SCOTCH COLLEGE

YEAR PHYSICS 11 MOTION TEST 1 November 2014

Total Marks = [50] Time: 50 mins

NAME: Solns

Question 1 **(2 marks)**

A farmer walked 745 m West from a gate to repair a fence post. When that job was finished he turned around and walked 984 m East to repair another part of the fence. Draw and label a vector diagram of his total journey then calculate his resultant displacement.

N
W + E
S

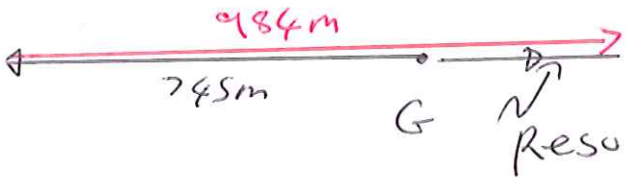


Diagram ✓

$S = 984\,E + 745\,W$

$= 239\text{ m East}$ ✓

Question 2 **(2 marks)**

If the total time spent walking by the farmer was 30 minutes, calculate his average velocity and his average speed?

$t = 30'$

$= 30 \times 60$

$= 1800\text{s}$

$\bar{v} = \frac{s}{t}$

$= \frac{239\,E}{1800}$ ✓

$= 0.13\text{ms}^{-1}\text{ East}$

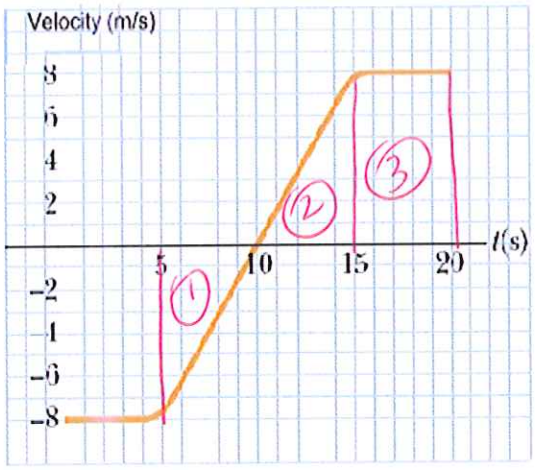
$\bar{s} = d/t$

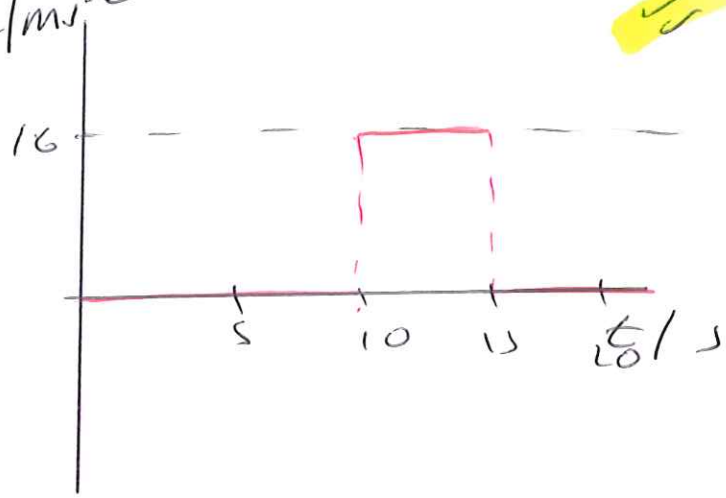
$= \frac{1729}{1802}$

$= 0.96\text{ms}^{-1}$ ✓

Question 3 **(6 marks)**

The velocity–time graph for a remote control car is shown below.





(a) What is the velocity and acceleration of the car at t =10s? **[2 marks]**

Velocity at t = 10s = 0 ms⁻¹

Acceleration at t = 10s = gradient

$= \frac{\text{rise}}{\text{run}}$

$= 8/5$

$= 1.6\ ms^{-2}$

(b) In the space to the right of the graph plot a graph of the acceleration of the car against time. **[2 marks]**

(c) Determine the displacement of the car in the time from t = 5 s to t = 20 s. **[2 marks]**

S = area ① + ② + ③

$= \frac{1}{2}(5 \times -8) + \frac{1}{2}(5 \times 8) + 5 \times 8$

$= -20 + 20 + 40$

= 40m in dir'n of a

Question 4 **(4 marks)**

A runway at a small airport is 1220 m long. A light aircraft accelerates at 0.785 m s^{-2} along this runway, starting at one end and taking off 200 m before reaching the other end. If the aircraft was initially stationary, calculate its speed when it took off.

