Physics 11 – MIDTERM TEST   Name: ________________   Date:____________

PLEASE READ ALL QUESTIONS CAREFULLY. DO NOT RUSH AS YOU WILL BE GIVEN SUFFICENT AMOUNT OF TIME

☺ GOOD LUCK ☺

[10] **A: Multiple-Choice: Each question is worth 1 mark**

1. The larger the ___________ of an object, the greater its inertia:

a) weight   (b) mass   c) volume   d) velocity

2. An object is said to be in equilibrium if:

a) it is in weightless environment
(b) the net force acting on it is zero
c) the net force acting on it is **not** zero
d) it accelerates

3. A free-falling object will:

(a) experience force of gravity only
b) experience force of gravity and normal force
c) experience normal force only
d) move with constant velocity

4. An object is a projectile:

a) if it does not propel itself
b) if it moves with constant horizontal velocity
c) if it experiences vertical acceleration
(d) answers a),b) and c) are all correct

5. Velocity is:

a) given by distance and time taken
b) the rate of change in speed
(c) given by displacement and time taken
d) always positive

6. The slope of the line tangent to the curve on a velocity-time graph at a particular time is the ....

a) Average velocity
(b) Instantaneous acceleration
c) Instantaneous velocity
d) Displacement

7. Which of the following statements is true about vector and scalar quantities?

a) All vectors have direction only

b) All vectors have magnitude or direction

c) All scalars have direction only

d) All scalars have magnitude only

8. An object that is experiencing forces that are not balanced will:

a) remain at rest

b) continue moving at constant velocity

c) accelerate

d) always stop

9. Bob runs two complete laps on a 400m long track in 3.0 minute exactly, arriving back where he started. What was the magnitude of his average velocity?

a) 0 m/s

b) 6.7 m/s

c) 40 m/s

d) there is not enough data provided

10. Strength of a gravitational field of any object is:

a) inversely proportional to the mass of the object

b) inversely proportional to the universal gravitational constant

c) directly proportional to radius of the object

d) given in Newtons per kilogram

[10] B: Fill-in blanks. 1 mark each

1. If an object rests on a strictly horizontal surface and does not experience any forces except the force of gravity and the normal force, then the magnitude of the normal force is equal to mg = magnitude of Fg

2. Force, displacement , acceleration and velocity are all vector quantities.

3. Inertia is the natural tendency of an object to resist change in its motion or state of rest.

4. Average and instantaneous velocity are equal for an object that moves with constant velocity.

5. Projectile experiences acceleration due to gravity.

6. For any object on the same surface the force of kinetic friction is always smaller / less than the force of static friction.

7. An object that moves in non-uniform motion will experience changes in its velocity - direction and/or magnitude.

8. Acceleration due to gravity is independent of object's mass.

9. When a projectile reaches its maximum height its vertical velocity is zero.

10. If an object is set in motion on a strictly horizontal frictionless surface it will never stop or accelerate unless acted on by an unbalanced force.

[25] C: Decide whether the statements below are true or false. 1 mark each

F Force of friction is never beneficial to humans

F An object has zero inertia when in weightless environment

T All objects that have mass form a gravitational field around them

T Weight of an object is directly proportional to the object's mass and to the strength of a gravitational field

T A projectile speeds up the closer it gets to the ground

T Normal force acting on an object that lies on a horizontal surface and is being pulled upwards at the same time is always smaller in magnitude than the magnitude of the force of gravity acting on the object

F The only way an object can experience zero acceleration is when it is at rest

T If Earth had only 50% of its mass the acceleration due to gravity on Earth would be 4.9 m/s^2

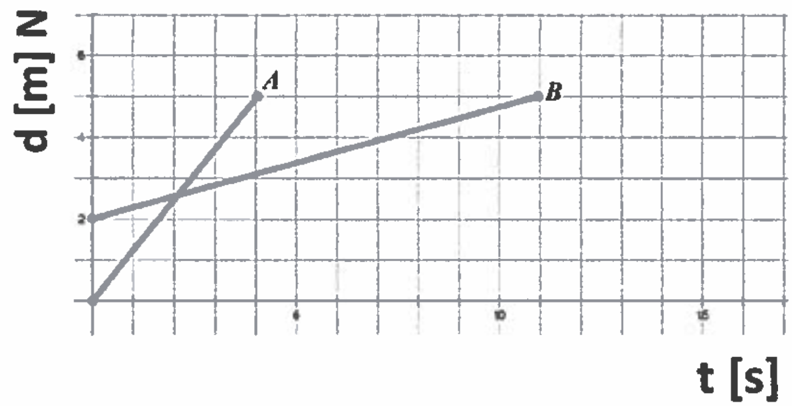
T Coefficient of friction has no units

F Force of gravity is an example of contact force

T A spring constant **k** is given in Newtons per meter

The motion of objects A and B is described by the position-time graph below. Decide whether the statements about the objects' motion are true or false:

