TRINITYHOUSE
Pre-Primary • Preparatory • High

PRELIMINARY EXAMINATION

8th SEPTEMBER 2016

PHYSICAL SCIENCES: PAPER I – PHYSICS

MEMO

EXAMINER: **MR D. BROWN**

MODERATORS: **MRS SHEPPARD, MISS STANDL AND MRS GOVENDER**

TIME: 3 hours

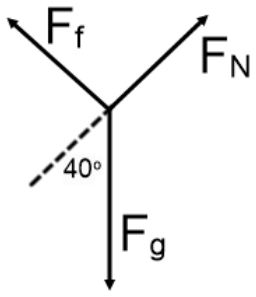
MC – MARKERS COMMENTS
c.o.e – CARRY OF ERROR

QUESTION 1 – MULTIPLE CHOICE

1.1 C
1.2 A
1.3 B
1.4 D
1.5 C
1.6 C
1.7 D
1.8 C
1.9 A
1.10 B

QUESTION 2 – AVALANCHE SKI DECK

2.1

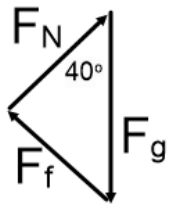


Ff = Force of friction on Mr Brown
Fg = Force of Earth on Mr Brown
FN = Force of Surface on Mr Brown

(4)

MC: some thought the ground was flat so they drew arrows up and down and left and right.
Some forgot to add a legend/key

2.2

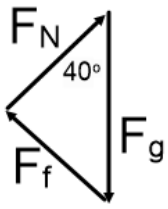


Fg = mg
= 85 x 9.8
= 833N ✓✓

Ff = Fg sin 40° ✓
= 833 sin 40°
= 535.44N ✓

MC: Many tried to use COS here. (4)

2.3



F_N = Fg cos 40° ✓
= 833cos 40°
= 638.12N ✓

Ff = μ F_N ✓
535.44 = μ 638.12
μ = 0.839 = 0.84 ✓ (4)

2.4 Ff = μ F_N
= 0.5 x 638.11 ✓ **c.o.e 2.3**
= 319.055 = 319.06 N ✓ (2)

2.5 State Newton's second law: *The net force acting on an object* ✓
is equal to the rate of change ✓ *of momentum* ✓
OR
When a net force, F_{net} is applied to an object of mass, m,
it accelerates in the direction of the net force. ✓
The acceleration, a, is directly proportional to the net force ✓
and inversely proportional to the mass ✓ (3)

2.6 Fnet = Fg// - Ff ✓
= 535.44 – 319.06 **(c.o.e. Q2.2 and Q2.4)**
= 216.38 N ✓ (2)

2.7 F_{net} = ma ✓ **MC: had to be F_{net} not F**
216.38 = 85 a ✓ **(c.o.e. Q2.6)**
a = 2.55 $m.s^{-2}$ ✓ **MC: some tried to work it backwards here** (3)

2.8 *work done <u>by a net force</u> on an object is equal to the change in the kinetic energy of the object* – the work energy theorem **MC underlined part left out by many** (2)

2.9 W_{net} = Ek_f – Ek_i **OR** W_{net} = ΔEk ✓
F_{net} . Δx✓ = ½ mv^2 – ½ mu^2 ✓
216.38 . Δx = ½ (85)$(6.29)^2$ – 0 ✓ **(c.o.e Q2.6)**
Δx = 7.77 m✓ **MC were not allowed to use trig or Eq of motion.** (5)

2.10 the law of conservation of energy as *the <u>total</u> energy in a system* ✓*cannot be created nor destroyed; only transferred from one form to another* ✓ (2)
MC again underlined part left out by most.