$u = 0\ ms^{-1}$ $a = 0.785\ ms^{-2}$

1020 m → : 200 m

$v = ?$

$v^2 = u^2 + 2as$

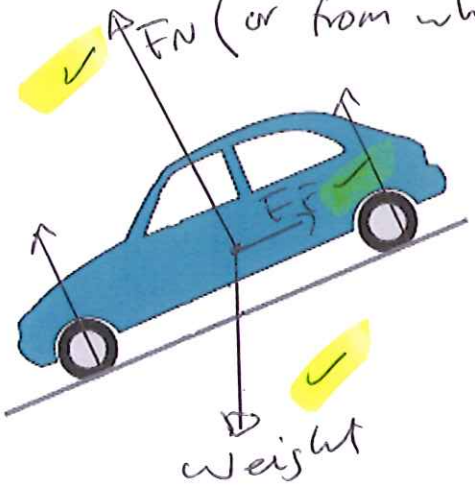
$\Rightarrow v^2 = 0 + 2(.785)(1020)$

$\Rightarrow v^2 = 1601$

$\Rightarrow v = 40\ ms^{-1}$

Question 5 **(12 marks)**

A car of mass 1600 kg left parked on a steep but rough road begins to roll down the hill. After a short while it reaches a constant speed. The road is inclined at 15° to the horizontal. Its speed is sufficiently slow that the air resistance is insignificant and can be ignored.



a. Draw in the forces acting on the car when it is parked. **[3 marks]**

3 forces!

b. Determine the component of the car's weight that acts parallel to the road **AND** the component that acts perpendicular to the road. **[2 marks]**

$F_{//} = mg\sin 15$

$= 4800N$

$F_{\perp} = mg\cos 15$

$= 15000N$

c. Is there a net force acting on the car when it is parked? Explain. **[1 mark]**

No - since $a = 0$

$\Rightarrow \Sigma F = 0$

c. Is there a net force acting on the car when it is rolling down the hill at constant velocity? Explain. **[2 marks]**

No ✓ $a = 0 \Rightarrow \Sigma F = 0$ ✓

d. What is the value of the normal reaction force that the road exerts on the car **AND** the value of road friction when it is rolling down the hill at constant velocity? **[2 marks]**

$F_N = F_\perp$

$= 15000N$ ✓

$F_R = F_{00m} = 4800N$ ✓

e. As the car comes out of the hill onto the flat road at the base of the hill, what happens to the value of the normal reaction force? Explain. **[2 marks]**

As car come out of the hill $\theta \to 0 \Rightarrow mg\cos\theta$ approaches mg as $\cos 0 = 1$.

~~OR~~

$\Rightarrow F_N$ gets larger and eventually equalls mg ✓

OR

On flat ground $\Sigma F_{vertical} = 0$

$\Rightarrow F_N = mg$

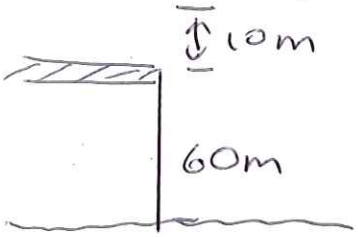
$\Rightarrow F_N$ increases to mg. ✓

Question 6 **[8 marks]**

Two physics students, James and Jordan, conduct the following experiment from a very high bridge. James drops a 1.5 kg shot-put from a vertical height of 60.0 m while at exactly the same time Jordan throws a 100 g mass with an initial downwards velocity of 10.0 m s^{-1} from a point 10.0 m above James.

Calculate the time that:

a. the shot-put takes to reach the ground **[2 marks]**



$s = ut + \frac{1}{2}at^2$

$\Rightarrow 60 = 0 + \frac{1}{2} 9.8 t^2$

$\Rightarrow t = 3.5\ s$

b. the 100 g mass takes to reach the ground. **[2 marks]**

$s = ut + \frac{1}{2}at^2$

$\Rightarrow 70 = 10t + \frac{1}{2} 9.8 t^2$

$\Rightarrow 4.9t^2 + 10t - 70 = 0$

$\Rightarrow t = 2.89\ s$

c. At what time will the 100 g mass overtake the shot-put? **[2 marks]**

At overtaking

$s_{100} = s_{SP} + 10$

$\Rightarrow ut + \frac{1}{2}at^2 = ut + \frac{1}{2}at^2 + 10$

$\Rightarrow 10t + 4.9t^2 = 0 + 4.9t^2 + 10$

$\Rightarrow t = 1\ s$

d. Explain why the acceleration of the shot put and the 100 g mass are the same, even though the shot put is heavier. **[2 marks]**

