Shore

Exam Number: ☐ ☐ ☐

Year 12
Physics
Class Test
2019

General Instructions

- Working time – 47 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Calculators may be used
- Answer to 2 significant figures unless otherwise stated

Total marks – 31

Part A – 6 marks

• Attempt Questions 1 – 6

• Allow about 10 minutes for this part

Part B – 25 marks

• Attempt Questions 7 – 12

• Allow about 37 minutes for this part

Note: Any time you have remaining should be spent revising your answers.

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Part A – 6 marks
Attempt Questions 1 – 6
Allow about 10 minutes for this part

Select the best answer.
Use the multiple-choice answer sheet provided.

1 A person has a weight of 550 N on the surface of Earth. On Mars, acceleration due to gravity is 3.9 m/s^2.

What would be the weight of the person on Mars?

(A) 550 N

(B) 56 kg

(C) 1375 N

(D) 220 N

2 A satellite of mass m orbits a planet of mass M at an orbital radius of r. What would be the change in potential energy to double the radius of orbit?

(A) $\frac{GMm}{r}$

(B) $-\frac{GMm}{r}$

(C) $\frac{GMm}{2r}$

(D) $-\frac{GMm}{2r}$

3 A new spacecraft has just been assembled in low earth orbit, at an orbital radius of 6680km. Assuming it takes 90 minutes to orbit the planet, what is the angular velocity of this spacecraft?

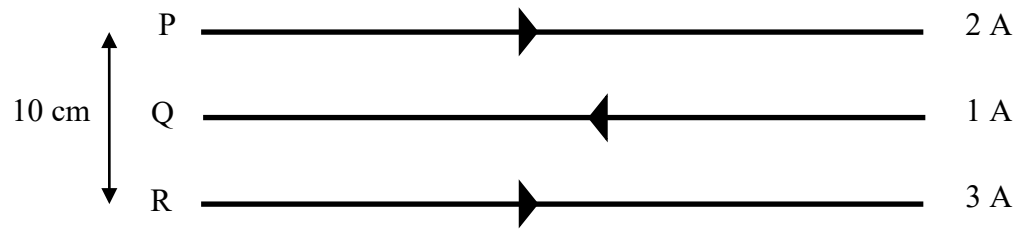
(A) 1.2×10^{-3} rad/s

(B) 0.07 rad/s

(C) 21 m/s

(D) 7772.53 m/s

4 P, Q and R are three equally spaced long parallel wires in air. They carry currents as shown below.



Calculate the force per metre acting on wire Q due to wires P and R.

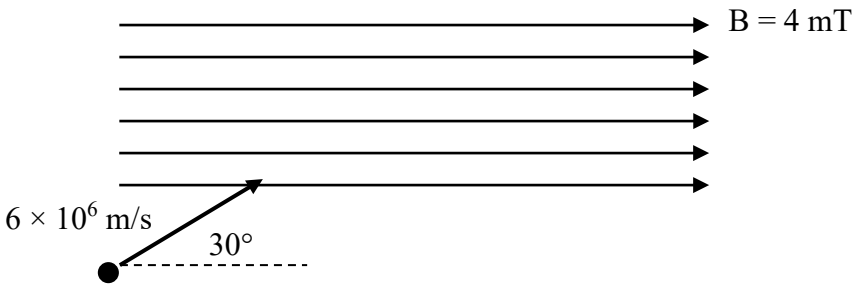
(A) 4.0×10^{-6} N/m Up the page

(B) 2.0×10^{-5} N/m Up the page

(C) 1.2×10^{-5} N/m Up the page

(D) 2.0×10^{-5} N/m Down the page

5 An electron enters a magnetic field as shown below.



Calculate the magnitude and direction of the force acting on the electron.