2.11 E_K at B = E_{total} = ½ (85)$(6.29)^2$ = 1681.47 J ✓

Etotal = Ek at c + Ep at c + Ef ✓ **MC Many tried Ep_{top} = Ek_{bot} here**
1681.47 = 0 + mgh ✓+ Ef
1681.47 = (85)(9.8)(1) ✓ + Ef
Ef = 848.47 J ✓ (5)

[36 marks]

QUESTION 3 – AFRISKI RESORT

3.1 Independent variable: Angle/incline/type of slope ✓ (1)

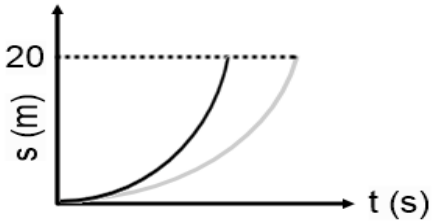
3.2 Dependent variable : Speed achieved at bottom ✓ Acceleration (1)

3.3 Same length of track (20m) **MC: Pupils can't be vague here**
Same snowboard / equipment
Same time of day / Same weather conditions
Same mass of rider or same snowboarder Any applicable 2 not vague ✓✓ (2)

3.4 INCREASES ✓ (1)

3.5 As the ramp gets steeper the Fn value gets less ✓
The coefficient (μ) does not change with steepness
Due to $\mathbf{F_f = \mu F_N}$ the Ff value gets less ✓
Therefore the Fnet = Fg// - Ff and Fnet is bigger causing more acceleration ✓ (4)
MC: Pupils had to link Fnet to FN. Many said μ decreased

3.6 INCREASES ✓ (1)

3.7 

✓ ends at 20 ✓curves sooner (2)

MC **Light grey = original**
Black = answer

[12 marks]

QUESTION 4 - A STUDY OF MOTION

4.1 Ball is travelling upwards at 3m/s ✓
Ball is slowing down ✓
Ball stops at B ✓ **MC : Must be mentioned, don't be vague!!!**
Ball speeds up downwards ✓
Ball reaches maximum speed at C (4)

4.2 E ✓ (1)

4.3 Method 1: Gradient = Acceleration = $\Delta v/\Delta t$ ✓
= -6.2 – 3 ✓
0.94 ✓
= -9.79 m.s^{-2} ✓ **Magnitude asked**

Method 2: Equations of motion v = u + gt ✓
-6.2 ✓ = 3 + g (0.94) ✓
g = -9.79 m.s^{-2} ✓ (4)

4.4 0.97 – 0.94 s = 0.03 ✓ (1)

4.5 The gradient represents acceleration to gravity which is a constant value
Therefore the gradient of AC should be parallel to DF (2)

[12 marks]

QUESTION 5 – MOMENTUM AND ICE HOCKEY

5.1 $\Delta t = 0.02$ s $\Delta s = 65$ cm $= 0.65$ m ✓ **MC Poorly read off diagram**
Average velocity = $\Delta s / \Delta t$ ✓ **Many tried s= $^{(u+v)t}/_2$ which**
= 0.65 / 0.02 ✓ **is not correct as not accelerating!!!**
= 32.5 m/s ✓ (4)

5.2 F Δt = m Δv ✓
Fnet 0.033 = (0.16) ✓conv (32,5 – 0) ✓ **c.o.e. Q5.1**
Fnet = 157.58 N ✓ to the LEFT/FORWARDS ✓ (5)

5.3 With the follow through the stick is in contact with the puck for longer ✓
The force applied is a constant force ✓
Fnet = $\Delta p/\Delta t$ ✓
Therefore Δ p is a greater if the Δt is longer ✓
$\Delta p = m\Delta v$ therefore the mass is constant so Δv will be greater ✓ (5)

5.4 The law of conservation of linear momentum: *The total linear momentum of an isolated system* ✓*remains constant* (is conserved) ✓ (2)

5.5 pi = pf✓ Taking initial direction of 160g puck as positive

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ ✓

(0.16)(20) + (0.11)(-10) ✓ = 0 + (0.11)(v) ✓

3.2 - 1.1 = 0.11 v

2.1 = 0.11 v

v = 19.09 m/s ✓ (5)

5.6

Total Ek before		Total Ek after
½ mu^2 + ½ mu^2 ✓ formula		½ mv^2 + ½ mv^2
½ (0.16)(20) ^{2} + ½ (0.11)(-10) ^{2}		½ (0.16)(0) ^{2} + ½ (0.11)(19.09) ^{2}
32 + 5.5		0 + 20.05
37.5 ✓	not equal to✓	20.05 ✓

Therefore it is INELASTIC collision ✓ (5)

[26 marks]

QUESTION 6 - THE END OF THE WORLD

6.1 Newton's Law of Universal Gravitation: *Every particle in the universe attracts every other particle with a force ✓which is directly proportional to the product of their masses ✓and inversely proportional to the square of the distance✓between their centres ✓* (4)