Position-Time Graph



F Object B moves with greater velocity

F Objects A and B have the same initial position

T Object A does not accelerate

F Objects A and B have the same velocity at the point where their graphs intersect

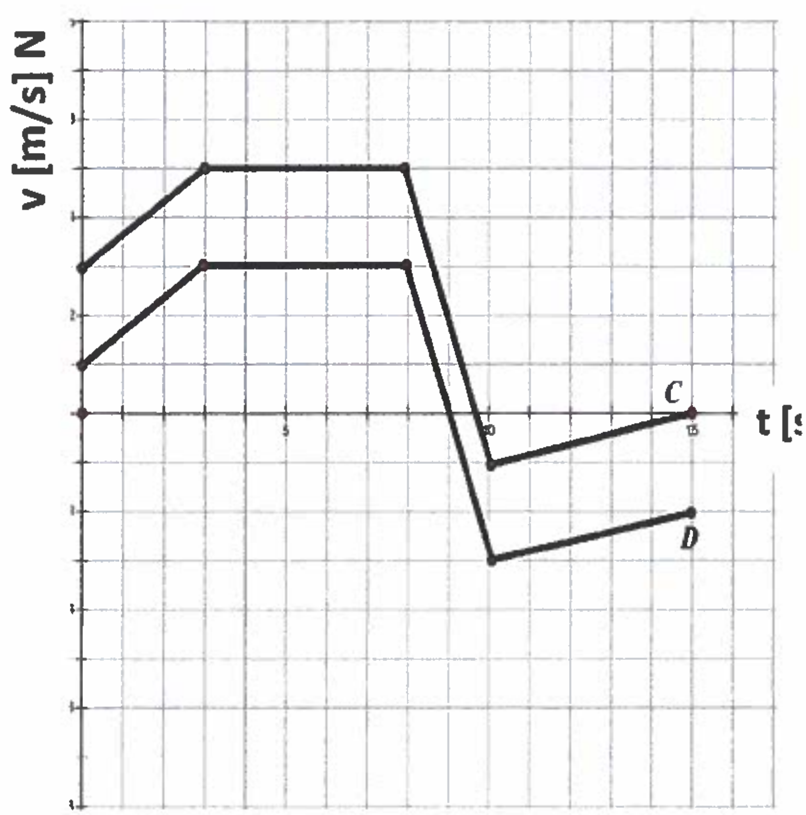
T Object B moves with velocity 0.45 (27) m/s [N]

F Both objects cover the same distance

T Both objects have the same final position

The motion of objects C and D is described by the velocity-time graph below. Decide whether the statements about the objects' motion are true or false:

Velocity-Time Graph



T Object D has smaller initial velocity then object C

F At all times, object C has higher speed than the speed of object D

T Object D is not moving at time 9 s.

T Object C is at rest twice between 0 and 15s.

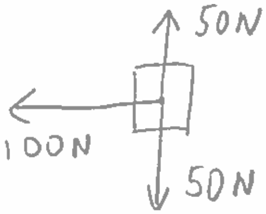
T There is only one time interval during which neither of the objects accelerates

T Object D accelerates at the rate of $0.67 m/s^2$ during the first 3 seconds

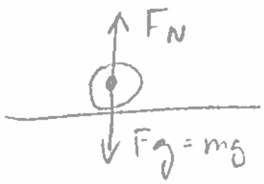
T Object C moves at 5m/s [N] during the time interval between 3 and 8 seconds

D: Short Answer: Please use the "GRASS" method where appropriate and show all your work.