Shot put has greater MASS
$\Rightarrow$ gravitational force is greater, but so is MASS

$a = \frac{F_G}{m}$

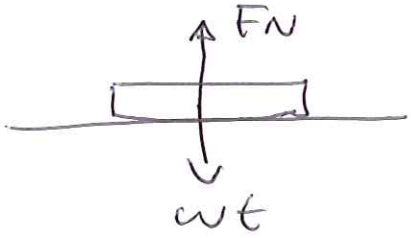
$\Rightarrow$ Thus a constant

Question 7 **[6 marks]**

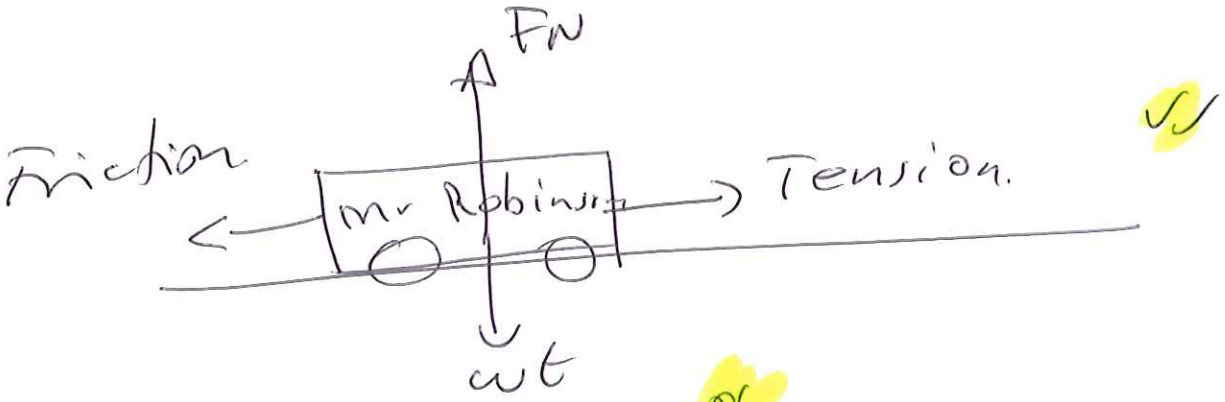
Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation. Draw a free body diagram for each of the situations shown below:

a. An egg is free-falling from a nest in a tree. Neglect air resistance. **[2 marks]**

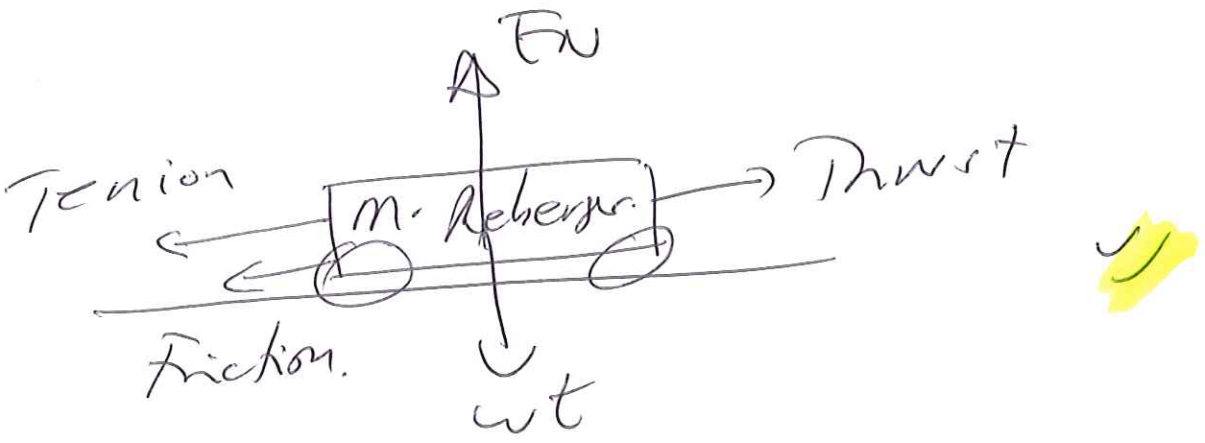
b. A book is at rest on a tabletop. **[2 marks]**



c. As a result of a flat battery, Mr Reberger's car is towing Mr Robinson's with a tow rope at a constant velocity. Draw a free body diagram of the forces acting on Mr Robinson's car **[2 marks]**

