GRADE 12 EXAMINATION

AUGUST 2017

PHYSICAL SCIENCES PAPER 1

PHYSICS

MODEL ANSWERS

Question 1

1.1 B ✓✓ **each**

1.2 C

1.3 D

1.4 D

1.5 A

1.6 C

1.7 A

1.8 B

1.9 A

1.10 C **[20]**

Question 2

2.1.1 $v^2 = u^2 + 2as$ ✓

$0^2 = 18^2 + 2(-9,8)(s)$ ✓✓

$s = 16,53m$ ✓

heght from sea = 70 + 16,53 = 86,53m ✓ (5)

2.1.2 Choosing downward as positive

$s = ut + \frac{1}{2}at^2$ ✓

$70 = -18t + \frac{1}{2}(9,8)t^2$ ✓✓ [Check for correct sign convention]

$0 = 4,9t^2 - 18t - 70$ [Solve as quadratic equation]

$t = 6,04$ s ✓

OR Calculcate time to max height; then time from max height to sea level and add

Time from start to max height: $v = u + at$

$0 = 18 + (-9,8)t$

$t = 1,84$ s ✓

Time from max height: $s = ut + \frac{1}{2}at^2$ ✓

Carry of error from 2.1.1 → $86,53 = 0t + \frac{1}{2}(9,8)t^2$

$t = 4,20$ s ✓

Total time = 1,84 + 4,20 = 6,04 s ✓ (4)

2.2 Velocity reached at 196cm:

$v^2 = u^2 + 2as$ ✓

$v^2 = 0^2 + 2(9,8)(1,96)$ ✓

$v = 6,2\ m.s^{-1}$ ✓

from 196cm to 227cm:

$s = ut + \frac{1}{2}at^2$ ✓

$0,31 = 6,2t + \frac{1}{2}(9,8)t^2$ ✓ [quadratic equation]

$t = 0,05$ s ✓

OR Calculcate time to 196cm mark: $s = ut + \frac{1}{2}at^2$ ✓

$1,96 = 0 + \frac{1}{2}(9,8)t^2$ ✓

$t = 0,63$ s ✓

Calculcate time to 227cm mark: $s = ut + \frac{1}{2}at^2$

$2,27 = 0 + \frac{1}{2}(9,8)t^2$ ✓

$t = 0,68$ s ✓

Difference: t = 0,68 – 0,63 = 0,05s ✓ (6)

2.3.1 100 m.s^{-1} ✓ and 80 m.s^{-1} ✓ (2)

2.3.2 Acceleration is the rate of change of velocity. ✓✓ (2)

2.3.3 $a = \frac{\Delta v}{\Delta t}$ ✓ $= \frac{-100}{6}$ ✓ $= -16{,}67\ m.s^{-2}$ ✓ (3)

[Question asks for magnitude only – thus ignore negative sign]

2.3.4 Constant ✓acceleration✓ east ✓

Or constantly✓ increasing velocity✓ east ✓

Or constant✓ deceleration✓ west ✓ (3)

2.3.5 Distance = Area A + B✓

= (100 x 9) ✓ + (½ x 6 x 100) ✓

= 1200 m ✓ (4)

OR A: s = ut = (100 x 9) ✓ = 900 m

B: (can use $v^2 = u^2 + 2as$ or $s = ut + ½ at^2$)

