *rate of work done on gas / dust to rate of work done by system*

3

[13]

Q2.

(a) Use of an appropriate equation of motion ✔

Where $v^2 = u^2 + 2as$ is correctly stated, condone one error in substitution e.g. sign of a

Where other equations are used it must be clear that v can be determined.

Must see v as subject and an attempt to determine t.

(v =) 0.35 (m s^{-1}) ✔

Allow more than 2 sf where correct.

2

(b) Use of tan 35 = u_v / 8.8

Or

Use of u cos 35 = 8.8 and u_v = u sin 35

and

6.2 or 6.16 with supporting a calculation ✔

Alternative: credit use of sine rule

Must see answer to at least two significant figures

1

(c) Use of an appropriate equation of motion ✔ ECF

Condone their incorrect value of u in this substitution.

Condone errors in signs in substitution Where other equations are used it must be clear how t can be determined.

Must see t as subject and an attempt to determine s.

(t=) 0.63 (s) ✔ ECF

0.61 (s) for use of u = 6 m s^{-1}

*For MP2, where their value of u is used, the answer must be consistent with this value. **Only** allow this use where their value of u, to 1 significant figure, = (5<u<7) m s^{-1}*

Condone 1 significant figure answer where U is 1 sig fig.

2

(d) Use of an appropriate equation of motion ✔ ECF

*Where equation is correctly stated, condone one error in substitution e.g. **one error on sign** of a substituted value **or** one incorrect value substituted (of course, ecf is acceptable)*

(h =) 1.9 (m) ✔ ECF

h = 1.83 m for use of u = 6 m s^{-1} allow ecf on t (check (c))

*For MP2, where their value of u is used, the answer must be consistent with this value. **Only** allow this use where their value of u, to 1 significant figure, = (5<u<7) m s^{-1}*

allow reverse calculation where u=0 and v = 6 m s^{-1}

2

(e) Smooth curve with maximum turning point seen, curve starts at the ball and finishes at **X** ✔

Curve should be approximately parabolic in shape.

*Curve must start below the label 'golf ball' and ends within 5mm of the ball or the label **X**. Curve must have a maximum turning point.*

1

(f) (Increase the angle to horizontal so) the ball must go higher (and increases its time in the air)

Or

(Increase the angle to horizontal so) the ball must have a greater (initial) vertical velocity ✔

(Covers the same horizontal distance over) a longer time in the air (so has a smaller horizontal velocity) ✔

Alternative:

Increased angle (to horizontal of projection) so smaller horizontal velocity ✔

must be falling towards ground to land at **X** ✔

(Increase the angle to horizontal so that) the vertical velocity greater than the horizontal / increase the vertical decreases the horizontal

2

[10]