Motion revision

Revise Law of conservation of Energy and Vectors (see back of booklet) holiday hwk

Generalised method for tackling motion problems.

1. Draw a diagram.
2. Assign values to variables (v, u, t, a, s etc.).
3. Assign direction (typically up is positive, down is negative, right is positive, left is negative).
4. Select appropriate equation, substitute variables, solve for unknown.
5. Write answer to 3 significant figures with direction as appropriate.

Examples

1. A rock is dropped out of a hot air balloon that is hovering stationary 200m above the ground.
    a. With what speed does the rock hit the ground?

$v = \sqrt{0^2 + 2(9.8)(200)} = 62.6 ms^{-1}$

    b. How long does the rock take to fall?

$-62.6 = 0 - 9.8t$

$t = 6.39s$

    c. If the hot air balloon is moving upwards at 5.00 ms^{-1} how long would the rock take to drop 200 m?

$v = \sqrt{25 - 2(9.8)(-200)} = -62.8 ms^{-1}$

$-62.8 = 5 - 9.8t$

$t = 6.92s$

2. A rocket takes off vertically upwards at 15.0 m s^{-1}.
    a. What is the maximum height reached by the rocket?

$0^2 = 15^2 + 2(-9.8)s$

$s = 11.5m$

    b. How long will the rocket take to fall back to its original position?

$0 = 15 - 9.8t$

$t_1 = 1.53s$

$t = t_1 + t_2 = 2(1.53) = 3.06s$

3. A boy takes a shot with a basketball with a vertical velocity of 6.50 m s^{-1} and watches as it comes down through the hoop, 1.05 m above his hand.
    a. Find the total flight time for the ball from hand to hoop.

$s = 1.05 = 6.5t - 4.9t^2$
$4.9t^2 - 6.5t + 1.05$
$t = 1.14s$

    b. Find the velocity of the ball as it strikes the hoop.

$v = \sqrt{0^2+2(-9.8)(1.11)} = 4.66ms^{-1}$

    c. An opponent is running towards the hoop at 35 km/h. He is 15.0 m away from being in position to grab the ball as it rebounds. Will he be there in time?

$s = \frac{35}{3.6}1.14 = 11.1m$
Hence no

4. A car is accelerated from 15.0 m s^{-1} to 48.0 m s^{-1} in 12.0 s.
    a. Calculate the average velocity.

$\frac{15+48}{2} = 31.5ms^{-1}$

    b. Calculate acceleration.

$a = \frac{48-15}{12} = 2.75ms^{-2}$ in the direction of the car

    c. Calculate displacement.

$s = (15)(12) + \frac{1}{2}(2.75)(12)^2$
s = 378m in the direction of the car

Revision – Equations of motion

1. A ball is thrown vertically upwards at 20 ms^{-1}.
    a) What is the maximum height reached by the ball?

$0^2 = 20^2 - 2(9.8)s$
$s = 20.4m$

    b) How long will the ball take to fall back to its original position.

$0 = 20 - 9.8t_1$
$t_1 = 2.04s$
$t = t_1 + t_2 = 2(2.04) = 4.08s$

2. A thrill seeker falls off a bungy jumping tower.

a) What is their velocity 1.10s after they left the platform? Assume elastic has not applied a force yet.

$v = 0 – 9.8(1.1) = 10.8 ms^{-1}$

b) How far has the bungy jumper fallen during the 1.10s?

$s = \frac{1}{2}(–9.8)(1.10)^2 = 5.93m$ down

c) What is the maximum velocity the bungy jumper achieves before beginning to slow down? He falls 10.4m before the elastic applies a force.

$v = \sqrt{0^2+2(-9.8)(10.4)} = 14.3 ms^{-1}$

d) If a bungy jumper jumps upwards a distance of 0.500m, what initial velocity is necessary to reach that height?

$0^2 = u^2 – 2(9.8)(0.5)$

$u = 3.13 ms^{-1}$

3. A boy standing on a bridge throws a ball vertically upwards at 3.00 ms^{-1} and watches as it lands in the river 6.50m below.

a) Find total time stone in flight.

$s = –6.5 = 3t – 4.9t^2$

$4.9t^2 – 3t – 6.5$

$t = \frac{3+\sqrt{9+4(4.9)(-6.5)}}{9.8} = 1.50s$

b) Find the velocity of stone as it strikes the water.

$v = \sqrt{3^2-2(9.8)(-6.5)} = 11.7 ms^{-1}$

c) A boat 50m away as the boy throws the stone, is travelling at 50km/h towards the bridge. Will the stone hit the boat if it passes the exact spot where the stone will land?

$t = \frac{50}{50/3.6} = 3.6$

Hence no

4. A rocket is uniformly accelerated from rest at 8 ms^{-2} for a period of 12 s. Find:

a) final velocity.

$v = 0 – 8(12) = 96.0 ms^{-1}$ up

b) displacement.

$s = \frac{1}{2}(8)(12)^2 = 576m$ up

c) Average velocity.