$s = \frac{(u + v).t}{2}$ ✓ $= \frac{(100 + 0).6}{2}$ ✓= 300 m

s_{total} = 900 + 300 = 1200 m✓

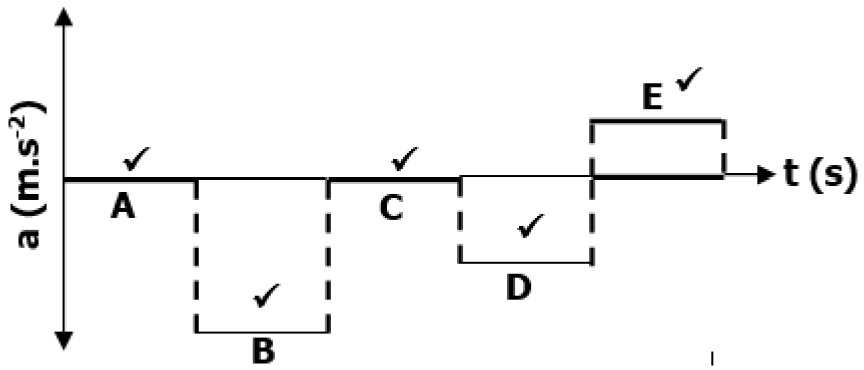
2.3.6 $S_{AB} = S_{DE}$

1200 ✓= (½ x b x 80) ✓

b = 30 s ✓

t_x = (20 + 30) = 50 s✓ (4)

2.3.7



(5)

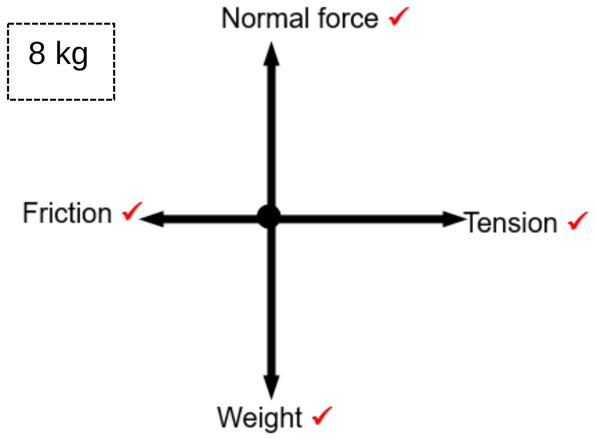
[38]

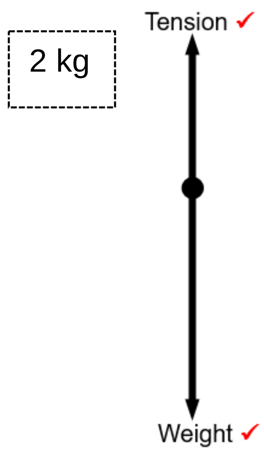
QUESTION 3

3.1 The gravitational force the Earth exerts on any object on or near its surface. ✓✓ (2)

3.2 $F_g = mg = 2 \times 9{,}8 = 19{,}6$ N ✓ downward ✓ (2)

3.3





Tension force should be longer than friction force

Tension force should be shorter than weight force

(6)

3.4 When a net force 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. ✓✓
OR
The net force acting on an object is equal to the rate of change of momentum. ✓✓ (2)

3.5 Applying NII on the system:

$F_{net} = ma$ ✓

$19{,}6 - 6$ ✓ $= 10a$ ✓

$a = 1{,}36$ m.s^{-2} ✓

Applying NII to either weight. Choosing down as positive:

2kg: $F_{net} = ma$

$19{,}6 - T$ ✓ $= 2 \times 1{,}36$ ✓

$T = 16{,}88$ N ✓

8kg: $F_{net} = ma$

$T - 6 = 8 \times 1{,}36$

$T = 16{,}88$N

OR Applying NII to each block separately:

8kg: $F_{net} = ma$ ✓

$T - 6 = 8a$ ✓.....(A)

2 kg: $F_{net} = ma$

$19{,}6 - T = 2a$ ✓........(B)

Adding (A) + (B): $19{,}6 - 6 = 10a$

$a = 1{,}38$ m.s^{-2} ✓

Applying NII to either weight. Choosing down as positive:

2kg: $F_{net} = ma$

$19{,}6 - T$ ✓$= 2 \times 1{,}38$ ✓

$T = 16{,}84$ N ✓

8kg: $F_{net} = ma$

$T - 6 = 8 \times 1{,}36$

$T = 16{,}88$N (7)

