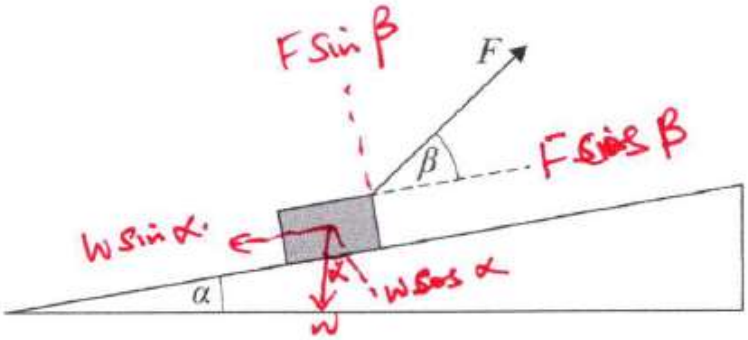
Force, energy and momentum – A2 Physics P1

1. June/2024/Paper_7408/1/No.18

A force of magnitude F acts on a box of mass m that moves along a frictionless slope. The slope is at an angle α to the horizontal and the force acts at an angle β to the slope.



What is the magnitude of the acceleration of the block along the slope?

[1 mark]

A $\frac{F}{m}\sin\alpha - g\sin\beta$ ○

B $\frac{F}{m}\cos\beta - g\sin\alpha$ ⊗

C $\frac{F}{m}\cos(\alpha+\beta) - g\cos\beta$ ○

D $\frac{F}{m}\cos(\alpha+\beta) - g\sin\beta$ ○

Net force $= F\cos\beta - W\sin\alpha$

$N \cdot F = F\cos\beta - mg\sin\alpha$

but $F = ma$ so

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

So

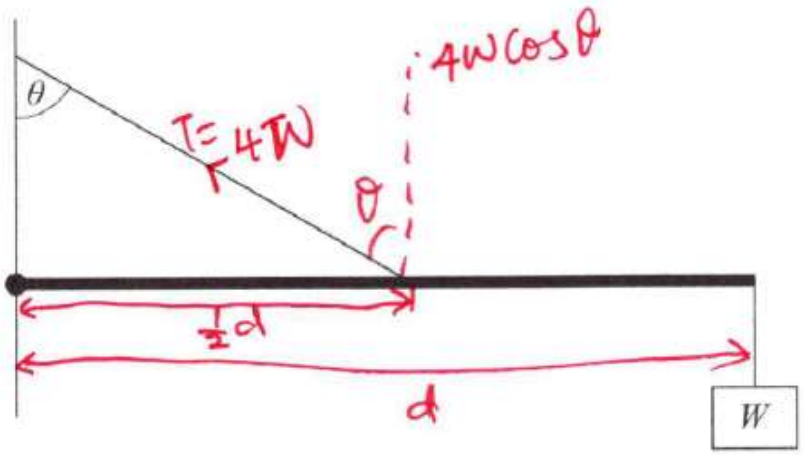
$a = \frac{F\cos\beta - mg\sin\alpha}{m}$

$a = \frac{F}{m}\cos\beta - g\sin\alpha$

2. June/2024/Paper_7408/1/No.19

The weight of a uniform bar is W.
An object also of weight W is attached to one end.
The bar is pivoted at the other end and held horizontal by a rope attached to its centre.
The tension in the rope is $4W$.

not to scale



What is angle θ?

[1 mark]

M = Fd

$0.5d \times 4W\cos\theta = 0.5d \times 4W + 0.5W$

$0.5d \times 4W$ $\qquad$ $0.5d \times 4W$

$\cos\theta = \frac{2 - 0.5}{2}dW$

$\theta = \cos^{-1}(1.5 \div 2)$

$\theta = 41.4^\circ$

A 41° ☒

B 45° ○

C 60° ○

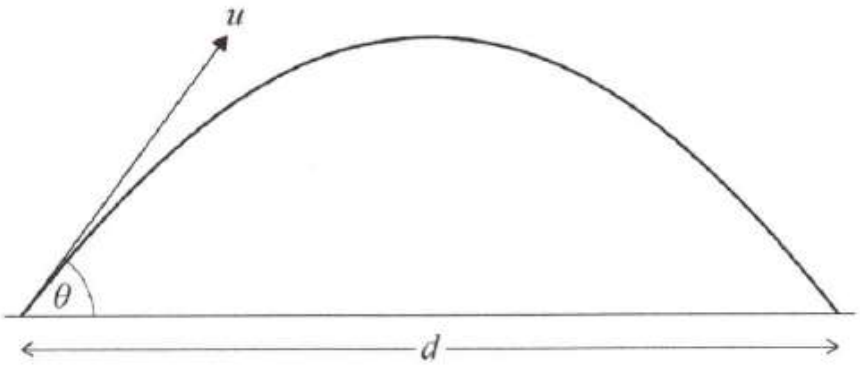
D 71° ○

3. June/2024/Paper_7408/1/No.20

A projectile is fired from ground level over horizontal ground.