6.2.1 $F = GMm/r2 = 6.78.$
$F_{new} = GMm/(^1/_2 r)^2$✓
$= 4\ GMm/r^2$
$= 27.12N$ ✓ (2)

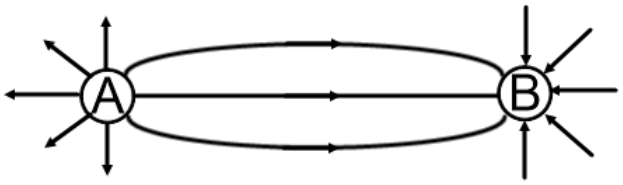
6.2.2 $F = GMm/r2 = 6.78.$
$F_{new} = GM2m/r^2$✓
$= 2\ GMm/r^2$
$= 13.56N$ ✓ (2)

6.3 No ✓ (Yes also allowed + justification)
It would not be viable because the applied force of 6.78N is too small ✓
to compete against the Earth's force of 6.5×10^9 N ✓ (3)

[11 marks]

QUESTION 7 – ELECTROSTATIC FORCE FIELDS

7.1 electric field intensity is defined *as the force ✓per unit positive charge✓* (2)

7.2 

✓ Shape
✓ arrows A to B
✓ Neat / accurate
-1 if lines don't enter at 90° (3)

7.3
E	=	kQ /r2 ✓	
1.2×10^6 ✓	=	$9 \times 10^9\ (6 \times 10^{-6})$✓ / r2	
r^2	=	0.045	
r	=	0.21 m ✓	(4)

7.4
Method 1:	F	=	E q ✓	
		=	(1.2×10^6)✓(12×10^{-6}) ✓	
		=	14.4 N✓ ATTRACTION (or towards A)✓	
Method 2:	F	=	$kq1q2 / r^2$ ✓	NO c.o.e ALLOWED
		=	$(9 \times 10^9)(6 \times 10^{-6})(12 \times 10^{-6})$✓$/ 0.21^2$ ✓	
		=	14.69N if r rounded from Q8.3 ✓	
		=	14.4N if r not rounded ATTRACTION (or towards A)✓	(5)

7.5 The magnitude of the force is the SAME ✓
Newton 3 ✓states
*When object A exerts a force on object B, object B **simultaneously** exerts an oppositely directed force of equal magnitude on object A ✓own wording allowed.* (3)

[17 marks]

QUESTION 8

8.1 See graph (6)
- ✓ Heading
- ✓ Scale of x axis
- ✓ Labelled axis
- ✓ Labelled axis units
- ✓✓Plotted points correctly

8.2.1 $8,0 \times 10^{14}$ Hz ✓ (1)

8.2.2 $c = f \times \lambda$ ✓
$3x10^{8} = 8,0x10^{14} \times \lambda$ ✓
$\lambda = 3,75 \times 10^{-7}$ m ✓ (3)

8.2.3 $E = hf$ ✓
$= (6.6 \times 10^{-34})(8,0 \times 10^{14})$ ✓ c.o.e Q8.2.1
$= 5,28 \times 10^{-19}$ J ✓ (3)

8.3 ±5,6 ✓x 10^{14} Hz ✓ (5,5 – 5,7) (2)

8.4.1 Between 2,2 and 2,4 eV ✓ (1)

8.4.2 Between $3,52 \times 10^{-19}$ J and $3,84 \times 10^{-19}$ J ✓ (1)

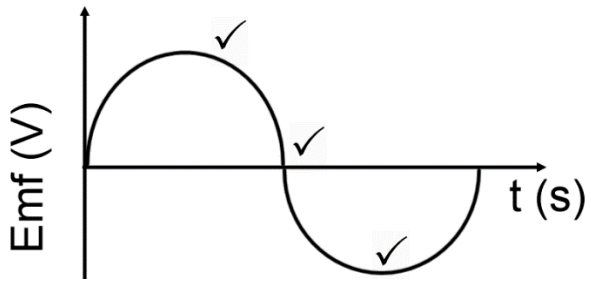
8.5.1 $Ek_{max} = ½ mv^2$ ✓
$2,27x10^{-19} = ½ (9,1x10^{-31})v^2$ ✓
$v = 706\,329,31$ m/s ✓ (3)