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QUESTION 4

4.1 E_{Mech} at P = E_{Mech} at Q

$(mgh + ½mv^2)_P = (mgh + ½mv^2)_Q$ ✓

$5 \times 9,8 \times 4$ ✓ $+ 0 = 0 + ½ \times 5 \times v^2$ ✓

$v = 8,85 \text{ m.s}^{-1}$ ✓ (4)

4.2 The work done by a net force on an object is equal to the change in the kinetic energy of the object. ✓✓ (2)

4.3 $F_{net} = ma$ $v^2 = u^2 + 2as$ ✓ **(one tick for both formulae)**

$-32,5 = 5.a$ ✓ $v^2 = 8,85^2 + 2(-6,5)(3)$ ✓

$a = -6,5 \text{ m.s}^{-2}$ ✓ $v = 6,27 \text{ m.s}^{-1}$ ✓

OR $W = \Delta E_K$ ✓

$-32,5 \times 3$ ✓ $= ½ \times 5 \times$ ✓ $(v^2 – 8,85^2)$ ✓

$v = 6,27 \text{ m.s}^{-1}$ ✓ (5)

4.4 $E_P = mgd.\sin 28$ ✓✓

OR $E_P = 49d.\sin 28$

OR $E_P = 23d$ (2)

4.5 $W_{Net} = \Delta E_K$ ✓

$F_f.d + F_{g//}.d = ½m(v^2 – u^2)$

$-19d$ ✓ $-(5)(9,8)(\sin 28)d$ ✓ $= ½ \times 5 \times (0^2 – 6,27^2)$ ✓

$-42.d = -98,28$

$d = 2,34\text{m}$ ✓

OR $E_{K \text{ at } R} = E_{P \text{ at } S} + W_{friction}$ ✓

$½ \times 5 \times 6,27^2$ ✓ $= (5)(9,8)(\sin 28)d$ ✓ $+ 19d$ ✓

$d = 2,34 \text{ m}$ ✓

OR $F_{net} = ma$ $v^2 = u^2 + 2as$ ✓ **(one tick for both formulae)**

$-19 - (5)(9,8)(\sin 28) = 5a$ ✓ $0^2 = 6,27^2 + 2(-8,4)d$ ✓

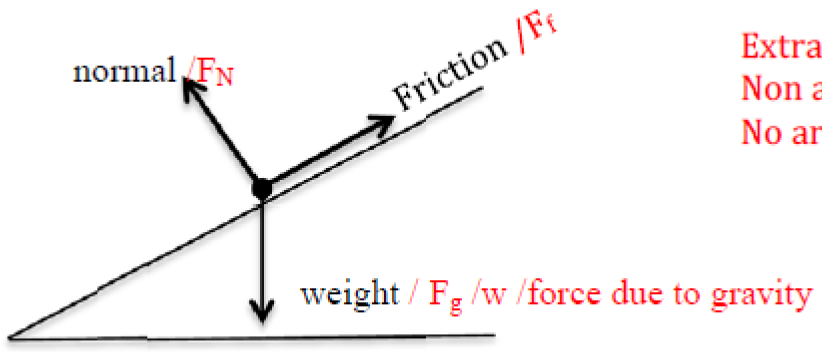
$a = -8,4 \text{ m.s}^{-2}$ ✓ $d = 2,34 \text{ m}$ ✓ (5)

4.6 As the box moves up the incline, the Normal force decreases. ✓

Since $F_f = \mu N$, ✓ so the frictional force will decrease ✓ (3)

[N = mgcosϴ; cosϴ decreases as ϴ increases Or cos 28 < 1]

4.7



Extra forces -1
Non attachment -1
No arrows -1

(3)

4.8 F_f = mgsin28 = (5)(9,8)(sin28) = 23 N (3)

4.9 F_f = Mn ✓

23 = μ(5)(9,8)(cos28) ✓

μ = 0,53 ✓ (3)