Its initial velocity is u at an angle θ to the horizontal.

The range of the projectile is d.



A second projectile is fired with a velocity $2u$ at the same angle.

What is the range of this projectile?
Assume that air resistance is negligible.

[1 mark]

$d = \frac{u^2 \sin\theta}{g}$

So $d \propto u^2 \Rightarrow u^2 = (2u)^2 = 4u^2$

A $\sqrt{2}d$ ○

B $2d$ ○

C $2\sqrt{2}d$ ○

D $4d$ ⊗

4. June/2024/Paper_7408/1/No.21

A particle travelling horizontally at $1.0 \times 10^{7}\ \text{m s}^{-1}$ enters a region where it has a constant vertical acceleration of $4 \times 10^{14}\ \text{m s}^{-2}$.

What is the horizontal distance the particle has travelled in the region when its vertical displacement is $8 \times 10^{-2}\ \text{m}$?

[1 mark]

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

$t^2 = \frac{s - ut}{0.5a} \Rightarrow t = \sqrt{\frac{8\times10^{-2} - (0 \times t)}{0.5 \times 4\times10^{14}}}$

$t = 4.0 \times 10^{-8}\ \text{s}$

A $0.2\ \text{m}$ ☒

B $0.1\ \text{m}$ ○

C $2 \times 10^{-8}\ \text{m}$ ○

D $0.4 \times 10^{-9}\ \text{m}$ ○

but $s = ut$

$= 2\times10^{8} \times 1.0\times10^{7}$

$= 0.2\text{m}$

5. June/2024/Paper_7408/1/No.22

An object is thrown vertically upwards at time $t = 0$

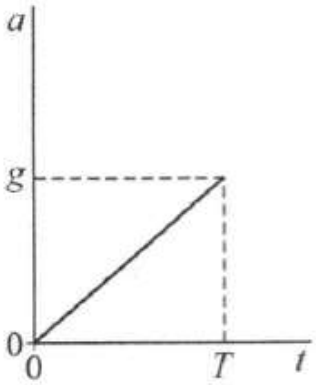
The object reaches its maximum height when $t = T$ and reaches its terminal speed on the way down.

The magnitude of the object's acceleration is a.

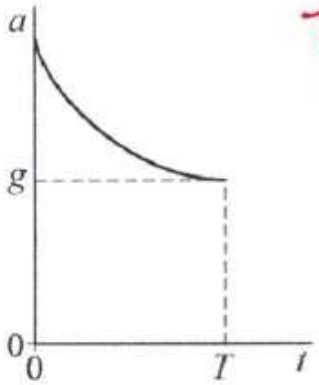
Which graph shows the variation of a with t?

[1 mark]

A

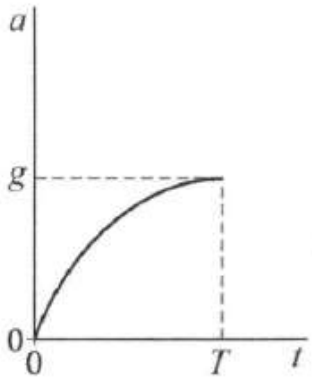


B

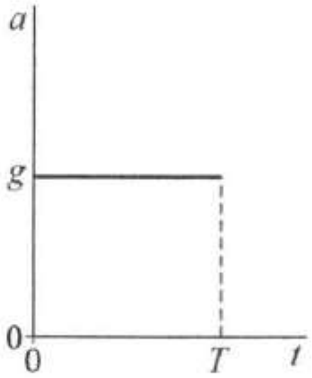


The object decelerates as it goes up due to air resistance so negative gradient

C



D



6. June/2024/Paper_7408/1/No.23

A man has a mass of 75.0 kg.
He stands on weighing scales in a lift that accelerates upwards at 2.60 m s^{-2}.

What is the reading on the scales during the acceleration?

[1 mark]

A 195 N

B 541 N

C 736 N

D 931 N ✗

$R - F = mg + ma$
$= m(g + a)$
$= 75(2.6 + 9.81)$
$= 75 \times 12.41$
$= 930.75$

7. June/2024/Paper_7408/1/No.24

An average force of 42 kN acts on the air passing through a jet engine. This force causes the speed of the air to increase by 540 $m\ s^{-1}$.

What mass of air passes through the engine in one minute?

[1 mark]

$F = \frac{\Delta mv}{\Delta t} = \frac{\Delta m \cdot \Delta v}{\Delta t}$

$\Delta m = \frac{F \times \Delta t}{\Delta v}$

$\Delta m = \frac{42 \times 10^3 \times 60 \times 1}{540}$

$\Delta m = 4668\ kg$

A 7.7×10^{-2} kg ○

B 4.7 kg ○

C 78 kg ○

D 4700 kg ⊗