[2] **1. a)Sketch a free-body diagram of a ball experiencing forces of 50 N [up], 100 N [left] and 50N [down]**



[2] **b) Provided that the ball is on a horizontal surfaces and the force 50 N [down] is the force of gravity acting on the ball, what do you know about the magnitude and direction of the normal force?**



$\|\vec{F}_N\| = mg = \|\vec{F}_g\|$

$\vec{F}_N$ = perpendicularly up!

[5] **2. Find the average speed of a train that needs only 1 hour and 30 minutes to cover 400 km.**

G: $\Delta t = 1.5\text{ hr}$
$\Delta d = 400\text{ km}$

R: $v = ?$

A: $v = \frac{\Delta d}{\Delta t}$

S: $v = \frac{400}{1.5}$
$= 267\text{ km/h}$

S: the average speed of the train is 267 km/h

[5] **3. State Newton's Second Law:**

A non-zero net force acting on an object with mass m will cause acceleration of such object.
This acceleration is in the same direction as the net force and the magnitude of the acceleration is directly proportional to F_{net} and inversely proportional to the mass m.

$\vec{a} = \frac{\vec{F}_{net}}{m}$

[8] 4. Find the mass of an object that rests on a horizontal surface and requires an applied force of 500 N in order to start moving. The coefficient of static friction between the surfaces of contact is 0.35 and the coefficient of kinetic friction for the same surfaces is 0.28.

G: $\vec{F}_{push} = 500N$

$\mu_s = 0.35$

$\mu_k = 0.28$

@ rest

$g = 9.8\ m/s^2$

R: $m = ?$

A: $\vec{F}_{fs} = ||\vec{F}_N|| \mu_s$

$||\vec{F}_{fs}|| = ||\vec{F}_{push}||$

S: $500\ N = ||\vec{F}_N|| 0.35$

$||\vec{F}_N|| = mg$

$= \frac{500}{0.35}$

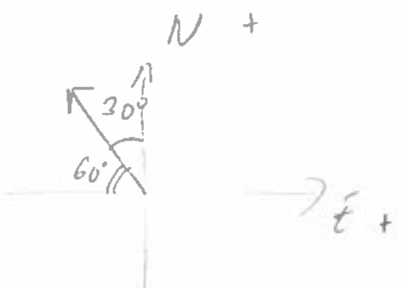
$mg = 1428.6$

$m = \frac{1428.6}{9.8}$

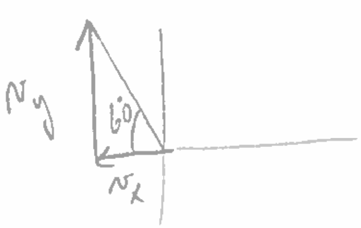
$m = 146\ kg$

S: The object's mass is 146 kg.

[2] 5. a) Sketch a diagram of displacement vector $\vec{d} = 500\ km\ [N\ 30°W]$



[4] b) Find the vector components of the displacement vector $\vec{d} = 500\ km\ [N\ 30°W]$



$\vec{d}_x = (-\cos 60°)(500)$

$= -250\ km$

$= 250\ km\ [W]$

$\vec{d}_y = 500\ (\sin 60°)$

$= 433\ km\ [N]$

[8] 6. A train's stopping distance, even when full emergency brakes are engaged, is 1.3 km. If the train was travelling at an initial velocity of 90 km/h [forward], determine its acceleration under full emergency braking.

1 G: $\Delta\vec{d}$ = 1.3 km [forward]
$\vec{v}_f$ = 0 km/h [forward]
$\vec{v}_i$ = 90 km/h [forward]

1 R: $\vec{a}$ = ?

1 A: $\vec{v}_f^{\,2} = v_i^2 + 2ad$
$\vec{a} = \frac{\vec{v}_f^{\,2} - v_i^2}{2d}$

1 S: $\vec{a} = \frac{0^2 - (90)^2}{2(1.3)}$
= −3115 km/h² [forward]
1 1 1

1 S: Train's acceleration is −3.1×10³ km/h² [forward]

[8] 7. How long does a boat need to sail to reach a light house 36 km [east], provided that its initial velocity is 35 km/h and it experiences constant acceleration of 18 km/h² [east]?