$v = \frac{576}{12} = 48.0 ms^{-1}$ up

5. A car is accelerated from 17 ms^{-1} to 44 ms^{-1} in 18 s. Calculate the :

a) Average velocity

$\frac{17+44}{2}$ = 30.5ms^{-1} in the direction of the car

b) Acceleration

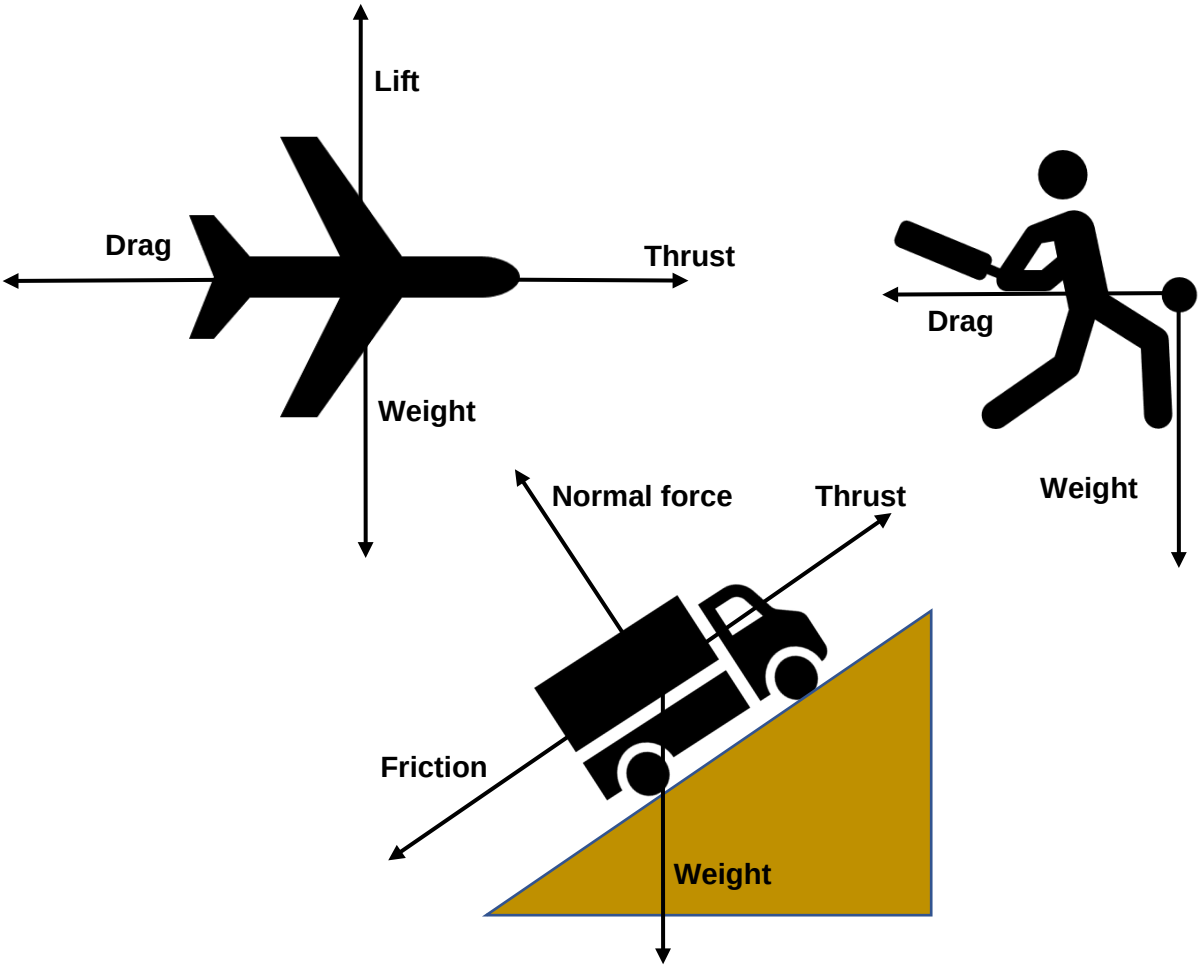
a = $\frac{44-17}{18}$ = 1.50ms^{-2} in the direction of the car

c) Displacement in this time.

s = 17(18) + $\frac{1}{2}$(1.5)$(18)^2$ = 549m in the direction of the car

Ans: 1a) 20.4 m b) 4.08 s 2a) 10.8 m s^{-1} down b) 5.93 m down c) 14.2 m s^{-1} down d) 3.13 m s^{-1} up 3a) 1.50 s b) 11.7 m s^{-1} down c) no 4a) 96 ms^{-1} b) 576m c) 48 ms^{-1} 5a) 30.5 ms^{-1} b) 1.5 ms^{-1} c) 549 m

a. Label all the forces acting on the objects below: **Free body diagram**



Vector rules:

Adding Vectors:

- Add vectors head to tail and resultant is the vector drawn from the base of the first to tip of the final vector.
- If an object is in equilibrium, no NET force exists and the vector diagram will be a closed figure.