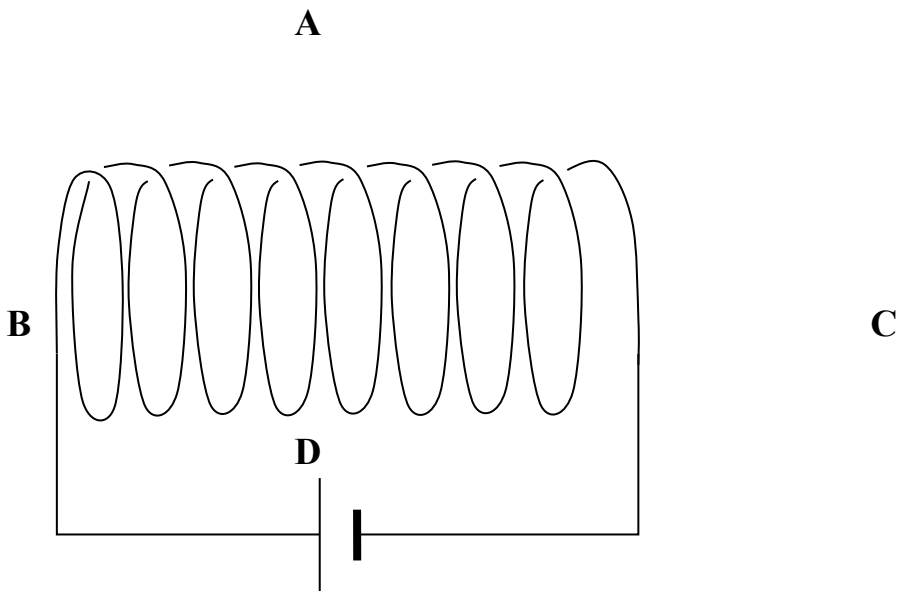
(A) 1.9×10^{-12} N Out of the page

(B) 1.9×10^{-12} N Into the page

(C) 1.9×10^{-15} N Out of the page

(D) 1.9×10^{-15} N Into the page

6 In which position will the flux density be greatest and directed to the left?



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Part B – 25 marks
Attempt Questions 7 – 12
Allow about 37 minutes for this part
Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 7 (4 marks) **Marks**

A sports magazine commenting on the athletic ability of Michael Jordan, the famous basketball player, said:

"Being an athlete takes more brains than brawn. It takes time and effort. It takes endurance and commitment. It takes an athlete who can stay in the air for 2.5 seconds while shooting a goal; an athlete who knows which laws of physics keep him there."

Is the information presented in this magazine valid? Use appropriate calculations to support your argument. **4**

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Question 8 (4 marks) **Marks**

The asteroid 243 Ida was discovered in 1884. The Galileo spacecraft, on its way to Jupiter, visited the asteroid in 1993. The asteroid was the first to be found to have a natural satellite, that is, its own moon, now called Dactyl.

a) Dactyl orbits Ida at a radius of 100 km and with a period of 27 hours. What is the mass of 243 Ida? **2**

b) Jupiter takes approximately 12 earth years to orbit the sun. Assuming Earth is 150 million km from the sun, what is the minimum displacement between Earth and Jupiter. **2**

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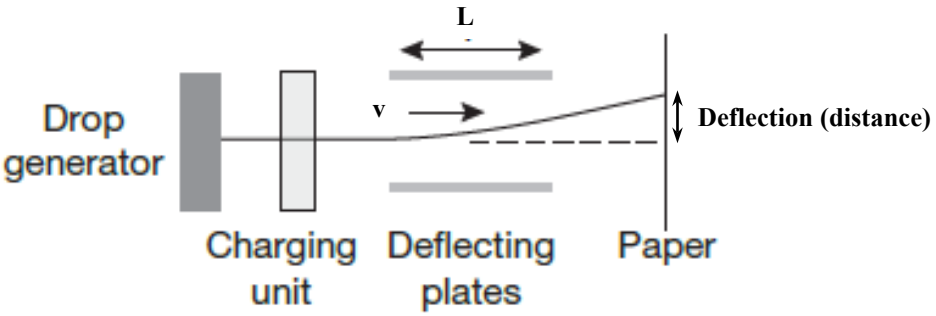
Question 9 (4 marks) **Marks**

a) By equating kinetic and gravitational potential energy, derive an expression for escape velocity v for a spacecraft of mass m, from a body of mass M, at a distance from the centre of mass r. **2**

b) An astronaut can push off her spacecraft at 2 m/s. At what distance from the centre of mass of the Earth would this be enough to permanently escape Earth's gravitational influence? **2**

Question 10 (5 marks) **Marks**

In an inkjet printer, small drops of ink are given a controlled charge and fired between two charged plates. The electric field deflects each drop and thus controls where the drop lands on the page.



Let m = the mass of the drop, q = the charge of the drop, v = the speed of the drop, L = the horizontal length of the plate crossed by the drop, and E = electric field strength.

a) Derive an expression for the deflection of the drop. (Assume weight force is negligible.) **3**

b) With the values $m = 1.0 \times 10^{-10}$ kg, $v = 20$ ms^{-1}, $L = 1.0$ cm and $E = 1.2 \times 10^{6}$ NC^{-1}, calculate the charge required on the drop to produce a deflection of 1.2 mm. **2**

