— School use only —

Section 1

Instructions

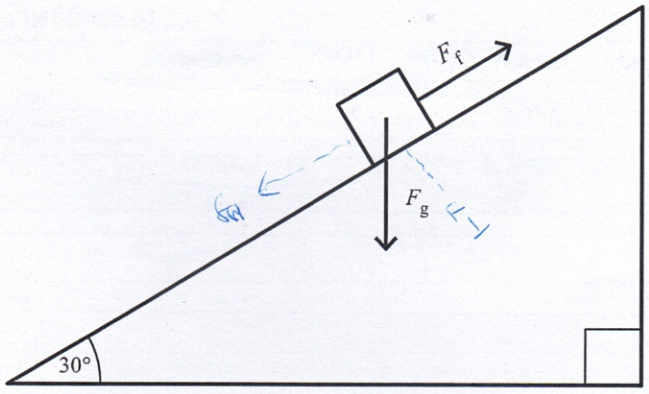
- Choose the best answer for Questions 1–20.
- This section has 20 questions and is worth 20 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	●	○	○	○

	A	B	C	D
1.	○	○	○	●
2.	○	○	○	●
3.	○	○	●	○
4.	○	○	○	●
5.	○	○	●	○
6.	○	●	○	○
7.	○	○	●	○
8.	●	○	○	○
9.	○	○	○	●
10.	○	○	●	○
11.	○	○	●	○
12.	○	○	○	●
13.	○	●	○	○
14.	○	●	○	○
15.	○	○	●	○
16.	○	○	○	●
17.	●	○	○	○
18.	○	●	○	○
19.	○	○	●	○
20.	●	○	○	○

QUESTION 21 (3 marks)

The diagram below shows forces acting upon an object on an inclined plane.



Calculate the acceleration of the object along the plane, given that the mass of the object is 50 kg, and the force due to friction (F) is 200 N. Show your working.

$F_g = 9.8 \cdot 50 = 490\,N$

$F_{\parallel} = 490 \sin(30) = 245\,N$, $F_{\perp} = 490\cos(30) \approx 424.35$

$F_{net\parallel} = 245 - 200 = 45\,N$ $\quad F = m \cdot a \quad \therefore \quad \frac{F}{m} = a = \frac{45}{50} = 0.9\,ms^{-2}$

Acceleration = 0.9 m s^{-2} (to 1 decimal place) along the plane

QUESTION 22 (2 marks)

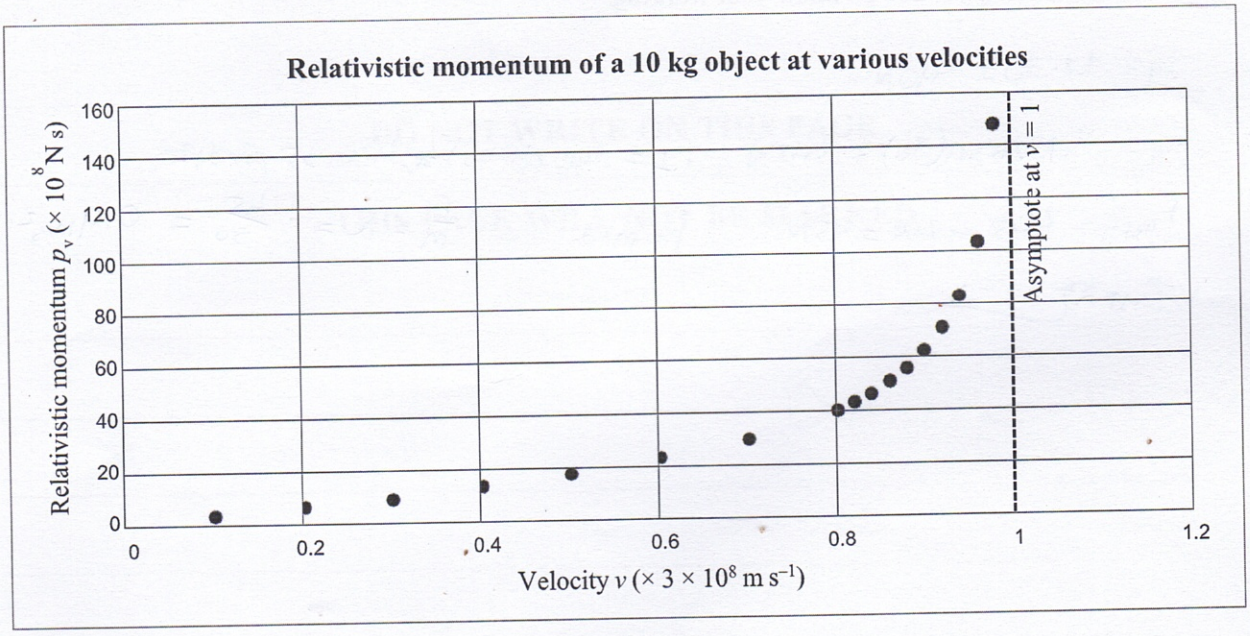
List the four gauge bosons of the Standard Model and, for each, identify the fundamental forces that they mediate.

Gluon: Strong Nuclear force, W^+, W^- boson: weak nuclear force

Photon: Electromagnetic force

QUESTION 23 (2 marks)

The graph below shows the theoretical momentum of a 10 kg object with respect to its velocity.



With reference to the graph, draw a conclusion explaining why no object with mass can travel at the speed of light in a vacuum.

if an object with mass were to travel at the speed of light in a vaccum, its momentum would be infinite, which is not physically possible. This is indicated by the asymptote at v= 1. An infinite force would be required to make the object reach this speed.