Subtracting Vectors:

- Add the negative vector (same size direction reverse)

Components of Vectors:

- Resolve a vector into its components (use sin/cos).
- Components are perpendicular to one another and operate independently of one another.

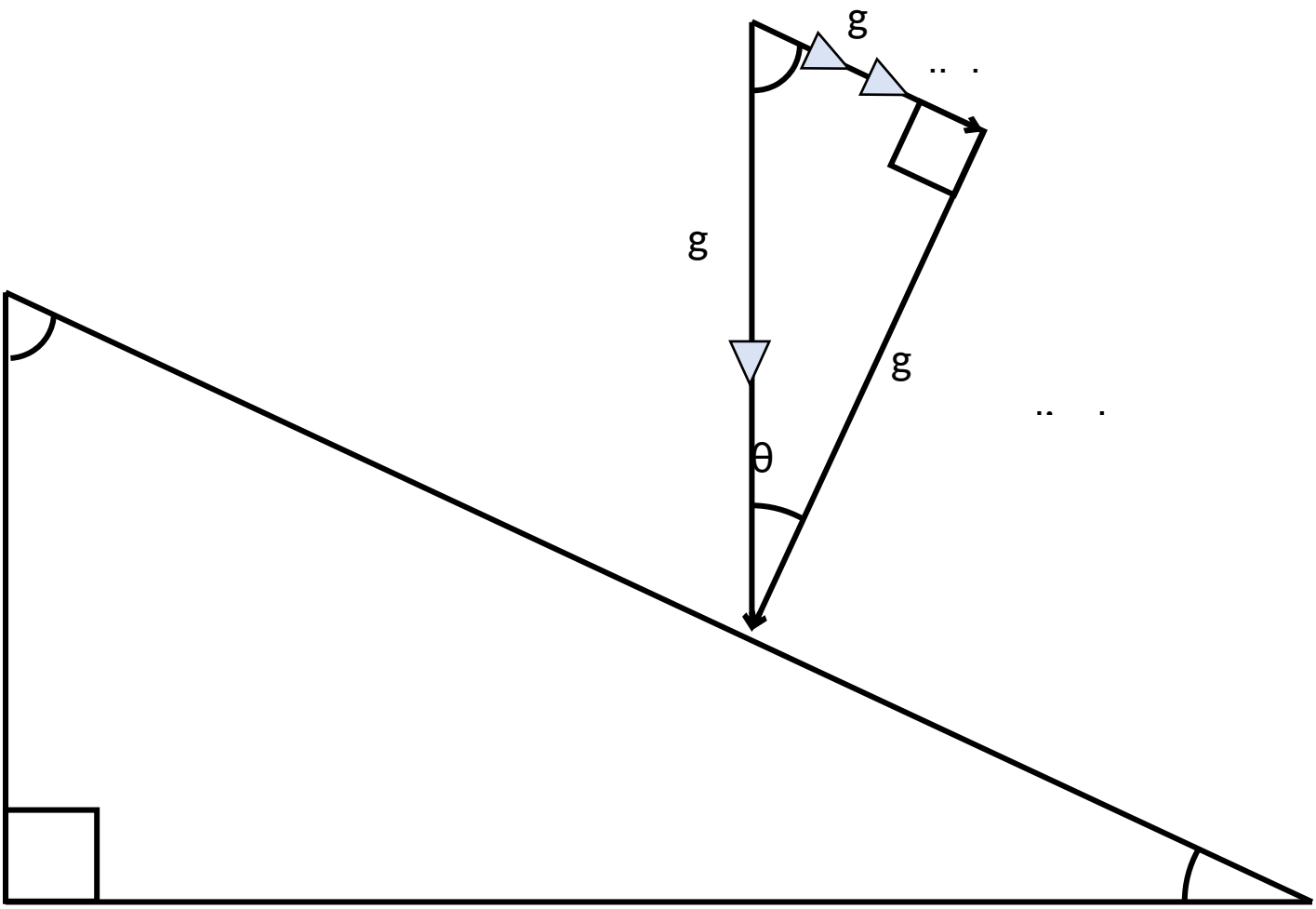
Motion on an inclined plane

- Vertical gravitational acceleration is at 9.8 ms^{-2}
- An object on a slope will accelerate at a slower rate
- The acceleration down the slope is the component of gravitational acceleration acting parallel to the slope

$$g_{¿} = g \sin\theta$$

- Should always be less than 9.8 ms^{-2}
- Force down a slope due to gravity is the component of Weight acting parallel to the slope (ignore friction)

$$W_{¿} = mgSin\theta$$



Example:

Determine the driving force applied to a 1 580 kg car moving at 60.0 kmh^{-1} up a slope with an angle of 5.80^0 The friction is 1020 N.

$\Sigma F = F_d - F_f - W_{parallel} = 0$
$F_d = 1020 + (1580)(9.8)\sin 5.8 = 2.58 \times 10^3 N$ up the slope