

Name of the Student: _____

Max. Marks : 22 Marks

Time : 22 Minutes

Mark Schemes

Q1.

(a) $E_k = E_p$ or $v = \sqrt{2gh}$ ✓

$$= \sqrt{2 \times 9.81 \times 90}$$

$$= 42.0 \text{ (m s}^{-1}\text{)} \quad \checkmark$$

*First mark for realising energy transformation from GPE to KE.**Second mark for correct answer.*

2

(b) calculation of area of pipe ($=0.0833 \text{ m}^2$) ✓

$$\text{radius} = \sqrt{\frac{0.0833}{\pi}} = 0.16 \text{ (m)} \quad \checkmark$$

2

(c) mass of water / s = 3500 kg ✓

$$\text{energy available per second} = 0.5 \times 3500 \times (42^2 - 12^2) \quad \checkmark$$

$$= 2.8 \text{ MW} \quad \checkmark$$

4

(d) heat / mechanical friction in turbines ✓

friction at walls of pipes / turbulence ✓

electrical heating in wires ✓

*Do **not** allow (friction) bald.**Seat of loss must be clear.*

Max 2

[10]**Q2.**

(a) resultant force = $11\,000 \times 2.9 = 31\,900 \text{ (N)}$ ✓

resultant force = thrust – air resistance

OR

$31\,900 = 230\,000 - \text{air resistance}$ ✓

$198\,000 \text{ (N)}$ ✓

3

- (b) Air resistance increases with speed so resultant force decreases with speed ✓

Eventually air resistance = thrust (so no acceleration) ✓

2

- (c) Time to reach maximum height = $2.5/9.8 = 0.255 \text{ s}$ ✓

maximum height = $1.5 + 4.9 \times 0.255^2 = 1.82 \text{ m}$ ✓

Time to reach ground from maximum height = 0.61 s giving total time = 0.87 s ✓

OR

$-1.5 = 2.5t - 0.5 \times 9.8 \times t^2$ ✓

rearrange quadratic gives $4.9t^2 - 2.5t - 1.5 = 0$ and

solution $t = \frac{2.5 \pm \sqrt{2.5^2 + 4 \times 4.9 \times 1.5}}{2 \times 4.9}$ ✓

Giving solutions 0.86 or -0.35 hence time = 0.86 s ✓

Allow credit for alternative routes

3

- (d) Starts at 2.5 m s^{-1} and maximum height same but reached earlier ✓

Maximum range no more than 175 m ✓

2

- (e) Motion unchanged vertically / maximum height of P is unchanged: air resistance decelerates P horizontally so less distance travelled. (both points needed) ✓

Air resistance increases with speed: speed is low vertically but very high horizontally (both points needed) ✓

2

[12]