QUESTION 24 (4 marks)

An object of mass 320 g moves along a circular path at a velocity of 12 m s^{-1}.

Determine the time it takes for the object to complete a full revolution, given it experiences a net force of 5.6 N.

$m = 0.320$, $v = 12$ $\quad F_{net} = \frac{mv^2}{r} = 5.6N$

$\therefore \frac{0.320 \cdot 12^2}{5.6} = r = \frac{288}{35}$

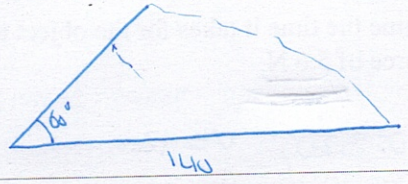
$v = \frac{2\pi r}{T} \quad \therefore \frac{2\pi r}{v} = T \quad \therefore T = \frac{2\pi \cdot \frac{288}{35}}{12} = \frac{48}{35}\pi = 4.3$

Time = 4.3 s (to 1 decimal place)

QUESTION 25 (6 marks)

An object is launched from ground level at an angle of 60° and lands 140 m away at the same starting height 4.3 s later.

a) Calculate the horizontal velocity of the object on impact. *[2 marks]*



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

$140 = u \cdot 4.3 + \frac{1}{2} \cdot -9.8 \cdot 4.3^2 \quad \therefore u = 53.6281 \text{ m/s}$

$u_x = 53.6281 \cdot \sin(60) = 46.4433$

Starting velocity is going to be the same as final velocity

Final Horizontal Velocity = 46.4 m s^{-1} (to 1 decimal place)

b) Determine the maximum height reached by the object when launched with a velocity of 62.5 m s^{-1}. Show your working. *[4 marks]*

$V_y = 62.5 \sin(60) = 54.127$

~~Better~~ $S = ut + \frac{1}{2}at^2 \quad \therefore$ ~~$v^2 = u^2 + 2as$~~

let $v = 0 \quad \therefore \frac{-u^2}{2 \cdot -9.8} = S \quad \therefore S = \frac{2929.64}{14.6} = 144.47$

Maximum Height = 144 m (to the nearest whole number)

QUESTION 26 (5 marks)

Explain the different penetrative properties of alpha radiation and beta-negative radiation in terms of their composition.

Alpha radiation is made up of 2 Neutrons, and 2 Protons. This causes it to have a +2 Charge, as there are no electrons to balance it. ~~When Alpha radiation collides with an object,~~ Its high mass and large size make a collision more likely to occur, and when a collision does occur, the magnitude of Charge of the Alpha Particle makes it likely to ionise and "use up" all of its energy doing so. This results in an overall high ionising Potential, but a low penetration power.

~~Beta negative radiation Consists of a single electron~~

Beta negative radiation consists of a single electron. Due to this it has a -1 Charge, and a much lower mass when compared to Alpha Particles. It's lower Charge results in a lower ionising Potential, and due to its smaller size, it is less likely to collide with another Particle, in order to initiate Ionisation, in the first Place. This results in a lower ionisation Potential, but greater Penetrating ability in comparison to Alpha.

QUESTION 27 (4 marks)

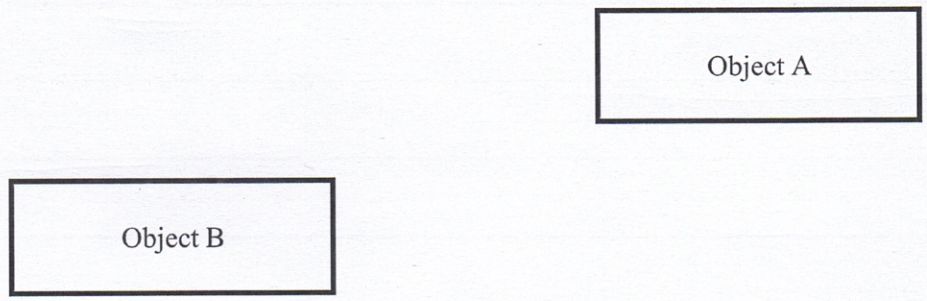
^{127}I is a stable isotope that is unlikely to experience nuclear decay under natural conditions, while ^{131}I will likely decay into ^{131}Xe.

Explain why ^{124}I is likely to decay into ^{124}Te.

?!: I literally have NO IDEA! will study this

QUESTION 28 (5 marks)

The diagram below shows two objects moving relative to one another. When stationary, and measured by a stationary observer, Object A and Object B are both 200 m in length.



a) Calculate the length of Object A, as measured by an observer on Object B, if $V_A = 0.7$ c and $V_B = 0$ c. Show your working. *[2 marks]*

$L = L_0 \cdot \sqrt{1-(0.7)^2} = L_0 \cdot \frac{\sqrt{51}}{10} \approx 142.83$

Length = 143 m (to the nearest whole number)

b) Calculate the relative velocity of Object B, as measured by an observer on Object A, if the observer measured $L_B = 100$ m. Show your working. *[3 marks]*

$100 = 200 \cdot \sqrt{1-\frac{v^2}{c^2}}$

$\left(\frac{1}{2}\right)^2 = 1 - \frac{v^2}{c^2}$

$-\left(\frac{1}{2}\right)^2 = \frac{v^2}{c^2} - 1 \quad \therefore \quad 1 - \left(\frac{1}{2}\right)^2 = \frac{v^2}{c^2} = \frac{3}{4} \quad \therefore v = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2} = 0.866$

Velocity = 0.866 c (to 3 decimal places)

END OF PAPER