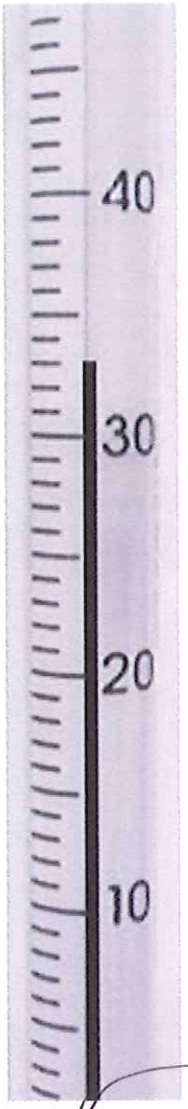


OR

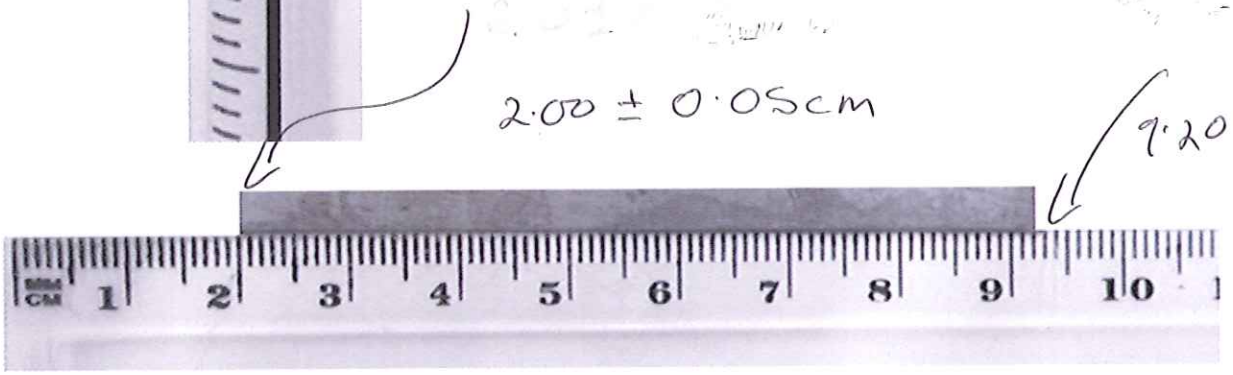


Question 8 **[4 marks]**

The photographs below show a thermometer used to measure the temperature of a solution, and a ruler measuring the length of a metal strip. For each photograph, record the measurement and state the uncertainty of the measurement.



a. The temperature measured by the thermometer is 33.0 °C.
b. The uncertainty is ±0.5 °C.



c. The length of the metal strip measured by the ruler is 7.20 cm.
d. The uncertainty is ± 0.1cm cm.

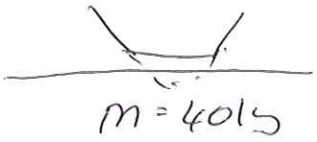
Question 9 **[6 marks]**

A 70 kg fisherman is quietly fishing in a 40 kg dinghy at rest on a still lake when, suddenly, he is attacked by a swarm of wasps. To escape, he leaps from the boat into the water with a force of 140 N.

a. What is the force acting on the boat? **[1 mark]**

140N ✓ in direction opp to fisherman.

b. With what acceleration will the boat move? **[2 marks]**



$F_R = ma$

$\Rightarrow 140 = 40a$

$\Rightarrow a = 3.5 ms^{-2}$ ✓✓

c. If the force on the fisherman lasted for 0.5 s, determine the speed attained by both the man and boat. **[3 marks]**

Boat

$a_b = 3.5 ms^{-2}$

$\Rightarrow v = u + at$

$= 0 + 3.5 \times 0.5$

$= 1.75 ms^{-1}$ ✓

Man

$F_R = ma$

$\Rightarrow 140 = 70 \times a$

$\Rightarrow a = 2 ms^{-2}$ ✓

$v = u + at$

$\Rightarrow v = 0 + 2 \times .5$

$= 1 ms^{-1}$ ✓