2021 Ph H2 Q1

Section: Our Dynamic Universe
Topic: Motion – Projectiles

Question Summary

A skier launches from a ramp at **16.0 m s⁻¹** at an angle of **42.0°** to the horizontal.

- (a) Calculate the horizontal and vertical components of the launch velocity.
- (b) Find the time taken to reach the maximum height h.
- (c) The skier takes a further 1.40 s to travel from h to the ground. Calculate the total horizontal distance from ramp to landing.
- (d) State how the skier's kinetic energy before landing compares to the kinetic energy at launch.

(a) Launch velocity components

(i) Horizontal component

$v_h = v\cos\theta = 16.0\cos 42.0^\circ = 11.9\,\text{ms}^{-1}$

(ii) Vertical component

$v_v = v\sin\theta = 16.0\sin 42.0^\circ = 10.7\,\text{ms}^{-1}$

(b) Time to reach maximum height

At maximum height $v = 0$:
$v = u + at$

$0 = 10.7 - 9.8t \Rightarrow t = \dfrac{10.7}{9.8} = 1.1\,\text{s}$

(c) Horizontal distance travelled

Total time = $t_{\text{up}} + t_{\text{down}} = 1.1 + 1.4 = 2.5\,\text{s}$.
$s = v_h \times t = 11.9 \times 2.5 = 29.8\,\text{m} \approx 30\,\text{m}$

(d) Kinetic energy comparison

Answer: The skier's kinetic energy just before landing is **greater** than at launch.
Reason: The skier has gained kinetic energy due to the conversion of gravitational potential energy as they drop below the ramp level.

Quick Tips

- Split the launch speed into horizontal and vertical components first.
- Vertical motion determines time; horizontal motion gives distance.
- KE increases when moving to a lower height (gravitational PE converts to KE).
