Unit 18 · Dynamics

ANSWER KEY · FOR TEACHERS

Full marks 24

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

K · 3

1. momentum
2. impulse
3. projectile
4. parabola
5. range
6. horizontal

Each carries 0.5 mark.

2 True or false

U · 3

i. ✓ **True**

ii. ✗ **False**: Only its vertical velocity is zero there; it still moves horizontally at $u\cos\theta$.

iii. ✓ **True**

iv. ✗ **False**: The greatest **range** is at 45°; the height $\frac{u^2\sin^2\theta}{2g}$ is greatest for a throw straight up.

v. ✓ **True**

vi. ✗ **False**: It lies between the two weights: $T = \frac{2m_1m_2g}{m_1+m_2}$, less than the heavier weight (which accelerates down) and more than the lighter.

Each carries 0.5 mark.

3 Multiple choice

i. **b.** momentum — K · 1

Impulse $= Ft = mv - mu$: N s = kg m/s, the unit of momentum.

ii. **c.** 2.45 m/s^2 — U · 1

$a = \frac{(5-3)g}{5+3} = \frac{2\times 9.8}{8} = 2.45$ m/s^2. The difference of weights moves both masses, all 8 kg.

iii. **b.** $u\cos\theta$ — U · 1

The vertical part is 0 at the top; the horizontal part, $u\cos\theta$, never changes.

iv. **b.** 20 m — A · 1

At 45°: $R = \frac{u^2}{g} = \frac{196}{9.8} = 20$ m.

v. **c.** $1 : \sqrt{3}$ — HA · 1

$T = \frac{2u\sin\theta}{g}$: $\frac{\sin 30^\circ}{\sin 60^\circ} = \frac{1}{\sqrt{3}}$. The ranges are equal, but the 60° stone goes higher and slower across, so it takes longer.

4 Short answers

a. MARKING SCHEME — U · 2

✓ Impulse 9.6 N s (the change of direction counted).

✓ 480 N.

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b. MARKING SCHEME A · 3

✓ $T = 2.04$ s.

✓ $H = 5.10$ m.

✓ $R = 35.3$ m.

c. ANSWER A · 5

Hanging mass: $2g - T = 2a$. Block: $T = 3a$. Adding: $2g = 5a$, $a = \dfrac{2 \times 9.8}{5} = \mathbf{3.92\ m/s^2}$.

$T = \mathbf{3 \times 3.92 = 11.76\ N}$ (less than the hanging weight, 19.6 N, as it must be for the mass to fall).

After 1.5 s: $v = at = \mathbf{5.88\ m/s}$; $s = \dfrac{1}{2}at^2 = \dfrac{1}{2} \times 3.92 \times 2.25 = \mathbf{4.41\ m}$.

MARKING SCHEME

✓ The equations for both bodies.

✓ $a = 3.92$ m/s^2.

✓ $T = 11.76$ N.

✓ $v = 5.88$ m/s.

✓ $s = 4.41$ m.

5 Think

ANSWER HA · 3

30°: $T = \dfrac{40 \times 0.5}{9.8} = 2.04$ s, $H = 5.10$ m. 60°: $T = \dfrac{40 \times 0.866}{9.8} = 3.53$ s, $H = \dfrac{400 \times 0.75}{19.6} = 15.3$ m. Both ranges are 35.3 m.

He is wrong: the 60° ball goes three times as high and takes $\sqrt{3}$ times as long, but moves across more slowly ($20\cos 60° = 10$ m/s against 17.3 m/s), so it covers the same distance.

MARKING SCHEME

✓ 2.04 s and 5.10 m at 30°.

✓ 3.53 s and 15.3 m at 60°.

✓ The same range from a longer time at a slower horizontal speed.

6 Activity: The angle of the longest throw

(not marked)

WHAT STUDENTS SHOULD FIND

The longest range near 45°, and 15° with 75° and 30° with 60° landing about the same distance away ($\sin 2\theta$ is the same). The speed is about $\sqrt{gR_{max}}$: a range of 3 m means about 5.4 m/s. Air slows a spray, so the real best angle may be a little under 45°.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	4	7	9	4	**24**

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