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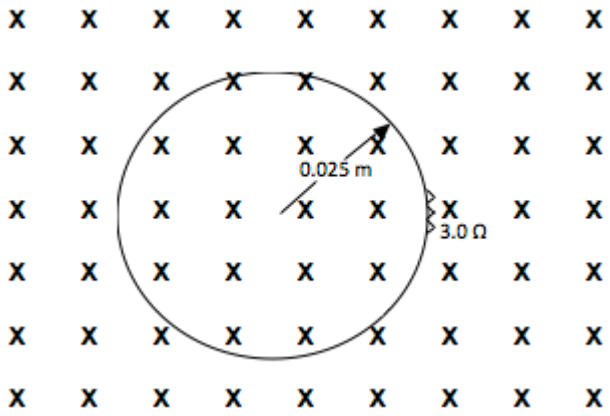
Question 11 (4 marks) **Marks**

The following diagram shows a single loop of wire inside a 0.1 T magnetic field.



The magnetic field is reduced to zero over a period of 0.1 s.

a) Calculate the initial magnetic flux inside the loop. **1**

b) Calculate the current induced in the coil assuming the loop has a resistance of 3.0 Ω. **2**

c) On the diagram, indicate the direction of the induced current in the loop. **1**

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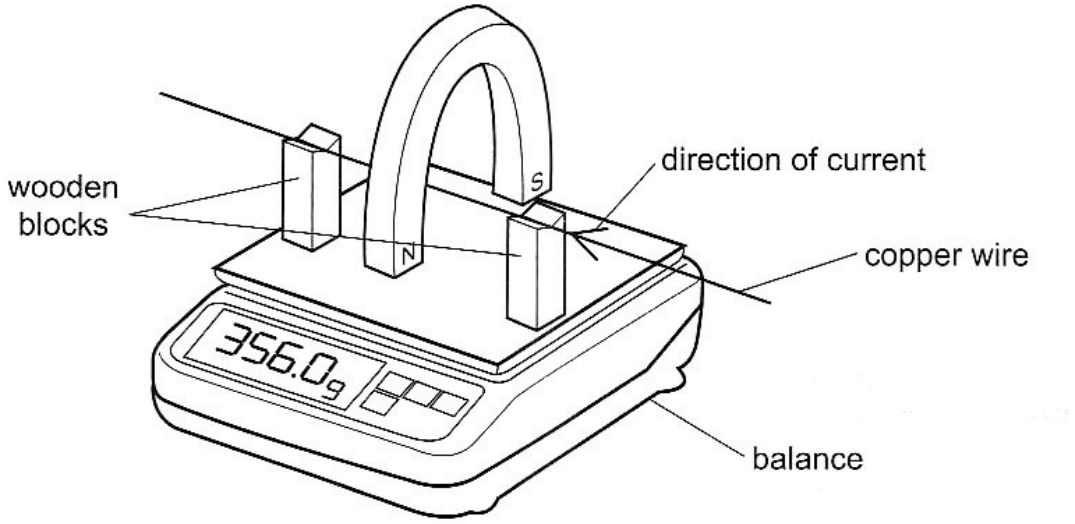
Question 12 (4 marks) **Marks**

A wire is set in a magnetic field as shown. All equipment is fixed in place, and the current is initially switched off resulting in the reading shown on the balance.



a) Name the physics principle that this experiment is set up to demonstrate **1**

b) When switched on, the copper wire carries a current of 4.5 A, and 1 cm of the wire passes through a magnetic field perpendicular to the wire of 0.5 T. Calculate the new reading on the electronic balance (answer to the nearest gram). **3**

END OF EXAM

PHYSICS YEAR 12 2019

CLASS TEST

ANSWERS AND SUGGESTED MARKING GUIDELINES

Part A

Question #	1	2	3	4	5	6
Answer	D	C	A	A	C	D

Question 7

Criteria	*Mark*
Correctly calculates the maximum height of the jump AND provides a judgement on validity using the calculated value in support	**4**
Correctly calculates the maximum height of the jump AND provides a judgement on validity **OR** Correct method to calculate the maximum height of the jump with one error of logic or substitution. Provides a judgement on validity using the calculated value in support.	**3**
Correct method to calculate the maximum height of the jump with one error of logic or substitution **OR** Identifies a valid equation to find a value AND a logical judgement of validity based on evidence	**2**
Identifies a valid equation to find a value AND a logical judgement of validity based on evidence	**1**

Sample Answer

Now, $v = u + at$

If Jordan stayed in the air for 2.5 seconds, then by 1.25 seconds, he reaches maximum height.

$\therefore 0 = u + 1.25 \times -9.8$

$\therefore u = 12.3$ m/s

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

$= 7.7$ m

If Michael Jordan could remain in the air for 2.5s, then he would have jumped to a height of 7.7m in the air. This is clearly an exaggeration and therefore the statement is not scientifically valid.