4.10 Static friction is greater than kinetic friction ✓✓

OR Coefficient of static friction is greater than the coefficient of kinetic friction (2)

[32]

QUESTION 5

5.1 The product of the mass and velocity of the object. ✓✓ (2)

5.2.1 Total p before = $m_A u_A + m_B u_B$ ✓= (500 x 6) + 0 ✓= 3000 kg.m.s^{-1} east ✓ (3)

5.2.2 Total p after = $m_A v_A + m_B v_B$ = (500 x -1) + (700 x 5) ✓ = 3000 kgm.s^{-1} east ✓ (2)

5.2.3 Yes ✓total momentum is conserved. (1)

5.3 Total E_K before collision = ½mu_A^2 + ½mu_B^2 = ½ x 500 x 6^2 + 0 ✓ = 9000J✓

Total E_K after collision = ½mv_A^2 + ½mv_B^2 = ½ x 500 x $(-1)^2$ + ½ x 700 x 5^2 ✓ = 9000J✓

Yes, ✓ it is an elastic collision (since E_K is conserved) (5)

5.4 $F_{Net} = \frac{\Delta p}{\Delta t} = \frac{mv - mu}{\Delta t}$ ✓ $= \frac{[500\times(-1)]✓ - [500\times 6]✓}{2✓} = \frac{-3500}{2} = -1750\ N$

$\therefore magnitude\ F = 1750\ N$✓ (5)

OR v= u + at ✓

-1 = 6 + a.2 ✓

a = -3,5 m.s^{-2} ✓

F_{Net} = ma

F_{Net} = 500 x (-3,5) ✓= - 1750N

Magnitude F_{Net} = 1750N✓

Note: Pupils may also calculate F_{Net} exerted on B.

[18]

QUESTION 6

6.1.1 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 ✓✓ (2)

6.1.2 $F_{m/e} = \frac{Gm_1m_2}{r^2}$ ✓ $= \frac{(6,7\times10^{-11})(5,97\times10^{24})(7,35\times10^{22})}{(3,84\times10^8)^2}$ ✓✓

$F = 1,99\times10^{20}$ N ✓ (4)

6.1.3 If the F_{res} on the moon = 0 then $F_{earth\ on\ moon} = F_{sun\ on\ moon}$

Carry of error from 6.1.2

$1,99\times10^{20}$ ✓ $= \frac{(6,7\times10^{-11})(1,99\times10^{30})(7,35\times10^{22})}{r^2}$ ✓✓

$r = 2,22\times10^{11}$ m ✓ (4)

6.2.1 The force per unit positive charge ✓✓ (2)

6.2.2 $E = \frac{kQ}{r^2}$ ✓

$500 = \frac{(9\times10^9)(2,7\times10^{-9})}{r^2}$ ✓

r = 0,22 m ✓ (3)

[15]

QUESTION 7

7.1.1 Emf is the **total energy** supplied per **coulomb (unit)** of charge by the **cell**. ✓✓
(Maximum power per unit current supplied by the cell) (2)

7.1.2 ***Option 1***

$V_{8\Omega}$ = IR ✓= 0,2 x 8 = 1,6 V✓

$I_{4\Omega} = \frac{V}{R} = \frac{1,6}{4} = 0,4A$ ✓

A_1 = 0,2 + 0,4 = 0,6 A ✓

Option 2

Ratio of reistances = 8Ω : 4Ω = 2;1

Ratio of currents = 1:2

Current through 4Ω resitor = 2 x 0,2 = 0,4 A

A_1 = 0,2 + 0,4 = 0,6 A

Option 3

$V_{8\Omega}$ = IR = 0,2 x 8 = 1,6 V

$R_{//} = \frac{8\times4}{8+4}$ = 2,67 Ω

Total current I = $\frac{V}{R} = \frac{1,6}{2,67} = 0,6A$ (4)