* Alternative solution

1 G: Δd = 36 km [East]
$\vec{v}_i$ = 35 km [E]
$\vec{a}$ = 18 km/h² [E]

1 R: Δt = ?

1 A: $\Delta d = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$

1 S: $36 = (35)t + \frac{1}{2}(18)t^2$
1 $0 = 9t^2 + 35t - 36$

1 S: $t = \frac{-35 \pm \sqrt{35^2 - 4(9)(-36)}}{2(9)}$
$= \frac{-35 \pm \sqrt{1225 + 1296}}{18}$
$= \frac{15.2}{18}$
1 = 0.844 hr = 51 mins

1 S: The boat needs to sail for 51 mins

[4] 8. Convert the following:

2 350 km/h ⟶ 97 (m/s)

$\frac{350\text{ km}}{h} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ h}}{3600\text{ s}} = 97\frac{m}{s}$

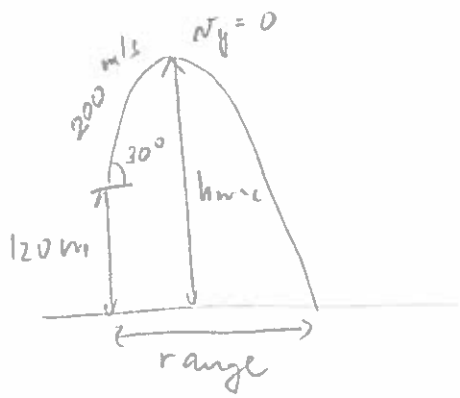
2 35 m/s ⟶ 126 (km/h)

$\frac{35\text{ m}}{s} \times \frac{1\text{ km}}{1000\text{ m}} \times \frac{3600\text{ s}}{1\text{ h}} = 126\text{ km/h}$

9. A projectile is fired with an initial velocity of 200 m/s at an angle of 30° above the horizontal from the top of a cliff 120 m high.

[2] Sketch a labelled diagram:

G: $v_i = 200$ m/s @ 30°



Find:

a) the time taken to reach maximum height

$\vec{v}_{ix} = 200(\cos 30°) = 173.2 \frac{m}{s}$ [right]

$v_{iy} = 200(\sin 30°) = 100$ m/s [up]

$$\Delta t = \frac{v_f - v_i}{g} = \frac{0 - 100}{9.8} = 10.2 \text{ s}$$

b) the maximum height with respect to the ground next to the cliff

$h_{max} = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or $\frac{v_f^2 - v_i^2}{2a} = d$

$= 1020 + (-510)$

$= 510.2$ m

$\frac{0 - 100^2}{2(9.8)} = 510.2$ m

Height above ground $510.2 + 120 = 630$ m

t_{FF}:

$-630 = 0 - \frac{1}{2}(9.8)t^2$

$t = \sqrt{\frac{630}{4.9}}$

$t = 11.3$ s

c) the total time in the air

$t_{tot} = t_{max} + t_{FF}$

$= 10.2 + 11.34$

$= 21.54$ s

d) the range

$d_x = (v_{ix})\,t_{tot}$

$= (173.2)(21.54)$

$= 3730.7$ m

e) the vector components of the final velocity just before the projectile hits the ground below the cliff.

$v_{fy}^2 = v_i^2 + 2ad$

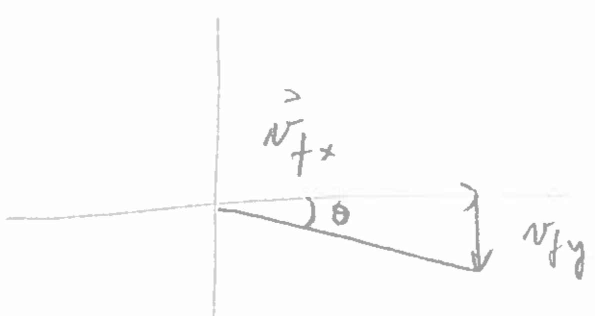
$= 0 + 2(9.8)(-630)$

$= -111$ m/s

$= 111\ \frac{m}{s}$ [down]

$\vec{v}_{fx} = \vec{v}_{ix} = 173$ m/s [right]

f) Sketch a diagram of the final velocity vector, neatly placed in a labelled coordinate system. Clearly indicate the vector components you found in the previous question.



Find the direction and magnitude of v_f!

$\|v_f\| = \sqrt{(111)^2 + (173)^2}$

$= 205.5$ m/s $= 206$ m/s

$\theta = \tan^{-1}\left(\frac{111}{173.2}\right)$

$= 33°$