Question 8 (a)

Criteria	*Mark*
Valid method with correct substitutions	**2**
Valid method with one error of logic or substitution	**1**

Sample Answer

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$M = \frac{4\pi^2 r^3}{T^2 G}$$

$$= \frac{4\pi^2 (100000)^3}{(27 \times 60 \times 60)^2 \times 6.67 \times 10^{-11}}$$

$$= 6.3 \times 10^{16}\, kg$$

Question 8 (b)

Criteria	*Mark*
Valid method with correct substitutions	**2**
Valid method with one error of logic or substitution in calculation of orbital radius of Jupiter	**1**

Sample Answer

$$\frac{r_{earth}^3}{T_{earth}^2} = \frac{r_{jupiter}^3}{T_{jupiter}^2}$$

$$r_{jupiter} = \sqrt[3]{\frac{r_{earth}^3 \times T_{jupiter}^2}{T_{earth}^2}}$$

$$= \sqrt[3]{\frac{150^3 \times 12^2}{1^2}}$$

$$= 790 \text{ million km}$$

$$790 - 150 = 640$$

$\therefore$ distance from Earth to Jupiter is 640 million km (2 sig figs)

Question 9 (a)

Criteria	*Mark*
Derives formula for escape velocity using ΔK = ΔU or conservation of energy	**2**
Uses ΔK = ΔU or conservation of energy but makes one error of logic or substitution OR correct formula for v_{esc}	**1**

Sample Answer

$$E_p = -\frac{GMm}{r}$$

$$E_k = \frac{1}{2}mv^2$$

$$|E_p| = |E_k|$$

$$\frac{GMm}{r} = \frac{1}{2}mv^2$$

$$v^2 = \frac{2GM}{r}$$

$$= \sqrt{\frac{2GM}{r}}$$

Question 9 (b)

Criteria	*Mark*
Correct answer to 2 significant figures with correct units according to student's answer to part (a)	**2**
One error of logic or substitution according to student's answer to part (a)	**1**

Sample Answer

$$v = \sqrt{\frac{2GM}{r}}$$

$$v^2 = \frac{2GM}{r}$$

$$r = \frac{2GM}{v^2}$$

$$= \frac{2 \times 6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{2^2}$$

$$= 2.0 \times 10^{14}\, m$$

Question 10 (a)

Criteria	*Mark*
Correct derivation of formula for deflection.	**3**
Derives the correct equation for acceleration due to the electric field.	**2**
Identifies the correct equations to combine in derivation.	**1**

Sample Answer

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

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

$F = Eq$

$ma = Eq$

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

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

$d = \frac{1}{2}\left(\frac{Eq}{m}\right)\left(\frac{L}{v}\right)^2$

Question 10 (b)

Criteria	*Mark*
Correct answer with units	**2**
Correct substitution into formula	**1**

Sample Answer

$q = 2\frac{dv^2}{L^2}.\frac{M}{E}$

$q = \frac{2\times1.2\times10^{-3}\times20^2\times1\times10^{-10}}{0.01^2\times1.2\times10^6} = \frac{9.6\times10^{-11}}{120}$

$= 8.0\times10^{-13}C$

Question 11 (a)

Criteria	*Mark*
Calculates value of magnetic flux	**1**

Sample Answer

$\varphi_B = BA$

$= 0.1 \times \pi \times 0.025^2$

$= 2.0 \times 10^{-4} Wb$

Question 11 (b)

Criteria	*Mark*
Calculates induced current	**2**
Calculates induced emf	**1**

Sample Answer

$emf = -n\frac{\Delta\varphi_B}{\Delta_t}$

$= -1\frac{2 \times 10^{-4}}{0.1}$

$= 2 \times 10^{-3} V$

$I = \frac{V}{R}$

$= \frac{2 \times 10^{-3}}{3}$

$= 6.5 \times 10^{-4} A$

Question 11 (c)

Criteria	*Mark*
Identifies direction of current flow	**1**

Sample Answer

Clockwise

Question 12 (a)

Criteria	*Mark*
Identifies the correct physical phenomena	**1**

Sample Answer

The motor effect

Question 12 (b)

Criteria	*Mark*
Calculates reading correct to the nearest gram	**3**
Calculates the additional mass resulting from the force	**2**
Calculates the force due to the magnetic field	**1**

Sample Answer

$F = BIl$

$= 0.5 \times 4.5 \times 0.01$

$= 0.0225N$

$m = \dfrac{F}{g}$

$= \dfrac{0.0225}{9.8}$

$= 2.2959 \times 10^{-3} kg$

$= 2$ g to the nearest g

$\therefore reading = 356 + 2$

$= 358g$