7.1.3 $R = \frac{V}{I}$ ✓ $= \frac{15,4}{0,6}$ ✓ $= 25,67\ \Omega$ ✓ [COE from 7.1.2] (3)

7.1.4 $R_{//} = \frac{8\times4}{8+4}$ = 2,67 Ω ✓✓ R_T = 2,67 + 25,67 = 28,34 Ω ✓ (3)

COE from 7.1.3

7.1.5 Emf = I(R +r) ✓
18 = 0,6(28,34 + r) ✓✓ ← COE from 7.1.2 and 7.1.4
18 = 17 + 0,6r
r = 1/0,6 = 1,67 Ω ✓

OR V_{Ext} = (1,6 + 15,4) = 17 V
V_{lost} = Emf – V_{Ext} = 18 – 17 = 1V
r = $\frac{V_{lost}}{I} = \frac{1}{0,6}$ =1,67 Ω (4)

7.1.6 (a) Decrease ✓ (1)

7.1.6 (b) The **total resistance of the circuit decreases**✓ therefore **current increases.**✓
More volts will be lost ✓ OR
Ir increases therefore the reading on the voltmeter will decrease,
since V_1 = emf – Ir ✓ OR emf = V_{ext} + V_{lost} (Ir='lost' volts) (4)

7.2.1 When the kettle is connected to a **<u>voltage</u> (potential difference) of 220 V** ✓,
its **<u>power</u> (consumption) is 1 500 W** ✓ (or $J.s^{-1}$).
[NB connection between the power consumption ONLY being 1500 W WHEN the kettle is connected to 220 V.] (2)

7.2.2 P = V.I ✓
1500 = 220.I ✓
I = 6,82 A ✓ (3)

7.2.3 Cost = 1,5 kW × (20/60) × 2,50 ✓✓ = R1,25 ✓

OR W = Pt = 1500 x 20 x 60 = 1 800 000 J
Cost = 1 800 000 / 3 600 000 ×2,50 = R1,25 (3)

[29]

QUESTION 8

8.1 **A** Slip rings✓

B Carbon brushes✓ (2)

8.2 x to y ✓ (1)

8.3 Mechanical Energy to electrical energy ✓✓ (2)

8.4 The product of the number of turns on the coil and the flux through the coil. ✓✓ (2)

8.5 Rotate the coil faster✓ **Two only**

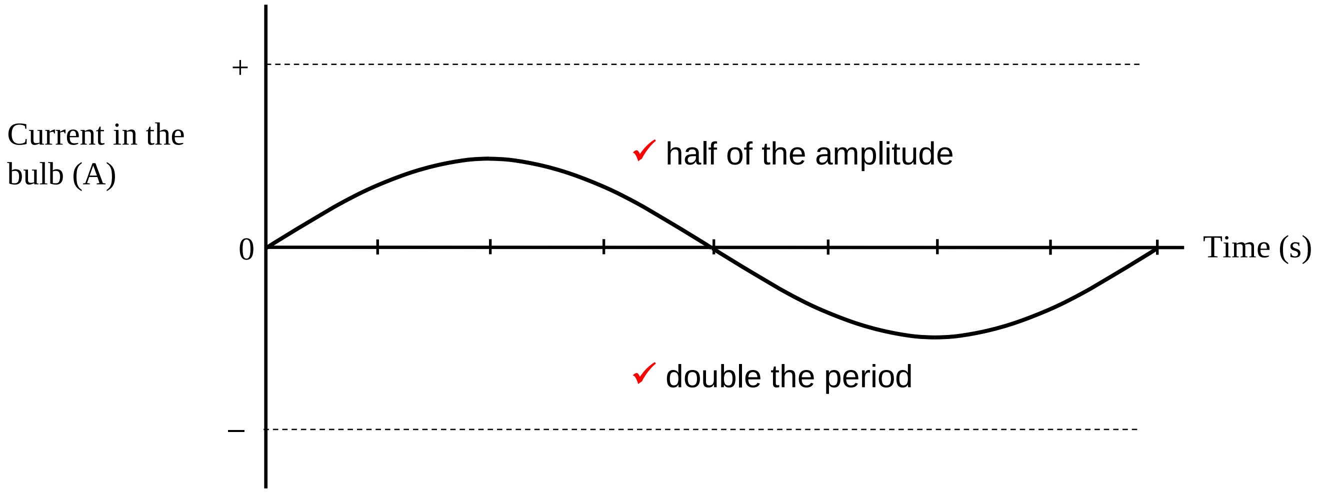
Use stronger magnets ✓

Increase the number of turns in the coil. (2)