8.5.2 REMAINS THE SAME ✓ (1)

[21 marks]

QUESTION 9 – ELECTROMAGNETIC INDUCTION

9.1



(3)

9.2 As the magnet north enters a north pole is induced on the coil ✓
According to Lenz's law the induced current is always such as to oppose the inducing action ✓
the making the current go one way in the coil ✓
As the magent north pole leaves a South pole is induced to attract it back ✓
Causing the current to be induced the other way ✓

9.3

- more turns ✓
- stronger magnet ✓
- faster swinging of magnet ✓ Decrease the time?
- bigger area of coil (any three) (3)

[11 marks]

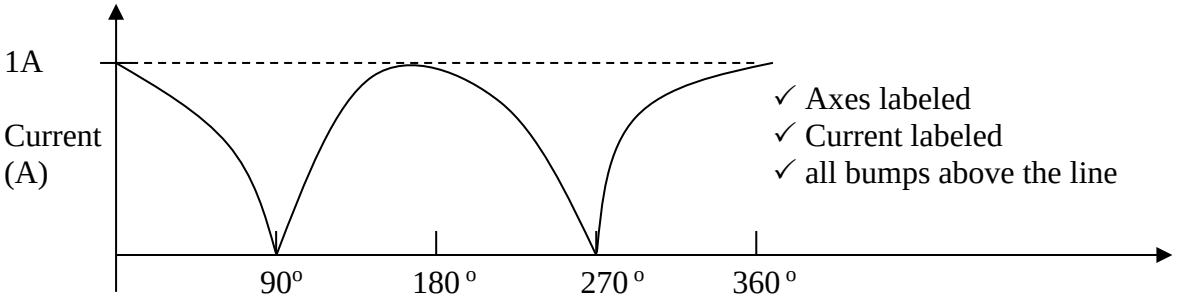
QUESTION 10

10.1 A – Slip rings ✓ B – (carbon) Brushes ✓ (2)

10.2 clockwise. ✓ (1)

10.3 Replace the slip rings with a split ring (commutator)✓ (1)

10.4



$$I = \frac{V}{R} = \frac{10}{10} = 1A \checkmark\checkmark$$ (5)

[9 marks]

QUESTION 11 - ELECTRIC CIRCUIT

11.1 $P = 0,81W$

$R = 100\Omega$

$P = I^2R$ ✓

$0,81$ ✓ $= I^2(100)$

$I = 0,09A$ ✓

(3)

11.2 $\frac{1}{R_{11}} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{50} + \frac{1}{50}$

$= \frac{2}{50}$

$R_{11} = \frac{50}{2} = 25\Omega$ ✓

$V = IR$ ✓

$= 0,09 \times 25$ ✓

$= 2,25V$ ✓

(5)

11.3

$R_{TOT} = R_3 + R_{11}$ ✓

$= 100 + 25$

$= 125\ \Omega$ ✓

$V = IR$ ✓

$= 0,09 \times 125$ ✓

$= 11,25\ V$ ✓

(4)

11.4

$\varepsilon mf = I(R + r)$ ✓

$= 0,09(125^{\text{COE}} + 25)$ ✓

$= 0,09(150)$

$= 13,5\ V$ ✓

(4)

11.5.1 INCREASES ✓

11.5.2 INCREASES ✓

11.5.3 DECREASES ✓

11.5.4 REMAINS THE SAME ✓

11.5.5 REMAINS THE SAME ✓ (5)

11.6 W = P x t ✓

= 2kW✓ x 5h

= 10 kWh ✓

Cost = 10 kWh ✓x R1,17

= R11,7 ✓ (4)

[25 marks]

NOTES FOR FINAL EXAMS:

- **Start new question on a new page**
- **Read instructions carefully**
- **Label diagrams if asked to.**
- **Include direction whenever it is a vector.**
- **When in doubt … round off to 2 decimals if not sure.**
- **Put small numbers into Scientific notation and then round to 2 decimal places.**
- **Make sure you answer the sections you are most confident with first!!!**
- **Plan your time wisely … work on a mark a minute to guide you.**
- **Learn your definitions, diagrams, write all formulae, show all your working out!**