

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Mark Schemes

Q1.

(a) (Use of volume (per sec) =) $\frac{\pi d^2}{4} \times 17.2$ ✓

(Volume per second =) $19.45 \text{ (m}^3 \text{ s}^{-1}\text{)} = \frac{774\pi}{125}$

$$\frac{\pi d^2}{4} \times 17.2 = \frac{9\pi}{25} \times 17.2$$

Use of $\rho = \frac{m}{V}$ ✓

Substitutes their volume (per second) and density where $\frac{m}{t}$ would be subject. Do not award MP2 if 2 errors are made in substitution.

(mass per second =) $0.389 \text{ (kg s}^{-1}\text{)} \checkmark$

Answer seen to at least 2 sf.

Calculator display = 0.3890548342

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(b) Use of $F = \frac{m}{t} \times v$ or ($F =$) 6.69 N or 6.708 (N) or 6.88 (N)

ORUse of $W = mg$ **OR** statement:

Upward force = weight ✓

Possible ECF from (a) where their m rounds to 0.4 kg.

$W = 3.72m$ seen or $3.72m$ as the subject of a force equation.

Do not allow 3.72×0.4 as use of $W = mg$

Applies condition for equilibrium by setting $F = mg$ **OR**

$6.69 = 3.72 m \text{ or } 6.708 = 3.72 m \text{ or } 6.88 = 3.72 m \checkmark$

$(m =) 1.80 \text{ (kg)} \checkmark$

Accept answer correctly rounded to at least 2 sf.

$$F = 6.88 \text{ N where } \frac{m}{t} = 0.4$$

$$m = 1.85 \text{ kg or } 1.8 \text{ kg}$$

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(c) Use of $E = Pt$

OR

converts kWh to J ✓

$$(E =) 340 \times 39 \text{ or } 13260 \text{ (J)}$$

$$(0.035 \text{ kWh} =) 35 \times 3600 \text{ or } 126000 \text{ (J)}$$

Alternative MP1 converts to any of the following units of energy.

$$\bullet 0.34 \text{ (kW)} \times 0.0108 \text{ (h)} \text{ or } 0.00368 \text{ (kWh)}$$

$$\bullet 0.035 \text{ kWh} = 35 \text{ (Wh)}$$

$$\bullet 340 \text{ (W)} \times \frac{13}{1200} \text{ (h)} \text{ or } \frac{221}{60} \text{ (Wh)} \text{ or } 3.683 \text{ (Wh)}$$

Or equivalent e.g W mins

Do not accept incorrect unit.

Do not accept incorrect subject.

MP2Do not allow answers obtained using incorrect power $\left(\frac{126000}{39}\right)$

$$\frac{340}{\text{incorrect power}} \text{ such as } \frac{340}{\frac{126000}{89}}$$

(=) 11% ✓

Accept answer correctly rounded to at least 2 sf.

Calculator display = 10.5238

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(d) Incorrect:

- this will increase weight **OR** helicopter must provide a greater lift **OR** (more mass therefore) greater GPE (for same height) **OR** (more mass therefore) greater KE (for same speed) **OR** idea that more energy is required. ✓
- the helicopter must displace more (atmospheric) gas (every second to produce greater lift force) **OR** blades must spin faster ✓
- the helicopter must do more work every second (so will transfer stored energy at a greater rate) **OR** the helicopter needs more power to fly ✓

OR

Incorrect:

- this will increase weight ✓
- atmosphere is too thin and can't displace sufficient mass of gas per second **OR** blades can't spin **fast enough** ✓
- can't get off ground due to insufficient lift force ✓

Do not accept increase in resistive forces or increase in drag for increase in weight.

Must state that it is incorrect for all 3 marks.

Maximum of 2 marks for suggestions that more than doubles flight time.

Accept lift or thrust or upward force.

A maximum of 1 mark for **MP3** and **MP1** where only mark seen is : idea that more energy is required.

MP2 can be scored independent of this.

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- (e) Use of an appropriate equation of motion:

$$v = u + at \quad \checkmark$$

By correct substitution including signs **or** correct rearrangement to make t subject.

$$(t =) 0.15 \text{ (s)} \quad \checkmark$$

Accept answer correctly rounded to at least 2 sf.

Calculator display = 0.14784946236559

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- (f) Use of $v^2 = u^2 + 2as$

OR

$$\text{Use of } v = u + at \text{ and } s = ut + \frac{1}{2}at^2 \quad \text{ECF}$$

OR

$$mg\Delta h = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \quad \checkmark$$

$$(h =) 0.61 \text{ (m)} \quad \checkmark \quad \text{ECF}$$

MP1 (Downward journey)

Allow $s = 0.65\text{m}$

$$2.2^2 = 0^2 + 2 \times 3.72 \times s$$

OR

$$2.2 = 0 + 3.72 t \text{ and } s = 0 + \frac{1}{2} 3.72 t^2 \quad \text{ECF}$$

OR

$$m \times 3.72 \Delta h = \frac{1}{2} m 2.2^2$$

MP1 (Upward journey)

Allow $s = 0.041 \text{ m}$ obtained from

$$s = 0.55 \times 0.15 - \frac{1}{2} 3.72 \times 0.15^2 \quad \text{ECF}$$

OR

$$0^2 = 0.55^2 - 2 \times 3.72 \times s$$

Check possible **ECF** for t from (e) used in calculation.

Condone sign suppression in **MP1** where answer of 0.65 m or 0.041 m or 0.6(1) m is seen.

Accept answer correctly rounded to at least 2 sf.

Calculator display = 0.60987903225806

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- (g) Student is correct:

Weight is the only force acting on the helicopter.

OR

Acceleration = (-3.72 ms^{-2}) ✓

Due to **Newton's 2nd law**, the acceleration acts in the **same direction** as the weight (which is always downwards).

OR

Due to **Newton's 2nd law**, the acceleration is **constant** because the (mass and) weight are **constant** ✓

MP1 statement that the object is in freefall. Where (resultant) force is mentioned must be identified as weight.

Where acceleration is quoted must have correct unit.

Accept $F=ma$ as a statement of Newton's 2nd law.

MP2 Accept no mention of force being weight where mass is included their answer, for e.g.:

*Due to **Newton's 2nd law** the acceleration is constant because the force **and** mass are constant.*

Neutral for statements that refer to deceleration / acceleration.

Do not accept arguments based on drag or air resistance affecting the motion of the helicopter.

Zero marks for statement that indicates the **acceleration varies**.

*Must state that student is correct **or** that the acceleration is constant to gain 2 marks.*

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