8.6 Replace bulb with a DC source (battery) ✓

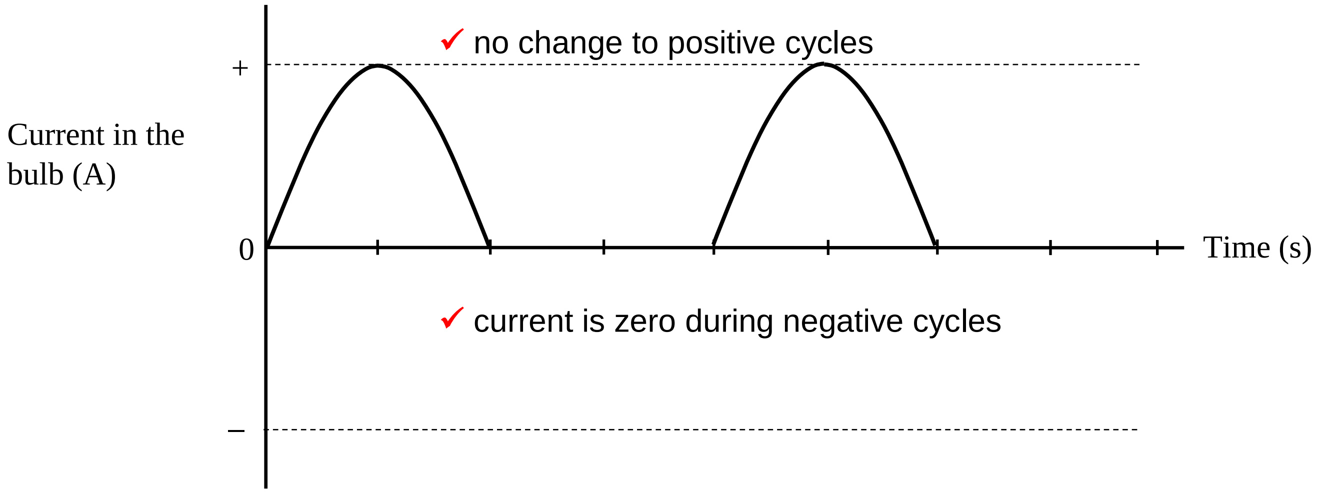
Replace the slip rings with a split ring commutator✓. (2)

8.7.1



(2)

8.7.2



(2)

8.8 AC voltages can be stepped up using a transformer. ✓ **One only**

Stepping up the voltage allows the current to be stepped down, reducing heat energy lost in long distance power lines. ✓ (1)

8.9 The emf induced is directly proportional to the rate of change of magnetic flux. ✓✓ (2)

[18]

QUESTION 9

9.1 The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. ✓✓ (2)

9.2 A step-up transformer ✓

A step-up transformer has more✓ turns in the secondary coil✓. (2)

9.3.1 No✓

DC will **not** produce the required <u>change in magnetic flux</u> ✓ in order to induce an emf in the secondary coil. (2)

9.3.2

$$\frac{N_s}{N_p} = \frac{V_s}{V_p} \checkmark$$

$$\frac{2250}{900} = \frac{V_s}{96} \checkmark$$

$$V_s = 240\ V \checkmark$$

$$I = \frac{V}{R} = \frac{240}{800} \checkmark = 0{,}3\ A \checkmark$$ (5)

[11]